DRAFT

ENVIRONMENTAL IMPACT STATEMENT

for

TESTING AND TRAINING ACTIVITIES

in the

PATUXENT RIVER COMPLEX

NAVAL AIR STATION PATUXENT RIVER, MARYLAND

April 2021

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Abstract

Designation: Draft Environmental Impact Statement

Title of Proposed Action: Testing and Training in the Patuxent River Complex

Project Location: Naval Air Station Patuxent River, Maryland

Lead Agency for the EA: United States Department of the Navy

Cooperating Agency: None

Affected Region: St. Mary's and Dorchester County, Maryland
Westmoreland and Northumberland County, Virginia

Action Proponent: Naval Air Systems Command (NAVAIR)
Naval Air Warfare Center Aircraft Division (NAWCAD)

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Date: April 2021

The United States Department of the Navy (Navy) prepared this Draft Environmental Impact Statement (EIS) to comply with the National Environmental Policy Act (NEPA). This Draft EIS evaluates the potential environmental impacts of continuing military readiness activities in the Patuxent River Complex (PRC). The PRC is based at Naval Air Station Patuxent River, located in Southern Maryland approximately 60 miles southeast of Washington, D.C. The PRC Study Area includes land, water, and airspace historically and currently used by the Naval Air Warfare Center Aircraft Division (NAWCAD).

Three alternatives were analyzed in this Draft EIS. The No Action Alternative represents current testing and training activity levels in the PRC Study Area and is reflective of the 10-year baseline. Alternatives 1 and 2 provide adjustments to current activity levels projected to meet future military readiness requirements at typical levels and at maximum levels during times of increased global conflict, respectively. Alternatives 1 and 2 also include adjustments to enhance certain current tenant squadron activities identified to meet future requirements and add the testing of certain technologies to address new and emerging threats. The Navy's Preferred Alternative is Alternative 2.

The environmental resource areas analyzed in this Draft EIS include: ambient airborne noise, air quality, water resources and sediments, biological resources, public health and safety, land use, socioeconomics, environmental justice, and cultural resources.

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EXECUTIVE SUMMARY

ES.1 Proposed Action

The United States (U.S.) Department of the Navy (Navy) has prepared this Environmental Impact Statement (EIS) to assess the potential environmental consequences associated with continuation of military testing and training activities within the Patuxent River Complex (PRC) to meet current and projected military readiness requirements. This action includes testing and training activities analyzed in the December 1998 *Final EIS for Increased Flight and Related Operations in the PRC* (hereinafter referred to as the 1998 PRC EIS) and subsequent Environmental Assessments, as well as adjustments to current testing and training activities required to support projected Navy military readiness requirements into the foreseeable future.

The PRC is based at Naval Air Station (NAS) Patuxent River, Maryland, approximately 60 miles southeast of Washington, D.C. The PRC Study Area consists of airspace that overlies portions of Maryland, Virginia, and Delaware, as well as land and water areas that support the testing and training of Navy and Marine Corps aircraft and aircraft systems.

The Navy is the lead agency for the Proposed Action. There are no cooperating agencies for this Proposed Action.

ES.2 Purpose of and Need for the Proposed Action

The purpose of the Proposed Action is to provide Sailors and Marines with equipment and technology that operates effectively and safely to support current and projected future military readiness requirements. The need for the Proposed Action is to maintain military readiness of naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas, now and into the future, consistent with Title 10 of the U.S. Code (U.S.C.) section 8062.

ES.3 Alternatives Considered

Alternatives were developed for analysis based upon the following screening factors:

- an annual capacity to:
  - conduct testing of current systems and current technologies
  - support maintenance, repair, modification, and modernization of current systems
  - conduct testing of new systems and new technologies to address emerging threats
  - support military training essential to develop and maintain proficiency, particularly of U.S. Naval Test Pilot School students and Naval Test Wing Atlantic pilots supporting aircraft research, development, test and evaluation (RDT&E)
  - accommodate potential increases in testing and training to meet future military readiness requirements
- the ability to:
  - provide a safe and operationally realistic air, land, and water environment to conduct testing and training activities
  - perform full-spectrum aircraft RDT&E using state-of-the-art ground and flight test facilities
  - sustain proximity to requisite range tracking, data transmission, instrumentation, and communication capabilities to provide accurate data to decision makers

- o conduct testing by aircraft developmental test pilots in fixed-wing jet, fixed-wing propeller, rotary-wing aircraft, and unmanned aerial systems (UAS) platforms
- o test and train in an environment with required range safety, laser safety, flight clearances, and frequency clearances
- o test year-round as well as day and night
- o retain Navy acquisition and RDT&E capabilities at a single location for cradle-to-grave aircraft program management

The Navy is considering two action alternatives that meet the purpose of and need for the Proposed Action and a No Action Alternative.

- Under the No Action Alternative, the Navy would continue testing and training activities within the PRC at the same annual flight hours and mix of aircraft, non-explosive munitions, and systems as is currently being conducted based on a 10-year operational baseline. This baseline includes testing and training activities analyzed in the 1998 PRC EIS and subsequent Environmental Assessments.
- Under Alternative 1, the Navy would conduct the same types of testing and training activities within the PRC as the No Action Alternative, but with higher annual flight hours as well as adjustments to current aircraft mix, non-explosive munitions numbers, and systems to accommodate projected testing and training requirements identified by Navy subject matter experts for the foreseeable future. This alternative is based on the annual level of increased operational tempo required to meet typical readiness of naval forces for the foreseeable future but not during increased global conflicts. Alternative 1 also includes adjustments to enhance certain current tenant squadron activities and adds the testing of directed energy technologies to address new and emerging threats.
- Under Alternative 2, the Navy would conduct the same types of testing and training activities within the PRC as Alternative 1, but with increased annual number of flight hours as well as adjustments to the current aircraft mix, non-explosive munitions numbers, and systems to accommodate projected testing and training requirements identified by Navy subject matter experts for increased global conflict. This alternative is based on the maximum potential annual level of increased operational tempo required to maintain readiness of naval forces for the foreseeable future and during increased global conflicts. Under this alternative, the Navy would be able to meet the highest level of military readiness. Alternative 2 is the Navy's Preferred Alternative.

ES.4 Summary of Potential Environmental Consequences of the Action Alternatives on the Resources Evaluated in the EIS

Council on Environmental Quality (CEQ) regulations, the National Environmental Policy Act (NEPA), and Navy instructions for implementing NEPA, specify that an EIS should address the resource areas potentially subject to impacts. In addition, the level of analysis should be commensurate with the anticipated level of environmental impact.

The following resource areas have been addressed in this EIS: ambient airborne noise, air quality, water resources and sediments, biological resources (e.g., aquatic and terrestrial protected species), public health and safety, land use, socioeconomics, environmental justice, and cultural resources. Because the Proposed Action does not include activities that would impact certain resources, these nonimpacted resources are not analyzed in this EIS. Resources and issues that were considered but not carried forward for further consideration include geological resources, visual resources, infrastructure, transportation, demographics (including employment and housing occupancy), airspace and airfield operations, and hazardous materials and waste.

The Navy has prepared this EIS based upon federal and state laws, statutes, regulations, and policies pertinent to the implementation of the Proposed Action, including the following:

- NEPA (42 U.S.C. sections 4321–4370h), which requires an environmental analysis for major federal actions that have the potential to significantly impact the quality of the human environment
- CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR parts 1500–1508)
- Navy regulations for implementing NEPA (32 CFR part 775), which provides Navy policy for implementing CEQ Regulations and NEPA
- Clean Air Act (42 U.S.C. section 7401 et seq.)
- Clean Water Act (33 U.S.C. section 1251 et seq.)
- Appropriation or Use of Waters, Reservoirs, and Dams, Annotated Code of Maryland, Environment Article, Section 5-501, et seq.
- Water Pollution Control, Annotated Code of Maryland, Environmental Article, Sections 9-313 through 9-323
- Coastal Zone Management Act (16 U.S.C. section 1451 et seq.)
- National Historic Preservation Act (54 U.S.C. section 306108 et seq.)
- Native American Graves Protection and Repatriation Act of 1990
- Endangered Species Act (16 U.S.C. section 1531 et seq.)
- Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (16 U.S.C. section 1801 et seq.)
- Marine Mammal Protection Act (16 U.S.C. section 1361 et seq.)
- Migratory Bird Treaty Act (16 U.S.C. sections 703–712)
- Bald and Golden Eagle Protection Act (16 U.S.C. sections 668–668d)
- Fish and Wildlife Conservation Act
- Federal Aviation Administration Regulations Part 91, General Operating and Flight Rules
- Military Munitions Rule, 40 CFR parts 260–266 and 270
- Executive Order (EO) 12962, Recreational Fisheries
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- EO 13045, Protection of Children from Environmental Health Risks and Safety Risks
- EO 13175, Consultation and Coordination with Indian Tribal Governments
- EO 13186, Responsibilities of the Federal Agencies to Protect Migratory Birds

Table ES-1 summarizes the potential impacts associated with each of the alternatives.

Table ES-1 Summary of Potential Impacts to Resource Areas

Resource Area	*No Action Alternative*	*Alternative 1*	*Alternative 2 (Preferred Alternative)*
Ambient Airborne Noise	Noise levels associated with each alternative reflect existing noise mitigation measures identified in the 1998 PRC EIS and operating procedures designed with noise impact minimization in mind (Table ES-3 and SOPs in Chapter 2).		
	Under the No Action Alternative, no changes from baseline conditions would occur. The intensity and frequency of loud noise events would remain the same. Time-averaged noise level exceeding 65 dBA DNL would continue to affect 594 acres of land encompassing an estimated 1,290 residents. DNL at the representative locations studied (i.e., selected sensitive locations) would continue to be as high as 66 dBA. The average number of speech interference events would remain at six per daytime hour or less outdoors, three per hour or less indoors with windows open, and two per hour or less with windows closed at the representative locations studied. $L_{eq(8hr)}$ would remain at 60 dBA at Lexington Park Elementary School and below 60 dBA at other schools studied. Classroom speech interference events per average hour would remain at two or fewer. The probability of sleep disturbance would remain at 1 percent or less at the locations studied. Hearing loss risk would remain low off the installation. Airspace overflight noise levels would continue to be as high as 110 dBA L_{max}. Time-averaged noise levels would continue to be below 55 dBA L_{dnmr}. Munitions and sonic boom time-averaged noise levels would continue to be below 50 dB CDNL on all land areas. Sonic boom intensity would	Under Alternative 1, the intensity of the loudest aircraft noise levels experienced would remain the same as under the No Action Alternative. However, the frequency of noise events would increase, resulting in 1,158 acres of land area exposed to elevated time-averaged noise levels (which reflect both the intensity and number of noise events) in the vicinity of the air station. The estimated population within that area is 2,640. DNL at representative locations would increase by up to 2 dB. The average number of speech interference events per daytime hour would change by less than one indoors, and the average number of outdoor events per hour would increase by one at 4 of the 15 locations studied. $L_{eq(8hr)}$ at two schools would increase by 2 dB to 61 and 62 dBA, respectively, while other schools studied would remain below 60 dBA. Classroom speech interference events per average hour would increase by less than one. The probability of sleep disturbance would increase by 1 percent at Cedar Cove Apartments and by less than 1 percent at other locations. Hearing loss risk would remain low off the installation. Airspace overflight noise levels would remain the same as under the No Action Alternative; time-averaged noise levels would increase by less than 2 dB, remaining below 55 dBA L_{dnmr}. Munitions and sonic boom noise	Under Alternative 2, the intensity of the loudest aircraft noise levels experienced would remain the same as under the No Action Alternative. However, the frequency of noise events would increase resulting in 1,370 acres of land area exposed to elevated noise levels in the vicinity of the air station. The estimated population within that area is 3,072. DNL at representative locations would increase by up to 2 dB. The average number of speech interference events per daytime hour would change by one at Cedar Cove Apartments and Elms Beach Park but change by less than one at the other locations. The average number of outdoor events per hour would increase by one at 6 of the 15 representative locations studied. $L_{eq(8hr)}$ at two schools would increase by 2 dB to 61 and 62 dBA, respectively, while other schools studied would remain below 60 dBA. Classroom speech interference events per average hour would increase by less than one. The probability of sleep disturbance would increase by 1 percent at three of the representative locations if windows are open, at two locations if windows are closed, and by less than 1 percent at other locations. Hearing loss risk would remain low off the installation. Airspace overflight noise levels would remain the same as under the No Action Alternative; time-

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	***No Action Alternative***	***Alternative 1***	***Alternative 2 (Preferred Alternative)***
	remain the same, and munitions noise would remain below 115 dBP on land.	levels would remain below 50 dB CDNL on all land areas. Sonic boom intensity would remain the same as under the No Action Alternative, and munitions noise would remain below 115 dBP on land.	averaged noise levels would increase by less than 3 dB, remaining below 55 dBA L_{dnmr}. Munitions and sonic boom noise levels would remain below 50 dB CDNL on all land areas. Sonic boom intensity would remain the same as under the No Action Alternative, and munitions noise would remain below 115 dBP on land.
Air Quality	Because ground support equipment is operated only at the installations in St. Mary's County, Maryland (in attainment), and no vessels or munitions are operated or expended in the nonattainment areas, only aircraft flight hours have the potential to impact general conformity in the Calvert and Sussex County nonattainment areas and Kent County (Delaware) and Charles City, Gloucester, James City, and York County (Virginia) maintenance areas. A General Conformity applicability analysis was conducted, and pollutant emissions are well below the *de minimis* level. Thus, a formal General Conformity determination is not applicable.		
	Under the No Action Alternative, there would be no change to baseline historical levels of criteria pollutant or greenhouse gas emissions. All criteria pollutants from PRC testing and training reflect less than 16 percent of the PRC Study Area emissions.	Under Alternative 1, pollutant emissions would increase over the baseline, but they would not be expected to exceed any regulatory thresholds and would continue to represent a very small portion of the overall PRC Study Area annual emissions that contribute to regional air quality. Specifically, all criteria pollutants from PRC testing and training reflect less than a 5 percent change of the PRC Study Area emissions from the baseline.	Under Alternative 2, pollutant emissions would also increase over baseline levels and would represent a slightly larger increase than under Action Alternative 1, but would still not exceed regulatory thresholds and would continue to represent a very small portion of the overall PRC Study Area annual emissions that contribute to regional air quality. Specifically, all criteria pollutants from PRC testing and training reflect a 7 percent or less change of the PRC Study Area emissions from the baseline.
Water Resources and Sediments	Under the No Action Alternative, minor, localized, and short-term changes to bottom contours and bottom type would occur as well as increases in turbidity associated with resuspended sediments from physical disturbances to bottom sediments from initial impact and recovery	Under Alternative 1, the impacts would be similar to but slightly higher (due to increased activities and non-explosive munitions and other MEM) than those described for the No Action Alternative.	Under Alternative 2, the impacts would be similar to but slightly higher (due to increased activities and non-explosive munitions and other MEM) than those described for the No Action Alternative.

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	*No Action Alternative*	*Alternative 1*	*Alternative 2 (Preferred Alternative)*
	of munitions and other MEM from the Chesapeake Bay floor as well as from anchor deployments and similar activities. In addition, the proposed testing and training activities would result in a minor potential for releases of MEMCs, but these releases are not expected to exceed water quality criteria or sediment guidelines. Pollutant stressors would not adversely affect designated beneficial use or pose unacceptable risks to human health or the environment. Combined stressor impacts would consist of minor, localized, short-term increases in turbidity and decreases in dissolved oxygen due to resuspension of bottom sediments related to physical disturbances.		
Biological Resources *Pertaining to All Alternatives*	The Navy considered all potential stressors on biological resources (acoustic, physical disturbance and strike, pollutants, energy, entanglement, ingestion, indirect/secondary, and stressors combined) from the Proposed Action alternatives. For all Proposed Action alternatives, the potential impact of the proposed activities is minimized by established SOPs (Chapter 2) and avoidance and mitigation measures (Table ES-3).		
Biological Resources, *Overall Differences Between Alternatives*	The type of events would be mostly the same as under Alternatives 1 and 2, but the number of events would be lower due to the decreased level of only current activities. The current level of activity characterizing the No Action Alternative has not resulted in long-term/population-level impacts for any biological resource.	The type of events would be mostly the same as under the No Action Alternative, but the number of events would be greater due to the increased level of current and additional activities. The additional events feature the same stressors, representative assets, and locations as under the No Action Alternative. Alternative 1 would add active sonobuoys in the same location as dipping sonar and directed energy weapon systems testing. The additional events and activities would not result in long-term/population-level impacts for any biological resource.	The type of events would be mostly the same as under the No Action Alternative, but the number of events would be greater due to a maximum level of current and additional activities. The additional events feature the same stressors, representative assets, and locations as under the No Action Alternative. Alternative 2 would add active sonobuoys in the same location as dipping sonar and directed energy weapon systems testing. The additional events and activities would not result in long-term/population-level impacts for

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

<table>
<tr><th>Resource Area</th><th>No Action Alternative</th><th>Alternative 1</th><th>Alternative 2 (Preferred Alternative)</th></tr>
<tr><td></td><td></td><td></td><td>any biological resource, in accordance with the analysis summarized below.</td></tr>
<tr><td rowspan="2">Biological Resources, Specific to Estuarine Environment (Alternative 2)</td><td colspan="3"><u>Estuarine vegetation</u> (e.g., marsh plants, seagrass beds) may be affected by physical disturbance and strike, pollutants, indirect or secondary stressors, and stressors combined from mostly water-based assets. However, the damaging effect of these localized and infrequent or temporary stressor sources is not expected to result in any long-term/population-level impacts on estuarine plant species.

Impact of additional activities: Estuarine vegetation may be impacted by directed energy weapon systems testing and associated UAS targets expended in the Bloodsworth Island SDZ, though minimally, due to the nature of the disturbances. Directed energy weapon systems testing over estuarine waters may damage plant tissue at or above the surface, but the effect would be unlikely to occur and/or insignificant in terms of population-level effects on estuarine plant species.</td></tr>
<tr><td colspan="3"><u>Estuarine animals</u> including sturgeon, sea turtles, water birds, and marine mammals, may be affected by acoustic, physical disturbance and strike, pollutants, energy, entanglement, ingestion, indirect/secondary, and stressors combined from mostly air- and water-based assets and associated weapons firing/MEM. However, the mostly behavioral response to these localized and infrequent or temporary sub-stressors is not expected to result in any long-term/population-level impacts on estuarine animal species.

Impact of additional activities: Invertebrates, fishes, and reptiles, including shellfish beds, sturgeon, and sea turtles, are not sensitive to mid-frequency sounds from dipping sonar and active sonobuoys. Marine mammals are sensitive to mid-frequency sonar but impacts from this rare activity would be avoided with application of established avoidance and mitigation measures and other factors. Directed energy weapon systems testing and associated UAS targets expended in the Chesapeake Bay Water Range and Bloodsworth Island SDZ are very unlikely to coincide with the occurrence of rare species (e.g., sturgeon, sea turtles, marine mammals) at the surface and it would be unlikely to harm large and resilient animals in the event of a brief exposure. Impacts on smaller estuarine animals could be more damaging but would be unlikely and insignificant in terms of population-level effects.</td></tr>
<tr><td rowspan="2">Biological Resources, Specific to Aerial, Terrestrial, and Freshwater Environments (Alternative 2)</td><td colspan="3"><u>Terrestrial vegetation</u> in mostly previously disturbed land areas may be affected by physical disturbance and strike, pollutants, indirect or secondary stressors, and stressors combined from land-based assets. However, the damaging effect of these localized and infrequent or temporary sub-stressors is not expected to result in long-term/population-level impacts on terrestrial plant species. Freshwater vegetation would not be affected by any of the action alternatives.

Impact of additional activities: Terrestrial vegetation may be damaged by directed energy weapon systems testing and associated UAS targets recovered over previously disturbed areas, but the effect would either be very unlikely to occur for rare plants or insignificant in terms of a population-level effects in the event of an effect on more-common plants. No effect on freshwater plants is expected from directed energy weapon systems testing.</td></tr>
<tr><td colspan="3"><u>Aerial and terrestrial animals,</u> including rare tiger beetles, shore birds, and wading birds, may be affected by acoustic, physical disturbance and strike, pollutants, energy, indirect/secondary, and stressors combined from mostly air- and land-based assets. Freshwater animals may be affected by acoustic stressors when their head is above water. However, the mostly behavioral response to these mostly localized and infrequent or temporary stressor sources is not expected to result in long-term/population-level impacts on aerial, terrestrial, or freshwater animal species.</td></tr>
</table>

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	*No Action Alternative*	*Alternative 1*	*Alternative 2 (Preferred Alternative)*
	Impact of additional activities: Rare species (e.g., tiger beetles, some wading/shore birds) are very unlikely to coincide with directed energy weapon systems testing over terrestrial areas and effects would be insignificant in terms of population-level effects on more-common animals. No effect on freshwater animals is expected from directed energy weapon systems testing.		
Public Health and Safety	The Navy would continue to employ established safety requirements and protocols, as discussed in Chapter 2 SOPs and Section 3.5, related to the safe operation of electromagnetic, laser, and other such systems. The Navy recovers expended UAS targets and surface targets to the extent practicable, to avoid them becoming a collision risk. With regard to vessel safety, the Navy practices the fundamentals of safe navigation, requiring vessel operators to be alert at all times, travel at a safe speed for the prevailing conditions, use state-of-the-art satellite navigational systems, and be trained to take proper action to avoid collisions. The acoustic stressor associated with aircraft operations may impact public health and safety by potentially resulting in a disproportionate impact on children as evaluated against the requirements of EO 13045; however, the Navy does not anticipate any significant disproportionate health impacts to children caused by aircraft noise.		
	Under the No Action Alternative, there would be no change in impacts over existing conditions. Release of non-explosive munitions primarily occurs in the Chesapeake Bay Water Range and is focused around the munition concentration areas, limiting the potential for striking the public. Additionally, the Navy would continue to implement SOPs that protect public health and safety. Unrecoverable pieces of MEM are typically small (such as sonobuoys), constructed of soft materials (such as foam-filled plastic), or intended to sink to the bottom after their useful function is completed and, therefore, would not pose a strike risk to civilian vessels or equipment. There would be no changes to airfields used, aircraft mix, or annual level of flight hours over baseline levels; consequently, the potential for aircraft mishaps or BASH incidents would remain unchanged. The public may encounter MEM; however, most of this material does not pose a potential for	Increased activities increase the potential for flight mishap and BASH incidents, but established management strategies would minimize risk. There would be no change over existing conditions for potential impacts associated with vessels or MEM. Testing with directed energy weapons (high-energy lasers and high-power microwaves) would follow strict procedures to ensure that nonparticipants are not exposed to intense light energy or microwave frequencies. These activities would occur within range and/or installation boundaries and exclusive use airspace where the public will not be impacted. Primary laser areas would include Hooper Center Main Target and Hannibal Target within the Chesapeake Bay Water Range or within NAS Patuxent River or OLF Webster boundaries on or near the runways. Under Alternative 1, an estimated 658 children experiencing noise levels above 65 dBA DNL contours would occur. This would	Increased activities increase the potential for flight mishap and BASH incidents, but established management strategies would minimize risk. Testing with directed energy weapons (high-energy lasers and high-power microwaves) would follow strict procedures to ensure that nonparticipants are not exposed to intense light energy or microwave frequencies. These activities would occur within range and/or installation boundaries and exclusive use airspace where the public will not be impacted. Activities involving directed energy weapons would occur within PRC airspace, land areas, and water areas permitted by Range Safety, where the hazard pattern could be contained within range and/or installation boundaries and exclusive use airspace could be provided (for air scenarios). Primary laser areas would include Hooper Center Main Target and Hannibal Target within the Chesapeake Bay Water Range or within

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	*No Action Alternative*	*Alternative 1*	*Alternative 2 (Preferred Alternative)*
	safety impacts. Dive sites would be easily avoided by vessels conducting testing or training activities. Similar knowledge and avoidance of popular fishing areas would minimize interactions between testing and training activities and recreational fishing. ATMO personnel would remain in the area until all flares were verified to be extinguished. Under baseline conditions, five block groups in the NAS Patuxent River area would be exposed to noise levels between 65 and 70 dBA DNL. However, only two of these block groups have potential for disproportional impacts because they include higher percentages of children (26.7and 30.5 percent, respectively) than St. Mary's County as a whole (24.8 percent). An estimated 337 children would be affected under the No Action Alternative by noise levels above 65 dBA DNL (but below 69 dBA DNL), equating to approximately 26 percent of the exposed population. No children would be affected by noise levels above 70 dBA DNL. Aircraft noise levels would be less than 65 dBA DNL at all locations on and near OLF Webster. The aircraft noise associated with the existing operations is intermittent; therefore, the Navy does not anticipate any significant disproportionate health impacts to children caused by aircraft noise. The acoustics stressor, when considered in conjunction with the physical disturbance/strike stressor and the public interaction stressor, would not result in	be an increase of 321 children (658 versus 337) over the No Action Alternative. The potential for combined impacts from the physical disturbance and the public interaction stressors would be greater than under the No Action Alternative due to the increased operations. Regardless, established procedures described above would ensure that the physical disturbance and public interaction stressors would pose no unacceptable risks to public health or safety.	NAS Patuxent River or OLF Webster boundaries on or near the runways). Under Alternative 2, an estimated 751 children experiencing noise levels above 65 dBA DNL contours would occur. This would be an increase of 414 children (751 versus 337) over the No Action Alternative. The potential for combined impacts from the physical disturbance and the public interaction stressors would be greater than under the No Action Alternative due to the increased operations. Regardless, established procedures described above would ensure that the physical disturbance and public interaction stressors would pose no unacceptable risks to public health or safety.

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	***No Action Alternative***	***Alternative 1***	***Alternative 2 (Preferred Alternative)***
	any combined impacts. However, the physical disturbance/strike stressor and the public interaction stressor may pose a potential for combined impacts. Commercial and recreational fishing activities could encounter MEM that could pose a strike risk (physical disturbance/strike), while the public may also encounter MEM that wash up on the shore (public interaction). The potential for direct interaction or a strike between the public and Navy assets or expended materials would not change from current conditions. Established procedures described above (e.g., recovering expended targets and MEM and public avoidance of testing and training areas) would ensure that the physical disturbance/strike and public interaction stressors, singly or when combined, would not pose unacceptable risks to public health or safety.		
Land Use	Impacts with each alternative reflect existing noise mitigation measures identified in the 1998 PRC EIS and operating procedures designed with noise impact minimization in mind (Table ES-3 and SOPs in Chapter 2). The Proposed Action would be consistent to the maximum extent practicable with the enforceable coastal zone management policies of Maryland and Virginia.		
	Under the No Action Alternative, there would be no changes to regional land use; however, a continuation of marginally incompatible noise exposure to a small area of residential land off the NAS Patuxent River installation would occur. Adjacent to the installation, approximately 9,800 acres would be exposed to noise levels of 65 dBA DNL or greater under the No Action Alternative, with 9,206 of these	Alternative 1 would result in a larger land area exposed to noise levels of 65 dBA DNL and greater, increasing from 594 acres under the No Action Alternative to about 1,158 acres (excluding 11,541 acres over water). Some areas would experience increased noise exposure at levels above recommended noise compatibility guidelines based on specific land uses. Under Alternative 1, three off-base local	Alternative 2 would result in larger DNL noise contours and noise exposure, encompassing a larger land area than under the No Action Alternative, increasing from 594 acres to about 1,370 acres (excluding 12,153 acres over water). Some areas would experience increased noise exposure at levels above recommended noise compatibility guidelines based on specific land uses.

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	*No Action Alternative*	*Alternative 1*	*Alternative 2 (Preferred Alternative)*
	acres occurring over water. The remaining 594 acres exposed to noise levels of 65 dBA DNL or greater would occur over land, including about 230 acres of residential land off the installation. Activities under the No Action Alternative would not expose any new surrounding areas to incompatible noise levels compared to the current AICUZ conditions. Land areas along the shoreline to the west of Hooper Target may continue to experience peak noise levels below 115 dBP but greater than 87 dBP; at these levels, land use compatibility guidelines recommend attenuation for structures for residential land uses. Effects of noise and overflights on recreational uses and protected areas under the No Action Alternative are essentially the same as described for the affected environment with noise levels below 55 dBA L_{dnmr}. These noise levels are generally considered compatible with any land uses underlying PRC airspace, including uses within protected areas. Jarboesville Park and John G. Lancaster Park occur within the baseline noise contour of 65 dBA DNL for aircraft noise at NAS Patuxent River. Lexington Manor Passive Park is within the 70 dBA DNL noise contour. Outdoor recreational use is generally considered compatible with these noise exposure levels under the AICUZ guidelines. Testing and training activities would not pose any new risks to surrounding land use.	parks are currently exposed to aircraft noise levels of 65 dBA to 70 dBA DNL at NAS Patuxent River. Lexington Manor Passive Park and John G. Lancaster Park would experience slight increases in noise exposure, but only John G. Lancaster Park would be newly exposed to levels of 70 to 75 dBA DNL and greater in portions of the park. The projected noise levels are considered compatible land uses under AICUZ guidelines, but some persons familiar with the parks may notice the slight increase in noise.	The loudest aircraft noise levels would not change, but the frequency of noise events would increase. Under Alternative 2, three off-base local parks are currently exposed to aircraft noise levels of 65 dBA to 70 dBA DNL at NAS Patuxent River. Lexington Manor Passive Park and John G. Lancaster Park would experience slight increases in noise exposure, but only John G. Lancaster Park would be newly exposed to levels of 70 to 75 dBA DNL and greater in portions of the park. The projected noise levels are considered compatible land uses under AICUZ guidelines, but some persons familiar with the parks may notice the slight increase in noise.

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	***No Action Alternative***	***Alternative 1***	***Alternative 2 (Preferred Alternative)***
Socioeconomics	Noise levels associated with each alternative reflect existing noise mitigation measures identified in the 1998 PRC EIS operating procedures designed with noise impact minimization in mind (Table ES-3 and SOPs in Chapter 2). The Mid-Bay region is known for its large military presence, and the majority of local boaters have experienced these events for decades. Noise generated from Navy vessels is temporary and localized and is consistent with the ambient noise environment of the inshore waters of the Chesapeake Bay and within the PRC Study Area. The Navy follows SOPs, which require that vessel operators are alert at all times, travel at a safe speed for the prevailing conditions, observe no-wake zones, use state-of-the-art satellite navigational systems, and are trained to take proper action to avoid collisions. In addition, the Navy provides Notice to Mariners, as appropriate, for testing and training activities. Continued implementation of these practices minimizes the potential for public interaction between Navy vessels and other vessels. For example, range safety protocols and SOPs include ensuring that an area is clear of all nonparticipating vessels before training activities take place. In addition, the Navy provides advance notification of training activities to the public through Notices to Mariners and postings on Navy websites. Existing procedures for maintaining safe and efficient air traffic in the PRC airspace would continue. Coordination between Patuxent River Terminal Radar Approach Control, Baywatch, and the Federal Aviation Administration would also continue in a proactive fashion to support public use of the area.		
	Under the No Action Alternative, recreational users within the vicinity of NAS Patuxent River and OLF Webster may experience noise from aircraft during testing and training activities. Noise associated with small- and medium-caliber weapons firing and deployment of non-explosive munitions and other MEM would primarily occur in the Chesapeake Bay Water Range and may be audible and disturbing to commercial and recreational boaters. Noise generated from munitions firing and aerial target launching at the Armament Test Area could be audible and potentially disturbing to commercial and recreational boaters in nearby areas during events. Commercial and recreational boaters in the Mid-Bay region could experience annoyance and disturbance associated with testing and training activities.	Under Alternative 1, potential impacts from noise associated with Navy testing and training to commercial and private vessel transportation, commercial and recreational fishing participants and other recreational users (i.e. divers, swimmers, etc.) would be similar in nature to the No Action Alternative, but more frequent. Due to the increases in PRC operational tempos, noise would likely impact a greater number of commercial and recreational participants who may be present near the Chesapeake Bay Water Range (outside of any established range safety clearance areas). Potential impacts to socioeconomic resources from public interaction would be similar in nature but more frequent and, therefore, likely impact a greater number of people than under the No Action Alternative. Potential impacts for public interaction during the use of directed	Under Alternative 2, potential impacts from noise associated with Navy testing and training to commercial and private vessel transportation, commercial and recreational fishing participants, and other recreational users (e.g., divers, swimmers) would be similar in nature to the No Action Alternative, but more frequent. Due to the increases in PRC operational tempos, noise would likely impact a greater number of commercial and recreational participants who may be present near the Chesapeake Bay Water Range (outside of any established range safety clearance areas). Potential impacts to socioeconomic resources from public interaction would be similar in nature but more frequent and, therefore, likely impact a greater number of people than under the No Action Alternative. Potential impacts for

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	***No Action Alternative***	***Alternative 1***	***Alternative 2 (Preferred Alternative)***
	Navy vessel movement is consistent with other vessel movement in waterways, and the Navy follows strict safety operations to reduce public interactions. The number of events and cleared hours under the No Action Alternative would be 68 events and 196 hours cleared for the Chesapeake Bay Water Range.	energy weapon systems (i.e., high-energy lasers and high-power microwaves) under this alternative would not be likely. Activities would occur within range and/or installation boundaries and exclusive use airspace. Primary laser areas would include Hooper Center Main Target and Hannibal Target within the Chesapeake Bay Water Range or within NAS Patuxent River or OLF Webster boundaries on or near the runways. Testing and training within the Chesapeake Bay Water Range may require clearance of commercial and recreational participants within small portions of the Bay, especially around Hannibal and Hooper Targets. The number of events and cleared hours under Alternative 1 would be 250 annual clearance events associated with 750 hours of clearance time compared to 68 events and 196 hours cleared under the No Action Alternative for the Chesapeake Bay Water Range.	public interaction during the use of directed energy weapon systems (i.e., high-energy lasers and high-power microwaves) under this alternative would not be likely. Activities would occur within range and/or installation boundaries and exclusive use airspace. Primary laser areas would include Hooper Center Main Target and Hannibal Target within the Chesapeake Bay Water Range or within NAS Patuxent River or OLF Webster boundaries on or near the runways. Testing and training within the Chesapeake Bay Water Range may require clearance of commercial and recreational participants within small portions of the Bay, especially around Hannibal and Hooper Targets. The number of events and cleared hours under Alternative 2 would be 275 annual clearance events associated with 825 hours of clearance time compared to 68 events and 196 hours cleared under the No Action Alternative for the Chesapeake Bay Water Range.
Environmental Justice	Acoustic stressors associated with each alternative reflect existing noise mitigation measures identified in the 1998 PRC EIS and operating procedures designed with noise impact minimization in mind (Table ES-3 and SOPs in Chapter 2). There would be six U.S. Census Bureau block groups that are within the affected area, defined as the area with 65 dBA DNL or greater noise levels. Of the six block groups within the affected area, four block groups have environmental justice communities present. Based on the environmental justice analysis, there would be potential for disproportionately high and adverse impacts to minority and low-income populations in the affected population under all alternatives due to noise.		
	Under the No Action Alternative, there would be a total of approximately 1,290 people off the installation that reside within the affected area. Out of the total population estimated to reside within the	Under Alternative 1, there would be an increase in the frequency of aircraft activities that would expose a larger area, and thus more residents (including minority and low-income populations), to	Under Alternative 2, there would be an increase in the frequency of aircraft activities that would expose a larger area, and therefore more residents (including minority and low-income populations), to

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	*No Action Alternative*	*Alternative 1*	*Alternative 2 (Preferred Alternative)*
	65 dBA DNL or greater noise levels, approximately 578 (44.8 percent) would be minority, which is meaningfully greater compared to St. Mary's County (24.9 percent) (i.e., greater than 15 percent), and approximately 155 people (12 percent) would be low income, which is higher compared to St. Mary's County (8.2 percent) and, therefore, disproportionate.	noise levels of 65 dBA DNL or greater compared to the No Action Alternative. Under this alternative, there would be a total of approximately 2,640 people off the installation that reside within the affected area. Out of the total population estimated to reside within the 65 dBA DNL or greater noise levels, approximately 1,143 people (43.3 percent) would be minority, which is meaningfully greater compared to St. Mary's County (24.9 percent), and approximately 303 people (11.5 percent) would be low income, which is higher compared to St. Mary's County (8.2 percent) and, therefore, disproportionate.	noise levels of 65 dBA DNL or greater compared to the No Action Alternative. Under this alternative, there would be a total of approximately 3,072 people off the installation that reside within the affected area. Out of the total population estimated to reside within the 65 dBA DNL or greater noise levels, approximately 1,301 people (42.4 percent) would be minority, which is meaningfully greater compared to St. Mary's County (24.9 percent), and approximately 345 people (11.2 percent) would be low income, which is higher compared to St. Mary's County (8.2 percent) and, therefore, disproportionate.
Cultural Resources	The Navy would continue to employ established safety requirements and protocols, as discussed in Chapter 2 SOPs, including avoiding navigational hazards that appear on nautical charts, such as submerged wrecks and obstructions. In-water cultural resources are not affected by acoustic stressors. Land-based cultural resources are not affected by physical disturbance and strike stressors.		
	Under the No Action Alternative, the subsonic noise and sonic booms associated with continuation of existing testing and training activities would not be of sufficient magnitude to impact historic properties under the PRC Study Area airspace. The continued use of the PRC Study Area and associated physical disturbance and strike stressor activities would not affect underwater historic properties in the Chesapeake Bay.	Under Alternative 1, the incremental increase in overflights of any individual historic resource would be infrequent and of short duration and would not diminish the characteristics that make the sites eligible for the NRHP; the minor change to the historic setting would not change the character or use of the historic properties. The minimal increase in visual or audible elements introduced by the undertaking would not diminish the integrity of the properties' significant historic attributes and would not alter the characteristics that qualify them for inclusion in the NRHP. Therefore, the proposed increased use of the PRC Study Area would cause no	Under Alternative 2, the incremental increase in overflights of any individual historic resource would be infrequent and of short duration and would not diminish the characteristics that make the sites eligible for the NRHP. The minimal increase in visual or audible elements introduced by the undertaking would not diminish the integrity of the properties' significant historic attributes and would not alter the characteristics that qualify them for inclusion in the NRHP. Therefore, the proposed increased use of the PRC Study Area would cause no adverse effect to the historic properties beneath the airspace. In addition, the proposed

Table ES-1 Summary of Potential Impacts to Resource Areas, Continued

Resource Area	*No Action Alternative*	*Alternative 1*	*Alternative 2 (Preferred Alternative)*
		adverse effect to the historic properties beneath the airspace. In addition, the proposed increased use of the PRC Study Area would not affect underwater historic properties in the Chesapeake Bay.	increased use of the PRC Study Area would not affect underwater historic properties in the Chesapeake Bay.

Key: AICUZ = Air Installations Compatible Use Zone; BASH = bird/animal aircraft strike hazard; CDNL = C-weighted day-night average sound level; dB = decibels; dBA = A-weighted decibels; dBP = decibels (peak); DNL = day-night average sound level; EO = Executive Order; L_{dnmr} = onset-rate adjusted monthly DNL; $L_{eq(8hr)}$ = eight-hour equivalent sound level; L_{max} = maximum sound level; MEM = military expended materials; MEMC = military expended material constituents; NAS = Naval Air Station; OLF = Outlying Field PRC = Patuxent River Complex; NRHP = National Register of Historic Places; SDZ = surface danger zone; SOP = standard operating procedure; UAS = unmanned aerial system.

ES.4.1 Summary of Cumulative Impacts

The Proposed Action would contribute incremental effects to airborne noise, air quality, water quality and sediment, biological resources, public health and safety, land use, socioeconomics, and environmental justice. When considering other past, present, and reasonably foreseeable future projects, there could be an overlap spatially and temporally with the Proposed Action, resulting in potential cumulative impacts. Several of the proposed projects in the region involve transportation improvements. These projects could add temporary noise, air quality, water quality, and biological impacts during construction. The St. Mary's County Airport Expansion could result in a minimal increase in the likelihood of annoyance for people living near the airport and potential cumulative impacts with the Proposed Action. The Cove Point Liquefied Natural Gas Terminal Expansion is operational and contributes to a slight increase in vessel traffic. In contrast, overall numbers of recreational and commercial vessels tend to fluctuate based on economic conditions. Projects such as the Readiness and Environmental Protection Integration parks, Sentinel Landscape, Rural Legacy Area expansions, and National Marine Sanctuary establishment would likely provide beneficial impacts such as maintaining open space, protecting natural and cultural resources, and providing land use buffers while protecting the military mission. As a result, these projects could partially offset potential cumulative impacts.

Each air-, land-, and water-based activity and asset associated with the Proposed Action has the potential to generate one or more stressors that may consequently impact a resource area. Table ES-2 shows the stressors by resource area used to further assess potential cumulative impacts. As shown, acoustic, physical disturbance/strike, pollutants, and public interactions could pose cumulative effects. The PRC Study Area is already experiencing and absorbing a variety of stressors. Implementing the Proposed Action would not be expected to result in a meaningful contribution to the ongoing stress or cause significant impact on any resource, but it could contribute minute impacts on resources that are already experiencing various degrees of interference and degradation. The measures described in Chapter 2 (Proposed Action and Alternatives) and in Table ES-3 would limit the likelihood of overlap of Navy stressors in time and space with non-Navy stressors to reduce the risk of direct impacts of the Proposed Action.

Table ES-2 Potential Cumulative Stressor Impacts by Resource Area

Resource	***Stressor***						
	Acoustic	***Physical Disturbance/ Strike***	***Pollutants***	***Public Interaction***	***Energy***	***Entanglement***	***Ingestion***
Airborne Noise	√						
Air Quality			√				
Water and Sediments		√	√				
Biological Resources	√	√					
Public Health and Safety	√	√		√			
Land Use	√						
Socioeconomics	√			√			
Environmental Justice	√						

ES.5 Mitigating Actions

The Navy has been mitigating the impacts from military readiness activities conducted throughout the PRC for more than two decades, in accordance with the 1998 PRC EIS as well as Environmental Assessments completed since that time.

Current mitigations implemented by the Navy derive from those existing NEPA documents or are voluntary as noted in Table ES-3. No new mitigations have been identified since publication of those existing NEPA documents. The Navy will continue to implement all current mitigations under the Proposed Action for all alternatives. The Navy will also apply the Standard Operating Procedures incorporated into the Proposed Action discussed in Chapter 2. No new mitigations are included as part of the Proposed Action at this time. Should regulatory agencies or the public identify potential mitigation measures as part of the NEPA consultation and review process, they will be considered in the development of future versions of this EIS.

Table ES-3 Impact Avoidance and Minimization Measures

Environmental Resource	*Mitigation Measure*	*Anticipated Benefit / Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*
Ambient Airborne Noise	Maintain a noise disturbance reporting system.	Facilitate communication between NAS Patuxent River and the surrounding community.	Provide a toll-free telephone number and email address for noise disturbance reporting. Maintain a database of noise disturbance reports. Monitor and track the number of annual noise disturbances and document trends in an annual noise report.	ATR Sustainability Office/NAS Patuxent River Air Operations
Ambient Airborne Noise	Provide noise awareness briefs.	Avoid noise-sensitive areas and mitigate noise impacts to the surrounding community.	Educate aircrew on local aircraft operating procedures and noise sensitive receptors beneath the PRC airspace. Monitor and track the number of briefs given annually.	ATR Sustainability Office/NAS Patuxent River Tenant Squadrons
Ambient Airborne Noise	Follow supersonic event restrictions and maintain sonic boom monitoring system.	Mitigate noise impacts generated by sonic booms to the surrounding community.	Restrict supersonic flights below 30,000 feet to weapons separation test flights. Restrict supersonic flights above 30,000 feet to mission-critical flights. Monitor and track annual numbers of supersonic events and document noise disturbance trends associated with supersonic events in an annual noise report. Maintain sonic boom monitoring system.	ATR Military Radar Unit (Baywatch)/NAS Patuxent River Air Operations/ATR Sustainability Office
Ambient Airborne Noise	Utilize expanded UAS routes.	Mitigate low-level noise impacts due to UAS overflights to residents of the Northern Neck of Virginia.	Increase areas within the PRC available for UAS operations to reduce repetitive noise exposure over any one location. Monitor and track the number of annual UAS flight hours.	NAS Patuxent River Central Schedules/NAS Patuxent River Air Operations/UX-24/Maryland Army National Guard/ATR Sustainability Office
Ambient Airborne Noise	Limit Open-Air Engine Test Cell operations.	Mitigate noise impacts due to jet engine open-air test cell events to residents of Solomons, Maryland.	Limit maintenance runs for jet (turbofan and turbojet) engines to mission-critical situations when enclosed test cell is unavailable for an extended period of time. Contact ATR Sustainability Office prior to testing to determine if event may be conducted based on favorable wind conditions. Monitor and track the number of annual events conducted in the jet engine testing instrumentation test cell.	Naval Air Warfare Center Aircraft Division Propulsion System Evaluation Department/ATR Sustainability Office

Table ES-3 Impact Avoidance and Minimization Measures, Continued

Environmental Resource	***Mitigation Measure***	***Anticipated Benefit / Evaluating Effectiveness***	***Implementing and Monitoring***	***Responsibility***
Biological Resources	Monitor for marine species prior to mid-frequency active sonar system event.	Mitigate impacts to marine species due to mid-frequency active sonar transmissions.	Visually survey for marine mammals and sea turtles within a radius of 1 nautical mile centered on the dip point prior to a mid-frequency active sonar event. Halt or delay the event if a marine mammal or sea turtle is observed until the animal has moved outside the survey area.	HX-21 helicopter aircrew
Biological Resources	Maintain altitude restrictions over Bloodsworth Island Range.	Mitigate impacts to waterfowl during migratory season.	Avoid overflight of Bloodsworth Island Range below 3,000 feet for fixed-wing aircraft and 1,000 feet for rotary-wing aircraft during migratory waterfowl season (typically November 15 to March 31).	NAS Patuxent River Central Schedules/ NAS Patuxent River Air Operations/NAS Patuxent River Tenant or Transient Aircraft
Biological Resources	Monitor for marine species prior to mine countermeasure testing events.	Mitigate impacts to marine species due to in-water electromagnetic devices towed at high speed.	Visually survey for marine mammals and sea turtles within the test area. Halt or delay the event if a marine mammal or sea turtle is observed until the animal has moved outside the survey area.	Program Executive Office (Littoral Mine Warfare) and Naval Air Warfare Center Aircraft Division
All resources	Continue test plan environmental review process.[1]	Ensure all testing and training activities conducted within the PRC are adequately assessed under NEPA.	Review all project test plans for compliance with the PRC EIS and other NEPA documents as applicable.	ATR Sustainability Office
Ambient Airborne Noise, Land Use, and Environmental Justice	Employ sonic boom prediction tool.[1]	Mitigate potential noise disturbances and property damage due to sonic booms to populated areas within the surrounding community.	Generate a sonic boom footprint for all supersonic weapons separation tests to predict potential noise impacts. Postpone flights or adjust aircraft angle of approach as needed to avoid impacts to populated areas.	ATR Range Safety/Naval Test Wing Atlantic Squadrons
Biological Resources	Close one TERF area landing zone during northern diamondback terrapin nesting season.[1]	Protect northern diamondback terrapin nests within the TERF area helicopter landing zones.	Close and use only one of two beach landing zones during northern diamondback terrapin nesting and hatching season (May to September). Place fencing around the active landing zone to prevent terrapins from nesting in the area. Conduct terrapin nest surveys within landing zones each season.	NAS Patuxent River Environmental Division (Natural Resources Department)

Table ES-3 Impact Avoidance and Minimization Measures, Continued

Environmental Resource	***Mitigation Measure***	***Anticipated Benefit / Evaluating Effectiveness***	***Implementing and Monitoring***	***Responsibility***
Biological Resources	Aircraft flight restrictions over the Hannibal Target during the peregrine nesting season (February 15 – August 15).[1]	Avoid/reduce potential environmental impacts to nesting peregrine falcons.	Aircraft maintain 0.5-mile buffer from the Hannibal Target from February 15 through August to avoid disturbance of peregrine falcon nesting activities.	NAS Patuxent River Air Operations

Key: ATR = Atlantic Test Ranges; EIS = Environmental Impact Statement; NAS = Naval Air Station; NEPA = National Environmental Policy Act; PRC = Patuxent River Complex; TERF = terrain flight; UAS = unmanned aerial systems.

1. Voluntary mitigation

ES.6 Public Involvement

Navy published a Notice of Intent to prepare an EIS on February 15, 2019, in the Federal Register. To further notify the public of the scoping period, the Navy published advertisements in eight newspapers, distributed press releases, mailed notification letters or postcards to key stakeholders, tribes, agencies, and parties expressing an interest in this project, and provided notification via the project website. The Notice of Intent described the Proposed Action and solicited agency and public comments during the scoping period from February 15, 2019, through April 1, 2019. Scoping meetings were held on the following dates and locations:

March 4, 2019	Heathsville, Virginia
March 5, 2019	California, Maryland
March 6, 2019	Princess Anne, Maryland
March 7, 2019	Cambridge, Maryland

The Navy received a total of 23 comments from federal agencies, state agencies, federally recognized tribes, nongovernmental organizations, individuals, and community groups. These comments were submitted via the project website's electronic comment form, in writing at the scoping meetings, and postal mail and e-mail. Comments received during the scoping period were considered in preparing the Draft EIS. Comment categories included Proposed Action, Noise, Airspace, Land Use, Safety, Cultural Resources, Biological Resources, Outreach, and General. A summary of comments can be found in Appendix G (Public Involvement).

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Abbreviations and Acronyms

<	less than
>	greater than
°C	Celsius
°F	Fahrenheit
μPa	micropascals
AESO	Aircraft Environmental Support Office
AGL	above ground level
AICUZ	Air Installations Compatible Use Zones
AMNS	Airborne Mine Neutralization System
ANSI	American National Standards Institute
APE	Area of Potential Effects
APZs	Accident Potential Zones
ASW	anti-submarine warfare
ATA	Armament Test Area
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
ATMO	Atlantic Targets and Marine Operations
ATR	Atlantic Test Ranges
BASH	bird/animal aircraft strike hazard
BGEPA	Bald and Golden Eagle Protection Act
BIR	Bloodsworth Island Range
CADs/PADs	cartridge actuated devices/propellant actuated devices
CB5MH_MD	Lower Chesapeake Bay Mesohaline Maryland
CBWR	Chesapeake Bay Water Range
CDNL	C-weighted day-night average sound level
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeters
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
C-UAS	counter-UAS
CV	coefficient of variation
CWA	Clean Water Act of 1972
CZMA	Coastal Zone Management Act
CZMPs	Coastal Zone Management Plans
CZs	Clear Zones
D.C.	District of Columbia
dB	decibels
dB re 1 μPa	decibels referenced to 1 micropascal
dB re 20 μPa	decibels referenced to 20 micropascals
dB re 20 μPa^2-s	decibels referenced to 20 micropascals squared seconds
dB rms	decibels in terms of root mean square SPL

dB SEL	decibels in terms of sound exposure level
dBA	A-weighted decibels
dBP	decibels (peak)
DDT	dichlorodiphenyltrichloroethane
DICASS	Directional Command Activated Sonobuoy System
DNL	day-night average sound level
DO	dissolved oxygen
DoD	Department of Defense
DoDI	Department of Defense Instruction
DPS	Distinct Population Segment
E	endangered
EA	Environmental Assessment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EO	Executive Order
ESA	Endangered Species Act
EW	electronic warfare
FAA	Federal Aviation Administration
FONSH	Finding of No Significant Harm
FONSI	Finding of No Significant Impact
FY	fiscal year
GHGs	greenhouse gases
GSE	ground support equipment
HAPs	hazardous air pollutants
Helo OPAREAs	Helicopter Operating Areas
Hz	hertz
IFR	Instrument Flight Rules
INRMP	Integrated Natural Resources Management Plan
JATO	jet-assisted take-off
JETI	Jet Engine Test Instrumentation
JSF	Joint Strike Fighter
kHz	kilohertz
km	kilometers
LAA	likely to adversely affect
L_{dnmr}	onset-rate adjusted monthly day-night average sound level
L_{eq}	equivalent sound level
$L_{eq(8hr)}$	eight-hour equivalent sound level
L_{max}	maximum sound level
LNG	liquefied natural gas
m	meters
MA	may affect
MBTA	Migratory Bird Treaty Act
MCM	mine countermeasure
MD ###	Maryland (Route) (e.g., MD 760)
MEM	military expended materials

MEMC	military expended material constituent
MFAS	mid-frequency active sonar
mg/L	milligrams per liter
mm	millimeters
MMPA	Marine Mammal Protection Act
MOPS	Magnetic Orange Pipe System
MPE	Maximum Permissible Exposure
MRNMAP	Military Operations Area-Range NoiseMap
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSAT	Mobile Source Air Toxics
MSL	mean sea level
MT/yr	metric tons per year
MTR	military training route
NAAQS	National Ambient Air Quality Standards
NAEMO	Navy Acoustics Effects Model
NAS	Naval Air Station
NASPAXRIVINST	Naval Air Station Patuxent River Instruction
NATOPS	Naval Air Training and Operating Procedures Standardization
NATS	Naval Air Transport Service
NAVAIR	Naval Air Systems Command
NAVAIRWARCENACDIVINST	Naval Air Warfare Center Aircraft Division Instruction
Navy	U.S. Department of the Navy
NAWCAD	Naval Air Warfare Center Aircraft Division
NE	no effect
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NHL	National Historic Landmarks
NHPA	National Historic Preservation Act
NIPTS	noise-induced permanent threshold shift
NLAA	not likely to adversely affect
nm	nautical mile
nm^2	square nautical miles
NMFS	National Marine Fisheries Service
NMS	National Marine Sanctuary
NO_2	nitrogen dioxide
NOA	Notice of Availability
NOI	Notice of Intent
NOTAMs	Notices to Airmen
NO_x	nitrogen oxides
NRC	Navy Recreation Center
NRHP	National Register of Historic Places
NTWL	Naval Test Wing Atlantic
NWR	National Wildlife Refuge
OAETC	Open-Air Engine Test Cell
OASIS	Organic Airborne and Surface Influence Sweep

OEA	Overseas Environmental Assessment
OLF	Outlying Field
OPAREA	Operating Area
OPNAV N45	CNO Environmental Readiness Division
OPNAVINST	Office of the Chief of Naval Operations Instruction
OPNAV-M	Office of the Chief of Naval Operations Manual
PAX	Patuxent River
PAXMH	Patuxent River Mesohaline
Pb	lead
PCB	polychlorinated biphenyl
PEO	Program Executive Office
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in diameter
PM_{10}	particulate matter less than or equal to 10 microns in diameter
ppt	parts per thousand
PRC	Patuxent River Complex
PTS	permanent threshold shift
R-	restricted area
R&D	research and development
RAICUZ	Range Air Installations Compatible Use Zones
RCRA	Resource Conservation and Recovery Act
RDT&E	research, development, test and evaluation
re 1 μPa	referenced to 1 micropascal
re 1 μPa^2-s	referenced to 1 micropascal squared seconds
re 20 μPa	referenced to 20 micropascals
re 20 μPa^2-s	referenced to 20 micropascals squared seconds
REPI	Readiness and Environmental Protection Integration
RLA	Rural Legacy Area
ROD	Record of Decision
ROI	region of influence
S&T	science and technology
SAR	search and rescue
SAV	submerged aquatic vegetation
SDZ	surface danger zone
SEL	sound exposure level
SEL_r	onset-rate adjusted sound exposure level
SHPO	State Historic Preservation Office(r)
SME	subject matter expert
SO	Sustainability Office
SO_2	sulfur dioxide
SOP	standard operating procedure
SPL	sound pressure level
spp.	species
STOVL	Short Takeoff and Vertical Landing
SUA	special use airspace
T	threatened

T&E	test and evaluation
TERF	terrain flight
TMDL	total maximum daily load
tpy	tons per year
TRACON	Terminal Radar Approach Control
TSS	total suspended solids
TTS	temporary threshold shift
U.S.	United States
U.S.C.	United States Code
UAS	unmanned aerial systems
UGS	unmanned ground systems
UMS	unmanned maritime systems
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USNTPS	United States Naval Test Pilot School
USV	unmanned surface vehicles
UUV	unmanned underwater vehicles
UXO	unexploded ordnance
VFR	Visual Flight Rules
VOC	volatile organic compound

1 Purpose of and Need for the Proposed Action

1.1 Introduction

The United States (U.S.) Department of the Navy (Navy) proposes to continue conducting military research, development, test and evaluation (RDT&E) (also referred to as "testing") and training activities within the Patuxent River Complex (PRC) at Naval Air Station (NAS) Patuxent River, Maryland. NAS Patuxent River is headquarters to the Naval Air Warfare Center Aircraft Division (NAWCAD), one of two product centers within the Naval Air Systems Command (NAVAIR). NAWCAD is the Navy's primary testing, engineering, and Fleet support activity for naval aircraft, engines, avionics, and aircraft support systems and is responsible for the scheduling and conduct of military readiness activities within the PRC. These activities are consistent with those analyzed in the December 1998 *Final Environmental Impact Statement (EIS) for Increased Flight and Related Operations in the Patuxent River Complex* (hereinafter referred to as the 1998 PRC EIS) (U.S. Department of the Navy, 1998) and are representative of the types of testing and training the Navy has been conducting in the PRC for decades.

The Navy has prepared this EIS in accordance with the National Environmental Policy Act (NEPA), as implemented by the Council on Environmental Quality (CEQ) Regulations and Navy regulations for implementing NEPA. This EIS will assess the potential environmental impacts associated with the continuation of and adjustments to current testing and training activities conducted within the PRC Study Area needed to support projected Navy military readiness requirements into the foreseeable future.

1.2 Background

The Navy has conducted aircraft testing and training in the PRC for more than 75 years, since the commissioning of NAS Patuxent River on April 1, 1943. From World War II to the present, the station has increasingly supported the RDT&E of aircraft and airborne weapon systems, evolving into the Center of Excellence for Naval Aviation.

In the 1990s, the Navy began consolidating its technical capabilities (facilities and personnel), to reduce redundancies and improve its products and services, streamlining the Naval Air Warfare Center into two product centers within NAVAIR: the Aircraft Division, headquartered at NAS Patuxent River, and the Weapons Division, headquartered at Naval Air Weapons Station China Lake, California. The majority of naval aviation research and development (R&D) activities were moved from Pennsylvania, New Jersey, and other locations to be combined with the NAWCAD test and evaluation (T&E) infrastructure at NAS Patuxent River. Shortly thereafter, NAVAIR headquarters, for naval aircraft and airborne weapon systems acquisition, relocated to the air station from Arlington, Virginia. This merger, of aircraft acquisition and RDT&E at a single location, uniquely positioned NAWCAD to use the combined resources, more efficiently and effectively, to meet Navy aviation technology requirements of the future. These consolidated capabilities have extended beyond the Navy to benefit other U.S. military services, federal agencies, commercial customers, and foreign governments. As such, NAWCAD Patuxent River (hereinafter referred to as NAWCAD) is a designated Major Range and Test Facility Base, a core Department of Defense (DoD) T&E asset providing information to DoD decision makers to support the Defense Acquisition System and deliver effective aircraft and airborne weapons systems to the warfighter.

To support Navy acquisition requirements, NAWCAD manages and operates three primary components: a test wing, test range, and ground test facilities and laboratories. NAWCAD Naval Test Wing Atlantic is composed of four T&E squadrons (Air Test and Evaluation Squadrons Two Zero [VX-20], Two One [HX-21], Two Three [VX-23], and Two Four [UX-24]) and the U.S. Naval Test Pilot School (see Appendix A, Table A-1: Primary Patuxent River Complex Users, for brief description of each). As the Fleet advocate for Navy aircraft T&E, Naval Test Wing Atlantic focuses on warfighter requirements by providing aircrew and aircraft, maintenance services, operational and safety oversight, and facility support for developmental flight and ground testing.

NAWCAD Atlantic Test Ranges (ATR) provide safe, highly instrumented, and controlled open-air ranges to conduct testing and training in air, land, and sea environments. The primary "Inner Range" is within the PRC Study Area (Figure 1.3-1) and contains military restricted airspace and underlying land and water areas. The Inner Range proximity to ATR instrumentation enables collection of the decision-quality data required to support Navy acquisition programs and other range customers. Additional air and sea space is available offshore in the Virginia Capes Atlantic Warning Areas, which can expand ATR support to over 50,000 square miles to meet testing and training requirements. Because the Atlantic Warning Areas are outside the PRC Study Area, their associated activities are included in other Navy NEPA/Executive Order 12114 documents (primarily the *Atlantic Fleet Training and Testing Final EIS/Overseas EIS* [(U.S. Department of the Navy, 2018a)]). Therefore, ATR hereinafter will imply the Inner Range only.

Prior to flight testing in the ATR, NAWCAD performs a significant amount of testing using its ground test facilities and laboratories to meet test flight prerequisites in support of the RDT&E mission. Ground-based testing involves non-flight R&D, aircraft and weapons systems component testing, and laboratory-based modeling and simulation activities carried out at more than 100 dedicated facilities at NAS Patuxent River and Outlying Field (OLF) Webster.

NAWCAD flight and related activities were analyzed in the 1998 PRC EIS. Since that time, the types, tempos, and mix of aircraft, non-explosive munitions, and systems have changed; different types of testing and training activities and new technologies have been introduced; and the PRC Study Area has been expanded. Some of these changes were addressed in Environmental Assessments (EAs) subsequently completed since 1998 (see Section 1.6, Key Documents). However, per CEQ guidance and Navy policy, new environmental conditions, studies, and regulations warrant an updated analysis.

1.3 Location and Description of the Patuxent River Complex

The PRC is based at NAS Patuxent River, located in Southern Maryland approximately 60 miles southeast of Washington, D.C. The 1998 PRC EIS defined the PRC as NAS Patuxent River and OLF Webster flight and ground test facilities and airfields along with the ATR restricted airspace, Chesapeake Bay Water Range, and fixed target areas. This EIS expands the PRC Study Area to include land, water, and airspace historically and currently used by NAWCAD that were not assessed in the previous EIS. These include Bloodsworth Island Range, waters beneath the restricted airspace outside the Chesapeake Bay Water Range, and surrounding Federal Aviation Administration (FAA) airspace including Helicopter Operating Areas (Helo OPAREAs) and Chessie Air Traffic Control Assigned Airspace (ATCAA). The PRC Study Area components are shown in Figure 1.3-1 and a description of each is provided in the following subsections.

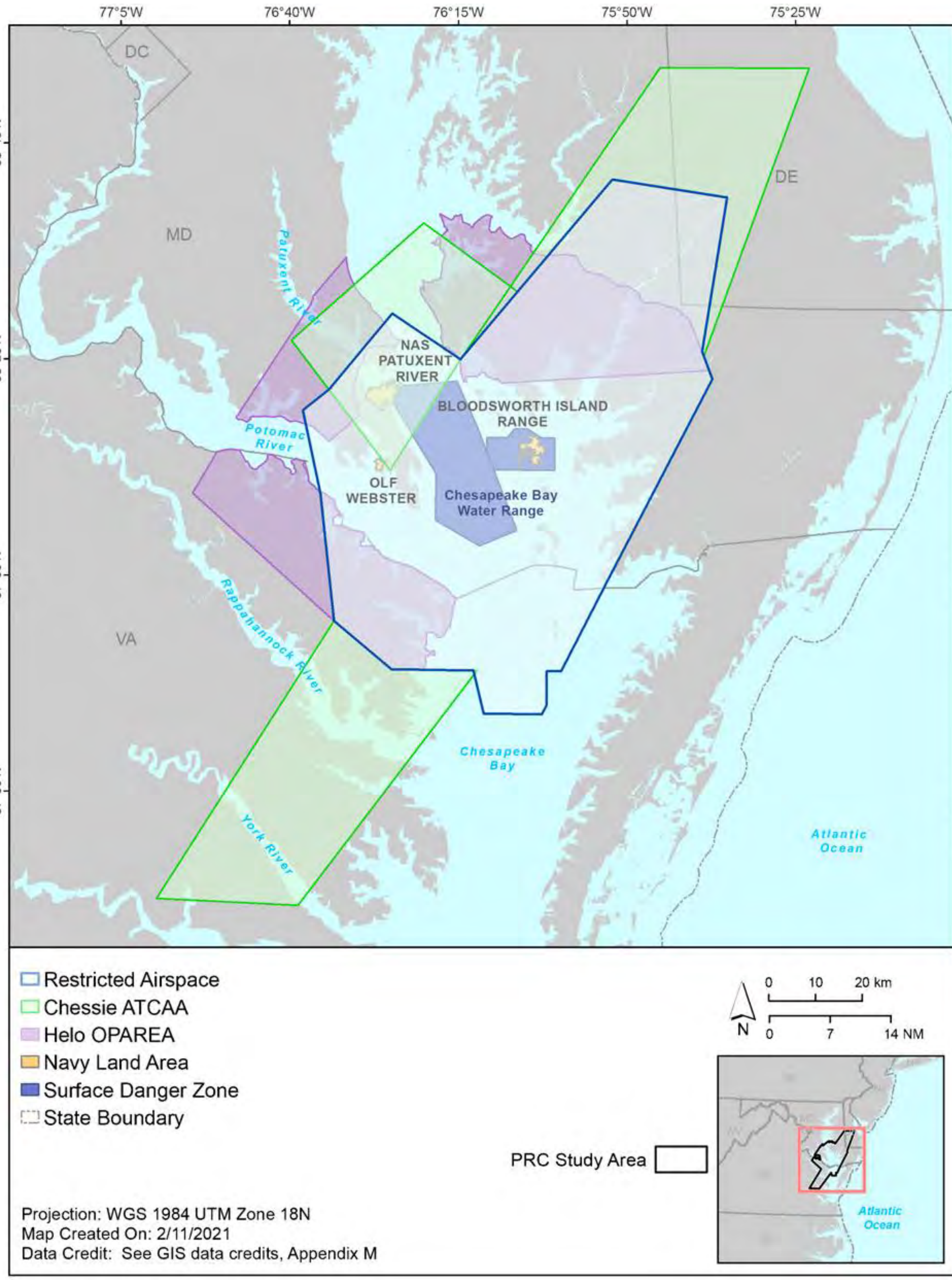


Figure 1.3-1 PRC Study Area

1.3.1 PRC Airspace

The FAA regulates and promotes safety of navigation for civil and military aircraft in U.S. airspace. Special use airspace (SUA) is designated by the FAA where activities must be confined because of their nature, where limitations are imposed upon aircraft that are not a part of those activities, or both. SUA is primarily established for military flight operations and may be used for commercial or general aviation when not reserved for military use.

Restricted airspace is a type of SUA within which the flight of aircraft, while not entirely prohibited, is subject to restriction. Restricted airspace is designated where operations are hazardous to nonparticipating aircraft and, when active, the nonparticipating aircraft are prohibited from entering unless the operator (or pilot) has advance permission from the controlling or using agency. For ATR restricted airspace, the FAA is the controlling agency that delegates permission to NAS Patuxent River Air Traffic Control (ATC) as the using agency. Figure 1.3-2 shows the PRC special use and shared airspace where the Navy conducts testing and training.

1.3.1.1 Restricted Airspace

ATR restricted airspace overlies approximately 2,352 square miles (1,800 square nautical miles) of Southern Maryland, the Eastern Shore of Maryland, the Northern Neck of Virginia, and southwest Delaware (Figure 1.3-2). Approximately 50 percent of the airspace rests over the waters of the middle Chesapeake Bay while the remaining 50 percent is over land. The airspace comprises six restricted areas with a vertical extent spanning from surface level up to 85,000 feet with some overlapping in altitude (Table 1.3-1). The FAA identifies the restricted areas as SUA under 14 Code of Federal Regulations (CFR) part 73. Each restricted area accommodates unique flight activities in support of the NAWCAD mission. When scheduled for exclusive use, the airspace allows simultaneous flights, contains testing and training activities, and maintains safe separation from all other air traffic.

The Navy requests and receives permission from the FAA to use the restricted airspace daily. During the time the airspace is in use (i.e., activated), the ATR military radar unit, Baywatch, provides restricted area containment surveillance under the supervision of NAS Patuxent River ATC. Restricted airspace is typically activated between 7:00 a.m. to 11:00 p.m. on weekdays and 8:00 a.m. to 6:00 p.m. on weekends. When not activated, the airspace is released back to FAA for command and control and may be used for commercial or general aviation.

Table 1.3-1 Atlantic Test Ranges Restricted Airspace

Restricted Area	*Minimum Altitude (feet)*	*Maximum Altitude (feet)*
R-4002	Surface	Up to 20,000
R-4005	Surface	Up to, but not including 25,000
R-4006	3,500	Up to, but not including 25,000
R-4007	Surface	Up to 5,000
R-4008	25,000	85,000
R-6609	Surface	20,000

Key: R- = restricted area.

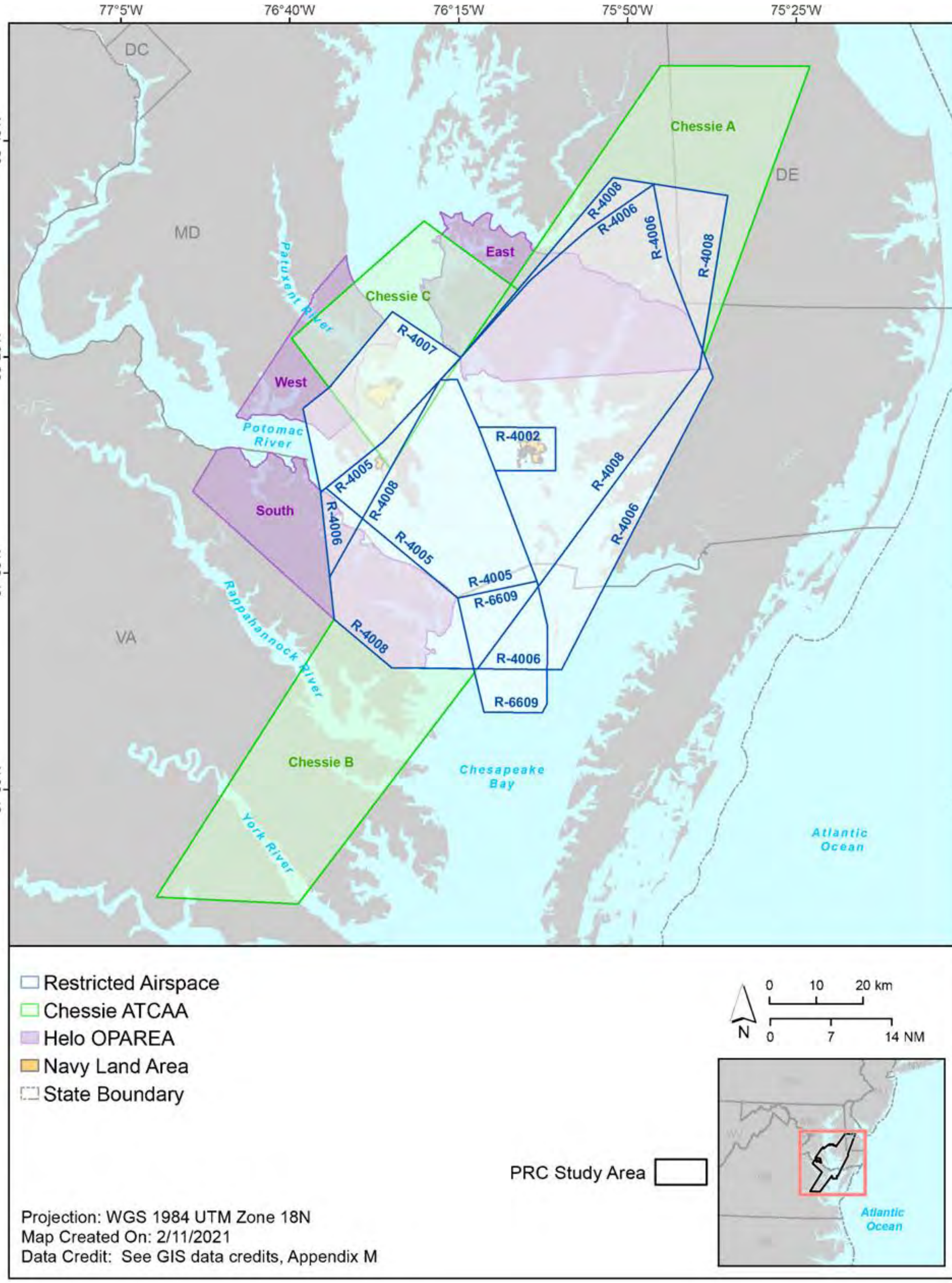


Figure 1.3-2 PRC Airspace

1.3.1.2 Helicopter Operating Areas

Adjacent to PRC restricted airspace are FAA Class E airspaces referred to in the *NAS Patuxent River Air Operations Manual* (U.S. Department of the Navy, 2017a) as the East, West, and South Helo OPAREAs (Figure 1.3-2). These areas are located over portions of the Eastern Shore of Maryland, Southern Maryland, and the Northern Neck of Virginia, respectively, with perimeters bound by the extent of the NAS Patuxent River Terminal Radar Approach Control and other geographic features. Although called Helo OPAREAs for airspace management purposes, they are shared with private and commuter aircraft and used by Navy rotary-wing as well as small, fixed-wing propeller aircraft to conduct lower altitude operations that do not require restricted airspace. HX-21 squadron and U.S. Naval Test Pilot School are the most frequent users of these airspaces.

Testing and training activities in the Helo OPAREAs are conducted consistent with FAA visual flight rules. For access, squadrons contact and obtain a beacon code from NAS Patuxent River Terminal Radar Approach Control to launch under visual flight rules. Use of the Helo OPAREAs deconflicts restricted airspace traffic and improves safety of flight by minimizing pilot flight time over water.

1.3.1.3 Chessie Air Traffic Control Assigned Airspace

Chessie ATCAA is a type of SUA that is part of the national FAA Class A airspace structure. The ATCAA was assigned to and developed exclusively for NAS Patuxent River ATC to provide air traffic segregation between Navy aircraft testing within this FAA airspace and other air traffic flying under instrument flight rules.

Contiguous with PRC restricted airspace, Chessie is subdivided into A, B, and C, with Chessie A and B altitudes ranging 27,000 to 41,000 feet and Chessie C 18,000 to 50,000 feet (Figure 1.3-2). The airspace accommodates flight tests that do not fit within the confines of the restricted airspace due to specific altitude and headings required to maximize tracking time and test points at supersonic speeds. Use of the ATCAA is infrequent and scheduling must be coordinated with the Washington Air Route Traffic Control Center.

1.3.2 PRC Land Areas and Facilities

The following paragraphs describe the PRC land areas and facilities that support Navy testing and training.

1.3.2.1 NAS Patuxent River

The NAS Patuxent River main base occupies approximately 6,379 acres of land in St. Mary's County, Maryland, located on a peninsula known as Cedar Point at the confluence of the Patuxent River and Chesapeake Bay (Figure 1.3-3). The air station also includes OLF Webster, Bloodsworth Island Range, and Navy Recreation Center Solomons, as well as a number of smaller remote instrumentation sites in Southern Maryland and on the Eastern Shore of Maryland.

NAS Patuxent River operates and maintains the land areas, airfield, and infrastructure required to support NAVAIR, NAWCAD, and other tenant commands. The air station's airfield, known as Trapnell Field, typically operates from 7:00 a.m. to 11:00 p.m. and includes three runways (11,800 feet long, 9,700 feet long, and 5,000 feet long) and eight primary helipads. The airspace immediately above the airfield is FAA Class D airspace encompassed by restricted area R-4007. Additional facilities include the ATC tower, three seaplane basins and a seaplane area (which are no longer used for seaplane operations), and the majority of the Navy's aircraft and airborne weapon systems ground test facilities and laboratories.

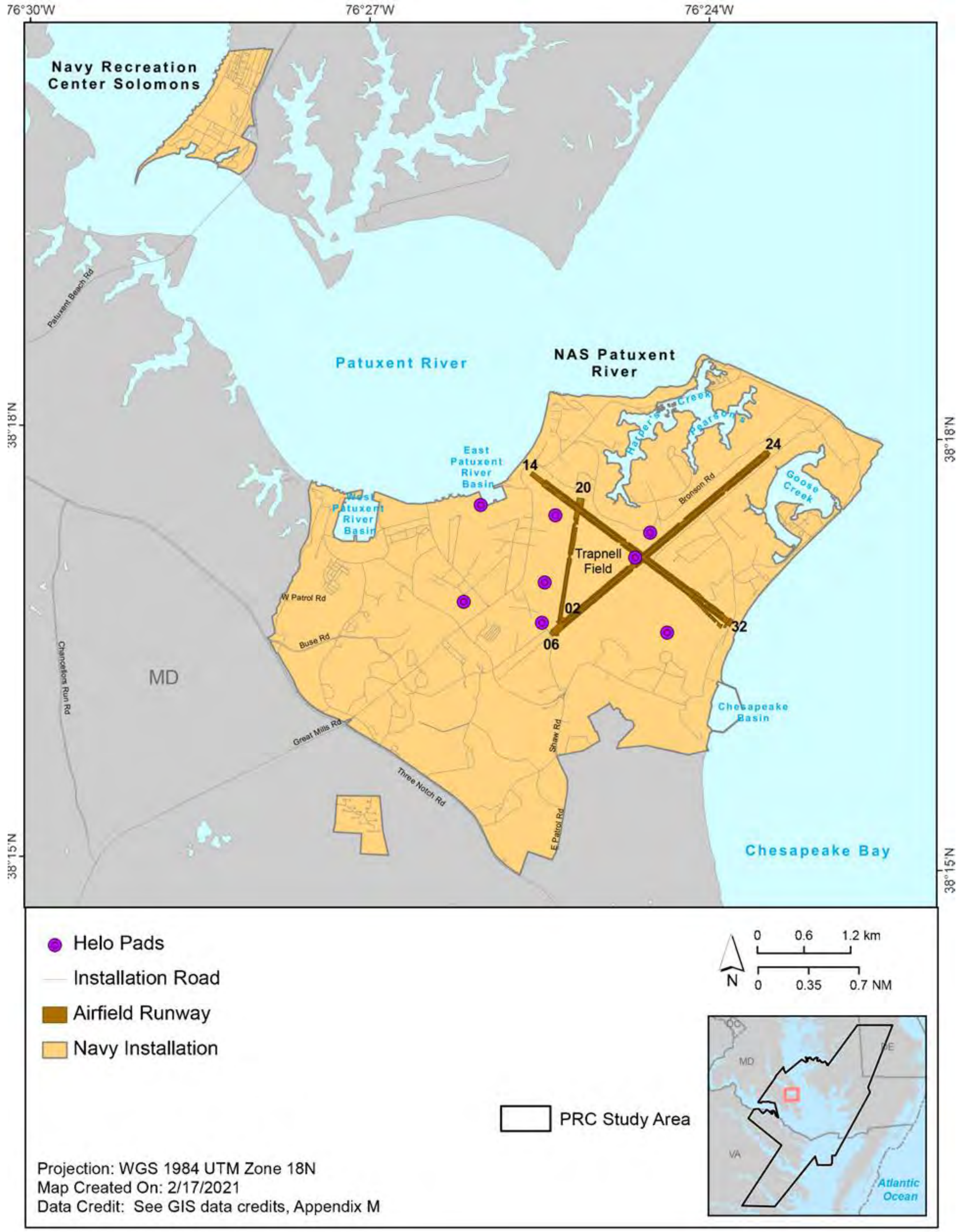


Figure 1.3-3 NAS Patuxent River

Navy Recreation Center Solomons is an annex of the air station in Calvert County, Maryland, located on a peninsula bounded by the Patuxent River. The facility encompasses 296 acres and was deemed a recreational center under Naval District Washington in 1971. Because testing and training activities are not conducted at this recreational facility, it is not included in the Proposed Action.

1.3.2.2 OLF Webster

OLF Webster is an annex of the main NAS Patuxent River site located in St. Inigoes, Maryland, along the eastern shore of the St. Mary's River, with St. Inigoes Creek and Molls Cove forming its northern boundary and the lower portions of the St. Mary's and Potomac Rivers forming its southern boundary (Figure 1.3-4). The 852-acre facility maintains two 5,000- by 150-foot runways with FAA Class E airspace immediately above the airfield. Normal hours of operation are from 9:00 a.m. to 5:00 p.m. year-round.

OLF Webster is the primary site for the operation of unmanned aerial systems (UAS) by the UX-24 squadron and Maryland Army National Guard. Unique capabilities offered by the facility provide UAS with: a dedicated operations center; exclusive-use areas; proximity to water for maritime operations; and direct entry into restricted airspace without need for FAA coordination.

1.3.2.3 Bloodsworth Island Range

Bloodsworth Island Range is located in Dorchester County, Maryland, in the middle of the Chesapeake Bay approximately 20 miles southeast of NAS Patuxent River. As specified in 33 CFR 334.190, the range includes the restricted land and surrounding restricted waters of its surface danger zone (SDZ).

Bloodsworth Island Range has a combined land area of 4,738 acres and consists of four barrier islands including Bloodsworth Island, Pone Island, Adam Island, and Northeast Island (Figure 1.3-5). A fifth island, Great Cove, was formerly part of the range but is now completely submerged. Access to all islands is restricted to Navy personnel or others escorted by the Navy.

From 1942 until 1996, the Navy used Bloodsworth and Pone islands for Fleet bombardment and bombing training using both live and non-explosive munitions. Since 1996, no munitions have been dropped or fired upon the range, and the Navy does not propose to resume those activities. Consistent with the *EA for Operations at the Bloodsworth Island Range* (U.S. Department of the Navy, 2006), the Navy continues to use Bloodsworth Island Range as a visual target for non-impact operations in support of aviation-related testing within its overlying restricted airspace. Management of Bloodsworth Island Range is assigned to both NAWCAD and NAS Patuxent River. During migratory waterfowl season (November 15 to March 31), flights over Bloodsworth Island Range maintain a minimum altitude of 3,000 feet and 1,000 feet for fixed- and rotary-wing aircraft, respectively, per current Navy policy (U.S. Department of the Navy, 2017a) (see Table 3.10-1, Impact Avoidance and Minimization Measures).

1.3.3 PRC Water Areas

The following subsections describe the PRC water areas beneath the ATR restricted airspace where the Navy conducts testing and training including the primary Chesapeake Bay Water Range as well as areas outside the water range used for transiting and supporting unique testing and training events (Figure 1.3-6).

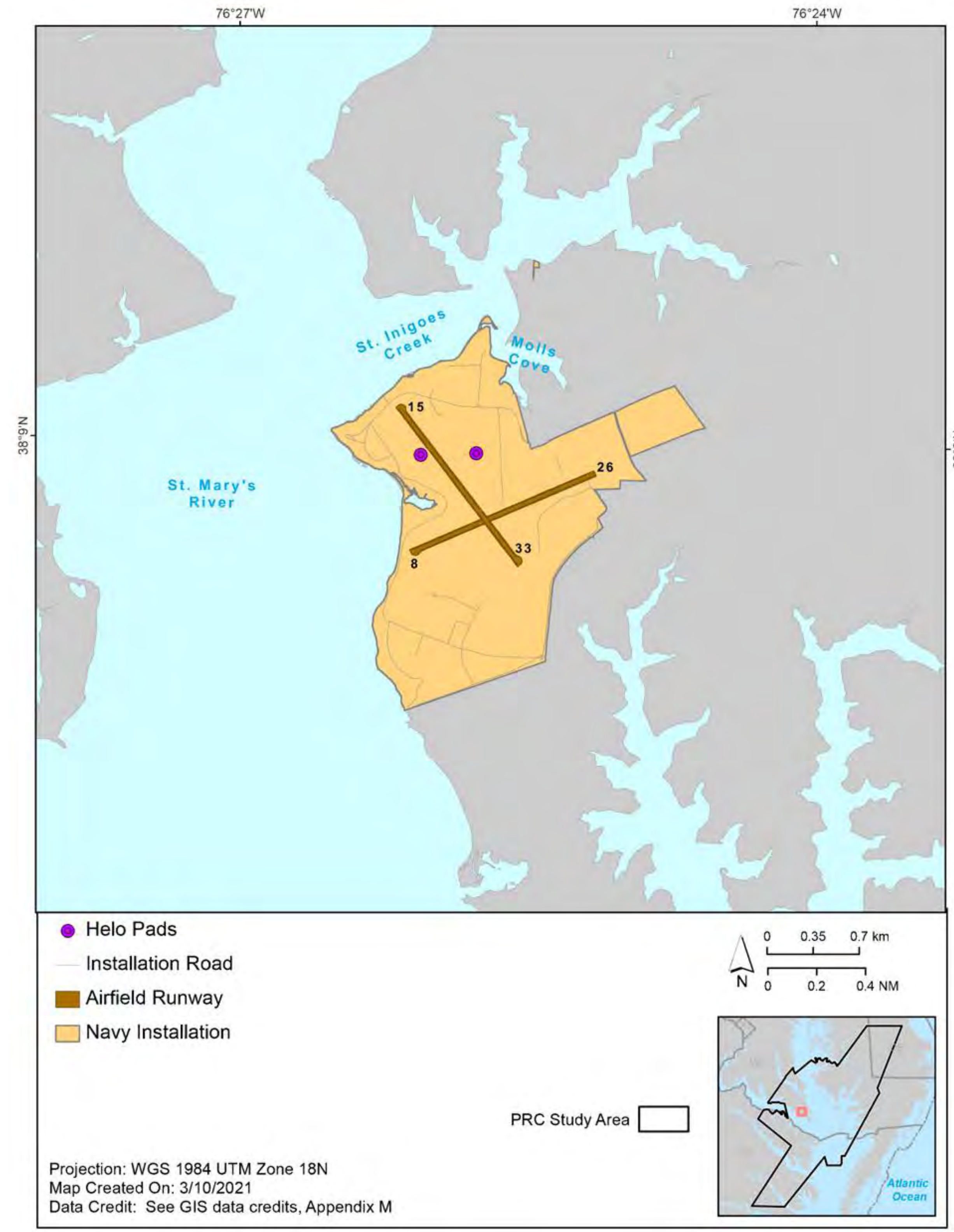


Figure 1.3-4 OLF Webster

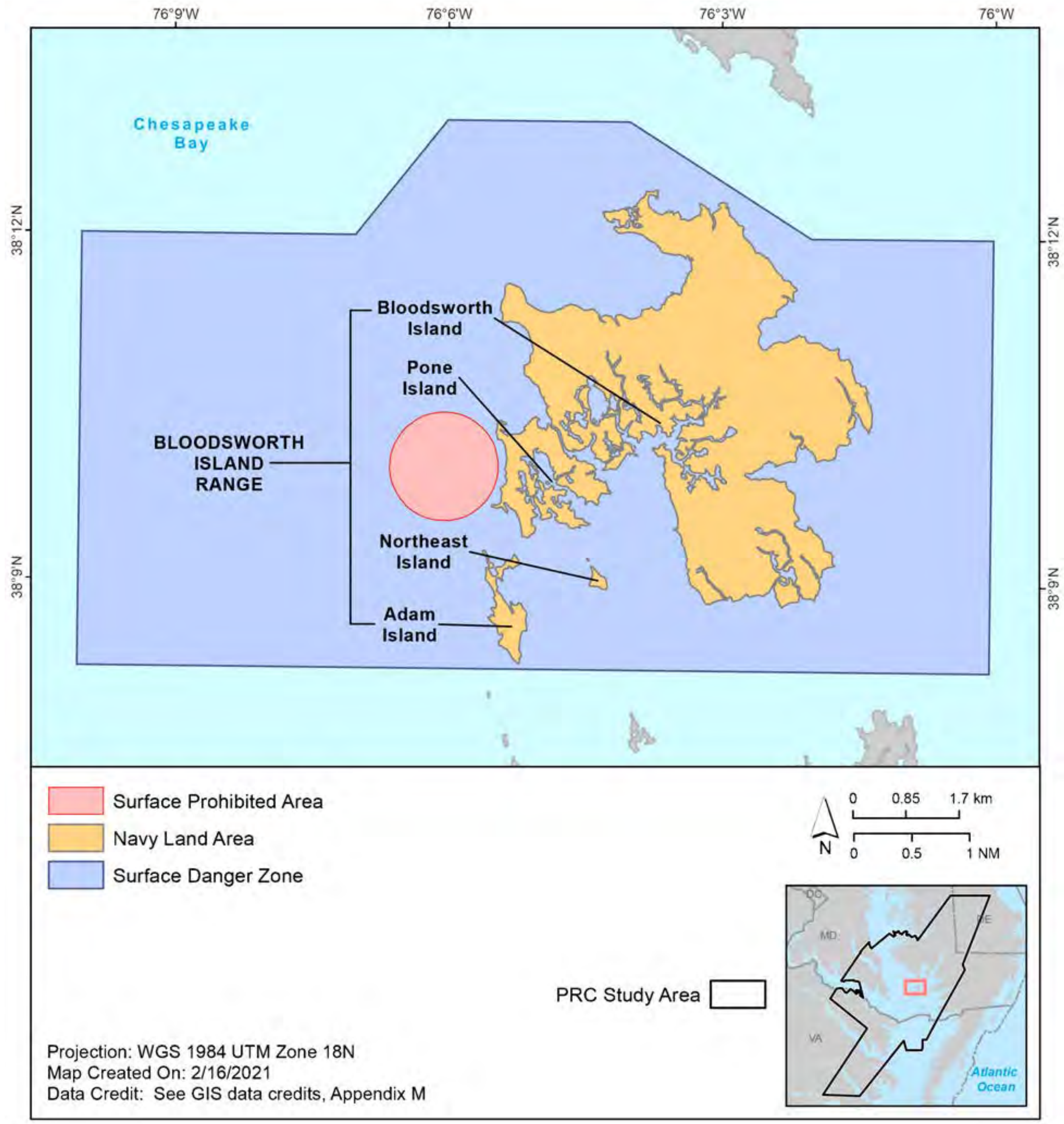
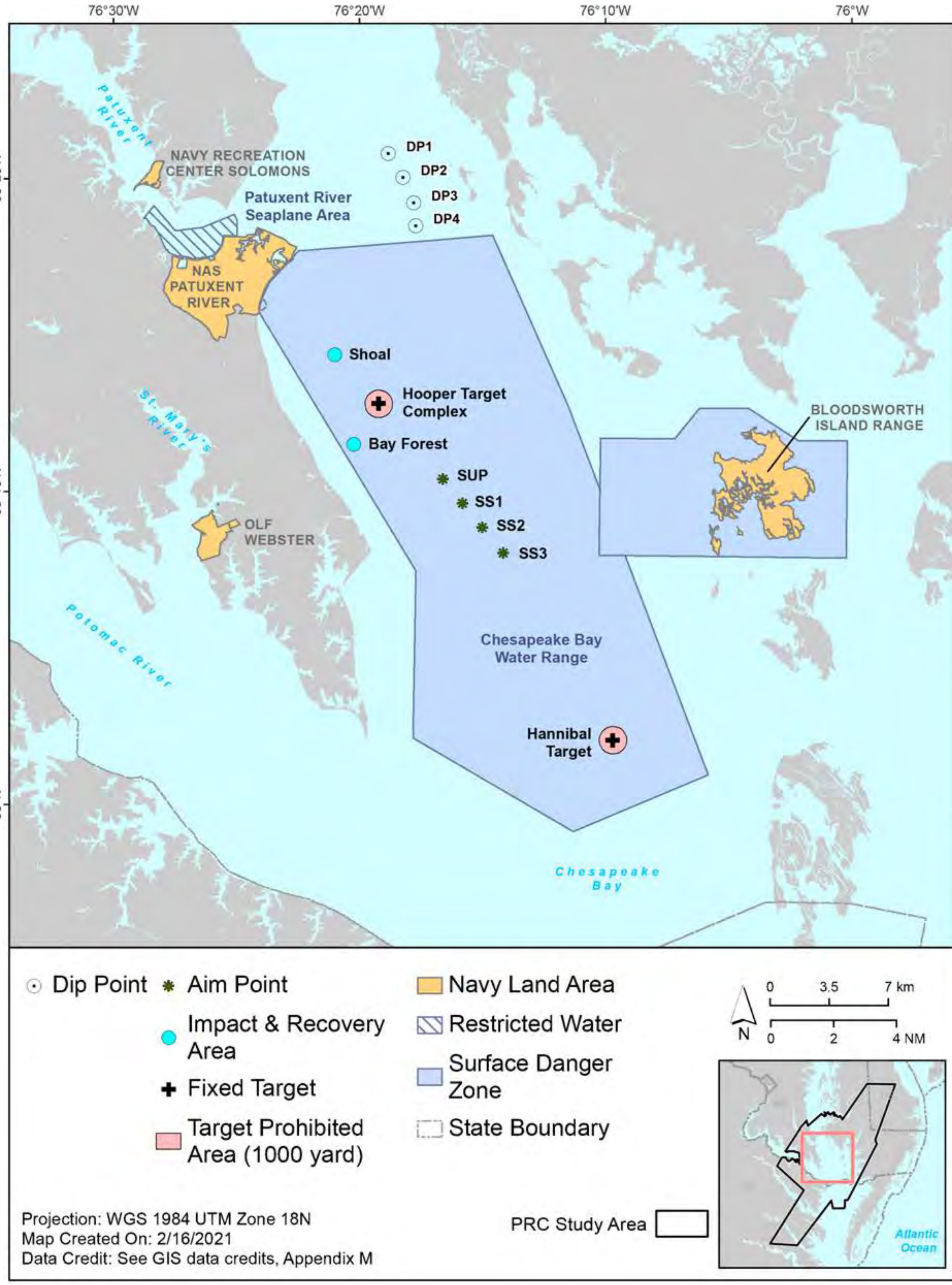


Figure 1.3-5 Bloodsworth Island Range



Key: DP = Dip Point; SS = Supersonic Aim Point; SUP = Supersonic Point.

Figure 1.3-6 PRC Water Areas

1.3.3.1 Chesapeake Bay Water Range

The Chesapeake Bay Water Range is a restricted water area located in the middle Chesapeake Bay and designated in 33 CFR part 334.200 as the "Chesapeake Bay, Point Lookout to Cedar Point; aerial and surface firing range and target area, U.S. Naval Air Station, Patuxent River, Maryland, danger zones." The SDZ is open to surface craft navigation at all times except when restricted for Navy activities. Within the water range SDZ is a combination of fixed target areas including two visual structure targets (Hooper Target Complex and Hannibal Target), two impact and recovery areas (Bay Forest and Shoal), and four virtual aim points (Supersonic Aim Points 1, 2, 3 [SS1, SS2, SS3] and Supersonic Point [SUP]) (Figure 1.3-6).

Fixed target areas provide safe, controlled locations where weapons separation testing and air-to-surface firing can be conducted. Surface-to-surface firing is also permitted at Hooper and Hannibal Targets. Further surrounding Hooper and Hannibal are small, circular prohibited areas (1,000 yards in radius) that are closed to navigation at all times with the exception of vessels engaged in operational and maintenance activities. All munitions used at the targets areas have non-explosive warheads, although gun ammunitions and some rocket and missile motors may have propellants necessary for firing (i.e., live-fired munitions). Table 1.3-2 provides a brief description of each fixed target area.

Table 1.3-2 Chesapeake Bay Water Range Fixed Target Areas

Chesapeake Bay Water Range Fixed Target Areas	***Target Description***
Hooper Target Complex 	Consists of a center main target (a reflective plywood visual target on a large concrete pylon); two peripheral Coast Guard buoys (Southeast and Southwest Buoys); and two aim points (Northeast and Northwest Buoys). Visual target structures are not fired upon but are rather used as reference points. Impact targets, if required, are typically items such as rafts or buoys floating near the target structures. Primary non-explosive munitions expended at Hooper include bombs, missiles, rockets, torpedoes, and gun ammunitions.
Hannibal Target 	Consists of a cargo ship, the *ex-American Mariner*, which was scuttled for use as a visual target. Target ship is 442 feet in length with a 58-foot beam. Historically used as a direct impact target but now is typically and intentionally missed to preserve the target's structural integrity. Primary non-explosive munitions expended at Hannibal include bombs, missiles, rockets, torpedoes, and gun ammunitions. Hannibal is heavily used for gunfire exercises.
Bay Forest and Shoal Impact and Recovery Areas	Shallow water impact and recovery areas are generally, but not exclusively, used when a munition or test item requires recovery. Shallow depth of water and relatively hard, sandy bottom facilitate test article recovery as compared to most of the mid-Chesapeake Bay's silt and soft clay bottom sediments (in which items sink) and water depths too deep for safe recovery by divers.
Aim Points	Four supersonic aim and release points used for weapons separation tests conducted at supersonic speeds. No physical structures are present; only geographic coordinates that are referenced and targeted by aircrew. Primary non-explosive munitions expended at aim points include general purpose and practice bombs.

1.3.3.2 Bloodsworth Island Range Surface Danger Zone and Prohibited Area

The Bloodsworth Island Range SDZ is defined in 33 CFR 334.190 as the “Chesapeake Bay, in vicinity of Bloodsworth Island, Maryland, U.S. Navy” and covers an area of approximately 16,430 acres (26 square miles) in the eastern portion of the middle Chesapeake Bay (Figure 1.3-5). The Surface Prohibited Area is a smaller area within the SDZ encompassing the waters west of Pone Island. No unauthorized individual or vessel is permitted to enter or remain in this area at any time. Per the CFR, no person, vessel, or other craft shall approach closer than 75 yards to the beaches, shoreline, or piers of the islands at any time unless authorized to do so by the Navy, nor approach rafts, barges, or platforms associated with the islands closer than 100 yards. Procedures to access Bloodsworth Island Range are described in Table 2.5-1 (Standard Operating Procedures).

1.3.3.3 Patuxent River Seaplane Area

The Patuxent River Seaplane Area is a restricted water addressed in 33 CFR part 334.180 as one of the “Patuxent River, Maryland; restricted areas, U.S. Naval Air Test Center, Patuxent River, Maryland.” The area runs contiguously with the north shore of NAS Patuxent River in the lower Patuxent River between Town Point and Hog Point (Figure 1.3-6). The seaplane area was historically used for seaplane takeoffs and landings. Today, it is used intermittently by the Navy for activities such as search and rescue training, watercraft testing, and science and technology demonstrations. As with Bloodsworth Island Range, there are restrictions in the CFR that prohibit approaching within 75 yards of the installation and 100 yards of associated equipment.

1.3.3.4 Dip Points

Testing and training activities involving dipping sonar systems deployed by helicopters occur at four discrete dip points located in the middle Chesapeake Bay north of the Chesapeake Bay Water Range (Figure 1.3-6). The dip points provide the physical conditions, including salinity and water depth, necessary to support dipping sonar events. Dip point depths range from approximately 100 feet to 146 feet, allowing the sonar transducer to be lowered from the helicopter to sufficient depths required for testing, typically between 45 feet to 75 feet (U.S. Department of the Navy, 2013a).

1.3.3.5 Installation Surrounding Waters

Waters areas that are adjacent to and immediately surrounding PRC installations may also be used to support testing and training. These include the southern end of the Patuxent River and middle Chesapeake Bay surrounding NAS Patuxent River (including the installation’s three basins) and the southern portions of the St. Mary’s and Potomac Rivers surrounding OLF Webster (Figure 1.3-6).

1.4 Purpose of and Need for the Proposed Action

Title 10 U.S.C. section 8062: "The Navy shall be organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea. It is responsible for the preparation of naval forces necessary for the effective prosecution of war except as otherwise assigned and, in accordance with integrated joint mobilization plans, for the expansion of the peacetime components of the Navy to meet the needs of war."

The purpose of the Proposed Action is to provide Sailors and Marines with equipment and technology that operate effectively and safely to support current and projected future military readiness requirements.

The need for the Proposed Action is to maintain military readiness of naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas, now and into the future, consistent with Title 10 United States Code (U.S.C.) section 8062.

1.4.1 Why the Navy Tests and Trains

The Navy is statutorily mandated (per 10 U.S.C. 8062) to protect U.S. national security by being ready, at all times, to effectively prosecute war and defend the nation by conducting operations at sea and ashore. Naval forces must be ready for a variety of military actions to address the economic, political, social, and environmental issues that occur in today's rapidly evolving world. Through its continuous presence on the world's oceans, the Navy can respond to a wide range of situations with over a third of its assets deployed overseas at any given time. This presence helps to deter foreign aggression by preventing conflict escalation and providing the commander in chief with options to promptly address global contingencies.

The Navy conducts testing and training (collectively referred to as "military readiness activities") to ensure service members are equipped to succeed in their mission of national defense. The Navy's test community is at the forefront of this objective, providing full life cycle RDT&E of Navy and Marine Corps aviation systems and related equipment to meet Fleet capability and readiness requirements. R&D of new technologies must continually occur to ensure naval forces can counter new and emerging threats. The test community develops, tests, and delivers the products and services to maintain technological advantages over U.S. adversaries.

Prior to Fleet delivery, all Navy systems and equipment must be tested to ensure proper functionality. Testing begins at the R&D phase and continues through final systems and hardware certification. For example, the design and build of a new aircraft involves the development of the aircraft's software and hardware, construction of the aircraft itself, testing of the aircraft's airworthiness, and successful operation of its systems. Once the aircraft is fielded, the test community continues support through its operations and sustainment phase by providing in-service engineering and logistics assistance, such as maintenance, repair, modification, and modernization (i.e., updates or upgrades) to software and hardware systems, as well as training on the operation of the systems.

Training ensures military forces are proficient at their jobs, ready to deploy quickly, and able to respond effectively while forward deployed. Before deployment, naval forces must train to develop a broad range of capabilities that enable them to respond to threats, from full-scale armed conflict in a variety of geographic areas to humanitarian assistance and disaster relief efforts. This training process prepares Navy and Marine Corps personnel to be skilled in operating and maintaining the aviation systems and equipment they will use to conduct their assigned missions. Training must be as realistic as possible to provide real world experiences vital to ensure successful national defense. Training also provides the test community valuable information to improve system and equipment capabilities and effectiveness.

Safe and effective testing and training requires access to range complexes, such as the PRC, to enable Sailors and Marines to "train as they fight" in a realistic environment with technological advantage. Use of the PRC supports the achievement of military readiness and continued ability of the Navy to fulfill its mission to protect the nation against potential adversaries and defend the rights of the U.S. and its allies to move freely on the ocean.

1.4.2 Strategic Importance of the PRC

The colocation of NAWCAD and NAVAIR headquarters within the PRC creates synergy between the Navy RDT&E and acquisition communities. The NAVAIR mission is to provide full life cycle support of naval aircraft, weapons, and aviation systems operated by Sailors and Marines. NAWCAD reinforces this mission by participating in all phases of the naval aviation acquisition process.

NAVAIR is affiliated with four Naval Aviation Program Executive Offices (PEOs), each with numerous Program Manager Air offices, responsible for the life cycle management and execution of their assigned major defense acquisition programs. They include:

- PEO Tactical Aircraft Programs
- PEO Air Anti-Submarine Warfare, Assault and Special Mission Programs
- PEO Unmanned Aviation and Strike Weapons
- PEO Joint Strike Fighter

PEOs and Program Manager Air offices sponsor the majority of testing within the PRC and establish the capabilities and requirements needed to maintain military readiness of the U.S. Navy Fleet.

To meet these requirements, NAWCAD applies expertise throughout the acquisition process to deliver high-quality data products essential for program decision makers to proceed to the next acquisition milestone. Operations conducted under highly controlled conditions, within PRC flight and ground test facilities, enable the collection of this empirical data and evaluation of systems performance. Unique PRC capabilities and resources are highlighted in Table 1.4-1.

Table 1.4-1 Unique PRC Capabilities and Resources

Unique PRC Capabilities and Resources
• Fully instrumented and integrated Atlantic Test Ranges, providing full-service support for cradle-to-grave testing and training in a safe and operationally realistic air, land, and sea environment
• Highly skilled technical workforce employing the most advanced methods of aviation engineering and RDT&E to meet Fleet requirements
• Test management coordination and range safety
• Radio frequency spectrum management
• Time, space, position information of tracked air vehicles, vessels, and munitions
• Real-time data transmission between test aircraft and ground stations using the Real-time Telemetry Processing System
• World-class signature measurement capabilities
• Data processing and display
• Sea, land, and aerial target; threat emitter; and mobile asset services
• Over 100 ground test facilities and laboratories dedicated to aviation systems RDT&E
• Interface with state-of-the-art simulation and stimulation facilities and laboratories modeling Fleet battlespace environments

Table 1.4-1 Unique PRC Capabilities and Resources, Continued

Unique PRC Capabilities and Resources
• Interconnectivity with Naval Air Warfare Center Weapons Division ranges and other Major Range and Test Facility Base sites
• Testing conducted by the Naval Test Wing Atlantic, the most technically diverse air wing in naval aviation including the Navy and Marine Corps' first dedicated unmanned aerial system test and evaluation squadron
• Center for full-spectrum RDT&E of Fleet unmanned aerial system platforms including launch and recovery, control systems, data and communication links, mission sensor packages, airspace integration, weapon integration, interoperability, and autonomy
• United States Naval Test Pilot School training of the world's finest developmental test pilots, flight officers, engineers, and industry and foreign partners; only United States military test pilot school to offer rotary-wing aircraft instruction

Key: RDT&E = research, development, test and evaluation.

Recent changes in the DoD 5000 Series of The Defense Acquisition Strategy promote a new adaptive acquisition framework. This new framework is intended to drive programs to deliver Fleet capabilities faster and more efficiently through accelerated technology maturation and rapid prototyping and fielding or, to "deliver capability at the speed of relevance."

Innovation. Readiness. Speed to the Fleet.

The Proposed Action, to continue conducting military testing and training activities within the PRC, is consistent with this strategy and critical to meeting its objective. As a Major Range and Test Facility Base, the united NAWCAD and PRC is an irreplaceable, national asset whose support of the Defense Acquisition System and delivery of superior naval aviation products must continue to maintain military readiness of our naval forces and sustain our nation's defense, now and into the future.

1.5 Scope of Environmental Analysis

This EIS includes an analysis of potential environmental impacts associated with a No Action Alternative and two action alternatives (further described in Chapter 2, Proposed Action and Alternatives). The No Action Alternative reflects a 10-year baseline of testing and training activities conducted within the PRC. The action alternatives convey anticipated future operational requirements, projected by range complex subject matter experts and users, to meet the purpose and need. Activities not included and considered outside the scope of this EIS are those conducted (1) indoors within specialized ground test facilities and/or laboratories at NAS Patuxent River and (2) offshore in the Atlantic Warning Areas (and previously evaluated in the *Atlantic Fleet Training and Testing EIS/Overseas EIS*) (U.S. Department of the Navy, 2018a).

The environmental resource areas analyzed in this EIS include airborne noise, air quality, water resources and sediments, biological resources, public health and safety, land use, socioeconomics, environmental justice, and cultural resources. Direct, indirect, and cumulative impacts to these resource areas are evaluated. In accordance with CEQ Regulations, 40 CFR section 1505.2, the Navy will issue a Record of Decision (ROD) that provides the rationale for choosing one of the alternatives.

1.6 Key Documents

Key documents are sources of information incorporated into this EIS. Documents are considered to be key because of similar actions, analyses, or impacts that may apply to this Proposed Action. CEQ guidance encourages incorporating documents by reference. Documents incorporated by reference in part or in whole include:

- **Final EIS, Increased Flight and Related Operations in the Patuxent River Complex, December 1998 (ROD signed May 17, 1999).** This EIS assessed the potential environmental effects of increased flight and related operations in PRC test areas under the exclusive control and scheduling authority of NAWCAD. The complex included NAS Patuxent River and OLF Webster flight and ground test facilities and airfields, as well as the restricted airspace, aerial and surface firing range, and fixed targets that comprised the Chesapeake Test Range, now known as ATR. The Preferred Alternative was Operational Workload III with a maximum of 24,400 flight hours per year (U.S. Department of the Navy, 1998).
- **Final EA, Joint Strike Fighter Navy/Marine Corps Variant Concept Demonstration Phase Flight, July 2000 (Finding of No Significant Impact [FONSI] signed August 28, 2000).** This EA addressed the Joint Strike Fighter (JSF) Program Office proposal to conduct a Concept Demonstration Phase Flight Test Program for JSF aircraft variants, including the Navy carrier-based variant and Marine Corps Short Takeoff and Vertical Landing (STOVL) variant. The Preferred Alternative involved using NAS Patuxent River flight test support, test equipment, laboratories, and personnel to carry out the Concept Demonstration Phase events for the carrier-based variant and STOVL JSF aircraft. (U.S. Department of the Navy, 2000)
- **Final EA, Expansion of Test Operations by the Naval Surface Warfare Center Carderock Division, Combatant Craft Division at the Naval Air Station Patuxent River, Maryland, July 2005 (no FONSI issued; expansion of test operations did not occur at NAS Patuxent River).** This EA analyzed the expansion of the existing Combatant Craft Division test operations and introduction of new tests at NAS Patuxent River to support RDT&E activities associated with surface vessels. Tests evaluated vessel performance, watercraft disabling and identification devices, various maritime technologies and products, warning shot effectiveness, and weapon systems firing. Activities occurred in the Chesapeake Bay Water Range and Patuxent River within the PRC. (U.S. Department of the Navy, 2005a)
- **Final EA/Overseas Environmental Assessment (OEA) for Organic Airborne and Surface Influence Sweep (OASIS) Mission Tests, June 2005 (FONSI/Finding of No Significant Harm (FONSH) signed September 6, 2005).** This EA/OEA evaluated the potential environmental impacts associated with OASIS test activities. The OASIS project tested mine countermeasure techniques by producing magnetic and acoustic influences (“sweeps”) from a towed platform. Flying qualities and performance, captive carry, jettison, mechanical characteristics, loading and unloading, ground handling, and integration of OASIS hardware and software with a helicopter platform were tested within the PRC. All OASIS activities conducted within PRC waters were non-magnetized events. (U.S. Department of the Navy, 2005b)
- **Final EA, Operations at the Bloodsworth Island Range, Maryland, February 2006 (FONSI signed February 2, 2006).** This EA evaluated the potential environmental effects of increasing the use of land and surface water resources of the Bloodsworth Island Range for RDT&E and select training events. Based on mission requirements, the Navy chose to continue non-impact operations in support of aviation-related testing within the restricted airspace above Bloodsworth Island

Range. The Navy selected the "No-Action Alternative" as the preferred alternative, maintaining the current operational environment. (U.S. Department of the Navy, 2006)

- **Final EA/OEA, The Joint Strike Fighter Development and Demonstration Developmental Test Program, January 2007 (FONSI/FONSH signed January 31, 2007).** This EA/OEA analyzed the potential effects from conducting the JSF Development Test Program. Proposed Development Test activities, involving three F-35 variants, were conducted over a six- to seven-year period at DoD facilities and ranges equipped with the assets and expertise to support the T&E of military strike aircraft weapon systems. Alternative One estimated approximately 35 percent of all Development Test activities to occur within the PRC. Additionally, Preferred Alternative Two, which included Alternative One, projected approximately 90 percent of all planned STOVL tests to occur within the PRC. (U.S. Department of the Navy, 2007a)
- **Supplemental EA/OEA Joint Strike Fighter Systems Development and Demonstration, Developmental Test Program, June 2013 (FONSI/FONSH signed August 26, 2013).** This Supplemental EA/OEA re-evaluated the potential effects of the Proposed Action to conduct the JSF DT Program. Alternative One estimated 46 percent of the east coast F-35 flights to occur in the PRC. Alternative Two (the Preferred Alternative) also projected 90 percent of the STOVL hover operations and 64 percent of ground-based operations to be performed at NAS Patuxent River. (U.S. Department of the Navy, 2013b)
- **Final EA, Functional Checks of the MH-60R Helicopter and the AN/AQS-22 System in the Chesapeake Bay, December 2013 (FONSI signed December 20, 2013).** This EA assessed the potential impacts from increasing the number of annual functional check events of the AN/AQS-22 sonar system and MH-60R helicopter in the middle Chesapeake Bay. Potential effects to physical, biological, and man-made resources associated with the alternatives were studied. Functional checks occurred at dip point locations north of the Chesapeake Bay Water Range within the PRC. (U.S. Department of the Navy, 2013a)
- **Final EA, Atlantic Test Ranges Expansion of Unmanned Systems Operations, September 2014 (FONSI signed September 21, 2015).** This EA assessed the potential environmental effects of expanding unmanned systems testing and training activities in the ATR Inner Range. The Proposed Action included types of UAS, unmanned ground systems, and unmanned maritime systems either separately or as part of complex, multi-system groups. Testing of unmanned systems supports the development of new generation unmanned platforms and their associated sensors and payloads. (U.S. Department of the Navy, 2015a)

A list of publications used in preparing this EIS can be found in Chapter 7 (References). Documents incorporated herein by reference are available upon request during the public review period by contacting the Navy via the information provided in the Abstract.

1.7 Relevant Laws and Regulations

The Navy has prepared this EIS based upon federal and state laws, statutes, regulations, and policies pertinent to the implementation of the Proposed Action, including the following:

- NEPA (42 U.S.C. sections 4321–4370h), which requires an environmental analysis for major federal actions that have the potential to significantly impact the quality of the human environment
- CEQ Regulations for Implementing the Procedural Provisions of NEPA (40 CFR parts 1500–1508)

- Navy regulations for implementing NEPA (32 CFR part 775), which provides Navy policy for implementing CEQ Regulations and NEPA
- Clean Air Act (42 U.S.C. section 7401 et seq.)
- Clean Water Act (33 U.S.C. section 1251 et seq.)
- Appropriation or Use of Waters, Reservoirs, and Dams, Annotated Code of Maryland, Environment Article, Section 5-501, et seq.
- Water Pollution Control, Annotated Code of Maryland, Environmental Article, Sections 9-313 through 9-323
- Coastal Zone Management Act (16 U.S.C. section 1451 et seq.)
- National Historic Preservation Act (54 U.S.C. section 306108 et seq.)
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. section 3001 et seq.)
- Endangered Species Act (16 U.S.C. section 1531 et seq.)
- Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (16 U.S.C. section 1801 et seq.)
- Marine Mammal Protection Act (16 U.S.C. section 1361 et seq.)
- Migratory Bird Treaty Act (16 U.S.C. sections 703–712)
- Bald and Golden Eagle Protection Act (16 U.S.C. sections 668–668d)
- Fish and Wildlife Conservation Act (16 U.S.C. sections 2901-2911)
- FAA Regulations Part 91, General Operating and Flight Rules
- Military Munitions Rule, 40 CFR parts 260–266 and 270
- Executive Order (EO) 12962, Recreational Fisheries
- EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations
- EO 13045, Protection of Children from Environmental Health Risks and Safety Risks
- EO 13175, Consultation and Coordination with Indian Tribal Governments
- EO 13186, Responsibilities of the Federal Agencies to Protect Migratory Birds

A description of the Proposed Action’s consistency with these laws, policies, and regulations, as well as the names of regulatory agencies responsible for their implementation, is presented in Chapter 5 (Other Considerations Required by NEPA) (Table 5.1-1, Principal Federal and State Laws Applicable to the Proposed Action).

1.8 Public and Agency Participation and Intergovernmental Coordination

CEQ regulations direct agencies to involve the public in preparing and implementing their NEPA procedures. On February 15, 2019, the Navy published in the Federal Register (Volume 84, Number 32 Federal Register page 4457) a Notice of Intent to prepare an EIS that included the dates and locations of scoping meetings. The Navy also notified the public and government representatives through mailings of letters and postcards, notices in local and regional newspapers and news websites, and on the EIS website at www.PRCEIS.com. Details on these scoping materials are provided in Chapter 6 (Public Involvement and Distribution). The Navy solicited public and agency comments during a scoping period from February 15, 2019, through April 1, 2019. Scoping meetings were held on the following dates and locations:

March 4, 2019	Heathsville, Virginia
March 5, 2019	California, Maryland
March 6, 2019	Princess Anne, Maryland
March 7, 2019	Cambridge, Maryland

Comments received during the scoping period were considered in preparing the Draft EIS. The comments are summarized in Section 6.4.2.2 (Public Scoping Comments) and are available in Appendix G (Public Involvement).

The Navy has prepared this Draft EIS to inform the public of the Proposed Action and to allow the opportunity for public review and comment. The 45-day public review period will begin with the U.S. Environmental Protection Agency's publication in the Federal Register of the Notice of Availability (NOA) of the Draft EIS for the PRC. The Navy will also publish a NOA and Notice of Public Meetings in the Federal Register that will describe the Proposed Action, solicit public comments, provide the public comment period dates, and announce the local and regional library locations where Draft EIS copies will be available for review. In addition, the Draft EIS will be available on the website at www.PRCEIS.com. The Navy will hold virtual public meetings to describe the environmental impacts of the Proposed Action and alternatives, and to receive comments on the Draft EIS impact analyses. Comments received during the 45-day public comment period will be considered for development of the Final EIS.

The Navy will consider all substantive comments received from the Draft EIS public review period for the development of the Final EIS. The U.S. Environmental Protection Agency will publish a NOA of the Final EIS in the Federal Register to start the 30-day wait period. New substantive comments received during the 30-day wait period will be addressed in the ROD. Following the 30-day wait period, a ROD will be prepared. The ROD will state the decision, identify alternatives considered (including the Preferred Alternative), address substantive comments received on the Final EIS that were not previously addressed, discuss other considerations that influenced the final decision, and address mitigation, if needed. Following signing of the ROD, the Navy will publish a NOA of the ROD in the Federal Register.

There are no cooperating agencies for this EIS. The Navy will consult with the National Marine Fisheries Service Greater Atlantic Region and U.S. Fish and Wildlife Service Chesapeake Bay Field Office in accordance with section 7 of the Endangered Species Act. The Navy will consult with the Mid-Atlantic Field Office Supervisor and Essential Fish Habitat Coordinator, Greater Atlantic Regional Fisheries Office, in accordance with the Magnuson-Stevens Fishery Conservation and Management Act. A Coastal Consistency Determination will be prepared and submitted to the Maryland Department of Natural Resources and Virginia Department of Environmental Quality. A Coastal Consistency Negative Determination will be submitted to the Delaware Department of Natural Resources and Environmental Control. The Navy will also coordinate with the State Historic Preservation Officer at the Maryland Historical Trust, Virginia Department of Historical Resources, and Delaware Division of Historical and Cultural Affairs regarding the Proposed Action.

2 Proposed Action and Alternatives

This chapter provides detailed information on the Proposed Action and alternatives that are analyzed in this Environmental Impact Statement (EIS).

2.1 Proposed Action

The Proposed Action is to continue conducting military testing and training activities within the Patuxent River Complex (PRC) to meet current and projected military readiness requirements. The Proposed Action includes testing and training activities analyzed in the 1998 PRC EIS and subsequent Environmental Assessments (EAs), as well as adjustments to current testing and training activities required to support projected United States (U.S.) Department of the Navy (Navy) military readiness requirements into the foreseeable future. This EIS consolidates the testing and training activities analyzed in these previous documents and, in addition to their continuation, accommodates the following adjustments to current testing and training activities deemed necessary to meet typical and maximum military readiness requirements into the future:

- higher annual average of aircraft flight hours and adjustments in aircraft mix (e.g., increased unmanned aerial system [UAS] platforms)
- increases in most non-explosive munitions and other military expended materials (MEM)
- increased use of PRC waters to accommodate surface vessel and subsurface vehicle testing and training
- adjustments in the types of mission systems being integrated and tested in aircraft and surface and subsurface platforms (e.g., anti-submarine warfare [ASW] and mine countermeasure [MCM] systems)
- expanded use of the Patuxent River Seaplane Area to enhance search and rescue (SAR) training
- addition of active sonobuoy testing in conjunction with helicopter dipping sonar tests
- testing of new technologies to address new and emerging threats

The types of testing and training activities and assets associated with the Proposed Action are described in the following sections.

2.1.1 Activities Continuing from the 1998 PRC EIS

Under the Proposed Action, the Navy would continue all activities analyzed in the 1998 PRC EIS. These activities can be broadly organized as aircraft flight activities, ground-based activities, or surface vessel activities. All activities would continue to occur within the PRC airspace, land areas, and/or water areas described in Section 1.3 (Location and Description of the Patuxent River Complex) and be executed according to the safety policies and procedures described in Section 2.5 (Standard Operating Procedures Included in Proposed Action).

2.1.1.1 Aircraft Flight Activities

As the Navy's premier aircraft test range, flight activities are the most frequent and foremost performed within the PRC. The Naval Air Warfare Center Aircraft Division (NAWCAD) Naval Test Wing Atlantic (NTWL) and other squadrons home-based at Naval Air Station (NAS) Patuxent River (hereinafter referred to collectively as tenant squadrons) conduct the majority of aircraft flights. Transient aircraft, not stationed at NAS Patuxent River, also utilize PRC airspace but on a much less frequent basis. This combination of tenant squadrons and transients comprise the primary users of the complex (Table 2.1-1). A description of each squadron is provided in Appendix A (Patuxent River Complex Activity and Asset Descriptions).

Table 2.1-1 Primary PRC Users

Naval Test Wing Atlantic Squadrons	
Air Test and Evaluation Squadron	Two Zero (VX-20)
	Two One (HX-21)
	Two Three (VX-23)
	Two Four (UX-24)
United States Naval Test Pilot School (USNTPS)	
Other NAS Patuxent River Squadrons	
Air Operations Search and Rescue (SAR)	
Fleet Air Reconnaissance Squadron Four (VQ-4)	
Air Test and Evaluation Squadron One (VX-1)	
Scientific Development Squadron One (VXS-1)	
Maryland Army National Guard (MDARNG)	
Non-NAS Patuxent River Transients	
Transient Squadrons	

Flight activities occur daily and may involve the full spectrum of manned and unmanned, fixed- and rotary-wing aircraft. All aircraft flights originating or terminating in the PRC or utilizing PRC airspace are analyzed in this EIS. Aircraft flights are considered test flights, training flights, or other flights depending on the type of flight activity.

Test flights evaluate the performance, reliability, and safety of new, modified, or upgraded aircraft and/or associated aircraft systems. Tenant squadrons execute most test flights either in direct support of Navy acquisition programs or in association with other military services, U.S. agencies, commercial customers, or foreign governments (U.S. Department of the Navy, 1998). Test flights typically require Atlantic Test Ranges (ATR) instrumentation and support and are performed under highly controlled conditions to allow the collection of empirical data. These flights are accomplished within four main test areas, with subareas that further define specific tests. A complete list of test flight activities is provided in Appendix A (Patuxent River Complex Activity and Asset Descriptions). Squadron VX-1 also conducts a small amount of test flights in carrying out its operational test (versus developmental test) mission.

Most training flights within the PRC are performed by the U.S. Naval Test Pilot School (USNTPS). The school contributes over 6,000 flight hours per year training new aircraft test pilots. Other tenants train to ensure their aircrew and aircraft are continuously able to support the NAWCAD research, development, test and evaluation (RDT&E) and operational squadron missions. Tenant training flights routinely occur within PRC airspace but do not typically require ATR support. Transient training flights are accommodated on a noninterference basis with the primary aircraft test mission. These flights are conducted by aircrews stationed within the surrounding area such as U.S. Air Force and state National Guard reservists from Maryland and Pennsylvania, as well as U.S. Navy Fleet active duty squadrons operating in Virginia. Transient training is primarily unit level (one to two aircraft) and may be passive (e.g., an authorized flight transiting through PRC airspace) or interactive (e.g., requiring a combination of ATR resources including but not limited to targets, real-time data retrieval, electronic warfare [EW] threat emitters, and radars) (U.S. Department of the Navy, 1998).

Other flights include those conducted by tenant squadrons that have a support and/or operational function. These other flights do not typically require ATR support but occur on a routine basis within the PRC. Table 2.1-2 provides a brief description of aircraft flight activities. More comprehensive descriptions of these activities are available in Appendix A (Patuxent River Complex Activity and Asset Descriptions).

Table 2.1-2 Aircraft Flight Activities

Activity Name	***Activity Description***
Test Flights	
Air Vehicle Tests	Expose the airframe and aircrew to the full operational limits of altitude, speed, load factor, gross weight, environmental conditions, and operational situations experienced during Fleet operations. Tests include aeromechanics (including weapons compatibility and separation tests), air vehicle subsystems, structural tests, and crew systems. May involve the release of non-explosive munitions or other MEM.
Carrier and Shipboard Suitability Tests	Evaluate aircraft compatibility with ship-based takeoff, approach, recovery equipment, and landing using special ground-based facilities designed to simulate a shipboard environment (e.g., TC-7 steam catapult, MK-7 arresting gear, and short takeoff vertical landing facility). Tests include fixed-wing, rotary-wing, and ships' air traffic and control and landing systems certification tests.
Mission Systems Tests	Evaluate the performance and operability of subsystems (e.g., electronics) that are integrated into cockpit displays and fire control systems of modern military aircraft (and ships). Both the operational functionality of the system (or subsystem) and interoperability with the aircraft and its systems are verified. Tests include communication (including lasers), navigation, information warfare, computers, armament control, sensors, electromagnetic environmental effects, laser designators and rangefinders, and ship and shore-based systems. Do not typically but may involve the release of non-explosive munitions or other MEM.
Electronic Warfare Tests	Evaluate U.S. military electronic combat systems against a wide variety of threat simulations, surrogates, and actual systems that represent real world threat scenarios. Tests include electronic attack (including directed energy and cyberwarfare), electronic protection, electronic warfare support, and radar cross section and infrared signature measurement. May involve the release of non-explosive munitions or other MEM related to electronic countermeasures (e.g., chaff, flares).
Operational Tests	VX-1 operational aircraft test and evaluate airborne anti-submarine warfare and maritime anti-surface warfare weapon systems, airborne strategic weapons systems, as well as support systems, equipment, and materials.
Training Flights	
Aircrew Proficiency Flights*	Performed to maintain the flying skills of pilots and aircrew personnel.
Field Carrier Landing Practice*	Performed on a runway equipped to simulate an aircraft carrier flight deck to familiarize pilots with carrier landings. Flown in close proximity to the airfield and below 3,000 feet.
United States Naval Test Pilot School Flights	Train experienced pilots in the processes and techniques of aircraft systems test and evaluation to be aircraft test pilots.
Transient Training Flights	Train transient aircrew in unit level skills such as aircrew proficiency, field carrier landing practice, electronic warfare, weapons integration and separation, simulated air-to-air combat, and other tactical training tasks. May involve the release of non-explosive munitions or other MEM.
Other Flights	
Support Flights	Naval Test Wing Atlantic aircraft provide support needed to successfully accomplish a testing or training event. Flights include in-flight refueling, safety/photo chase, logistics, cooperative target and threat simulation, range surveillance, or other unique services.
Cross-Country Flights	Flown to transport equipment, material, and/or personnel to and from the air station in support of testing, training, or basekeeping operations.
Functional Check Flights	Conducted to determine whether the airframe, propulsion, accessories, and equipment are functioning in accordance with predetermined standards when subjected to the intended operating environment.

Table 2.1-2 Aircraft Flight Activities, Continued

Activity Name	Activity Description
Mission of State Flights	Unmanned aerial systems (e.g., MQ-4C Triton) perform post-hurricane surveillance involving high-altitude and meteorological surveys in support of post-disaster relief efforts.
Search and Rescue Flights	Search and rescue helicopters (MH-60) locate and recover military or civilian personnel injured or lost during a testing, training, or non-military event. May involve the release of marine markers as surface reference points to locate/mark survivors.
Strategic Communications Flights	VQ-4 aircraft (E-6B) conduct operational patrols to provide airborne command posts and strategic communications relays.
Scientific Development Flights	VXS-1 aircraft execute airborne science and technology projects such as bathymetry, electronic countermeasures, gravity mapping, and radar development.

Key: MEM = military expended materials.
Note:
* = May also be performed by transients.

2.1.1.2 Ground-Based Activities

Ground-based activities include those performed by aircraft on the ground that are related to aircraft flights or non-flight tests that are conducted in specialized ground test facilities and laboratories. Aircraft ground-based activities are conducted to maintain aircraft at optimum and safe performance levels and include aircraft pre- and post-flight checks, ground taxiing, aircraft ground testing, aircraft servicing, and aircraft engine maintenance (U.S. Department of the Navy, 1998). Aircraft pre- and post-flight activities include systems and propulsion tests and hydraulic checks performed before a mission is undertaken and after it is completed. Aircraft ground tests include outdoor run-ups, steam ingestion, hover pad, and aircraft run stand testing. These activities may involve various types of ground support equipment (GSE) and are performed routinely by aircrew and maintenance personnel on airfield flight lines, taxiways, tarmacs, and hangar aprons.

Ground test facility and laboratory testing involves non-flight research and development, aircraft and weapons systems component testing, and laboratory-based modeling and simulations that are carried out at over 100 specialized facilities at NAS Patuxent River and Outlying Field (OLF) Webster. Most ground tests are performed indoors and are, therefore, not included in this EIS analysis. However, tests conducted within facilities having an open-air, outdoor environment are included in the Proposed Action. Locations of representative facilities with outdoor testing areas are shown in Figure 2.1-1.

The Open-Air Engine Test Cell Facility and Armament Test Area (ATA) are two such facilities with outdoor components. The Open-Air Engine Test Cell Facility conducts full performance static runs of turbojet, turboprop, and shaft engines. Engines are mounted on portable test cells, allowing the development of up to 30,000 pounds of thrust. Tests evaluate test cell instrumentation and control systems and determine if engines meet the standards for issue and installation into aircraft. The ATA is an operational range area containing a gun-firing tunnel, rocket test stand, two munition drop test pits, helicopter missile launch pad, and an aerial target launch area (Figure 2.1-2). Activities include aircraft gun-firing; munition drop tests; aerial target launching; weapons compatibility and certification testing; and occasional use of a cockpit escape system test rig. Facilities that emit electromagnetic energy in an outdoor environment are also included in the Proposed Action. They include the Air Combat Environmental Test and Evaluation Facility, Communications Test and Evaluation Facility, Facilities for Antenna and Radar Cross Section Measurement, and several electromagnetic radiation test facilities. Ground test facilities and their associated tests are further detailed in Appendix A (Patuxent River Complex Activity and Asset Descriptions).

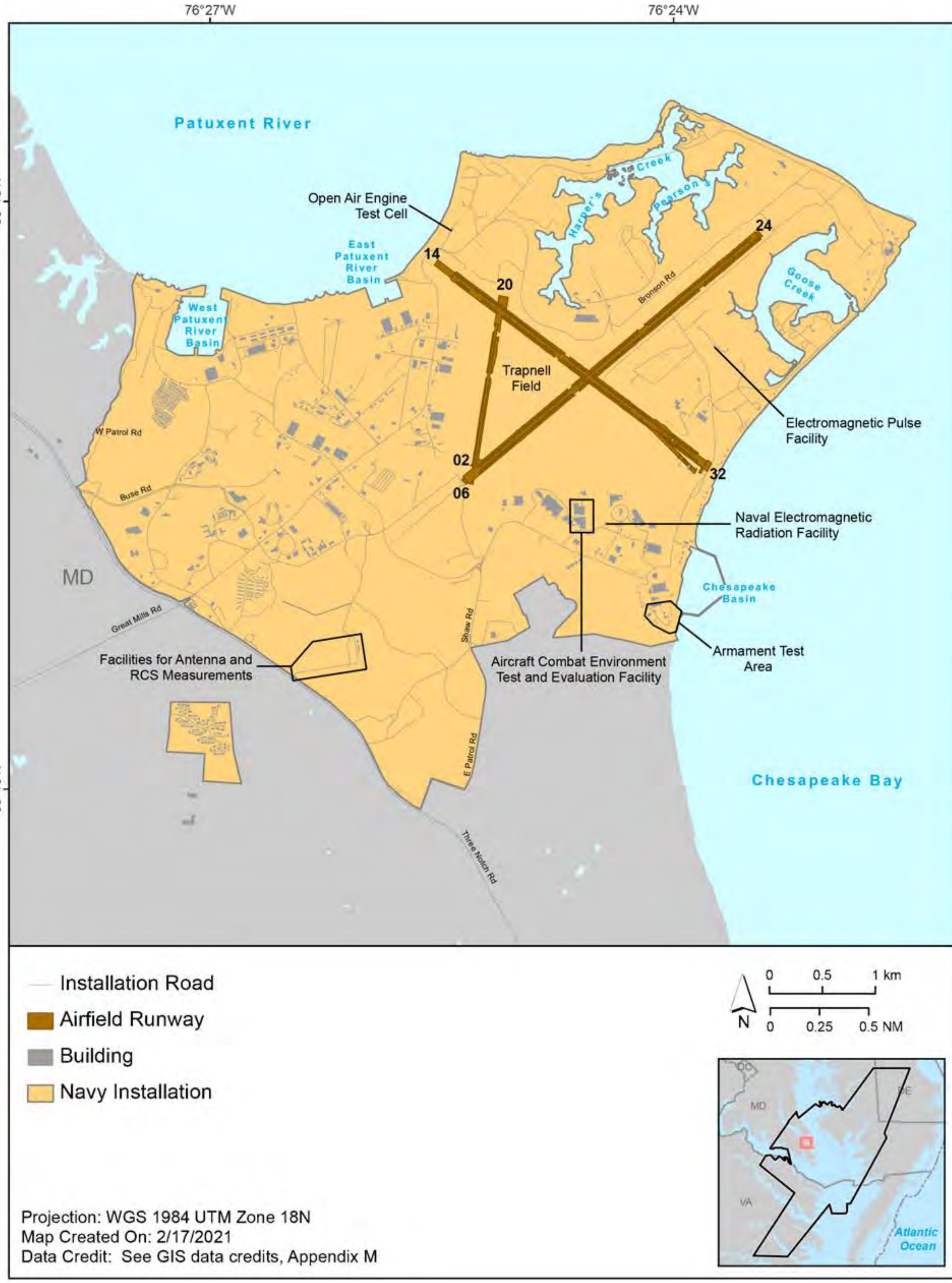


Figure 2.1-1 Ground Test Facilities and Laboratories

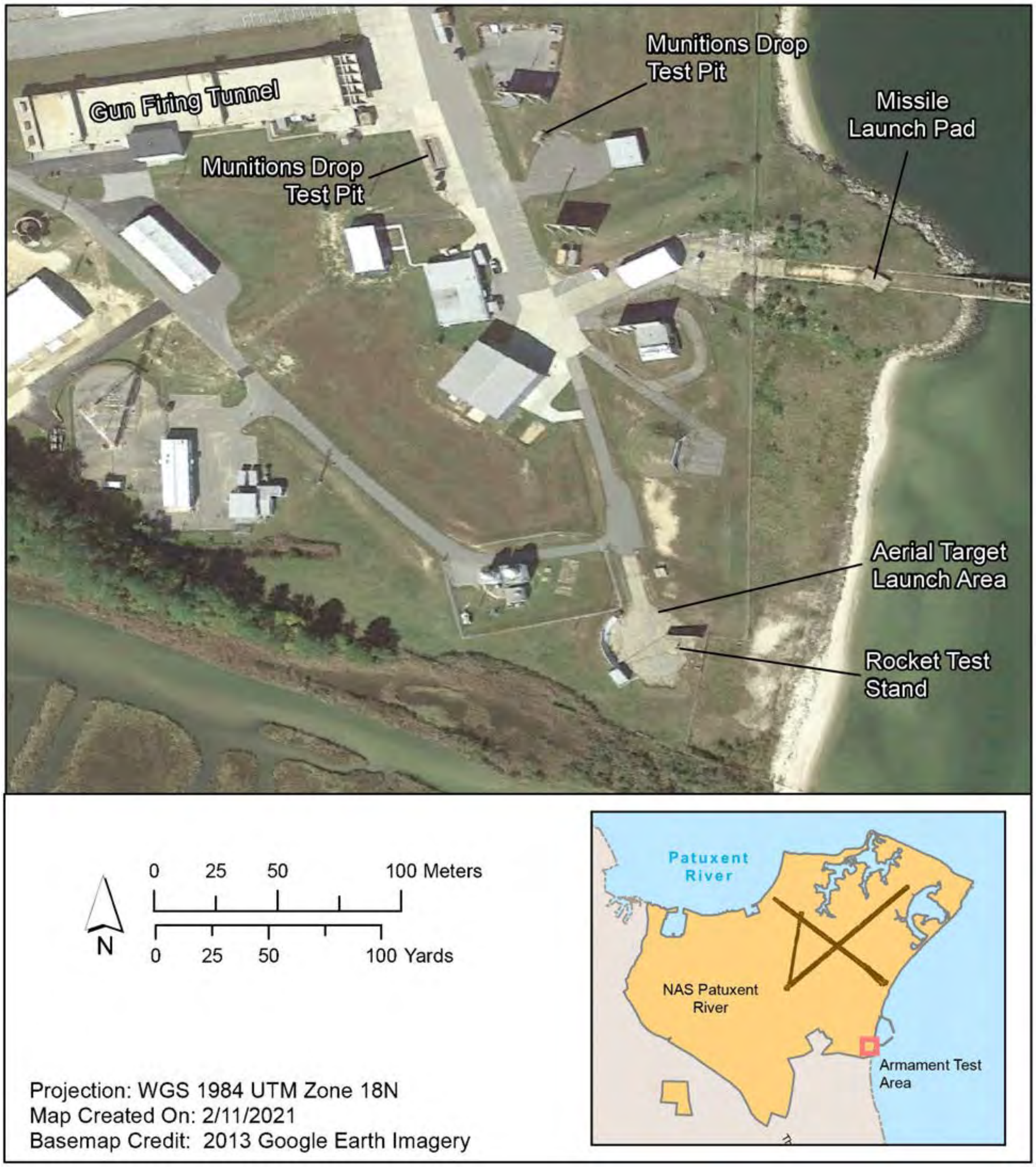


Figure 2.1-2 Armament Test Area

2.1.1.3 Surface Vessel Activities

Surface vessel activities involve the use of the Chesapeake Bay Water Range and its fixed target areas. The safe use of the target areas is largely achieved by NAWCAD Atlantic Targets and Marine Operations (ATMO) Division range support boats. Range support boats account for the majority of surface activities conducted within PRC waters and provide the services required to safely accomplish a testing or training event. These include range surveillance and clearance, logistics, cooperative target and threat simulation, target launch or presentation, target or test article recovery, and other unique services. Support boats can be manned or remote controlled (i.e., unmanned), depending on customer requirements, or can be used to tow a target or act as targets themselves. Information on the current ATMO fleet is available in Appendix A (Patuxent River Complex Activity and Asset Descriptions). ATMO may also periodically contract or procure other boat types of similar size and performance.

2.1.2 Expanded Technologies and Capabilities Since the 1998 PRC EIS

As Navy aircraft, weapons, and systems evolve, so must the testing and training mission. Accordingly, different types of testing and training activities and new technologies have been introduced to accurately evaluate their effectiveness. The following sections describe the testing and training activities assessed in EAs completed since 1998 (Section 1.6, Key Documents) as well as any proposed adjustments to these and other current activities needed to meet military readiness requirements. All of these activities fall within the existing testing and training areas, described above, except rather than being conducted by current aircraft, they are performed by new or different air, land, surface, or subsurface platforms. Example areas include vehicle performance testing, mission systems testing, weapons integration testing, EW testing, and unit level training.

2.1.2.1 Surface and Subsurface Testing and Training

As a Major Range and Test Base Facility, NAWCAD has expanded its capabilities and resources beyond aircraft flights to support the testing and training of non-NAWCAD surface and subsurface platforms. These activities were analyzed in a 2005 EA (U.S. Department of the Navy, 2005a) (and NAWCAD Records of Environmental Consideration) and include surface vessel and subsurface vehicle testing, watercraft detection and disabling testing, and small boat training. Additional details on these activities can be found in Appendix A (Patuxent River Complex Activity and Asset Descriptions).

Platforms include a variety of combatant and patrol craft as well as various unmanned maritime systems (UMS) including unmanned surface vehicles (USV) and unmanned underwater vehicles (UUV). These platforms are typically sponsored by customers such as the Naval Sea Systems Command (including the Naval Surface Warfare Center); U.S. Coast Guard; Office of Naval Research; Defense Advanced Research Projects Agency; or other nonmilitary groups, university research laboratories, agencies, or commercial vendors.

Watercraft detection and disabling tests may involve the release of non-explosive munitions (e.g., gun ammunition and missiles) or other MEM and require the use of fixed, floating, or mobile surface targets. Small boat training may involve surface-to-surface gunfire against Hannibal Target or mobile surface targets. These activities occur within the Chesapeake Bay Water Range and installation surrounding waters (Figure 1.3-6, PRC Water Areas), although those involving weapons release occur within the Chesapeake Bay Water Range only.

Under the Proposed Action, the Navy would continue supporting surface and subsurface activities by non-NAWCAD organizations. These activities are not routine but rather intermittent and based on customer requirements. Such occurrences will be included in the annual numbers of vessels and UMS proposed to operate within the PRC.

2.1.2.2 Mine Countermeasure Systems Testing

An EA was prepared in 2005 to assess the integration of the organic airborne and surface influence sweep MCM system with an MH-60 helicopter (U.S. Department of the Navy, 2005b). Since then, the integration of numerous MCM systems have been tested on various manned and unmanned air, surface, and subsurface platforms (e.g., MQ-8 Fire Scout and various UUV). MCM systems are typically airborne or towed and used for mine detection or neutralization. Details on representative types of MCM systems are available in Appendix A (Patuxent River Complex Activity and Asset Descriptions).

MCM systems use a variety of sensors or mechanical devices to detect and/or neutralize mines or other targets (e.g., mine shapes). Tests may call for individual targets or multiple targets to simulate a water or land-based minefield. All mines/mine shapes are non-explosive, and mine detonation does not occur within the PRC. With the exception of deployed mine neutralizers (specifically from the airborne mine neutralization system), all targets and MCM systems are fully recovered.

MCM events are infrequent, intermittent, and dependent on customer requirements. These activities occur within the Chesapeake Bay Water Range and installation surrounding waters (Figure 1.3-6, PRC Water Areas). The Proposed Action would allow the continued integration of MCM systems with manned and unmanned air, surface, and subsurface test platforms.

2.1.2.3 Bloodsworth Island Range Activities

Under the Proposed Action, the Navy would continue the use of the Bloodsworth Island Range as a non-impact range in support of aviation-related RDT&E consistent with the 2006 EA. Most activities occur within the restricted airspace overlying the range and include the following: aircrew proficiency flights, SAR flights, air vehicle tests (e.g., flying qualities and performance, propulsion, crew systems, night vision systems), mission systems tests (e.g., radar, UAS sensors, laser designators, microwave communications, navigation systems, mapping systems, and other electronic systems), and EW tests (U.S. Department of the Navy, 2006).

Visual targets at Bloodsworth Island Range allow aircrews to train on how to sight and recognize ground-based threats. Current targets consist of billboard-type signs, radar reflectors, simulated weapons platforms (e.g., full-size molded plastic tanks), discarded military and civilian vehicles (oil and gas removed), and other equipment. The Navy would continue Bloodsworth Island Range target maintenance, including target replacement and/or relocation, as needed to meet specific testing or training requirements. The Proposed Action would also allow for the continued maintenance of Bloodsworth Island Range natural and cultural resources.

Use of Bloodsworth Island Range is highly variable and fluctuates with Navy aircraft program test requirements. Requirements for small UAS to use Bloodsworth Island Range overlying airspace R-4002 as exclusive use may increase in the future. This could further alleviate increasing demands to de-conflict manned and unmanned aircraft within PRC airspace. Increased R-4002 utilization by UAS would be reflected in annual PRC flight hour totals.

2.1.2.4 Anti-Submarine Warfare Systems Testing and Training

A 2013 EA analyzed an increase in the number of testing and training events involving the AN/AQS-22 dipping sonar system in the MH-60 helicopter (U.S. Department of the Navy, 2013a). Tests evaluate software and hardware upgrades to the sonar system as well as integration of new weapons that operate in concert with the system and its ASW mission (e.g., sonobuoys). Training includes aircrew proficiency in operating the dipping sonar as it is upgraded or new weapons integrated. Dipping sonar events may be active or passive and occur at dip points north of the Chesapeake Bay Water Range (Figure 1.3-6, PRC Water Areas). When active, the AN/AQS-22 sonar operates in the mid-frequency range of 1 to 10 kilohertz.

Under the Proposed Action, the Navy would continue to conduct activities evaluating the integration and performance of mid-frequency ASW sonar systems. In addition, the Navy is proposing to deploy up to two active sonobuoys in conjunction with some (approximately 35 percent) of the helicopter dipping sonar tests. Similar to the dipping sonar, the sonobuoys, such as the Directional Command Activated Sonobuoy System, would operate in the mid-frequency range. Appendix A (Patuxent River Complex Activity and Asset Descriptions) offers additional information on these ASW sonar systems. Proposed activities using mid-frequency active sonar systems would continue to occur at the sonar dip points. All sonobuoys would be immediately scuttled following test events.

2.1.2.5 Science and Technology Demonstrations

Science and technology (S&T) demonstrations are generally conducted or sponsored by nonmilitary groups or agencies (e.g., commercial vendors, colleges and universities, and national laboratories) for the purpose of demonstrating or testing the capabilities of new systems and subsystems. To date, two S&T events have taken place within the PRC: one in 2012 and the other in 2015. These events did not require EAs but were categorically excluded. Events involved technical teams demonstrating experimental and emergent technologies with up to 50 types of UUV as well USV and UAS platforms. Demonstrations were held in the areas of mine warfare, amphibious warfare, harbor/port security, intelligence and reconnaissance, bottom survey and mapping, infrastructure inspection, unexploded ordnance detection, explosive ordnance disposal, underwater salvage and recovery, and aircraft crash investigation. Events included daily activities with various systems for up to two weeks. Activities were conducted in multiple sites throughout the PRC, including installation surrounding waters (especially OLF Webster) and the Chesapeake Bay Water Range (Figure 1.3-6, PRC Water Areas). Targets included pre-existing bottom structures within the St. Mary's River, Potomac River, Patuxent River and Chesapeake Bay as well as some mine shapes and simulated non-explosive objects, all of which were recovered. The Navy would continue to support S&T Demonstrations per customer requirements. Event increases would be included in the annual numbers of UMS, aircraft, and/or manned surface vessel platforms proposed to operate within the PRC. The types of platforms and systems demonstrated and activities conducted may change as technologies evolve.

2.1.2.6 Unmanned Systems Testing and Training

A 2015 EA analyzed the expansion of unmanned systems RDT&E and training operations in the ATR including UAS, UMS, and unmanned ground systems (UGS) (U.S. Department of the Navy, 2015a). Activities range from a single vehicle to integration testing between unmanned air, maritime, and ground platforms. Each type of unmanned system is divided into categories described in Appendix A (Patuxent River Complex Activity and Asset Descriptions).

Testing and training activities involving UAS are similar to those performed by manned aircraft. Tests involving UMS and UGS primarily focus on their integration and interoperability with UAS or manned aircraft and surface vessels (U.S. Department of the Navy, 2015a). Activities unique to unmanned systems include integration and interoperability, teaming, and autonomy tests. These activities are further detailed in Appendix A (Patuxent River Complex Activity and Asset Descriptions). Unmanned systems activities may involve the release of non-explosive munitions or other MEM within the Chesapeake Bay Water Range and use a variety of targets. UMS may also employ towed arrays and high frequency acoustic source sensors during activities (U.S. Department of the Navy, 2015a).

Another area addressed in the 2015 EA is the use of UAS as targets to determine the effectiveness of emerging counter-UAS (C-UAS) technologies. UAS targets are typically small commercial off-the-shelf systems, such as quadcopters, and may be engaged from static or mobile, air, land, or surface platforms using a variety of C-UAS technologies. These activities may take place over the Chesapeake Bay Water Range, Bloodsworth Island Range, and PRC installation surrounding waters or airfields. A majority of C-UAS activities originate from OLF Webster and approximately 65 percent occur over land.

The Navy would continue to support the expansion of unmanned systems including the testing of rapidly emerging C-UAS technologies. Unmanned air, ground, and maritime platforms would continue to operate within PRC airspace, land areas, and water areas, respectively.

2.1.2.7 Directed Energy Systems Testing

Directed energy activities involve low- and high-energy laser and high-power microwave systems. Example directed energy systems analyzed in the 1998 PRC EIS include:

- laser designators and illuminators for targeting laser-guided munitions
- laser radars for ranging (e.g., aircraft tracking) and weather detection and mapping
- ground-based tests, including high-power microwaves, to evaluate aircraft system electromagnetic vulnerability within specialized ground test facilities

High-energy laser systems used for communications have also been tested within the complex. The Navy is proposing to expand directed energy testing within the PRC to include high-energy laser and high-power microwave weapons systems to address new and emerging threats.

A directed energy weapon emits energy that may deny, disrupt, disable, or destroy targeted electronics or cause mechanical damage to structures, platforms, or other equipment. The most immediate requirements are from Naval Sea Systems Command in support of C-UAS as well as counter-small boat (i.e., engine stalling or stoppage) testing. These directed energy activities fall within the existing EW test area described in Table 2.1-2 and detailed in Appendix A (Patuxent River Complex Activity and Asset Descriptions).

High-energy laser and high-power microwave weapons may be integrated into air, land, and surface platforms. Integration of both low-power lasers and/or high-energy laser in UUV is also an emerging requirement (Lynn, 2018). High-energy laser and high-power microwave testing would include surface-to-air, surface-to-surface, and air-to-surface scenarios as well as static tests. An example surface-to-air scenario is a directed energy weapon integrated in a fixed or mobile land-based or surface vessel platform against a single or multiple UAS targets. High-power microwave weapons could also be involved in air-to-air scenarios such as the detection and destruction of a threat UAS by an attack UAS. Directed energy weapons testing would require the use of aerial, surface, and land-based targets. High-power microwave weapons testing could also use facility targets for counter-electronics tests on infrastructure systems (e.g., non-kinetic disrupt of computer networks).

Testing of directed energy weapon systems would support the ongoing development of non-kinetic weapons in response to military mission requirements. Frequency would vary depending on customer requirements with each test series lasting up to two weeks (Behre & McQuage, 2019). Activities involving directed energy weapons would occur within PRC airspace, land areas, and water areas permitted by Range Safety, where the hazard pattern could be contained within range and/or installation boundaries and exclusive use airspace could be provided (for air scenarios). Primary laser areas would include Hooper Center Main Target and Hannibal Target within the Chesapeake Bay Water Range or within NAS Patuxent River or OLF Webster boundaries on or near the runways. Laser use at Bloodsworth Island Range is currently approved on case-by-case basis.

2.1.3 Testing and Training Assets

Testing and training activities conducted within the PRC may use a variety of air-, water-, and land-based assets as well as non-explosive munitions and other expendables. Details on these assets and the examples used for analysis in this EIS are provided in Appendix A (Patuxent River Complex Activity and Asset Descriptions) and briefly described below.

2.1.3.1 Air-Based Assets

Air-based assets used in the PRC include aircraft and aerial targets. Types of aircraft include the full spectrum of manned and unmanned, fixed- and rotary-wing platforms. Most aircraft fall within four broad categories based upon their design and operational characteristics. They include fixed-wing jet, fixed-wing propeller, rotary-wing aircraft (including tiltrotor), and UAS. UAS are further divided into five groups ranging from small (Group 1 handheld systems) to large (Group 5 full-scale aircraft) (Appendix A, Patuxent River Complex Activity and Asset Descriptions). In addition, unique aircraft associated with USNTPS (e.g., X-26 glider) are sometimes flown in the complex.

As Fleet requirements evolve, aircraft are modified or replaced, and aircraft models, series, or variants change. The resultant mix of aircraft within the PRC is, therefore, constantly changing; however, the four broad category types remain the same. Accordingly, representative aircraft platforms have been chosen for each of the fixed-wing jet, fixed-wing prop, rotary-wing, and UAS categories for analysis. They include the F/A-18E/F, C-12, UH-60A, and T-34 (UAS surrogate) respectively.

Aerial targets include towed banners and unmanned air platforms that range from small hand-launched UAS, to subsonic aerial target drones, to full-scale aircraft. Predominant aerial targets include BQM series (e.g., BQM-74 and BQM-177) and other UAS targets (e.g., quadcopters). BQM launches are infrequent but when required occur from the ATA. These aerial targets are not destroyed and are recovered from the Chesapeake Bay Water Range for reuse. UAS targets primarily consist of small Group 1 commercial off-the-shelf systems but may include up to Group 3. UAS targets may be flown over PRC land or water areas with recovery rates of 100 percent and 40 percent, respectively.

2.1.3.2 Water-Based Assets

Water-based assets used in the PRC include vessels, UMS, and surface and subsurface targets. Vessels include ATMO range support boats and non-NAWCAD combatant and patrol craft. These vessels range in size from small rigid inflatable boats to larger classes of patrol boats and littoral combat ships. Amphibious vehicles may also operate within the PRC but on rare occasion and not on land. Vessels generally deploy from the ATMO marina in the Chesapeake Basin and primarily operate within the Chesapeake Bay Water Range. A small amount of time (10 to 15 percent) may be spent outside the water range, but still within the PRC Study Area, to transit, support range activities, or participate in specialized tests. Scenarios typically involve one to two vessels but may include multiple vessels operating over various time frames and locations. Activities can last from a few hours to up to 12 hours, with range support boats averaging 4 hours and combatant and patrol craft averaging 8 hours per vessel activity.

UMS include USV and UUV. USV and UUV each fall within four distinct vehicle classes based on size and are either remote controlled (require a human operator) or autonomous (programmed to operate independently without human interaction) (U.S. Department of the Navy, 2015a). Primary types of USV include conventional hull craft, hydrofoil, and semi-submersible vehicles. UUV are typically torpedo-shaped vehicles but may also include box-shaped underwater robots (e.g., remotely operated vehicles and bottom crawlers). Most UUV operate at least 6 to 10 feet off the seafloor bottom; however, some remotely operated vehicles and crawlers may rest or operate on the bottom.

Surface targets may be mobile (manned or unmanned), free floating or towed, or stationary (anchored). Example types of mobile surface targets include High Speed Maneuverable Surface Targets, QST-35 Seaborne Powered Targets, and Ship Deployable Surface Targets (i.e., jet skis). High Speed Maneuverable Surface Targets and QST-35 are also used as range support boats and are, therefore, not expendable. Free floating or towed surface targets, such as Low-Cost Modular Targets, are not frequently used within the PRC. These targets generally support gun-firing or other weapons-related events and can be modified with a billboard that takes most of the damage. Approximately 95 percent of any fragmented pieces from expended targets are recovered.

Stationary surface targets are anchored to the seafloor or other objects to be visible at the water's surface. Examples include spar buoy, mine shapes, and moored rafts. Subsurface targets include UUV used as targets and mine shapes anchored at various underwater depths. All temporary stationary surface targets and subsurface targets are fully recovered following events (in contrast to the permanent stationary targets [Hannibal and Hooper]).

2.1.3.3 Land-Based Assets

Land-based assets used in the PRC include ground vehicles, land targets, and ground test facilities and laboratories. Representative types of ground test facilities and laboratories are described in Section 2.1.1.2 (Ground-Based Activities) as well as Appendix A (Patuxent River Complex Activity and Asset Descriptions). Ground vehicles include aircraft GSE, UGS, and other manned vehicles. GSE is used by tenant squadrons and organizations to ensure proper aircraft performance, support scheduled aircraft flights, or conduct aircraft maintenance. General types of GSE include tow tractors, start carts, test stands, portable power units, cranes, lifts, and weapons loaders that are operated on or around PRC installation airfields (e.g., flight lines, taxiways, tarmac and hangar aprons, test pads, and hover pads). UGS are typically robotic platforms that are used as an extension of human capability. They are not frequently used within the PRC but could be involved in unique events such as S&T demonstrations. UGS are divided into categories based on size (i.e., transportability) and mode of operation ranging from tethered to autonomous.

Land targets may be fixed or mobile and consist of fixed target arrays, full-scale three-dimensional targets, and manned or remote-controlled vehicles. These targets are primarily used for visual targeting, laser designating, sensor testing, or tracking; however, their use is infrequent. No munitions are released on land targets. Some land targets are semi-permanent features (e.g., radar reflecting posts), whereas others are temporarily placed and removed following events. All ground vehicles and land targets are operated or placed in previously disturbed vegetative or nonvegetative areas (documented not to contain sensitive biological or cultural resources) or on improved, graded, or paved surfaces (e.g., airfields, runways, and roads) at PRC installations.

2.1.3.4 Munitions and Other MEM

The majority of munitions and other MEM are expended during weapons separation tests. These tests assess the ability of a weapon to safely and reliably separate from an aircraft. The effectiveness of the weapon itself is not a part of the test (U.S. Department of the Navy, 1998). All munitions used within the PRC are, therefore, non-explosive, meaning they do not contain a functional warhead and are not composed of explosive material. Instead, the munitions are steel shapes, similar in appearance, size, and weight to the explosive munition they intend to replicate, and contain steel, concrete, vermiculite, or other non-explosive materials (U.S. Department of the Navy, 1998). Although non-explosive munitions do not contain explosive warheads, some may contain propellant (e.g., live rocket or missile motors), fuse sensors, signal cartridges (also referred to as spotting charges), or other energetic materials. Telemetry warheads may also be incorporated for data collection during testing. In addition, some bomb warheads may contain non-explosive “bomblets” (e.g., cluster bombs) while some rocket warheads may contain non-explosive flechettes.

The majority of munitions within the PRC are released or jettisoned (dropped) from aircraft; however, gun ammunitions (non-explosive rounds) and rockets may be live-fired from aircraft or combatant and patrol craft. Rockets, missiles, and gun ammunitions are also live-fired from and within the ATA. Primary types of non-explosive munitions used include bombs, mines, missiles, rockets, torpedoes, and small- and medium-caliber gun ammunitions. Other MEM (e.g., chaff, flares, marine markers, sonobuoys) may be used as required for certain types of testing or training. Descriptions of typical types of munitions and other MEM are provided in Appendix A (Patuxent River Complex Activity and Asset Descriptions) and the material accessories associated with these expendables are listed in Appendix E (Military Expended Materials and Physical Disturbance and Strike Analysis).

Non-explosive munitions and other MEM are expended in the Chesapeake Bay Water Range. The highest amounts are concentrated near the fixed target areas illustrated in Figure 2.1-3. Hooper and Hannibal Targets are the most heavily used, with Hannibal receiving the most gun ammunition expenditure. Most non-explosive munitions are unrecovered, with the exception of high-value assets such as torpedoes and missiles. Recovery of assets is performed by ATMO support boats and/or divers, usually from the Bay Forest or Shoal Impact and Recovery Areas.

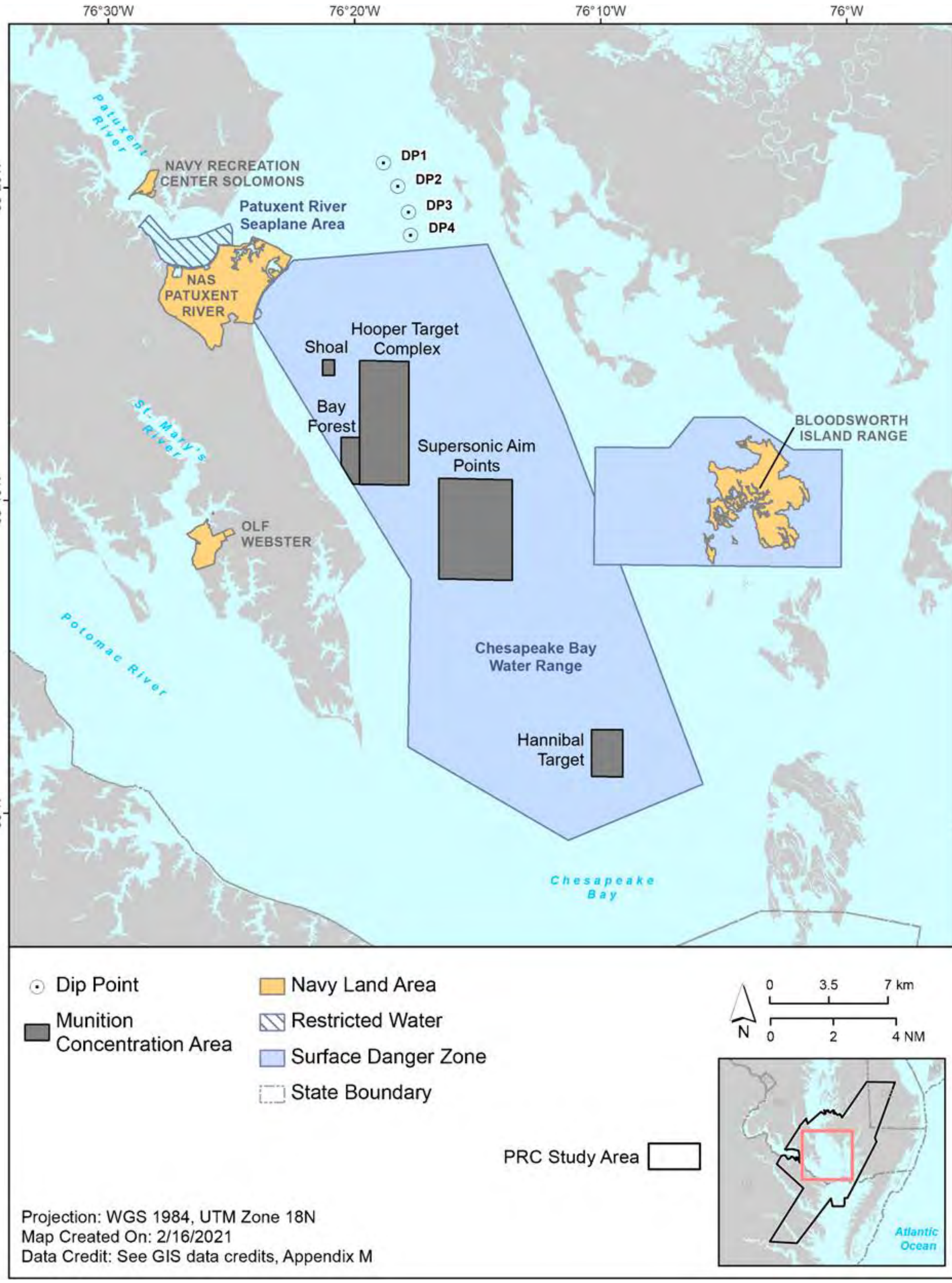


Figure 2.1-3 Chesapeake Bay Water Range Munition Concentration Areas

2.2 Screening Factors

The identification, consideration, and analysis of alternatives are critical components of the National Environmental Policy Act (NEPA) process and contribute to the goal of objective decision-making. The Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations 1502.14) require decision makers to consider the environmental effects of the Proposed Action and a range of alternatives to the Proposed Action, including a No Action Alternative. CEQ guidance further stipulates that an EIS must rigorously and objectively explore all reasonable alternatives for implementing the Proposed Action and, for alternatives eliminated from detailed study, briefly discuss their reasons for elimination. An alternative that does not meet the purpose of and need for the Proposed Action, except the No Action Alternative, is not considered reasonable. Only those alternatives determined to be reasonable require detailed analysis.

The Navy developed the alternatives considered in this EIS after explicit feedback from subject matter experts (SMEs) including Naval Air Systems Command (NAVAIR) Program Office representatives, NTWL and other tenant squadrons, ATR management representatives, and Navy engineers, environmental managers, and scientists. The Navy also used recent or updated military policy and best available data in developing alternatives. For instance, policy updates to The Defense Acquisition Strategy Department of Defense (DoD) 5000 Series (discussed in Section 1.4.2, Strategic Importance of the PRC) influenced alternative development. These changes are accelerating the DoD acquisition process, requiring delivery of Fleet capabilities with increased speed and efficiency to more rapidly meet evolving readiness requirements.

To accommodate these emergent requirements, the Navy must be able to make reasonable predictions of future levels of testing and training. However, unlike training, which is more routine and predictable, testing is highly variable and more dependent on technological advancements, national security interests, and fiscal fluctuations. The types of aircraft platforms, weapons, and systems tested by Navy programs each year are dictated by Congressional and DoD priorities. Consequently, testing occurs in discrete test phases that differ in duration and frequency. Some test phases are relatively short while others can take multiple years. With all of these challenges, Navy forecasts for future testing must remain fluid. Accordingly, reasonable alternatives developed to meet the purpose of and need for the Proposed Action were evaluated against the following screening factors:

- an annual capacity to:
    - conduct testing of current systems and current technologies
    - support maintenance, repair, modification, and modernization of current systems
    - conduct testing of new systems and new technologies to address emerging threats
    - support military training essential to develop and maintain proficiency, particularly of USNTPS students and NTWL pilots supporting aircraft RDT&E
    - accommodate potential increases in testing and training to meet future military readiness requirements
- as well as the ability to:
    - provide a safe and operationally realistic air, land, and sea environment to conduct testing and training activities
    - perform full-spectrum aircraft RDT&E using state-of-the-art ground and flight test facilities

- sustain proximity to requisite range tracking, data transmission, instrumentation, and communication capabilities to provide accurate data to decision makers
- conduct testing by aircraft developmental test pilots in fixed-wing jet, fixed-wing propeller, rotary-wing aircraft, and UAS platforms
- test and train in an environment with required range safety, laser safety, flight clearances, and frequency clearances
- test year-round as well as day and night
- retain Navy acquisition and RDT&E capabilities at a single location for cradle-to-grave aircraft program management

2.3 Alternatives Carried Forward for Analysis

Consistent with recent military policy, the Navy also used best available data in developing alternatives. Flight hour data and associated metrics were compiled from fiscal years (FY) 2008 to 2017 to reflect a 10-year baseline. The 10-year average and highest individual year within the 10-year period (i.e., peak) were provided to Navy SMEs. This enables SMEs to make reasonable projections of activity levels (or operational tempos) required to meet current and future military readiness for the foreseeable future at typical levels, as well as maximum levels during an increased global conflict scenario. SME interviews and projections were recorded in the NAWCAD Operational Requirements Document (U.S. Department of the Navy, 2019a).

A challenge to maintaining military readiness is contending with emerging threats. To keep pace with national security interests, naval forces need the ability to quickly respond to these emerging threats. Accordingly, EIS alternatives must have sufficient annual capacity to test and train at levels that meet evolving Fleet readiness requirements. Given the challenges of predicting testing requirements, subsequent planning for future activities must accommodate emergent requirements as much as possible. Navy SME projections provide the Navy the ability to test and train to a potential annual maximum level. The peak is used in this analysis to ensure the Navy does not underestimate potential impacts. Consequently, Navy testing and training during any given year can be less than the levels analyzed. This will allow the Navy the sustained ability to quickly respond to global conflict scenarios.

Based on the reasonable alternative screening factors (listed in Section 2.2, Screening Factors) and the operational tempos projected by Navy SMEs to meet the purpose of and need for the Proposed Action, a No Action Alternative and two action alternatives are carried forward for analysis in this EIS. The No Action Alternative represents current activity levels for the PRC and is reflective of the 10-year baseline. Alternatives 1 and 2 provide adjustments to current activity levels projected to meet future military readiness requirements at typical levels and at maximum levels during times of increased global conflict, respectively. Alternatives 1 and 2 also include adjustments to enhance certain current tenant squadron activities identified to meet future requirements during SME interviews, and add the testing of directed energy weapons technologies to address new and emerging threats (especially C-UAS scenarios). The Navy's Preferred Alternative is Alternative 2.

Table 2.3-1 and Table 2.3-2 present the baseline (No Action Alternative), typical (Alternative 1), and maximum (Alternative 2) annual operational tempos for the PRC used in the development of alternatives. To facilitate analysis, testing and training activities and assets in Table 2.3-1 are organized as air-based, land-based, or water-based according to the primary location in which they occur within the complex. Table 2.3-2 relates non-explosive munitions and other MEM expenditure by activity type for each of the alternatives. These tables are intended to be high-level summaries and are expanded upon in Appendix A (Patuxent River Complex Activity and Asset Descriptions) and Section 3.0 (Introduction). Both Table 2.3-1 and Table 2.3-2 provide a comparison of alternatives.

Table 2.3-1 Annual PRC Operational Tempo per Alternative: Activities and Assets

Activity Name	***No Action Alternative***	***Action Alternative 1***	***Action Alternative 2***	***Location and Recovery Rate (as applicable)***
Air-Based Activities				
Aircraft Flight Activities (# of Flight Hours)	20,100	23,400	26,000	*PRC Airspace* – restricted areas – 80%; Helicopter Operating Areas – 20%
Supersonic Activities (# of Events)	247	180	198	*PRC Airspace* – restricted areas – 98% R-4008 above 30,000 feet; greater than 2% below 30,000 feet weapons separation testing only; Chessie Air Traffic Control Assigned Airspace – 1 to 3 events per year
Air-Based Assets				
Aerial (BQM) Targets (# of Targets)	3	5	6	*PRC Airspace* – launched from Armament Test Area; 100% recovered from CBWR
Unmanned Aerial Systems Targets[2] (# of Targets)	50	136	150	*PRC Airspace* – restricted areas – 65% over land areas; 35% over water areas (25% CBWR; 10% Bloodsworth Island Range Surface Danger Zone); 100% recovered from land; 40% recovered from water
Land-Based Activities				
Aircraft Ground-Based Activities (# of Hours)	3,693	4,299	4,729	*PRC Land Areas and Facilities* – installation airfields flight line, taxiways, tarmacs, and hangar aprons
Outdoor Static Engine Runs (# of Events/Hours)	92	92	101	*PRC Land Areas and Facilities* – Open-Air Engine Test Cell Facility
Weapons Compatibility & Gun Fire Tests (# of Events)	11 gunfire	12 gunfire	13 gunfire	*PRC Land Areas and Facilities* – Armament Test Area
	14 compatibility	15 compatibility	17 compatibility	
Land-Based Assets				
Ground Support Equipment (# of Hours)	47,894	54,646	58,763	*PRC Land Areas and Facilities* – on and around Installation airfields
Unmanned Ground Systems (# of Systems)	2	40	44	*PRC Land Areas and Facilities* – installations (primarily Outlying Field Webster;

Table 2.3-1 Annual PRC Operational Tempo per Alternative: Activities and Assets, Continued

Activity Name	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*	*Location and Recovery Rate (as applicable)*
				previously disturbed approved areas)
Water-Based Activities				
Anti-Submarine Warfare Systems Tests[2] (# of Events)	4 active 30 passive	36 active 32 passive	39 active 35 passive	*PRC Water Areas* - sonar dip points
Mine Countermeasure Systems Tests[2] (# of Events)	22	24	26	*PRC Water Areas* – CBWR; installation surrounding waters. MCM systems are 100% recovered.
Water-Based Assets				
Vessels (# of Vessels)[1]	593	605	666	*PRC Water* Areas – CBWR – 85% to 90%; outside CBWR but still within PRC Study Area – 10% to 15%
Unmanned Maritime Systems (# of Systems)[3]	51	160	176	*PRC Water* Areas – primarily installation surrounding waters but also within the CBWR
Surface Targets (# of Targets)	476	489	539	*PRC Water* Areas – CBWR – 85% to 90%; Outside CBWR but still within PRC Study Area – 10% to 15%; mobile and stationary are 100% recovered; free floating or towed are 95% recovered
Subsurface Targets (# of Targets)	5	16	18	*PRC Water Areas* – CBWR; installation surrounding waters; 100% recovered

Key: CBWR = Chesapeake Bay Water Range; MCM = mine countermeasures; PRC = Patuxent River Complex.

Notes:

1. Includes one, one, and two amphibious vehicles per alternative, respectively.
2. Associated aircraft flight hours are included in flight hour totals.
3. Includes one, two, and two bottom crawlers or remotely operated vehicles, respectively; may rest or operate on seafloor bottom.

Table 2.3-2 Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems

Type	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*	*Location[2] and Recovery Rate (as applicable)*
Test Flights				
Torpedoes	37	37	41	*PRC Water Areas* – CBWR; 80% recovered
Missiles	4	42	46	*PRC Water Areas* – CBWR; 55% recovered
Bombs	194	270	297	*PRC Water Areas* – CBWR; 0% recovered
Mines (Mine Laying)	16	184	202	
Rockets[1]	385	534	587	
Rockets (Flechette Warhead)	33	46	51	
Small-Caliber Gun Ammunition[1]	26,197	38,780	42,670	
Medium-Caliber Gun Ammunition[1]	8,539	16,292	17,922	
Chaff (Canisters [pounds])	96 (431)	196 (882)	217 (977)	
Flares (Decoys)	320	255	281	
Flares (Illumination)	47	37	41	
Dye Markers	37	37	41	
Launchers/Pods	7	14	15	
Signal Cartridges/ Spotting Charges	12	12	13	
Passive Sonobuoys	122	122	134	
Miscellaneous Items (Mass Equivalents and Fuel Tanks)	1	1	1	
Search & Rescue Rafts and Kits	2	15	17	*PRC Water Areas* – CBWR; 100% recovered
Training Flights				
Bombs	2	3	3	*PRC Water Areas* – CBWR; 0% recovered
Chaff (Canisters [pounds])	25 (112)	50 (225)	54 (243)	
Flares (Illumination)	4	3	3	
Small-Caliber Gun Ammunition[1]	500	740	814	
Other Flights				
Marine Markers	22*	34	37	*PRC Water Areas* – CBWR – 50%; Patuxent River Seaplane Area – 50%; 0% recovered

Table 2.3-2 Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems, Continued

Type	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*	*Location[2] and Recovery Rate (as applicable)*
Weapons Compatibility & Gun Fire Tests – Armament Test Area				
Chaff (# of Pounds)	81	85	94	Chaff are swept following events
Cartridge Actuated Devices & Propellant Actuated Devices	513	539	593	100% recovered from ATA
Jet-Assisted Takeoff Bottles	6	10	12	*PRC Water Areas* – CBWR; 0% recovered
Rockets[1]	18	19	21	
Small-Caliber Gun Ammunition[1]	19,977	20,976	23,074	Expended into gun firing tunnel at ATA
Medium-Caliber Gun Ammunition[1]	2,430	2,552	2,807	
Surface and Subsurface Testing and Training				
Small-Caliber Gun Ammunition[1]	9,403	13,900	15,278	PRC Water Areas – CBWR; 0% recovered
Medium-Caliber Gun Ammunition[1]	422	858	943	
Mine Countermeasure Systems Tests				
Airborne Mine Neutralization System Neutralizers	2	4	5	*PRC Water Areas* – CBWR; 0% recovered
Anti-Submarine Warfare Systems Tests				
Active Sonobuoys	0	24	26	*PRC Water Areas – s*onar dip points; scuttled following events
Directed Energy Weapons Tests				
High-Energy Laser (# of Days)	0	50	50	*PRC Airspace, Land Areas, and Water Areas* – where hazard pattern can be contained within range and/or installation boundary and exclusive use airspace can be provided
High-Power Microwave (# of Days)	0	120	120	

Key: ATA = Armament Test Area; CBWR = Chesapeake Bay Water Range; MEM = military expended materials; PRC = Patuxent River Complex.

Notes:

1. Denotes live-fired non-explosive munition.
2. For munitions and other MEM expended in the CBWR in support of multiple activities, combined PRC totals per alternative are as follows:
   Bombs = 196 / 273 / 300
   Small-Caliber Gun Ammunition = 36,100 / 53,420 / 58,762
   Medium-Caliber Gun Ammunition = 8,961 / 17,150 / 18,865
   Chaff = 121 (543) / 246 (1,107) / 271 (1,220)
   Flare (Illumination) = 51 / 40 / 44

* Marine markers are 100% expended in the CBWR for No Action Alternative.

2.3.1 No Action Alternative

As previously mentioned in Section 2.2 (Screening Factors), CEQ regulations require analysis of a range of alternatives, including a No Action Alternative, to provide a clear basis for choice among options by the decision maker and the public (40 Code of Federal Regulations 1502.14). The guidance identifies two approaches in developing the No Action Alternative (46 Federal Register 18026). One approach, for ongoing activities over extended periods of time, is to continue the present course of action or current management direction or intensity, such as the continuation of Navy testing and training within the PRC at current levels. Under this approach, the analysis compares the effects of continuing current activity levels with the effects of the Proposed Action. This approach is being applied as the No Action Alternative for this EIS.

Under the No Action Alternative, the Navy would continue testing and training activities within the PRC, at the same annual flight hours and mix of aircraft, non-explosive munitions, and systems as is currently being conducted based on a 10-year baseline (FY2008–FY2017) peak year (Table 2.3-1 and Table 2.3-2). This baseline includes testing and training activities analyzed in the 1998 PRC EIS and subsequent EAs.

The No Action Alternative does not meet the purpose of and need for the Proposed Action and does not ensure readiness of naval forces, since it does not accommodate the projected military readiness requirements highlighted in Section 2.1 (Proposed Action) for:

- higher annual average of aircraft flight hours and adjustments in aircraft mix
- increases in most non-explosive munitions and other MEM
- increased use of PRC waters to accommodate surface vessel and subsurface vehicle testing and training
- adjustments in types of mission systems being integrated and tested in aircraft and surface and subsurface platforms
- expanded use of the Patuxent River Seaplane Area to enhance SAR training
- the addition of active sonobuoy testing in conjunction with helicopter dipping sonar tests
- the testing of new technologies to address new and emerging threats

As required by NEPA, although the No Action Alternative does not meet the purpose of and need for the Proposed Action, it is carried forward for analysis in this EIS and establishes a baseline by which to compare the effects of the action alternatives.

2.3.2 Action Alternative 1

Under Action Alternative 1, the Navy would conduct the same types of testing and training activities within the PRC as the No Action Alternative but with higher annual flight hours as well as adjustments to current aircraft mix, non-explosive munitions numbers, and systems to accommodate projected testing and training requirements identified by Navy SMEs for the foreseeable future. This alternative is based on the annual level of increased operational tempo (Table 2.3-1 and Table 2.3-2) projected by Navy SMEs and validated by Navy leadership to be required to maintain readiness of naval forces for the foreseeable future but not during increased global conflicts. Under this alternative, the Navy would be able to meet the typical, but not the highest, level of military readiness.

Action Alternative 1 accommodates the following projected changes from the No Action Alternative:

- higher annual average of aircraft flight hours and adjustments in aircraft mix

- increases in most non-explosive munitions and other MEM
- increased use of PRC waters to accommodate surface vessel and subsurface vehicle testing and training
- adjustments in types of mission systems being integrated and tested in aircraft and surface and subsurface platforms
- expanded use of the Patuxent River Seaplane Area to enhance SAR training
- the addition of active sonobuoy testing in conjunction with helicopter dipping sonar tests
- the testing of new technologies to address new and emerging threats

Expanding the use of marine markers into the Patuxent River Seaplane Area would enable the SAR MH-60 aircrew to train in close proximity to their hangar versus scheduling and transiting to the ATR restricted airspace. This would increase the ability to maintain SAR operational readiness and allow restricted airspace to remain open to high-priority aircraft test programs. Approximately 50 percent of projected marine markers (roughly 20 per year) would be expended in the Patuxent River Seaplane Area (Table 2.3-2).

Transiting to offshore locations, such as the Atlantic Warning Areas, is currently required for HX-21 active sonobuoy events. Testing active sonobuoys at the PRC dip points in conjunction with existing, active dipping sonar systems would provide HX-21 enhanced test and evaluation capability, significant time and cost savings, and ability to more rapidly provide ASW capability to the U.S. Navy Fleet. Approximately 35 percent of the total active dipping sonar events would deploy active sonobuoys (Table 2.3-2). Each event would include one to two sonobuoys transmitting sonar up to 15 minutes per event.

Finally, Alternative 1 adds the testing of new directed energy technologies to address new and emerging threats (e.g., C-UAS scenarios). High-energy laser and high-power microwave weapons systems testing would consist of two-week test series (five days per week) with weapon firing activity occurring twice per day. Five high-energy laser and 12 high-power microwave test series would be conducted annually for an operational tempo of 50 high-energy laser and 120 high-power microwave test days per year within the PRC (Table 2.3-2).

Action Alternative 1 meets the purpose of and need for the Proposed Action with respect to allowing the Navy the ability to maintain readiness of naval forces at typical levels for the foreseeable future.

2.3.3 Action Alternative 2 (Preferred Alternative)

Under Action Alternative 2, the Navy would conduct the same types of testing and training activities within the PRC as Action Alternative 1 but with increased annual number of flight hours as well as adjustments to current aircraft mix, non-explosive munitions numbers, and systems to accommodate projected testing and training requirements identified by Navy SMEs for increased global conflict. This alternative is based on the maximum potential annual level of increased operational tempo (Table 2.3-1 and Table 2.3-2) required to maintain readiness of naval forces for the foreseeable future and during increased global conflicts. Under this alternative, the Navy would be able to meet the highest level of military readiness.

Alternative 2 is the Preferred Alternative because it meets the purpose of and need for the Proposed Action and allows the Navy the greatest capacity to maintain readiness of naval forces for the foreseeable future at maximum levels in an increased global conflict scenario.

2.4 Alternatives Considered but Not Carried Forward for Detailed Analysis

The following alternatives were considered but not carried forward for detailed analysis in this EIS as they did not meet the purpose of and need for the Proposed Action, nor did they satisfy the reasonable alternative screening factors presented in Section 2.2 (Screening Factors).

2.4.1 Alternative Testing and Training Locations

NAWCAD at NAS Patuxent River is a core DoD Major Range and Test Facility Base, "whose test and evaluation infrastructure and associated workforce must be preserved as a national asset to provide test and evaluation capabilities to support the DoD acquisition system" (U.S. Department of Defense, 2018a). NAWCAD supports the DoD acquisition system as one of two NAVAIR product centers with a mission to provide aviation-related products and services to the Fleet. Successful RDT&E in support of Navy aircraft acquisition requires access to safe and operationally realistic air, land, and sea environments; extensive network of interconnected aircraft flight and ground test facilities; proximity to range instrumentation for air vehicle, vessel, and munitions tracking, data collection, and transmission; a full spectrum of manned and unmanned, fixed- and rotary-winged test platforms; experienced developmental test pilots trained in the full-spectrum of aircraft platforms; and a full suite of fixed and mobile aerial, surface, and land targets as well as EW threat emitters. Having a similar DoD mission, ranges from the second NAVAIR product center, the Naval Air Warfare Center Weapons Division, were considered. These include the China Lake Land Ranges and Point Mugu Sea Range, both in California. Although both ranges meet some of the criteria above, China Lake is landlocked without direct/adjacent water access, and the Point Mugu Sea Range does not have the proximate nor amount of special use airspace necessary for aircraft testing until 3 nautical miles offshore. In addition, the relocation of NAWCAD aircraft ground test facilities prerequisite to open-air flight testing or the entire NTWL to these or other locations would be too cost prohibitive and, therefore, not reasonable or foreseeable. The PRC and its combined aircraft acquisition and RDT&E capabilities and resources offer the most efficient and effective means for meeting the purpose and need of the Proposed Action to provide Sailors and Marines with the safe and effective equipment and technology required to maintain the military readiness of our naval forces. Therefore, conducting activities at alternative sites outside the PRC does not meet the purpose of and need for the Proposed Action nor constitute a reasonable alternative. Accordingly, alternative testing and training locations are not analyzed further in this EIS.

2.4.2 Simulated Testing and Training Only

The Navy uses simulation for testing and training whenever possible; however, there are limits to the realism that simulation technology presently provides. According to 10 United States Code sections 2366 and 2399, testing cannot be based exclusively on computer modeling or simulation. Although simulation is a key component of aircraft systems development, it does not adequately provide information on how well a system will perform or whether it will be capable of operating in diverse marine environments. For this reason, at some point in the development process, aircraft systems must undergo in-flight testing.

Testing in an open-air, realistic environment provides critical information on a system's operability and supportability. As the Navy's aircraft acquisition authority, this information enables NAVAIR program managers to verify that aircraft performance criteria and specifications are met prior to procurement. This not only ensures what is purchased performs as expected but also that the Navy accepts aircraft systems that support the warfighter's needs. In addition, test requirements protect Sailors and Marines who depend upon these technologies to operate safely and effectively to execute their mission.

Simulated technology also does not provide pilots or operators with the level of detail required to maintain proficiency. Unlike live field training, computer-based training cannot deliver the realism needed to attain combat readiness. A simulator cannot match the dynamic nature of the environment or replace live, real-world theater scenarios. Service members must train regularly and frequently to develop and maintain skills necessary to master their mission in complex environments. Sole reliance on simulation would deny them the ability to develop battle-ready proficiency and the opportunity to “train as they fight.” Therefore, simulation as an alternative to replace live testing and training does not meet the purpose of and need for the Proposed Action and is not considered reasonable. Consequently, a simulated testing and training only option is not analyzed further in this EIS.

2.5 Standard Operating Procedures Included in the Proposed Action

Standard operating procedures (SOPs) are existing policies, practices, and measures developed by the Navy for the primary purpose of providing safety (including public health and safety) and mission success. In many cases, adhering to SOPs may offer secondary benefits to environmental and cultural resources by avoiding, reducing, or eliminating impacts. However, SOPs are distinguished from mitigation measures (described in Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) because SOPs are (1) existing requirements for the Proposed Action, (2) ongoing, regularly occurring practices, or (3) not unique to the Proposed Action. In other words, SOPs are inherently part of the Proposed Action, not measures proposed solely to reduce or eliminate environment impacts from the Proposed Action. Table 2.5-1 lists the primary SOPs that are incorporated into the Proposed Action for this EIS. These SOPs comply with a wide range of guidance and instructions issued by the DoD, Office of the Chief of Naval Operations, NAS Patuxent River, NAVAIR, NAWCAD, and others and are considered in Chapter 3 (Affected Environment and Environmental Consequences) environmental analysis for applicable resources. Additional details for SOPs relevant to specific resource areas may be expounded in the respective resource area sections. Mitigation measures are discussed separately in Section 3.10.

Table 2.5-1 Standard Operating Procedures

Standard Operating Procedure (SOP)	***Description***	***Primary Guidance Document(s)***	***Impacts Reduced/Avoided***
Test Planning	Safe operations within the PRC begin with test planning. A test plan must be submitted for all testing and training activities that require ATR support. Each test plan provides specific information to ensure activities are conducted in the safest manner possible including test objectives, instrumentation and asset requirements, data collection plans, risk levels and assessments, necessary pilot/operator experience levels, range/flight safety issues, and risk/safety mitigation plans. All test plans are thoroughly reviewed and approved prior to activities commencing. The test planning process also includes an environmental review described in Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization).	Naval Air Systems Command Instruction 3960.4C, *Project Test Plan Policy and Guide for Testing Air Vehicles, Air Vehicle Weapons, and Air Vehicle Installed Systems* NASPAXRIVINST 5090.4, *Environmental Review Process*	This SOP benefits public health and safety by reducing the potential safety risks associated with military readiness activities.
De-Conflicting Airspace	The Navy schedules and de-conflicts its own use of airspace to allow the necessary separation of multiple aircraft to prevent interference with equipment sensors, avoid commercial and recreational air traffic, and ensure the safety of military personnel and the public. ATR Central Schedules coordinates and maintains the ATR restricted area flight schedule, scheduling blocks of airspace as needed to meet operational requirements. Per the Navy's request each day, the FAA activates the restricted airspace for exclusive use by the Navy to maintain safe separation from all other air traffic. NAS Patuxent River Air Operations is responsible for monitoring and controlling the airspace while activated, delegating airfield and restricted area control to its ATC tower and the ATR Military Radar Unit, respectively. Flight controllers use air search radars to de-conflict air traffic within the airfields and restricted areas. Traffic advisories to Visual Flight Rules pilots are provided by ATC as required. Concurrent operations within the restricted airspace are limited to no more than 10 "groups" of aircraft at a time (known as the "10 aircraft rule"). A "group" may consist of one or more aircraft in a tight formation, usually a test aircraft and chase plane combination (U.S. Department of the Navy, 1998). This preserves the ability of the ATR Military Radar Unit to monitor the airspace effectively and ensure adequate aircraft separation and flight crew safety.	NASPAXRIVINST 3710.5X, *NAS Patuxent River Air Operations Manual*	These SOPs benefit public health and safety by reducing the potential for interactions with aircraft flight activities.

Table 2.5-1 Standard Operating Procedures, Continued

Standard Operating Procedure (SOP)	***Description***	***Primary Guidance Document(s)***	***Impacts Reduced/Avoided***
Aircraft and Flight Safety	The Navy follows aviation and airspace management procedures provided in the *NATOPS General Flight and Operating Instructions Manual*. PRC flight operations are conducted consistent with existing NATOPS manuals for specific types of aircraft being flown or, if not existing, may determine the performance characteristics and limits used to develop NATOPS manuals for the aircraft being flown. In addition, all aircraft operating within the PRC must adhere to the “course rules” prescribed in the *NAS Patuxent River Air Operations Manual*, which dictates flight and safety procedures specific to PRC airfields and airspaces. The research, development, test and evaluation mission and variety/mixture of manned and unmanned fixed- and rotary-wing aircraft result in complex traffic patterns and procedures. Adherence to course rules plays a critical role in ensuring a safe and orderly flying environment.	OPNAVINST 3710.7, *NATOPS General Flight and Operating Instructions Manual* Specific aircraft NATOPS manuals NASPAXRIVINST 3710.5X, *NAS Patuxent River Air Operations Manual*	These SOPs benefit public health and safety by reducing the potential for interactions with aircraft flight activities.
	To reduce the risk of aircraft collisions with birds and other animals (e.g., bats and deer), all flights are conducted according to the *BASH Program*. The plan details responsibilities of personnel to deal with BASH hazards, practices to reduce BASH potential (including altitude restrictions), and guidelines to decrease airfield attractiveness to particular wildlife species. Pilots are trained to avoid high bird count areas and receive ATC warnings when bird concentrations are observed near runways, taxiways, or within approach control airspace. Should a bird or animal strike occur, a report is completed by the squadron and submitted into the Navy’s Web-Enabled Safety System Aviation Mishap and Hazard Reporting System.	NASPAXRIVINST 3750.5H, *BASH Program*	These SOPs primarily benefit aircrew safety by reducing the potential for aircraft damage and mishaps with secondary benefits to birds and other wildlife by reducing the potential for aircraft strike.
UAS Safety	Similar to manned aircraft, UAS flights are conducted according to the *Air Operations Manual* as well as the NATOPS manual (if available) for the type of UAS being flown. Flights must occur within active restricted airspace unless operating with an approved FAA Certificate of Authorization (U.S. Department of the Navy, 2017a). The *Air Operations Manual* details UAS operating areas, routes, and equipment used to safely operate within the PRC (e.g., primary and secondary control links, collision avoidance lighting, flight termination systems). Larger Groups 4 and 5 UAS operate under Instrument Flight Rules in the National Airspace System and in compliance with applicable procedures, clearances, and instructions prescribed by NAS Patuxent River ATC, Naval Air Systems Command Flight Clearance Office, and FAA Certificate of Authorization (U.S. Department of the Navy, 2015a). UAS overflights of highly populated areas are avoided as much as practicable.	Specific aircraft NATOPS manuals NASPAXRIVINST 3710.5X, *NAS Patuxent River Air Operations Manual*	These SOPs benefit public health and safety by reducing the potential for interaction with UAS.

Table 2.5-1 Standard Operating Procedures, Continued

Standard Operating Procedure (SOP)	***Description***	***Primary Guidance Document(s)***	***Impacts Reduced/Avoided***
Sonic Booms	Most supersonic flights within the PRC are performed above 30,000 feet within ATR restricted airspace (R-4008) and over the Chesapeake Bay. These flights are performed to meet mission-critical needs and minimize the potential of sonic boom impacts. As a general policy, the Navy does not intentionally generate sonic booms below 30,000 feet with the exception of essential missions such as test flights requiring supersonic speed. Supersonic flights below 30,000 feet are authorized in R-4005 to accommodate essential supersonic weapons separation tests that require ATR optical tracking. All supersonic flights are conducted under an approved flight and/or test plan in accordance with *Air Operations Manual* and *Range Safety Manual* procedures. Aircrew members notify ATC prior to a supersonic event and complete post-event flight reports with start and ending coordinates. Supersonic events requiring the use of Chessie Air Traffic Control Assigned Airspace are pre-coordinated and have established routes to minimize the effects of resultant sonic booms. Additional mitigation measures for sonic booms are described in Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization).	NASPAXRIVINST 3710.5X, *NAS Patuxent River Air Operations Manual* NAVAIRWARCENACDIV INST 3710.1A, *Range Safety Manual*	These SOPs benefit ambient airborne noise and public health and safety by reducing the potential for exposure to sonic booms.
De-Conflicting Sea Space	The Chesapeake Bay Water Range SDZ is open to navigation at all times except during Navy testing and training activities. Within the SDZ, the 1,000-yard radius prohibited areas surrounding Hooper and Hannibal Targets are closed to navigation at all times unless authorized by NAS Patuxent River. Boundaries of the SDZ and prohibited areas are identified and annotated on nautical charts and adhered to by commercial and recreational boaters. De-confliction of space is only required when the Chesapeake Bay Water Range and its target areas must be cleared to support testing and training activities, predominantly weapons separation events.	ATMO Range Clearance SOP	These SOPs benefit public health and safety (including persons participating in activities that have socioeconomic value, such as commercial or recreational fishing or LNG transport) by reducing the potential for interactions with testing and training activities.
	Additional procedures are in place to address LNG tankers transiting the Chesapeake Bay shipping channel. The ATR and Cove Point LNG Terminal coordinate tanker transiting schedules to de-conflict the testing and training activities potentially incompatible with LNG such as flare drop, gunnery, or supersonic weapons separation events. This coordination also ensures a safety buffer of 1,000 yards is maintained around the tankers at all times.	Range Safety SOP 3170.1, *LNG Tanker Transit Procedures*	

Table 2.5-1 Standard Operating Procedures, Continued

Standard Operating Procedure (SOP)	***Description***	***Primary Guidance Document(s)***	***Impacts Reduced/Avoided***
Vessel Safety (including UMS)	Navy vessels are required to operate in accordance with applicable navigation rules. This includes operating at safe speeds while meeting mission requirements. Both vessels and UMS operate at minimum distances from shore to include allowances for sufficient depth and swell conditions (U.S. Department of the Navy, 2015a). Most avoid contact with the seafloor to prevent collision and vessel damage with limited exceptions such as amphibious vehicles or bottom crawlers operating in designated locations. Navigation hazards that appear on nautical charts, such as submerged wrecks and obstructions, are also avoided. The majority of vessel activity within the PRC is conducted by ATMO. ATMO maintains training standards for its crew members who must be familiar with U.S. Coast Guard basic seamanship and search and rescue procedures as well as proficient in the areas of vessel operation, visual lookout and vessel detection, and radar and marine radio equipment usage and calibration. Appropriate visual and radar surveillance tools and personal protective equipment are used by ATMO boat crews to detect and avoid commercial and recreational vessels and prevent personnel injury.	U.S. Coast Guard Commandant Instructions M16114.5C, *Boat Crew Seamanship Manual* U.S. Coast Guard Commandant Instructions M16130.2F, *National Search and Rescue Supplement*	These SOPs primarily benefit public health and safety by reducing the potential for interaction with vessel and UMS activities with secondary benefits to biological and cultural resources by reducing the potential for vessel and/or UMS strikes.
Range Clearance	Range clearance is accomplished using a combination of surface search radar, video sites, range support boats, and aircraft. Target areas are cleared approximately one hour before they are scheduled for use (U.S. Department of the Navy, 1998). Specific procedures depend on the type of testing and the season of the year. The procedures include visual sweeps of the area using one or more support craft and chase aircraft and/or radar sweeps. Recreational boaters, fishermen, or watermen are requested to exit the restricted areas via radio transmission, written signs, hand signals, or other appropriate methods. Helicopters equipped with loudspeakers are sometimes used. Should an individual refuse to leave the area, the U.S. Coast Guard is called to escort the individual out of the area; however, recreational boaters, fishermen, and watermen are usually cooperative. As an additional safety measure, prior to any weapon release, pilots fly over the target area to perform a visual check to ensure the target is clear. All involved parties (range support boats, flight controllers, control room system engineers, control tower staff, and other range safety personnel) are linked together by a voice radio system (U.S. Department of the Navy, 1998). Similar procedures, using range support boats and alerting watermen, are used to clear the Bloodsworth Island Range SDZ.	NAVAIRWARCENACDIV INST 3700.3, *Range Safety Policy* NAVAIRWARCENACDIV INST 3710.1A, *Range Safety Manual* ATMO Range Clearance SOP	These SOPs benefit public health and safety by reducing the potential for interaction with testing and training activities.

Table 2.5-1 Standard Operating Procedures, Continued

Standard Operating Procedure (SOP)	***Description***	***Primary Guidance Document(s)***	***Impacts Reduced/Avoided***
Weapon Safety	Events involving the release or firing of non-explosive weapons are carefully planned and conducted under approved test plan procedures to ensure safety is maintained throughout the operation. Range Safety develops hazard patterns to meet safety standards and contain weapon specific hazards within ATR boundaries (i.e., flight profiles within the restricted airspace and surface impact area within the SDZ). The size of the hazard pattern is based on the type of platform to be used, the particular weapon, and the release conditions required to achieve test or training objectives. Prior to each event, the hazard pattern must be clear of nonparticipating vessels and aircraft before activities commence. Procedures for safe weapons separation are outlined in the *Range Safety Manual* as well as individual Range Safety SOPs for events not described in the manual but repetitively occurring within the PRC.	NAVAIRWARCENACDIV INST 3710.1A, *Range Safety Manual* Other Range Safety SOPs	These SOPs benefit public health and safety by reducing the potential for interaction with non-explosive weapons.
Laser Safety	The Navy operates laser systems approved for fielding by the Laser Safety Review Board or service equivalent. Similar to kinetic weapons, laser energy must be contained within a hazard pattern. Range Safety calculates laser hazard patterns within the boundaries of the Chesapeake Bay Water Range or PRC installations depending on the operation location. Scheduling of exclusive use airspace is also required. Only properly trained and authorized personnel operate lasers within the PRC. Prior to lasing, the hazard pattern must be cleared of nonparticipating aircraft, vessels, and/or personnel, and intended targets must be positively identified and confirmed. Personnel participating in laser activities within the hazard pattern must have appropriate personal protective equipment. Laser activity occurring above the horizon may require additional coordination with both the FAA and the Laser Clearinghouse.	*American National Standards Institute for Safe Use of Lasers* Z136.1 Military Handbook 828C, *Department of Defense Handbook for Range Laser Safety* DoDI 6055.15, *DoD Laser Protection Program* OPNAVINST 5100.27B, *Navy Laser Hazards Control Program* Range Safety SOP 3752.4A, *Laser Targeting Systems in Chesapeake Bay Restricted Areas*	These SOPs benefit public health and safety by reducing the potential interaction with high-energy lasers.

Table 2.5-1 Standard Operating Procedures, Continued

Standard Operating Procedure (SOP)	*Description*	*Primary Guidance Document(s)*	*Impacts Reduced/Avoided*
Electromagnetic Radiation Safety	The Navy manages the operation of systems that emit RF energy under its Hazards of Electromagnetic Radiation to Personnel, Fuel, and Ordnance programs. Program safety is maintained by implementing radiation hazard control measures. The *Hazards of Electromagnetic Radiation to Personnel and Fuel Assessment of NAS Patuxent River, Maryland* (U.S. Department of the Navy, 2016a) provides control measures for antenna and transmitter systems within the PRC as well as safe standoff distances to be maintained when the systems are operational. Additional SOPs are followed at simulation and electromagnetic environmental effects ground test facilities where control measures may not be adequate due to their ever-changing test environments (Navy, 2016). Use of RF is approved and monitored at all times by the Mid-Atlantic Area Frequency Coordination Office. The office ensures effective and compatible authorized use of the RF spectrum by all PRC users and is responsible for the coordination and approval of all Navy electronic warfare frequency usage in the Middle Atlantic Area (U.S. Department of the Navy, 1998).	DoDI 6055.11, *Protecting Personnel from Electromagnetic Fields* DoDI 4650.01, *Policy and Procedures for Management and Use of the Electromagnetic Spectrum* OPNAVINST 5100.23G, *Navy Safety & Occupational Health Program Manual* Integrated Battlespace Simulation and Test SOP 1150.3	These SOPs benefit public health and safety by reducing the potential interaction with electromagnetic radiation.
Bloodsworth Island Range Access	The Navy prevents unauthorized access onto the Bloodsworth Island Range due to the presence of UXO. The surface of each of the islands composing the Bloodsworth Island Range have been identified as No Trespassing Zones, not to be entered at any time without authorization. "No trespassing" signs are clearly located around the range perimeter to discourage its unauthorized use. Personnel requiring Bloodsworth Island Range access must complete UXO safety training provided by qualified explosive ordnance disposal personnel or be escorted by an individual who has completed the training requirement. This restriction is complemented by the No Navigation Zone that has been established within 75 yards of the Bloodsworth Island Range islands or any NAS Patuxent River property (U.S. Department of the Navy, 2006). No fishing, crabbing, or hunting is allowed within the No Navigation Zone unless authorization is obtained (i.e., appropriate fishing or hunting license).	NASPAXRIVINST 9072.1, *Bloodsworth Island Access Procedures*	This SOP benefits public health and safety by reducing the potential for exposure to UXO and navigation obstacles that may be present in eroded Bloodsworth Island Range shorelines.

Key: ATC = Air Traffic Control; ATMO = Atlantic Targets and Marine Operations; ATR = Atlantic Test Ranges; BASH = Bird/Animal Aircraft Strike Hazard; DoDI = Department of Defense Instruction; FAA = Federal Aviation Administration; LNG = liquefied natural gas; NASPAXRIVINST = Naval Air Station Patuxent River Instruction; NATOPS = Naval Air Training and Operating Procedures Standardization; NAVAIRWARCENACDIVINST = Naval Air Warfare Center Aircraft Division Instruction; OPNAVINST = Office of the Chief of Naval Operations Instruction; R- = restricted area; RF = radio frequency; SDZ = Surface Danger Zone; SOP = standard operating procedure; UAS = unmanned aerial systems; UXO = unexploded ordnance.

3 Affected Environment and Environmental Consequences

3.0 Introduction

This chapter provides an introduction (Section 3.0) and a section for each of the nine resource areas being evaluated in this Environmental Impact Statement (EIS) (Sections 3.1 through 3.9).

Section 3.0 introduces the Navy-compiled and generated data used and overall approach to analysis for the EIS. This approach examines the testing and training activities and assets associated with the Proposed Action described in Chapter 2 (Proposed Action and Alternatives) and shown in Table 2.3-1 (Annual PRC Operational Tempo per Alternative: Activities and Assets) and Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems) and identifies the environmental stressors each activity or asset may generate.

Sections 3.1 through 3.9 describe the existing environmental conditions in the Patuxent River Complex (PRC) Study Area, defined in Section 1.3 (Location and Description of the Patuxent River Complex) and depicted in Figure 1.3-1 (PRC Study Area), and provide the analysis for each resource potentially impacted by the Proposed Action. The level of information presented is sufficient for conducting a defensible analysis of potential impacts.

3.0.1 Navy Compiled and Generated Data

While preparing this document, the United States (U.S.) Department of the Navy (Navy) used the best available data, science, and information accepted by the relevant and appropriate regulatory and scientific communities to establish an environmental baseline and perform environmental analyses for all affected resources in accordance with the National Environmental Policy Act (NEPA).

In support of the environmental baseline and environmental consequences sections for this EIS, the Navy has sponsored and supported both internal and independent studies, modeling, and research including a Noise Study, Marine Mammal Density Study, and Navy Acoustic Effects Modeling. These Navy efforts were largely focused on providing the most up-to-date science for environmental analysis and decision-making and are further discussed in Section 3.1 (Ambient Airborne Noise) and Section 3.4 (Biological Resources), respectively.

3.0.2 Overall Approach to Analysis

The Navy's overall approach to analysis in this EIS includes the following general steps:

- identifying resources and stressors for analysis;
- analyzing resource-specific impacts for individual stressors;
- analyzing resource-specific impacts for multiple stressors;
- analyzing cumulative effects; and
- analyzing current mitigation effectiveness in reducing identified potential impacts.

Navy testing and training activities in the Proposed Action may produce one or more stimuli that cause stress on a resource. Each proposed Navy activity was examined to determine its potential stressors. The term stressor is broadly used in this document to refer to an agent, condition, or other stimulus that causes stress to an organism or alters a resource. Not all stressors affect every resource, nor do all proposed Navy activities produce all stressors.

The potential direct, indirect, and cumulative impacts of the Proposed Action were analyzed based on these potential stressors being present with the resource. Data sets used for analysis were considered across the full spectrum of Navy testing and training for the foreseeable future. Direct impacts are caused by the action and occur at the same time and place. Indirect impacts result when a direct impact on one resource induces an impact on another resource (referred to as a secondary stressor). Indirect impacts would be reasonably foreseeable because of a functional relationship between the directly impacted resource and the secondarily impacted resource. For example, a significant change in water quality could secondarily impact those resources that rely on water quality, such as aquatic animals and public health and safety. Cumulative effects or impacts are the impacts of the action added to other past, present, and reasonably foreseeable future actions.

First, a preliminary analysis was conducted to determine the environmental resources potentially impacted and associated stressors. Secondly, each resource was analyzed for potential impacts of individual stressors, followed by an analysis of the combined impacts of all stressors related to the Proposed Action. A cumulative impact analysis was conducted to evaluate the incremental impact of the Proposed Action when added to other past, present, and reasonably foreseeable future actions (Chapter 4, Cumulative Impacts).

In this stressor-based and sequential approach, the initial analyses were used to develop each subsequent step so the analysis focused on relevant issues (defined during scoping) that warranted the most attention. The systematic nature of this approach allowed the Proposed Action with the associated stressors and potential impacts to be effectively tracked throughout the process. This approach provides a comprehensive analysis of applicable stressors and potential impacts.

“Significantly,” as used in NEPA, requires considerations of both context and intensity. Context means that the significance of an action must be analyzed in several contexts such as society as a whole (e.g., human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of a proposed action. For instance, in the case of a site-specific action, significance would usually depend on the effects in the locale rather than in the world as a whole. Both short- and long-term effects are relevant. Intensity refers to the severity or extent of the potential environmental impact, which can be thought of in terms of the potential amount of the likely change. In general, the more sensitive the context, the less intense a potential impact needs to be in order to be considered significant. Likewise, the less sensitive the context, the more intense a potential impact would need to be in order to be considered significant.

3.0.2.1 Resources and Issues Evaluated

All potentially relevant environmental resource areas were initially considered for analysis in this EIS. In compliance with NEPA, the Council on Environmental Quality, and Navy guidance or policy, the discussion of the affected environment (i.e., existing conditions) focuses only on the resource areas potentially subject to impacts. Additionally, the level of detail used in describing a resource is commensurate with the anticipated level of potential environmental impact. Resources evaluated include ambient airborne noise, air quality, water quality and sediments, biological resources, public health and safety, land use, socioeconomics, environmental justice, and cultural resources.

3.0.2.2 Resources and Issues Eliminated from Further Consideration

The Proposed Action does not include activities that may alter soil topography or distribution, such as construction or demolition projects, nor will it cause any changes to personnel. In addition, proposed activities will be conducted consistent with current PRC airspace and airfield use, hazardous materials and waste management, and cultural resource protection plans. Resources and issues considered but not carried forward for further consideration include geological resources, visual resources, infrastructure, transportation, demographics (including employment and housing occupancy), airspace and airfield operations, and hazardous materials and waste.

Geological resources include topography, geology, and soils. It does not include submerged sediments analyzed in other resource areas. Topography is typically described with respect to the elevation, slope, and surface features found within a given area. The geology of an area may include bedrock materials, mineral deposits, and fossil remains. Soil refers to unconsolidated earthen materials overlying bedrock or other parent material. Soil structure, elasticity, strength, shrink-swell potential, and erodibility determine the ability for the ground to support structures and facilities. Soils are typically described in terms of their type, slope, physical characteristics, and relative compatibility or limitations with regard to particular construction activities and types of land use. The Proposed Action does not involve new construction or modification of landforms/topography. In addition, ground vehicles and land targets are typically operated or placed in previously disturbed, vegetative or non-vegetative areas (documented not to contain sensitive biological or cultural resources), or improved, graded, or paved surfaces (e.g., airfields, runways, or roads) at Naval Air Station (NAS) Patuxent River or Outlying Field (OLF) Webster. As a result, geological resources is not carried forward for analysis as no changes or impacts to geological resources would occur.

Visual resources include the natural and built features of the landscape visible from public views that contribute to an area's visual quality. Visual perception is an important component of environmental quality that can be impacted through changes created by various projects. Visual impacts occur as a result of the relationship between people and the physical environment. Since the Proposed Action does not involve changes to the visible landscape, visual resources are not carried forward for analysis.

Infrastructure addresses topics such as utilities (including drinking water production, storage, and distribution; wastewater collection treatment and disposal; storm water management, solid waste management, energy production, transmission, and distribution; and communications), and facilities (including airfields, buildings, ranges, testing areas, piers, housing, etc.). Impacts to utilities are primarily associated with changes in the number of personnel utilizing the utility infrastructure and/or construction, renovation, and demolition actions that result in a change on the demands on the existing utility infrastructure. Since the Proposed Action does not involve changes to personnel or construction, no changes to utilities or facilities would occur and, therefore, this resource area is not carried forward for analysis.

Transportation includes all of the air, land, and sea routes with the means of moving passengers and goods. A transportation system can consist of any or all of the following: roadways, bus routes, railways, subways, bikeways, trails, waterways, airports, and taxis, and can be looked at on a local or regional scale. For this EIS, potential impacts to air and vessel traffic is addressed in Section 3.7 (Socioeconomics). However, such impacts are not caused by change in the existing transportation system within the PRC Study Area. Alteration of land transportation systems is not part of the Proposed Action and, therefore, is not carried forward for analysis.

Demographics, employment characteristics, and housing occupancy status data provide key insights into socioeconomic conditions that might be affected by a proposed action. Socioeconomics is typically defined as the basic attributes and resources associated with the human environment, particularly characteristics of population and economic activity. Since the Proposed Action does not involve changes to populations, housing or employment, these socioeconomic resource areas are not carried forward for analysis. However, the following socioeconomic resources may be impacted by the Proposed Action: recreational activities and commercial and recreational transportation and fishing (Section 3.7, Socioeconomics). Information regarding the effect of noise on property values is available in Appendix B (A Noise Primer: Noise and Its Effects on the Environment, hereinafter referred to as *Noise Primer*).

Airspace, which is defined in vertical and horizontal dimensions, is considered to be a finite resource that must be managed for the benefit of all aviation sectors including commercial, general, and military aviation. Airfield operations include flight operations at the installations and surrounding airports. The *NAS Patuxent River Air Operations Manual* (U.S. Department of the Navy, 2017a) specifies the procedures military aircraft must follow when operating at and between NAS Patuxent River and OLF Webster within different restricted areas, including other testing and training locations, to remain clear of other civil air traffic transiting this airspace environment. Close coordination between the Patuxent River Terminal Radar Approach Control, Atlantic Test Ranges (ATR) military radar unit (Baywatch), and the Federal Aviation Administration (FAA) plays a key role in minimizing any impacts by ensuring instrument flight rule aircraft are separated from military flight activities while providing air traffic advisories to visual flight rule aircraft. The Proposed Action does not include changes to the PRC Study Area airspace or airfield use. Any higher daily/annual operating levels are safely accommodated through adherence to existing standard operating procedures (Table 2.5-1, Standard Operating Procedures), FAA Orders, and other best management practices that clearly govern how flight activities must be conducted. While the mix of aircraft types would change somewhat over time due to the nature of the testing mission, this would not affect the overall operating characteristics of those aircraft types currently flown within this airspace environment. Any new procedures that may be required to maintain safety standards would be included in the *NAS Patuxent River Air Operations Manual* and other guidance that regulate Navy flight operations within the study area. Since the Proposed Action does not involve changes to the airspace or airfield operations, this resource area is not carried forward for analysis.

Hazardous materials are defined by 49 Code of Federal Regulations (CFR) section 171.8 as “hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table, and materials that meet the defining criteria for hazard classes and divisions in 49 CFR part 173.” Hazardous wastes are defined by the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments, as: “a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (A) cause, or significantly contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.”

NAS Patuxent River maintains a robust hazardous materials compliance program that is in compliance with all applicable regulations. Hazardous materials are used in support of various aircraft, vehicle, and infrastructure maintenance and repair at NAS Patuxent River and affiliated installations. These materials are managed in accordance with Naval District Washington Instruction 5090.0, *Regional Consolidated Hazardous Material Reutilization and Inventory Management Program*. Hazardous wastes are generated at the installation and are associated with activities such as painting/coating, etching, cleaning, lab wastes, and indoor shooting ranges. These wastes are managed under a Regulated Waste Management

Plan (U.S. Department of the Navy, 2011a). The PRC is a RCRA large-quantity generator of hazardous waste (i.e., generates more than 2,200 pounds of hazardous waste or 2.2 pounds of acute hazardous waste per month, the maximum generator status under RCRA) (U.S. Environmental Protection Agency RCRA Identification Number MD7170024536).

As addressed in Section 3.3 (Water Resources and Sediments), a variety of military munitions are tested within the PRC, which includes dropping and firing them over the Chesapeake Bay Water Range. It is 40 CFR part 266, subpart M, Military Munitions Rule, that defines when military munitions become a solid waste and potentially a waste military munition, as defined under the RCRA. The Military Munitions Rule specifies that "(a) A military munition is not a solid waste when: (1) Used for its intended purpose, including: (i) Use in training military personnel or explosives and munitions emergency response specialists (including training in proper destruction of unused propellant or other munitions); or (ii) Use in research, development, testing, and evaluation of military munitions, weapons, or weapon systems..." This exemption of used military munitions from the definition of a solid waste and, therefore, a hazardous waste under RCRA pertains to military munitions used on a military range. The Chesapeake Bay Water Range meets the definition of a military range under the Military Munitions Rule as it is "...a designated land or water area set aside, managed, and used to conduct research on, develop, test, and evaluate military munitions and explosives, other ordnance, or weapon systems, or to train military personnel in their use and handling." As described previously, the Proposed Action does not include the use of explosive munitions in testing or training. However, all other military munitions described in Section 2.1.3.4 (Munitions and Other MEM) used in testing or training under the Proposed Action are subject to the Military Munitions Rule and are, therefore, not regulated as a solid waste or hazardous waste under RCRA.

Because the Proposed Action would not introduce new types of hazardous materials, result in the generation of new hazardous waste streams, or change the RCRA generator status of NAS Patuxent River, this resource area is not carried forward for analysis. Quantities of these materials may change (although not significantly) in relation to proposed changes in operational tempo. However, the hazardous materials and hazardous waste programs that are currently in place are mature, well established, and would be able to accommodate changes in materials and wastes with minimal difficulty. The management of hazardous materials and wastes would continue to be conducted in a manner that is compliant with all applicable regulations and is protective of human health and the environment.

3.0.2.3 Identifying Stressors for Analysis

Each air-, land-, and water-based activity and asset associated with the Proposed Action has the potential to generate one or more stressors that may consequently impact a resource area. Table 3.0-1 correlates the testing and training activities and assets described in Chapter 2 (Proposed Action and Alternatives) to each potential stressor that they may generate, regardless of the intensity of the impact.

The proposed testing and training activities were evaluated to identify specific components that could act as stressors by having direct or indirect impacts on the environment. Each stressor discussion includes a description of activities and/or assets that may generate the stressor. The potential stressors that may impact each resource are identified in Table 3.0-2 and further described in applicable resource sections of this chapter. For the purpose of Table 3.0-2, a stressor may have a potential impact on a resource area if the two overlap in space and time (e.g., land use and acoustic stressor).

Table 3.0-1 Testing and Training Activities, Assets, and Locations by Stressor

Activity Category and Subcategory	*Primary Asset(s)*[1]	*Location(s)*[2]	*Alternatives*	*Potential Stressors*						
				Acoustic	*Physical Disturbance and Strike*	*Pollutants*	*Public Interaction*	*Energy*	*Entanglement*	*Ingestion*
Activities Continuing from the 1998 PRC EIS										
Aircraft Flight Activities	Air-Based	Restricted Airspace, Helo OPAREAs	All	✓	✓	✓	✓	✓		
	MEM	CBWR, Patuxent River Seaplane Area		✓	✓	✓	✓		✓	✓
Ground-Based Activities	Land-Based	Previously Disturbed Land Areas and Ground Test Facilities	All	✓	✓	✓		✓		
	MEM	CBWR, ATA		✓		✓				
Surface Vessel Activities	Water-Based	CBWR and Other Estuarine Waters	All	✓	✓	✓	✓	✓		
	MEM (Targets Fragments)	CBWR			✓	✓	✓			✓
Expanded Technologies and Capabilities Since the 1998 PRC EIS										
Surface and Subsurface Testing and Training	Water-Based	CBWR and Other Estuarine Waters	All	✓	✓	✓	✓	✓		
	MEM + Target Fragment	CBWR		✓	✓	✓	✓			✓
Mine Countermeasure Systems Testing	Air-Based	CBWR and Other Estuarine Waters	All	✓	✓	✓	✓	✓		
	Water-Based			✓	✓	✓	✓	✓		
	MEM	CBWR		✓	✓	✓	✓		✓	
Bloodsworth Island Range Activities	Air-Based	Bloodsworth Island Range	All	✓	✓	✓	✓	✓		
	Land-Based (Stationary Targets)			✓	✓					
Anti-submarine Warfare Systems Testing and Training	Air-Based	Dip Points (North of the CBWR)	All	✓	✓	✓	✓	✓		
	Water-Based (Dipping Sonar)			✓	✓		✓			
	MEM (Active Sonobuoys)		1 & 2	✓	✓	✓	✓		✓	
Science and Technology Demonstrations	Air-Based	CBWR and Other Estuarine Waters	All	✓	✓	✓	✓	✓		
	Water-Based			✓	✓	✓	✓	✓		
Unmanned Systems Testing and Training	Air-Based	Restricted Airspace, Helo OPAREAs	All	✓	✓	✓	✓	✓		
	Water-Based	CBWR and Other Estuarine Waters		✓	✓	✓	✓	✓		

Table 3.0-1 Testing and Training Activities, Assets, and Locations by Stressor, Continued

Activity Category and Subcategory	*Primary Asset(s)*[1]	*Location(s)*[2]	*Alternatives*	*Potential Stressors*						
				Acoustic	*Physical Disturbance and Strike*	*Pollutants*	*Public Interaction*	*Energy*	*Entanglement*	*Ingestion*
	Land-Based	Previously Disturbed Land Areas		✓	✓	✓		✓		
Directed Energy Weapons Systems Testing[3]	Air-Based	Restricted Airspace	1 & 2	✓	✓	✓	✓	✓		
	Water-Based	CBWR and BIR SDZ		✓	✓	✓	✓	✓		
	Land-Based	Previously Disturbed Land Areas		✓	✓	✓		✓		
	MEM (Expended UAS Targets)	Previous Disturbed Land Areas, CBWR, or BIR SDZ		✓	✓	✓	✓			✓

Key: ATA = Armament Test Area; BIR SDZ = Bloodsworth Island Range Surface Danger Zone; CBWR = Chesapeake Bay Water Range; EIS = Environmental Impact Statement; MEM = military expended materials; Helo OPAREAs = Helicopter Operating Areas; PRC = Patuxent River Complex; UAS = unmanned aerial systems.

Notes:

1. Refer to Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems) for specific MEM associated with activities.
2. Refer to Figures in Chapters 1 and 2 for referenced locations.
3. Weapon platforms and targets may include air, water, and land-based assets covered under other activities (e.g., aircraft flight activities, surface vessel activities).

Table 3.0-2 Stressor Potential to Impact Resource Areas

Resource Areas	*Potential Stressors*						
	Acoustic	*Physical Disturbance and Strike*	*Pollutants*	*Public Interaction*	*Energy*	*Entanglement*	*Ingestion*
Ambient Airborne Noise	✓						
Air Quality			✓				
Water Quality and Sediments		✓	✓				
Biological Resources	✓	✓	✓		✓	✓	✓
Public Health and Safety	✓	✓		✓			
Land Use	✓						
Socioeconomics	✓			✓			
Environmental Justice	✓						
Cultural Resources	✓	✓					

In the subsequent sections, the various tables are not exclusive of each other, and the stressors from a single named activity from Chapter 2 (Proposed Action and Alternatives) could show up on several stressor-based tables. Also, activities are not always conducted independently of each other, which is pertinent to the analysis of combined effects (see Section 3.0.2.5, Resource-Specific Impacts Analysis for

Multiple Stressors). For example, aircraft flight operations over the Chesapeake Bay Water Range are often conducted in conjunction with surface vessel activities (e.g., target presentation).

The following sections characterize each stressor introduced into the environment through the activities and assets described in Section 2.1 (Proposed Action) and linked to stressors in Table 3.0-1. They also provide additional detail to the operational tempos in Table 2.3-1 (Annual PRC Operational Tempo per Alternative: Activities and Assets) and Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems) to provide the basis for analysis of potential impacts on resources in the remainder of Chapter 3 (Affected Environment and Environmental Consequences).

3.0.2.3.1 Acoustic Stressors

Acoustic stressors include sound emitted into the air or water for a specific purpose (e.g., sonic booms, static engine runs, active sonar and other transducers), as well as incidental sources of sound produced as a byproduct of operating air-, water-, or land-based assets and use of non-explosive weapons or other military expended materials (MEM). This stressor may affect the following resources in the PRC Study Area: ambient airborne noise, biological resources, land use, socioeconomics, and environmental justice. All the activities associated with the Proposed Action Alternatives generate potential noise stressors. Characteristics of sound sources associated with the proposed activities and assets are described in the following sections. Explanations of the terminology and metrics used when describing sound are in both Appendix B (Noise Primer) and Appendix C (Noise Study). However, some explanation of airborne and underwater sounds is provided in this section to preface the analysis of acoustic stressor effects on both human and other biological resources.

Sound levels are characterized in terms of decibels (dB). However, the dB level for the same sound wave varies according to the substance it is moving through (e.g., air/water) and how the wave is measured. Therefore, noise metrics used to describe particular types of sound must be selected to best correspond to the potential effects being assessed. Airborne sound levels are calculated for a reference pressure level of 20 micropascals (μPa) and cannot be compared directly to in-water sound levels, which are calculated against a 1 μPa reference pressure level. The time component of sound measurement is also important, with peak-to-peak (top of wave to bottom) and 0-to-peak levels being essentially instantaneous maximum levels, whereas most other sound metrics are summarized over a time interval (e.g., root mean squared). Short-lived noises with very brief rise and decay times, such as weapons firing noise, referred to as impulsive noises are often measured in terms of peak-to-peak or 0-to-peak. Non-impulsive, continuous sounds are often measured over time intervals. Sounds that are not pure tones can also vary according to intensity and frequency. Sound levels that are adjusted to de-emphasize frequencies not heard well by humans (e.g., below 1 kilohertz [kHz]) are A-weighted decibels (dBA). Other organisms (e.g., fish) have hearing frequency sensitivity ranges that differ from that of humans. Unweighted sound levels are more appropriate than A-weighted sound levels for assessment of potential impacts to species that are highly sensitive to frequencies below 1 kHz.

Not all sounds are stressors that can do physical harm to organisms; there are acoustic sources with narrow beam widths, downward-directed transmissions, short pulse lengths, frequencies above known hearing ranges, low source levels, or combinations of these factors that are not anticipated to result in any significant effects on animals. These sources are categorized as *de minimis* sources and are not expected to cause any injury or mortality to biological resources. However, these sources are analyzed qualitatively for short-term effects on communication and behavior/stress. When applied to the

Proposed Action Alternatives, and in a typical underwater environment, *de minimis* sources fall into one or both of the following categories:

- **Sources that transmit primarily at very high frequencies:** Sources above 200 kHz are above the hearing range of most aquatic animals in the PRC Study Area.
- **Sources with source levels of 160 dB referenced to 1 micropascal (re 1 µPa) or less:** Low-powered sources with source levels less than 160 dB re 1 µPa are typically navigational sonars, range pingers, transponders, and acoustic communication devices.

Sound levels diminish (i.e., attenuate) with increasing distance from their source, and there are different models that are appropriate for shallow versus deep water (practical versus spherical, respectively). Assuming practical spreading for a 160 dB re 1 µPa source level underwater, the sound will attenuate to less than 140 dB within 22 meters and less than 120 dB within 464 meters of the source. Ranges would be even shorter for a source with a source level less than 160 dB re 1 µPa. However, there are many factors that can alter the propagation of sound underwater based on practical spreading (e.g., frequency of sound, water depth/topography, bottom type, vertical obstructions, temperature, salinity). Because of the complexity of analyzing sound propagation in the Bay environment, the Navy relies on acoustic modeling that considers both sound source characteristics and varying conditions across the study area in its environmental analyses of source levels that are substantially greater than *de minimis*. The Navy Acoustic Effects Model is further described in Section 3.4.5 (Marine Mammal Protection Act – Biological Assessment).

Sound generated in air is transmitted to water primarily in a narrow area directly below the source. A sound wave propagating from an airborne source must enter the water at an angle of incidence of about 13 degrees (13°) or less from the vertical for the wave to continue propagating under the water's surface. At greater angles of incidence, the water surface acts as an effective reflector of the sound wave and allows very little penetration of the wave below the water. At lower altitudes, sound levels reaching the water surface would be higher, but the transmission area would be smaller. Within the limited conditions under which sound pressure transitions most efficiently between air and water, the translation to underwater noise levels is approximately +32 dB (Appendix B, Noise Primer). Similarly, the maximum sound levels generated from underwater stressors in the airborne environment are greatly reduced (-32 dB) and limited in terms of conditions under which sound energy travels most efficiently (e.g., angle of incidence).

In the air or underwater environment, the potential for detection depends on the frequency and intensity of sound in relation to the existing, ambient sound environment; sounds that are not loud enough or that cannot be heard by biological resources are considered to have no meaningful effect on them. The existing, ambient sound environment in the PRC water column and atmosphere depends on the average distribution of various sources of sound that is caused by natural events and human activities, including the Proposed Action. The potential impact on an animal from an acoustic stressor also depends on how often the organism(s) experiences the sound. The distribution of the acoustic stressor is described under Sections 3.0.2.3.1.1 through 3.0.2.3.1.4 for air-, water-, and land-based assets and non-explosive munitions and other expended materials (e.g., weapons firing and impact noise). The distribution and density of organisms is described in their respective affected environment sections (Section 3.1, Ambient Airborne Noise, and Section 3.4, Biological Resources).

3.0.2.3.1.1 Aircraft and Aerial Targets (Air-Based Assets)

Aircraft flight activities involving, fixed-wing jet, fixed-wing propeller, rotary-wing, and unmanned aerial systems (UAS), occur throughout the PRC. Aircraft used in testing and training generally have jet or turboprop engines. Motors, propellers, and rotors produce the most noise, with some noise contributed by aerodynamic turbulence. Aircraft sounds have more energy at lower frequencies. Aerial targets, including BQM series and other UAS targets (e.g., quadcopters), contribute sound in a similar fashion. The majority of aircraft noise in the study area would be generated at NAS Patuxent River airfield (Trapnell Field) and OLF Webster during airfield operations (i.e., takeoffs and landings) that occur below 3,000 feet above ground level (AGL). Flight activities typically involve one or two aircraft and average two hours in duration. The majority of manned and unmanned flight hours occur Monday through Friday (between 7:00 a.m. and 11:00 p.m.). Due to the “10 aircraft rule,” a maximum of 20 aircraft may be operating within the restricted airspaces at any given time since a “group” of aircraft may consist of one or more aircraft in a tight formation, such as a test aircraft and a chase plane combination (U.S. Department of the Navy, 1998).

Because of the variety of aircraft platforms operated within the PRC and to facilitate analysis, representatives were chosen for each aircraft category based on their flight characteristics as well as highest use and operation below 3,000 feet AGL within the 10-year historical baseline. Table 3.0-3 provides the representative types of aircraft and maximum flight hours associated with the Proposed Action Alternatives and the percent of average flight hours above and below 3,000 feet AGL.

Table 3.0-3 Estimated Flight Altitude and Percent of Flight Hours by Aircraft Category of the Proposed Action Alternatives

Air-Based Assets	*Representative Type*	*Minimum Flight Altitude (ft AGL)*	*Annual Hours (Events)*			*Avg. % of Hours*
			No Action Alternative	*Action Alternative 1*	*Action Alternative 2*	
AIRCRAFT						
Supersonic Events*	F/A-18	Mostly above 30,000	(247)	(180)	(198)	
Above 3,000 ft AGL		**3,000**	**11,840**	**11,410**	**12,680**	**52%**
Below 3,000 ft AGL		**Varies**	**8,260**	**11,990**	**13,320**	**48%**
Fixed-Wing Jet	F/A-18E	600	1,990	2,510	2,790	**10%**
Fixed-Wing Propeller	C-12		1,970	1,770	1,960	**9%**
Rotary-Wing	H-60	50	4,000	6,930	7,710	**27%**
UAS	T-34 (Surrogate)	<50	300	780	860	**2%**
AERIAL TARGETS**						
Large Aerial Target	BQM-177	>800	3	5	6	**<1%**
Small UAS Target	Quadcopter	<50	50	136	150	**<1%**
TOTAL HOURS			**20,100**	**23,400**	**26,000**	**100%**

Key: > greater than; < less than; AGL = above ground level; ft = feet; UAS = unmanned aerial system.
Notes:
*Included in flight hours above 3,000 ft AGL for fixed-wing jets
**Flight hours associated with the number of targets shown are included in flight hours for UAS.

The distribution of flight hours between aircraft types may fluctuate year-to-year based on mission needs. However, the flight hour average below 3,000 AGL of each representative aircraft type is depicted in Table

3.0-3 and used for stressor analysis (e.g., air quality). Most of the flight hours (80 percent) in Table 3.0-3 would take place in the restricted airspace, with the remainder occurring in the Helicopter Operating Areas (Helo OPAREAs). The total hours of flights would be roughly split between aircraft operating at altitudes above and below 3,000 feet AGL (52 percent and 48 percent respectively). Use of UAS (both as targets and non-targets) is relatively rare (3 percent of overall flight hours, and may occur at lower altitudes than manned aircraft. Smaller UAS can also be battery-powered and operate at relatively slow speeds. Supersonic flight occurs mostly above 30,000 feet AGL and represents a portion of the total flight hours for fixed-wing jets. The rare exception to high altitude supersonic flight occurs during weapons separation testing associated with MEM release (refer to Appendix C, Noise Study, for detailed analysis on supersonic events). Minor reductions in supersonic events under Alternatives 1 and 2 reflect a trend toward supersonic tests being conducted in offshore Warning Areas rather than within PRC airspace. Warning Areas include sufficient airspace dimensions to support supersonic test requirements of fifth-generation fighter aircraft such as the F-35. Aerial target launches, with the exception of small UAS targets, are rare and highly contingent on customer requirements.

Fixed-Wing Aircraft

Noise generated by fixed-wing aircraft is temporary in nature and extremely variable in intensity. Based on historical data, most fixed-wing aircraft sorties (a flight mission made by an individual aircraft) occur above 3,000 feet AGL, at altitudes typically between 3,500 to 24,999 feet and up to 85,000 feet within restricted areas R-4006 and R-4008 respectively (Figure 1.3-2, PRC Airspace). However, certain fixed-wing aircraft missions, such as the P-8 anti-submarine warfare (ASW) mission, are representative of low altitude flights that may occasionally be required for manned, fixed-wing aircraft. The P-8 aircraft flying at an altitude of 600 feet AGL generates 110 dBA sound exposure level (SEL) at the surface (Table 3.0-4).

Table 3.0-4 Airborne Noise from Subsonic (Non-Impulsive) and Supersonic (Impulsive) Aircraft Associated with the Proposed Action for Representative Aircraft

Noise Source	*Sound Pressure Level (dB re 20 µPa SEL)*
Subsonic, Non-impulsive Sound Levels	
Jet Aircraft Under Afterburner at 50 ft[1]	148 dB peak
Jet Aircraft Under Full Power Without Afterburner at 50 ft[1]	144 dB peak
F-35A Takeoff Through 1,000 ft AGL[2]	119 dBA SEL (1 second duration)
H-60 Helicopter Hovering at 82 ft AGL[3]	113 dB
Aerial Target (BQM) launch at 1,000 ft AGL[4]	112 dBA L_{max}*
P-8 aircraft at 600 ft AGL	110 dBA SEL (1 second duration)
Supersonic, Impulsive Sound Levels	
F/A-18 at 23,500 ft AGL and Mach 1.2[5]	102 dBA SEL (1.2 second duration)

Sources: [1] (U.S. Department of the Navy, 2009a), [2] (U.S. Department of the Air Force, 2016), [3] (Bousman & Kufeld, 2005), [4] (U.S. Department of the Air Force, 2017), [5] (Bahm & Haering Jr., 1995)

Key: AGL = above ground level; dB re 20 µPa = decibel(s) referenced to 20 micropascals; dBA = A-weighted decibels; ft = feet; L_{max} = maximum sound level; SEL = sound exposure level.

Note: * Extrapolated from 119.5 dBA L_{max}, measured at approximately 400 feet, assuming 6 dB reduction per doubling of distance

The highest SEL by a fixed-wing aircraft flying at subsonic speed outside the airfield environment is 115 dBA SEL, generated by the F-35C flying at 1,000 feet (Table 3.0-4). The highest non-impulsive noise measured from aircraft of 152 dB re 1 µPa at 2 meters below the water surface is generated by a fixed-wing jet during subsonic flight at 1,000 feet AGL (Table 3.0-5). Exposure to fixed-wing aircraft noise at low altitudes is typically brief (seconds) as an aircraft quickly passes overhead. Aircraft operating at higher altitudes are often heard for longer periods of time (minutes) but are less loud.

Table 3.0-5 Underwater Noise from Subsonic (Non-Impulsive) and Supersonic (Impulsive) Aircraft Associated with the Proposed Action for Representative Aircraft

Noise Source	***Sound Pressure Level (dB re 1 µPa)***
Subsonic, Non-impulsive Sound Pressure Levels (Full-band SPL)	
F/A-18 at 1,000 ft Altitude	152 at 2 m below surface[1]
H-60 Helicopter Hovering at 82 ft Altitude	>145 at 1 m below surface*[2]
F/A-18 at 10,000 ft Altitude	128 at 2 m below surface[1]
Supersonic, Impulsive Sound Pressure Levels (Peak SPL)	
F/A-18 at 32,808 ft Altitude at Mach 1.2-2	158–159 at 1 m below surface[3]

Sources: [1] (Eller & Cavanagh, 2000); [2] (Bousman, W.G. and R.M. Kufeld, 2005); [3] (Laney & Cavanagh, 2000)
Key: > = greater than; dB re 1 µPa = decibel(s) referenced to 1 micropascal; ft = feet; m = meters; SPL = sound pressure level.
Note:
* Estimate based on in-air level

Supersonic Flight

An intense but infrequent type of aircraft noise is the sonic boom, produced when a fixed-wing jet exceeds the speed of sound during supersonic flight. Supersonic flights are conducted by fixed-wing jets and primarily occur above 30,000 feet in R-4008. Although infrequent, the Chessie Air Traffic Control Assigned Airspace (ATCAA) can be used for supersonic flights for events that do not fit within the confines of the restricted airspace. Supersonic runs essential for weapons separation testing may occur in R-4005 below 30,000 feet but above 10,000 feet AGL where non-explosive weapons release is permitted on Hooper Target or supersonic aim points, and can be captured by ATR instrumentation. The representative aircraft types that perform supersonic flight activities and number of supersonic events associated with the Proposed Action are provided in Table 3.0-3.

Several factors that influence sonic booms include: weight, size, and shape of aircraft or vehicle; altitude; flight paths; and atmospheric conditions. A larger and heavier aircraft must displace more air and create more lift to sustain flight, compared with small, light-weight aircraft. Therefore, larger aircraft create sonic booms that are stronger than those of smaller, lighter aircraft. Consequently, the larger and heavier the aircraft, the stronger the shock waves (U.S. Department of the Navy, 2007b). Aircraft maneuvers that result in changes to acceleration, flight path angle, or heading can also affect the strength of a boom. In general, an increase in flight path angle (lifting the aircraft's nose) will diffuse a boom while a decrease (lowering the aircraft's nose) will focus it. In addition, acceleration will focus a boom while deceleration will weaken it. Any change in horizontal direction will focus a boom, causing two or more wave fronts that originated from the aircraft at different times to coincide exactly (U.S. Department of the Navy, 2001). Atmospheric conditions such as wind speed and direction, and air temperature and pressure can also influence the sound propagation of a sonic boom.

Of all the factors influencing sonic booms, increasing altitude is the most effective method of reducing sonic boom intensity. The width of the boom "carpet" or area exposed to sonic boom beneath an aircraft is about 1 mile for each 1,000 feet of altitude (U.S. Department of the Air Force, 2003). For example, an aircraft flying supersonic, straight, and level at 50,000 feet can produce a sonic boom carpet about 50 miles wide. The sonic boom, however, would not be uniform, and its intensity at the ground or water surface would decrease with greater aircraft altitude. Maximum intensity is directly beneath the aircraft and decreases as the lateral distance from the flight path increases. At greater than a certain lateral distance, shock waves refract away from the ground or water surface and no longer intersect the surface. The lateral spreading of the sonic boom depends only on altitude, speed, and the atmosphere and is independent of the vehicle's shape, size, and weight. The ratio of the aircraft length to maximum cross-sectional area also influences the intensity of the sonic boom. The longer and more slender the aircraft, the weaker the shock waves. The wider and more blunt the aircraft, the stronger the shock waves can be (U.S. Department of the Navy, 2007b).

In air, the energy from a sonic boom is concentrated in the frequency range from 0.1 to 100 hertz (Hz). During high altitude supersonic flight, the airborne noise levels on the surface would be less than 102 dBA re 1 µPa (Bahm & Haering Jr., 1995). During level supersonic flights at over 30,000 feet AGL, low-frequency impulsive noise generates up to 159 dB re 1 µPa at the water surface (Table 3.0-5) that diminishes to 135 dB at a depth of 50 meters (Eller & Cavanagh, 2000). The sound frequency associated with these pressures is approximately 10 Hz (Eller & Cavanagh, 2000; Sparrow, 2002). Higher and lower frequencies are progressively lower in sound pressure level measured in dB re 1 µPa, and frequencies greater than 20 Hz have been found to be difficult to observe at depths greater than 33 feet (10 meters) (Sohn et al., 2000). An estimate for the airborne impulsive sound generated from weapons separation testing just above the surface would be over 113 dBA re 20 µPa (138 dB unweighted minus 25 dB), based on a sound frequency spectrum for F/A-18 sonic booms (Bahm & Haering Jr., 1995) and underwater sound levels. A focused and more intense sonic boom would be created when the aircraft changes directions during descent and ascent (U.S. Department of the Air Force, 2000). However, the surface diameter of the focused sonic boom area has been described as only a few hundred feet (Eller & Cavanagh, 2000).

Rotary-Wing Aircraft

Similar to fixed-wing aircraft, noise generated from rotary-wing aircraft is also temporary in nature and extremely variable in intensity. In general, helicopters produce lower-frequency sounds and vibration at a higher intensity than fixed-wing aircraft (Richardson et al., 1995). Most rotary-wing aircraft flight activities occur in the Helo OPAREAs or restricted areas R-4005, R-4006, or R-6609. Some events also require low-altitude (50 to 300 feet) flights over a defined area, such as terrain-following exercises, or mine countermeasure (MCM) system, or ASW activities deploying towed systems, or dipping sonar. Terrain-following exercises are limited to around Harpers and Pearson Creeks, near the airfield environment of NAS Patuxent River, and may involve landing on previously disturbed land areas.

Helicopter sounds contain dominant tones from the rotors that are generally below 500 Hz and often radiate more sound forward than backward. The underwater noise produced from helicopters is generally brief when compared with the duration of audibility in the air. The airborne sound level generated by a UH-60 flying at 25 meters (82 feet) on the surface is 113 dBA re 20 µPa (Table 3.0-4). Based on airborne noise levels reported in Bouseman and Kufeld (2005) from an H-60 hovering at 25 meters (82 feet) altitude, the underwater noise produced is estimated to be approximately 145 dBA re 1 µPa at 1 meter below the water's surface.

Aerial Target Launch Noise

Table 3.0-3 provides the representative type and number of aerial target launches associated with the Proposed Action. Very few BQM launches occur within the PRC Study Area. However, when required, they are launched from the Armament Test Area (ATA), travel through the restricted airspace, and land in the Chesapeake Bay Water Range, where they are fully recovered. Launch of an aerial target begins on the launch stand with its turbojet engines running while final launch preparations are made. Next, a separate and much louder rocket engine is lit producing noise that rapidly reaches the launch event's maximum noise level of approximately 112 dBA at a distance of 1,000 feet (Table 3.0-4). The rocket runs for a few seconds as the aerial target accelerates up and away from the launch pad until the aerial target reverts to running on its relatively quiet and low-thrust turbojet engine. During flight, small UAS targets do not generate noise levels comparable to those of full-scale aircraft, though they fly at relatively low altitudes.

3.0.2.3.1.2 Vessels (and Other Water-Based Assets)

Fewer proposed activities involve water-based assets (e.g., surface vessels, in-water or bottom devices) relative to air-based assets. Water-based assets produce sound from sonar and other transducers, various combinations of hull and propulsion system (i.e., vessel noise), and vessel noise simulators (e.g., MCM systems such as Magnetic Orange Pipe and Organic Airborne and Surface Influence Sweep [OASIS]). There are also some slow-moving bottom and stationary anchored devices[1] associated with the Proposed Action (e.g., remote operating vehicles, bottom crawlers, mine shapes, spar buoys, moored rafts) that are more of a physical disturbance than an acoustic stressor. For a description of specific water-based assets and proposed activities that use them, refer to Appendix A (Patuxent River Complex Activity and Asset Descriptions).

Sonar and Other Transducers

ASW and MCM systems may employ sonar or other transducers at the sonar dip points and either the Chesapeake Bay Water Range or other estuarine waters in PRC Study Area, respectively. Other water-based assets (e.g., vessels, unmanned maritime systems [UMS]) may also use lower source levels of sonar for navigation or mapping purposes. The airborne noise aspect of these activities is limited to that of the towing platforms (e.g., helicopter) included in the previous section on air-based assets or subsequent section on propulsion system noise.

Active sonar and other transducers emit non-impulsive sound waves into the water to detect objects, safely navigate, and communicate. Whereas many water-based assets associated with the Proposed Action employ *de minimis* active sonar for navigation, only ASW dipping sonar (e.g., AN/AQS-22) and active sonobuoys (e.g., Directional Command Activated Sonobuoy System or DICASS) can generate source levels and frequencies greater than *de minimis*. The acoustic parameters of both the dipping sonar system and sonobuoy are provided in Table 3.0-6.

Table 3.0-6 Mid-Frequency ASW Sonar Characteristics

Mid-Frequency ASW Sonar Characteristics	
Active Dipping Sonar (e.g., AN/AQS-22)	
Frequency Range	1–10 kHz
Pulse Length	1 second to < 10 seconds
Dip Cycle	3 or 4 minutes per dip (for events in the Chesapeake Bay)
Pulse Repetition Interval	< 10%
Max Source Level	< 235 dB re 1 μPa at 1 meter from the source
Active Sonobuoy (e.g., DICASS)	
Frequency Range	8 kHz
Pulse Repetition Interval	Approximately 12 pings, 30 seconds between pings
Max Source Level	201 dB re 1 μPa at 1 meter from the source

Key: < = less than; ASW = anti-submarine warfare; dB re 1 μPa = decibel(s) referenced to 1 micropascal; DICASS = Directional Command-Activated Sonobuoy System; kHz = kilohertz.

[1] Stationary targets can be anchored to objects other than the seafloor and at various depths within the water column.

No more than two functional checks of ASW dipping sonar would be conducted within a 24-hour period; more typically, one event would occur within a 24-hour period. Dipping sonar events would occur at four discrete “dip points” in the PRC Study Area (Figure 1.3-6, PRC Water Areas). Prior to all events, the hovering helicopter performs a survey, defined by a 1-nautical mile radius centered on the dip point in use, to ensure the area is cleared of surface marine life and safe for operations (see Table 3.10-1, Impact Avoidance and Minimization Measures). Active dipping sonar events occur up to 39 times a year (Alternative 2), 13 of which also include active sonobuoys (Table 3.0-7).

Table 3.0-7 Annual Dipping Sonar and Sonobuoy Testing and Training Events

<table>
<tr><th rowspan="2">Dipping Sonar Event Type</th><th rowspan="2">Representative Example(s)</th><th colspan="3">Events (Hours)</th></tr>
<tr><th>No Action Alternative</th><th>Action Alternative 1</th><th>Action Alternative 2</th></tr>
<tr><td colspan="5">Active Sonar Events</td></tr>
<tr><td><u>Scenario 1</u>: Dipping Sonar Testing
- Number of dips per event: 3
- Duration per dip: 3 minutes</td><td rowspan="2">AN/AQS-22</td><td>2
(0.30)</td><td>12
(1.80)</td><td>13
(1.95)</td></tr>
<tr><td><u>Scenario 2</u>: Dipping Sonar Proficiency Training
- Number of dips per event: 1
- Duration per dip: 3 minutes</td><td>2
(0.10)</td><td>12
(0.60)</td><td>13
(0.65)</td></tr>
<tr><td rowspan="5"><u>Scenario 3</u>: Dipping Sonar + Sonobuoy Testing
- 2 Sonobuoy: 15 minutes per buoy
- 1 Dipping Sonar: 2 dips at 4 minutes per dip</td><td rowspan="5">AN/AQS-22 + DICASS</td><td rowspan="5">0</td><td>12</td><td>13</td></tr>
<tr><td colspan="2">Active Sonobuoys</td></tr>
<tr><td>(6.00)</td><td>(6.50)</td></tr>
<tr><td colspan="2">Dipping Sonar</td></tr>
<tr><td>(1.60)</td><td>(1.70)</td></tr>
<tr><td colspan="2">Total Active Sonar Events*
Active Sonar Hours</td><td>4
(0.40)</td><td>36
(10.00)</td><td>39
(10.80)</td></tr>
<tr><td colspan="5">Non-Active Sonar Events</td></tr>
<tr><td>Dipping Sonar Testing</td><td rowspan="2">AN/AQS-22</td><td>14</td><td>20</td><td>22</td></tr>
<tr><td>Dipping Sonar Proficiency Training</td><td>16</td><td>12</td><td>13</td></tr>
<tr><td colspan="2">Total Non-Active Sonar Events*</td><td>30</td><td>32</td><td>35</td></tr>
</table>

Key: DICASS = Directional Command Activated Sonobuoy System.
Note:
*Events are distributed equally across the seasons. Up to 10% of annual events may occur at night.

During an ASW dipping test and/or training event, a MH-60R helicopter hovers at an altitude of approximately 50 to 300 feet above sea level and lowers the sonar transducer into the water using a powered reel system to a predetermined depth. Once lowered to the selected depth, the transducer may be activated, briefly transmitting a pulsed, acoustic signal (i.e., ping) to verify all systems are functioning properly and receiving echoes from submerged objects such as sonobuoys. Multiple pings may be emitted at multiple depths during a single event. Upon completion, the transducer is reeled in and, in some instances, the helicopter transits to a second dip point before the functional check procedure is repeated.

<u>Propulsion System Noise</u>

The number of mobile water-based assets (e.g., vessels, UMS, surface and subsurface targets) within the PRC is dependent on customer requirements and can therefore be highly variable. Surface vessels are categoriezed as small (less than 50 feet), medium (50 to 100 feet), or large (greater than 100 but less than 400 feet). Proposed activities generating propulsion system noise include surface vessels activities, surface and subsurface testing and training, MCM, science and technology demonstrations, unmanned systems testing, and directed energy weapons systems testing. Scenarios may involve one or two vessels to several vessels operating over various timeframes and locations. Activities can last from a few hours up to 12 hours per day, with a range support boat and/or surface target deployment averaging 4 hours and combatant and patrol craft deployment 8 hours. To determine the annual hours, the number of assets is multiplied by hours. The vast majority of operating hours are also spent idle (75 percent) or slow speed (5 percent) for assets capable of high-speed operation. Also, the vast majority of high-speed movement is represented by fuel-powered surface vessels (with exposed propellers) operating in the Chesapeake Bay Water Range where depths are mostly greater than 4 meters. Use of water-based assets in the lower Patuxent and Potomac Rivers is less frequent than in the water range and is comprised of UMS (i.e., in-water devices) and 15 percent of vessel and target hours.

The total hours of surface vessel operation would be roughly split between use as range support or combatant and patrol, and use as a target coincident with detection systems, MEM, and/or directed energy system. Use of mobile in-water devices (i.e., subsurface UMS, MCM systems) is relatively rare but somewhat less confined to the Chesapeake Bay Water Range, and requires at least 5-meter depths to safely operate. Relatively small subsurface UMS used in the PRC Study Area employ an enclosed battery-powered propeller and typically operate at relatively slow speeds, though some can operate at high speed (greater than 10 knots). Towed or self-propelled MCM systems can also operate at high speed. The operating hours for water-based assets that represent potential acoustic (and physical disturbance and strike stressors) are provided in Table 3.0-8. Appendix A (Patuxent River Complex Activity and Asset Descriptions) provides a detailed characterization of representative vessel types, lengths, and speed capabilities as well as a description of UMS classes.

Table 3.0-8 Annual Operating Hours for Water-Based Assets Associated with the Proposed Action

Water-Based Assets	***Subcategory (Representative)*** [1]	***Total Operating Hours (Number of Assets)***			***Percent of Operating Hours***		
		No Action Alternative	***Action Alternative 1***	***Action Alternative 2***	***High Speed*** [2]	***Slow Speed***	***Idle***
Vessels and Surface UMS							
Range Support Boats	Large (Navy Relentless)	695 (110)	695 (110)	765 (121)	0%	40%	60%
	Medium (Patrol Boat 777)	629 (232)	629 (232)	692 (255)	20%	5%	75%
	Small (Fountain Boat)	856 (228)	856 (228)	942 (251)			
Combatant and Patrol Vessels	Large (Cyclone-Class Patrol Ship)	64 (8)	32 (3)	35 (3)	0%	40%	60%
	Medium (Mark V Patrol Boat)	16 (2)	50 (6)	55 (7)	20%	5%	75%
	Small (Rigid Inflatable Boat)	104 (13)	211 (26)	232 (29)			
Unmanned Maritime Systems	Unmanned Surface Vehicles (HSMST)	15 (5)	120 (40)	132 (44)			
Mobile Surface Targets	Medium Towed Target (LCMT/PAX Pontoon Target)	15 (3)	50 (10)	55 (11)	20%	5%	75%

Table 3.0-8 Annual Operating Hours for Water-based Assets Associated with the Proposed Action, Continued

Water-Based Assets	*Subcategory (Representative)* [1]	*Total Operating Hours (Number of Assets)*			*Percent of Operating Hours*		
		No Action Alternative	*Action Alternative 1*	*Action Alternative 2*	*High Speed*[2]	*Slow Speed*	*Idle*
	Medium Motorized Propeller (SEPTAR)	1,513 (326)	1,513 (326)	1,664 (359)			
	Small Motorized Impeller (SDST)	15 (3)	25 (5)	36 (6)			
	Small Motorized Propeller (HSMST)	904 (140)	904 (140)	994 (154)			
Underwater UMS / In-Water Devices							
Unmanned Maritime Systems	Unmanned Underwater Vehicles (Small–Large)	138 (46)	360 (120)	396 (132)	20%	5%	75%
Mobile Subsurface Targets	Subsurface Targets (e.g., AMPS, EMATT)	3 (3)	12 (12)	13 (13)	20%	5%	75%
Mine Countermeasure Systems	MOP	36 (18)	36 (18)	38 (18)	20%	5%	75%
	OASIS	4 (2)	4 (2)	4 (2)	100%	0%	0%
	AMNS	0.4 (2)	0.8 (4)	1.0 (5)	20%	5%	75%
TOTALS		**5,007.4**	**5,497.8**	**6,054.0**	**0–100%**	**0–40%**	**0–75%**

Key: AMNS = Airborne Mine Neutralization System; AMPS = Autonomous Mobile Periscope System; EMATT = Expendable Mobile ASW Training Target; HSMST = High Speed Maneuvering Surface Target; LCMT = Low-Cost Modular Target; MOP = Magnetic Orange Pipe; OASIS = Organic Airborne and Surface Influence Sweep; PAX = Naval Air Station Patuxent River; SDST = Ship Deployable Surface Target; SEPTAR = Seaborne Powered Target.

Notes:

1. Refer to Appendix A (Patuxent River Complex Activity and Asset Descriptions) for description of representatives
2. Greater than 10 knots

The main source of vessel noise is propeller cavitation (pressure areas that surround the blades), which varies in frequency and level based on the size of the propeller and speed. The Noise Study (Appendix C) focuses on airborne noise and does not include sound generated by any vessel propulsion system. With many but not all Proposed Action activities, vessels are used in conjunction with aircraft that are much louder; surface and subsurface testing and training can also involve activities without aircraft. In addition, airborne noise generated by Navy vessel operations is similar to noise levels generated by civilian vessels, which operate regularly in the same water areas. Airborne vessel sound levels depend on vessel size and speed, but typically range from 59 to 73 dB re 20µ Pa at locations on the deck of the boat (Vasconcellos & Latorre, 2017). Noise levels decrease with increasing distance from the source. Vessels tend to operate at lower speeds and therefore generally produce lower noise levels while operating close to shore. Airborne vessel noise experienced on shore is not typically sufficiently loud to interfere with speech or cause annoyance. People experiencing airborne vessel noise while on the open water are usually also in vessels and are unlikely to be annoyed by the noise. Because there is minimal potential for impacts associated with airborne vessel noise, no further analysis of airborne vessel noise is required.

Underwater noise from vessel movements is typically non-impulsive, continuous, and relatively broadband, containing energy from 100 Hz to more than 10 kHz, and ranging from 150 to 190 dB re

1 µPa at 1 meter, depending on vessel size and speed (Erbe, 2002; Hildebrand, 2009). During testing and training, maximum speeds of most naval vessels generally range from 10 to 15 knots to limit fuel consumption; however, vessels will occasionally operate at higher than average speeds (e.g., to serve as a high-speed target) or at slower speeds (e.g., to maintain steerage while recovering a high-value test asset) as required. Typically, sound produced by vessels will increase with speed. Noise would be expected to attenuate quickly according to the practical spreading model described earlier in the acoustic stressor background. The approximate safe operating depth, underwater sound parameters, and hours of operation and high speed (greater than 10 knots), slow speed, and idle are provided in Table 3.0-9.

Table 3.0-9 Approximate Minimum Operating Depth, Underwater Sound Parameters, and Hours of Operation at High Speed, Slow Speed, and Idle for Water-Based Assets Associated with the Proposed Action Alternatives

<table>
<tr><th rowspan="2">Water-Based Assets</th><th rowspan="2">Asset Category[1]</th><th rowspan="2">Minimum Operating Depth (Meters)</th><th colspan="2">Underwater Sound Parameters[2]</th><th colspan="3">Average Percent of Total Operating Hours[3]</th></tr>
<tr><th>Source Level (dB re 1 µPa)</th><th>Peak Frequency (kHz)</th><th>High Speed (>10 Knots)</th><th>Slow Speed</th><th>Idle</th></tr>
<tr><td colspan="8">Vessels and Surface UMS</td></tr>
<tr><td rowspan="3">Range Support or Combatant and Patrol Vessels</td><td>Large Vessel</td><td>3</td><td>178</td><td>0.1</td><td>0.00%</td><td>5.29%</td><td>7.93%</td></tr>
<tr><td>Medium Vessel</td><td>2</td><td>168</td><td>0.8</td><td>2.58%</td><td>0.62%</td><td>9.25%</td></tr>
<tr><td>Small Vessel</td><td>1</td><td>164</td><td>2.5</td><td>3.83%</td><td>0.97%</td><td>14.54%</td></tr>
<tr><td>Unmanned Maritime Systems</td><td>Unmanned Surface Vehicles</td><td>1</td><td>164</td><td>2.5</td><td>0.06%</td><td>0.11%</td><td>1.64%</td></tr>
<tr><td rowspan="4">Mobile Surface Targets</td><td>Medium-Towed</td><td>2</td><td>N/A</td><td>N/A</td><td>0.06%</td><td>0.05%</td><td>0.68%</td></tr>
<tr><td>Medium</td><td>2</td><td colspan="2" rowspan="3">Presumed same as Range Support or Combatant and Patrol vessels</td><td>6.04%</td><td>1.38%</td><td>20.61%</td></tr>
<tr><td>Small-Impeller</td><td>0.5</td><td>0.06%</td><td>0.02%</td><td>0.45%</td></tr>
<tr><td>Small-Propeller</td><td>1</td><td>3.61%</td><td>0.82%</td><td>12.31%</td></tr>
<tr><td colspan="8">Underwater UMS / In-Water Devices</td></tr>
<tr><td>Unmanned Maritime Systems</td><td>Unmanned Underwater Vehicles</td><td rowspan="3">5</td><td rowspan="3">Lower than small vessels</td><td rowspan="3">Higher than small vessels</td><td>0.55%</td><td>0.33%</td><td>4.91%</td></tr>
<tr><td>Mobile Subsurface Targets</td><td>Mobile Subsurface Targets</td><td>0.01%</td><td>0.01%</td><td>0.16%</td></tr>
<tr><td>Mine Countermeasure Systems</td><td>In-water Devices</td><td>0.22%</td><td>0.03%</td><td>0.48%</td></tr>
</table>

Key: > = greater than; dB re 1 µPa = decibels referenced to 1 micropascal; kHz = kilohertz; N/A = not applicable; UMS = unmanned maritime systems.

Notes:

1. Refer to Table 3.0-8 and Appendix A (Patuxent River Complex Activity and Asset Descriptions) for representative assets and descriptions, respectively.
2. Based on average sound pressure level measured (from sum of acoustic energy across the frequency bands from 10 to 3,500 hertz) at slow speeds in waters generally colder and more saline than the Bay portion of the PRC Study Area (Kipple & Gabriele, 2004).
3. Plus 5 dB (at most) for high speed, based on small vessel (twin 250 horsepower engines) measurements from 10 to 32.4 knots (Erbe, 2002); note that larger vessels tended to present a smaller difference in decibels between 10 and 32.4 knots.

Based on the estimates in Table 3.0-9, the following sound source levels by vessel size are employed in the analysis for masking and behavioral response/stress in subsequent analysis (where appropriate):

- Small vessels (37 percent of operating hours): 164 to 169 dB re 1 µPa at slow- to high-speed operation, respectively, with a peak frequency of approximately 2.5 kHz;
- Medium vessels (42 percent of operating hours): 168 to 173 dB re 1 µPa at slow- to high-speed operation, respectively, with a peak frequency of approximately 0.8 kHz;
- Large vessels (14 percent of operating hours): 178 dB re 1 µPa at slow-speed operation, with a peak frequency of 0.1 kHz;
- Surface UMS (2 percent of operating hours): less than 164 to 178 dB re 1 µPa at slow- to high-speed (small to medium vessels, respectively) to slow-speed (large vessel) operation, respectively, with peak frequencies from approximate 0.1 to 2.5 kHz (large to small vessels); and
- Underwater UMS/in-water devices (6 percent of operating hours): source characteristics expected to be similar to those of small vessels, but at lower amplitudes due to the reduced size and speed of the platform.

The vast majority (73 percent) of vessel activity is proposed at idle (0 speed) and produces much lower sound levels than even slow-speed operation. Using the equation for practical spreading, the expected sound level for slow to fast moving, small to medium vessels (less than 4 percent of water-based asset hours) would diminish to 160 dB re 1µPa at 2 and 7 meters, respectively. The ambient noise level underwater in the Chesapeake Bay Water Range likely ranges from 60 dB to greater than 120 dB at low-mid frequencies (10 Hz to 10 kHz) depending on the level of the wind and vessel traffic (Urick, 1983).

3.0.2.3.1.3 Land-Based Assets

Proposed activities involving land-based assets (e.g., vehicles and unmanned ground systems) may generate acoustic stressors. Land-based activities that generate these stressors include aircraft ground-based activities, ground vehicles and mobile land targets, and tests conducted at the Open-Air Engine Test Cell (OAETC) facility and ATA ground test facilities. The Noise Study (Appendix C) does not include sound generated by any land-based assets because they are typically used in conjunction with aircraft that are much louder.

Aircraft Ground-Based Activities

While not in-flight, aircraft may conduct pre- and post-flight checks, ground taxiing, turns, or other maintenance activities. The amount of non-flight aircraft activities is proportional to and approximately 18 percent of the proposed flight hours (Table 3.0-10). Ground-based aircraft activities occur on PRC installation airfields, taxiways, tarmacs, and hangar aprons. Noise would therefore be concentrated to these areas, as described in Appendix C (Noise Study).

Ground Vehicle and Mobile Land Targets

Similar to aircraft ground activity, the operation of ground support equipment occurs on or around PRC installation airfields and is proportional to aircraft flight hours (Table 3.0-10). Therefore, these types of activities are routine and frequent. The vast majority of movement is represented by fuel-powered ground support vehicles and aircraft (93 percent and 7 percent, respectively) moving around the installation airfields. Use of unmanned ground systems is relatively rare (less than 1 percent) and confined to previously disturbed areas within PRC installations and mostly within OLF Webster (Table 3.0-10). Most proposed to operate within the PRC are relatively small devices that are typically battery-powered and operate at relatively slow speeds. There is also the occasional use of mobile land-based targets (e.g., vehicles) that is not tracked but is generally limited to the airfield environment.

All ground vehicles may operate in previously disturbed vegetative or non-vegetative areas (documented not to contain sensitive biological or cultural resources), or improved, graded, or paved surfaces (e.g., airfields, runways, and roads), which are within PRC installation boundaries. Because the noise environment of these installations is dominated by aircraft noise, ground vehicle noise does not affect overall noise levels. Operations of heavy-duty ground vehicles, such as the Aircraft Tow Tractor, generate localized elevated noise levels as high as 85 dBA at a distance of 50 feet (Federal Highway Administration, 2006). Aircraft noise levels in the same areas frequently exceed 115 dBA (see Section 3.0.2.3.1.1, Aircraft and Aerial Targets (Air-Based Assets)). Because ground vehicle noise does not have the potential to generate substantive impacts in the context of an active airfield acoustic environment, no further analysis is required.

Table 3.0-10 Types of Land-Based Asset Activities (Hours per Year)

Asset Categories[1]	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*
Aircraft Ground-Based Activities (Hours)			
Fixed-Wing Jet, Fixed-Wing Prop, Rotary-Wing, Unmanned Aerial System	3,693	4,299	4,729
Ground Support Equipment (Hours)			
Aircraft Tow Tractor	9,918	11,316	12,169
Mobile Electric Power Plant (Generator)	13,050	14,890	16,012
Mobile Aircraft Start Unit	10,962	12,508	13,450
Heavy Duty Land-Based Tow Tractor	7,830	8,934	9,607
Test Stand (Hydraulic Portable)	2,271	2,591	2,786
Truck (Ammunition Loading, Transport)	1,566	1,787	1,921
Air-Launched Weapons Loader	1,253	1,429	1,537
Truck (Aerial Stores Lift)	1,044	1,191	1,281
Ground Support Equipment Total Hours	**47,894**	**54,646**	**58,763**
Unmanned Ground Systems (Hours)			
Soldier Transportable, Vehicle Transportable, Self Transportable, and Applique	4	80	88

Note:
1. Refer to Appendix A (Patuxent River Complex Activity and Asset Descriptions) for representative assets and descriptions (not including ground support equipment).

Ground Test Facilities

The OAETC runs for calendar years 2013 to 2017 were analyzed in the Noise Study (Appendix C) and are depicted as a five-year baseline in Table 3.0-11. Of the hours shown, approximately half are spent in idle and half at high power. In addition, these activities are intermittent, with many days of no activity. Turbofan and thrust engine testing, conducted in the jet engine test instrument test cells of the OAETC, has the greatest potential to cause noise impacts on the surrounding communities. As a mitigation from the 1998 PRC EIS, the NAS Patuxent River Instruction 13900.1B, *Noise Reduction Procedures for Open-Air Testing of Uninstalled Engines*, was established in July 2012 to minimize noise impacts to the Solomons Island community (U.S. Department of the Navy, 2012) (Table 3.10-1, Impact Avoidance and Minimization Measures). To ensure conformance with the instruction, the ATR Sustainability Office monitors and tracks jet engine test instrument test cell runs quarterly and annually in EIS

Implementation Progress Reports. OAETC personnel also contact the ATR Sustainability Office prior to conducting engine runs to verify wind direction and go/no-go scenarios.

Table 3.0-11 Type and Number of Ground Test Facility Events

Asset Categories[1]	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*
Open-Air Engine Test Cell (OAETC) (Hours = Events)[2]			
Jet Engine Test Instrument (T-36)	31	31	34
Turboprop Test Instrument	46	46	51
Shaft Engine Test Instrument	12	12	13
T-24 (turboshaft)	2	2	2
T-26 (turbojet)	1	1	1
OAETC Total Hours/Events	**92**	**92**	**101**
Armament Test Area (ATA) (Events)			
Gun Fire Test	11	12	13
Weapons Compatibility Test	14	15	17
ATA Total Events	**25**	**27**	**30**

Notes:
1. Refer to Appendix A (Patuxent River Complex Activity and Asset Descriptions) for representative assets and descriptions.
2. OAETC data is a five-year baseline from calendar years 2013 to 2017.

Activities conducted outdoors at the ATA may also produce noise. Table 3.0-11 provides the number of ATA test events. Although gun ammunition is fired from the outdoors, it is expended directly into the gun-firing tunnel. The noise levels generated from these activities are described in the subsequent section on non-explosive munitions and other MEM.

3.0.2.3.1.4 Non-explosive Munitions and Other Military Expended Materials

The Navy tests and trains using a variety of non-explosive munitions and other MEM, as described in Section 2.1.3.4 (Munitions and Other MEM). MEM may also include small UAS targets and fragments from surface targets described as primarily air- and water-based assets. Proposed activities that generate noise with non-explosive munitions or other MEM include aircraft flight operations, ground-based activities, and surface and subsurface testing and training. Depending on the weapon type, incidental (side effect) noise may be produced at firing or launch, while in flight, or upon impact. Typical non-explosive munitions and other MEM expended annually in the PRC are shown in Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems). Representatives were chosen for each type based on the highest percent used during the 10-year baseline and/or for which associated constituents were available. A description of types is provided in Appendix A (Patuxent River Complex Activity and Asset Descriptions) and representatives for each type are described in Appendix E (Military Expended Materials and Physical Disturbance and Strike Analysis).

The Noise Study depicts a minimum elevated noise level of 50 dB C-weighted day-night average sound level generated from weapons firing extending about a kilometer around fixed targets in the Chesapeake Bay Water Range. These sound levels are average day-night projections for the surface from primarily air-based assets (i.e., aircraft). The peak noise level (dBP) from weapons firing of 130 dB re 20 μPa (unweighted for human hearing) or more occurs infrequently for short durations within 3 kilometers (1.6 nautical miles) of the fixed targets (Appendix C, Noise Study). Peak sound levels of 115 and 130 dB re 20 µPa have been associated with high and moderate risk of complaints, respectively. The loudest sound associated with weapons-firing events is typically of low frequency (less than 250 Hz).

Weapons Live-Fire and Launch Noise

Gun ammunition firing and rocket launching occurs within the Chesapeake Bay Water Range or the ATA. The associated activities include aircraft flight activities, land-based activities (e.g., ATA) and surface and subsurface testing and training. Table 3.0-12 provides examples of live-fire and launch noise at just above the water's surface. Other munitions types used in the PRC generate similar noise levels to those listed or, in the case of dropped munitions (e.g., bombs, torpedoes), minimal noise at release and during flight.

The highest intensity, low-frequency weapons firing noise of 137 dBP re 20 µPa from rocket firing would be similar in impulsive intensity to the occasional (unfocused) sonic booms associated with weapons separation testing, but weapons firing would be more frequent, and associated with the physical disturbance of air- or water-based asset. Weapons firing is therefore among the most intense and frequent acoustic stressor from the Proposed Action apart from aircraft noise in and around the airfield environment. However, weapons firing noise is relatively brief and associated with significant physical disturbance. The highest intensity, low-frequency weapons firing noise generated underwater from rocket firing would be similar in impulsive intensity to the occasional (unfocused) sonic booms associated with weapons separation testing, but weapons firing would be more frequent and associated with the physical disturbance of air- or water-based assets.

Directed energy weapons are typically silent. Noise associated with the firing of these weapons would be localized noise generated by aircraft, surface vessels, or land-based assets carrying the weapon. No further analysis is required regarding directed energy noise impacts.

Table 3.0-12 Airborne Noise from Representative Live-Fire and Launched Munitions

Noise Source	*Representative Munition Type*	*Sound Level[1]*
Medium-caliber Gun Ammunition	30 mm	118 dBP
Small-caliber Gun Ammunition	7.62 mm	109 dBP
Rockets	2.75-inch	137 dBP

Key: dBP = peak pressure decibel level referenced to 20 micropascals; mm = millimeter.
Notes:
1. Noise levels were calculated using Air Gunnery Noise Model for a location 1,000 feet directly below the firing of the largest representative ammunition round listed. Noise levels at the surface vary widely depending on actual distance and bearing between firing point and sound receiver.

Impact Noise

Weapons separation tests associated with aircraft flight activities also involves the jettison of weapons from aircraft to test their safe release within the Chesapeake Bay Water Range. Other aircraft flight activities release other MEM (e.g., sonobuoys, marine markers, illumination flares). Any object dropped in the water would create a noise upon impact, depending on the object's size, mass, and speed. Sounds of this type are produced by the kinetic energy transfer of the object with the target surface and are highly localized to the area of disturbance. A significant portion of an object's kinetic energy would be lost to splash, any deformation of the object, and other forms of non-mechanical energy (McLennan, 1997). The remaining energy could contribute to sound generation. Most objects would be only momentarily detectable, if at all, but some large objects traveling at high speeds could generate a broadband impulsive sound upon impact with the water surface. Sound associated with impact events is typically of low frequency (less than 250 Hz) and of short duration.

With regard to underwater noise, a large missile impacting the water surface at over 1,028 meters per second may produce a sound of up to 271 to 281 dB re 1 µPa (McLennan, 1997). However, the relatively few missiles associated with the Proposed Action are mostly dropped to reach much lower speeds before impact, and fired MEM are generally much smaller than missiles (e.g., gun ammunition). The corresponding sound level of most MEM impact noise at the surface is probably similar to rocket firing at 1,000 feet AGL (Table 3.0-12), based on the underwater pressure generated by small-caliber bullets impacting the surface, reported by Leslie (1964); 1.7 foot-pounds (81.4 pascals) measured underwater for .38 caliber bullet translates to approximately 158 dB re 1 µPa (158 - 32 dB = 126 dB re 20 µPa).

3.0.2.3.2 Physical Disturbance and Strike Stressors

This section describes the characteristics of physical disturbance and strike stressors from Navy testing and training activities. This stressor may affect the following resources in the PRC Study Area: water quality and sediment, biological resources, and public health and safety. All the activities associated with the Proposed Action alternative generate potential noise stressors. Disturbance differs from strike in terms of duration and proximity. Strike is direct contact from an instantaneous impact whereas disturbance is an effect from proximity to a strike nearby or displacement of habitat by material introduced by the Proposed Action. Proximity with respect to physical disturbance could be due to visual stimuli or displacement of the medium (air or water) by air-, water-, or land-based assets.

3.0.2.3.2.1 Aircraft and Aerial Targets (Air-Based Assets)

Typical types of aircraft flown within the PRC Study Area are provided in Appendix A (Patuxent River Complex Activity and Asset Descriptions), and representatives for each type are listed in Section 2.1.3.1 (Air-Based Assets). Types and descriptions of aerial targets are also available in Appendix A. Table 3.0-3 provides the number of aircraft flight hours above and below 3,000 feet AGL associated with the Proposed Action. In general, aircraft movement in PRC airspaces is more frequent and widespread over and around the airfield environment, with more localized and infrequent occurrence elsewhere in the PRC airspace. Aircraft may operate singly or in combination in any particular event. Speeds range from less than 100 knots (generated by Group 1 UAS) to supersonic (greater than Mach 1.0 but not hypersonic) depending on test requirements. A typical BQM target is smaller than manned aircraft (approximately 20 feet in length with a 10.5-foot wingspan). Although capable of supersonic speeds, the target will only operate at subsonic speeds within the PRC. The UAS targets proposed for directed energy testing are much smaller and slower than the BQM.

3.0.2.3.2.2 Vessels (and Other Water-Based Assets)

The characterization of mobile water-based assets from a multiple resource perspective is covered in Section 3.0.2.3.1.2 (Acoustic Stressors, Vessels (and Other Water-Based Assets)), which also provides the available metrics for the physical disturbance/strike stressor (e.g., hours of high-speed vessel movement). Therefore, this section covers only water-based assets that are essentially stationary (e.g., mine shapes, spar buoys, dipping sonar).

Stationary targets do not pose a threat to highly mobile resources when anchored in place. However, during the deployment process, physical disturbance to sediments and biological resource habitats as well as in-water cultural resources such as shipwrecks could potentially occur; although targets would not be placed in areas of in-water cultural resources that are mapped as navigation hazards (refer to Section 2.5, Standard Operating Procedures Included in the Proposed Action). Table 3.0-13 provides the typical types and quantities of stationary targets. These targets are typically placed in the Chesapeake

Bay Water Range although some may be used outside the water range within installation surrounding waters. All stationary targets are fully recovered following the event.

Table 3.0-13 Type and Annual Number of Stationary Targets or Bottom Devices

Asset Categories	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*
Stationary Surface Target			
Mine Shapes	2	4	5
Spar Buoy	1	2	2
Moored Raft	1	2	2
Stationary Subsurface Target			
Mine Shapes	2	4	5
Bottom Devices (Stationary or Slow-moving)			
Bottom Crawler	1	1	2
Remote Operated Vehicle	1	1	2

The physical disturbance of the ASW dipping sonar being lowered slowly from a hovering helicopter at low altitude (refer to Section 3.0.2.3.1.2, Acoustic Stressors, Vessels (and Other Water-Based Assets) – Sonar and Other Transducers, for more information) is likely dwarfed by the disturbance of the helicopter.

3.0.2.3.2.3 Ground-Based Aircraft and Ground Vehicles (Land-Based Assets)

As noted in Section 3.0.2.3.1.3 (Land-Based Assets), most non-flight aircraft activities occurs on or around the airfields at NAS Patuxent River or OLF Webster. Ground vehicles typically operate in previously disturbed vegetative or non-vegetative areas (documented not to contain sensitive biological or cultural resources), or improved, graded, or paved surfaces (e.g., airfields, runways, and roads). However, movement of ground vehicles, particularly over unpaved surfaces would potentially impact multiple resource areas. Table 3.0-10 identifies the potential aircraft ground activities and ground vehicle operations that are potential physical disturbance/strike stressors.

3.0.2.3.2.4 Non-explosive Munitions and Other Military Expended Materials

Military expended materials that may cause physical disturbance or strike include: (1) all sizes of non-explosive live-fired (i.e., gun ammunition and rockets) and non-explosive munitions (e.g., bombs, mines, missiles, torpedoes), (2) expended materials other than munitions, such as sonobuoys, and (3) any unrecovered target fragments. Release/deployment of munitions and other MEM has the potential to impact multiple resources areas (e.g., public health and safety and biological resources). However, most are expended in the Chesapeake Bay Water Range, as they have been for decades, and are focused around the munition concentration areas (Figure 2.1-3, Chesapeake Bay Water Range Munition Concentration Areas). The types and numbers of non-explosive munitions expended per year as well as location expended are provided in Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems). Almost all munitions and other MEM is unrecovered with the exception of the following: missiles are 55 percent recovered; torpedoes are 80 percent recovered; search and rescue rafts and kits are 100 percent recovered; free floating surface target fragments are 95 percent recovered; UAS targets are 100 percent recovered from land and 40 percent recovered water; and cartridge actuated devices and propellant actuated devices (CADs/PADs) are 100 percent recovered from land. For gun ammunition, cartridge cases are retained within the aircraft platform (and a portion within the vessel platform) after firing while projectiles are deposited into the Chesapeake Bay Water Range. Appendix E (Military Expended Materials and Physical

Disturbance and Strike Analysis) contains a detailed analysis of MEM in terms of physical disturbance and strike potential.

3.0.2.3.3 Pollutant Stressors

Substances that are generated by the operation of aircraft, vessels, ground vehicles, ground assets, and munitions and other MEM may impact air and water quality as well as biological resources. Substances associated with engine fuel combustion, as well as expended material constituents and byproducts can be pollutant stressors associated with the Proposed Action. In the context of this EIS analysis, potential pollutants include metals, physical/chemical decomposition of MEM (which are not pollutants themselves), other MEM constituents (e.g., plastic and chemical constituents), and air emissions. While many of these may naturally occur, such as nickel, they are considered in the context of their quantity and concentration as a stressor, typically based upon establish regulatory limits or guidelines for public health and the environment.

3.0.2.3.3.1 Aircraft and Aerial Targets (Air-Based Assets)

Criteria air pollutants (Section 3.2, Air Quality) are generated by the combustion of fuel by fixed-wing and rotary-wing aircraft as well as UAS and aerial targets. Types and numbers of aircraft and aerial target activities are provided in Table 3.0-3. Aircraft specifics related to the operational time spent at various power settings for each representative aircraft are provided in Appendix D (Air Quality Calculations).

3.0.2.3.3.2 Vessels (and Other Water-Based Assets)

Criteria air pollutants are generated by the combustion of fuel by mobile water-based assets. Vessels and powered (i.e., motorized) targets require fuel, generating criteria air pollutants during their operation, and towed targets as well as ASW and MCM systems generate criteria air pollutants secondarily because another aircraft or vessel is required to provide power for movement and/or deployment. Types and numbers (events/hours) of mobile water-based assets are provided in Table 3.0-8. Mobile water-based asset specifics related to the operational time spent at various power settings for each representative are provided in Appendix D (Air Quality Calculations).

3.0.2.3.3.3 Land-Based Assets

Criteria air pollutants are generated by the combustion of fuel by non-flight aircraft activities, operation of ground vehicles, and static engines runs at the OAETC Facility. Types and numbers of land-based assets are shown in Table 3.0-10. Ground vehicle specifics related to the operational time for each representative aircraft are provided in Appendix D (Air Quality Calculations).

3.0.2.3.3.4 Non-explosive Munitions and Other Military Expended Materials

Criteria air pollutants are generated by the combustion of propellants in various types of munitions. Propellants used to fire small- and medium-caliber projectiles generate criteria pollutants when ignited. Non-explosive munitions contain spotting charges and propellants that generate criteria air pollutants when they function. Chaff cartridges used by aircraft are launched by a charge that generates small quantities of criteria air pollutants. Countermeasure flares, parachute flares, and marine markers are designed to burn for a prescribed period, emitting criteria pollutants in the process. Directed energy weapons testing does not include the use of propellants, and thus these activities are not a source of pollutant stressors.

In addition, hazardous constituents commonly found in the energetics, propellant, and pyrotechnic elements of munitions may also leach from solid components of munitions and release into the water. Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems) shows the types and numbers of non-explosive munitions and other MEM expended at the ATA and within the Chesapeake Bay Water Range. Approximately 50 percent of marine markers would be expended in the Patuxent River Seaplane Area and up to 24 and 26 active sonobuoys expended at the dip points under Alternatives 1 and 2, respectively. MEM within the water range are concentrated around the munition concentration areas (Figure 2.1-3, Chesapeake Bay Water Range Munition Concentration Areas). Similarly, CADs/PADs expenditure at ATA occurs in a pit with very limited exposure to the open-air environment. All CADs/PADs expended are recovered and all chaff fibers at the ATA are swept following events. Jet-assisted takeoff bottles expended in the water range are not recovered.

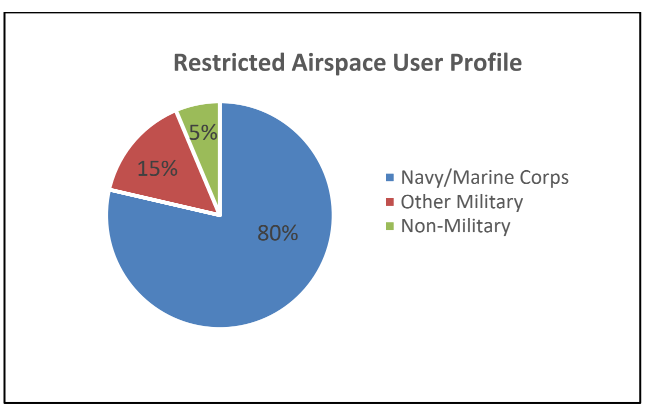
3.0.2.3.4 Public Interaction Stressors

Naval testing and training within the PRC Study Area has the potential for public interaction in the airspace and waterways with the use of air- and water-based assets. The study area airspace and waterways where public interaction may occur is described in Section 1.3 (Location and Description of the Patuxent River Complex) and depicted in Figure 1.3-1 (PRC Study Area).

3.0.2.3.4.1 Air-Based Assets

The Proposed Action air-based asset operations that occur within the PRC airspace coexist with operations by the public. Coordination procedures, including safe practices, associated with co-use of the different airspaces is discussed in Table 2.5-1 (Standard Operating Procedures), Section 3.5 (Public Health and Safety), and Section 3.7 (Socioeconomics).

The majority of aircraft operations occur within the restricted areas of the PRC Study Area (Figure 1.3-2, PRC Airspace). In addition, deployment of ASW and MCM systems as well as some munitions and other MEM, may occur from aircraft while in the restricted airspace into the Chesapeake Bay Water Range. PRC restricted airspace is normally activated between 7:00 a.m. and 11:00 p.m. on weekdays, although about 97 percent of sorties are flown between 7:00 a.m. and 10:00 p.m. The highest level of activity occurs at midmorning with a lull at midday and slight increase in mid-afternoon. While night operations can occur after 10:00 p.m., almost no operations begin after midnight. Weekend activation is typically 8:00 a.m. to 6:00 p.m., with air traffic including transient military reservists and high priority flight tests. The Navy is the predominant user of restricted airspace followed by other military services, both U.S. and foreign (Figure 3.0-1). Non-military aircraft include commercial air carriers and private general aviators.



Data Source: (U.S. Department of the Navy, 2019b)

Figure 3.0-1 PRC Restricted Airspace User Profile

Airspace

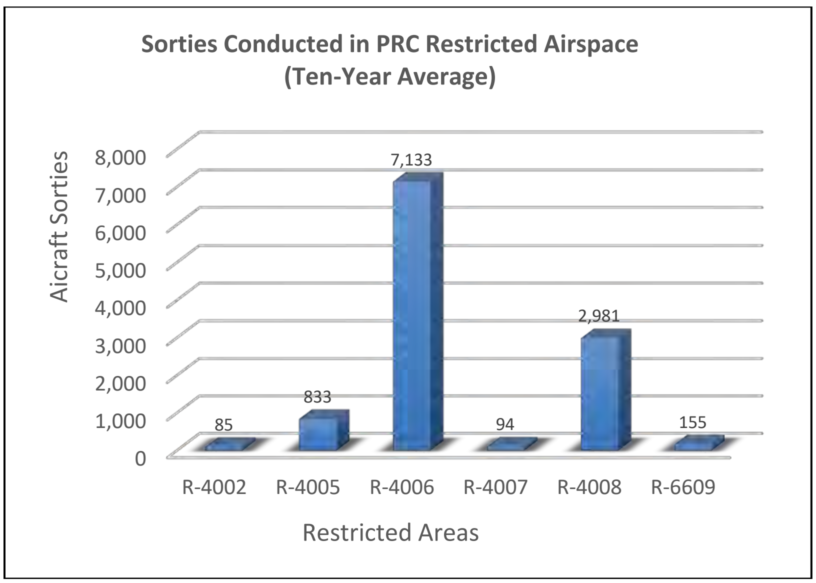
Aircraft flights occur in the restricted airspace, Helo OPAREAs, and Chessie ATCAA (Figure 1.3-2, PRC Airspace). The historic distribution and use of airspace within the PRC Study Area (as derived from the 10-year baseline) are indicative of the future and will likely remain unchanged.

Restricted Airspace

Use of restricted airspace is quantified by sorties and reported annually to the FAA via Annual Air Traffic Activity Reports. A sortie is defined as the combination of an aircraft takeoff, flight, and landing. Figure 3.0-2 shows the number of sorties conducted in each restricted area during the 10-year 2008 to 2017 baseline period (note by calendar year versus fiscal year).

The majority (nearly 60 percent) of aircraft sorties, and therefore majority of testing and training flights, are conducted in R-4006 between the altitudes of 3,500 up to 24,999 feet, followed by R-4008 (30 percent) at higher altitudes between 25,000 to 85,000 feet. Supersonic flights not involving weapons typically occur in R-4008 above 30,000 feet.

R-4005 has the next highest use and is divided into four sectors to accommodate multiple exclusive use flights including R-4005 North, South, West, and Southwest. R-4005 West and Southwest are used heavily by the UX-24 squadron and Maryland Army National Guard to operate Groups 1 through 4 UAS.



Data Source: (U.S. Department of the Navy, 2019b)

Figure 3.0-2 Sorties Conducted in PRC Restricted Airspace

R-4005 West overlies OLF Webster and contains one of two unmanned aircraft operating areas. The second and primary unmanned aircraft operating areas is between 3,500 and 6,000 feet in the southern part of R-4006 overlying the northern neck of Virginia. R-4005 Southwest overlies the Potomac River and allows UAS to transit between OLF Webster and the greater unmanned aircraft operating area at 3,500 feet. Outside of the unmanned aircraft operating areas, UAS launching from OLF Webster utilize three unmanned aircraft routes (Route A, B, and C).

R-6609 contains the former Tangier Target no longer in use. However, aircraft testing is still permitted in the airspace.

R-4007 encompasses the NAS Patuxent River Class D airspace and, when active, limits activity in the airspace. Although used infrequently, R-4007 is critical to the mission when minimal air traffic is necessary for testing around the airfield.

Finally, R-4002, overlying Bloodsworth Island, receives the least use as the range is non-impact. However, this airspace is always available for overflights above 3,000 feet for fixed-wing aircraft and 1,000 feet for rotary-wing aircraft, respectively.

Helicopter Operating Areas

The Helo OPAREAs are shared with private and commercial air traffic. There is no formal tracking of flight hours in Helo OPAREAs because operations are performed under visual flight rules. However, based on United States Naval Test Pilot School and HX-21 squadron estimates, approximately 20 percent of the total PRC Study Area flight hours occur within these adjacent shared airspaces. Of those flight hours, about half are projected to be flown in the West Helo OPAREA. Table 3.0-14 reflects the PRC flight hour breakdown by restricted areas and Helo OPAREAs.

Table 3.0-14 Current and Proposed Annual Flight Hours by PRC Airspace

PRC Airspace	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*
Restricted Areas	16,080	18,720	20,800
Helicopter Operating Areas	4,020	4,680	5,200
TOTAL	**20,100**	**23,400**	**26,000**

Chessie ATCAA

Since most supersonic work above 30,000 feet can be conducted within R-4008, Chessie airspace is not frequently used and there are years when it is not scheduled at all. Difficult coordination requirements with FAA Washington Center also limit its use. Pilots must request Chessie ATCAA at least 30 minutes, but no more than one hour prior to activation time. Air Traffic Control subject matter experts estimate a combined use of Chessie A and B an average of three times per year. The projection for Chessie C is less, at one time per year due to additional notification required to Baywatch. During the 10-year baseline, Chessie ATCAA was scheduled an annual high of seven times in 2011. This tempo of use is expected to remain the same.

3.0.2.3.4.2 Water-Based Assets

Similar to air-based assets, the Proposed Action water-based asset operations that occur within the PRC waterways coexist with operations by the public. Coordination procedures, including safe practices, associated with co-use of the waterways is discussed in Table 2.5-1 (Standard Operating Procedures), Section 3.5 (Public Health and Safety), and Section 3.7 (Socioeconomics). In addition to vessel movement throughout the PRC Study Area, weapon systems deployment testing and training (e.g., ASW and MCM systems, and munitions and other MEM) occurs within the Chesapeake Bay Water Range.

Testing and training activities within the Chesapeake Bay Water Range may require clearance of commercial, fishing, and recreational boating within small portions of the Bay, especially around Hannibal and Hooper Targets (Section 1.3.3, PRC Water Areas). Hannibal and Hooper Targets provide safe, controlled locations for the use of non-explosive munitions and other MEM. The targets are immediately surrounded by prohibited areas (1,000 yards in radius) that are closed to navigation at all times and further surrounded by a restricted area, known as the aerial and surface firing range, that is open to navigation except during Navy exercises.

When the targets are scheduled for use (referred to as a target closure), only the scheduled user may be in the restricted area. Target closures are coordinated and scheduled by ATR Central Schedules personnel and cleared approximately one hour before an event. The cleared area around the target is typically between 1 to 3 square miles, including the prohibited area, depending on the type of test. This equates to between 0.1 and 0.3 percent of the surface waters underlying the PRC airspace.

The areas are cleared an average of two to three hours per event, although some could be shorter or longer in duration. Table 3.0-15 shows the number of target closures per year for each alternative. These numbers account for busier months (typically March through November) when multiple events occur per day. During times of target closure, waterman can fish or recreate in other areas of the Bay during Navy operations and return to the cleared area after testing and training exercises are complete.

Table 3.0-15 Range Target Clearance Events

Clearance Event Description	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*
Total Clearance Events	68	250	275
Hours Cleared	196	750	825

3.0.2.3.5 Energy Stressors

This section describes the characteristics of energy stressors from Navy testing and training activities. This stressor may affect only biological resources in the PRC Study Area. Forms of energy (e.g., electro-magnetic, laser, microwave) may be introduced to the environment from air- and water-based assets as well as ground test facilities and directed energy weapons systems. Proposed activities with associated energy stressors include aircraft flight operations, ground-based activities, surface vessel activities, surface and subsurface testing and training, MCM, science and technology demonstrations, unmanned systems testing, and directed energy weapons system testing. The annual numbers of energy-generating assets and systems associated with the Proposed Action are provided (Table 3.0-16).

Table 3.0-16 Operating Hours by Energy-producing Asset for the Proposed Action Alternatives

Energy-produced Assets (Measures)	*Annual Numbers*		
	No Action Alternative	*Action Alternative 1*	*Action Alternative 2*
Air-Based Assets (Hours)			
Aircraft	20,100	23,400	26,000
Water-Based Assets [Hours (Number of Assets)]			
Manned Vessels	960 (241)	1,067 (254)	1,174 (280)
MOP	36 (18)	36 (18)	38 (19)
OASIS	4 (2)	4 (2)	4 (3)
Ground-Based Assets – Stationary[1]			
Various ground test facilities generating electromagnetic energy (including high-power microwave testing) (quantification of events is not necessary per description in this section)			
Directed Energy Weapons Systems (Test Days)[2]			
High-Energy Laser	0	50	50
High-Power Microwave	0	120	120

Key: MOP = Magnetic Orange Pipe; OASIS = Organic Airborne and Surface Influence Sweep.
Notes:
[1] Ground test facilities are described in Appendix A, Table A-5, Ground Test Facility and Laboratory Testing.
[2] Targeting Air-, Water-, or Ground-Based Assets

3.0.2.3.5.1 Air-Based Assets

Sources of electromagnetic energy from air-based assets include radar, communications transmitters, electronic countermeasures transmitters, and data links. Electromagnetic devices in the PRC Study Area operate across a wide range of frequencies and power. Frequencies include radio waves, microwaves, and infrared, visible, and ultraviolet light. Power levels range from every day, low-power radios to higher-power signature measurement radars. It is assumed that most Navy air-based assets associated with the Proposed Action will be transmitting from a variety of electromagnetic devices at all times while testing or training, with very limited exceptions. Most of these transmissions (e.g., for routine surveillance, communications, and navigation) will be at low power. High-power settings are used for activities including missile and rocket testing, radar and other system testing, and signature analysis.

The number of Navy aircraft in the PRC Study Area at any given time varies and is dependent on testing and training requirements. Therefore, in-air electromagnetic energy as part of the Proposed Action would be widely dispersed throughout the PRC Study Area since the energy system is not focused on a particular target but used while the aircraft operates in the airspace. The amount of electromagnetic energy emitted from airborne platforms would be limited to a 20-aircraft maximum at any given time. This is due to the "10 aircraft rule" implemented by NAS Patuxent River Air Traffic Control for flight safety (Table 2.5-1, Standard Operating Procedures). A "group" of aircraft may consist of one or more aircraft in a tight formation, such as a test aircraft and a chase plane combination (U.S. Department of the Navy, 1998). Rarely does a group consist of more than two aircraft.

The term radar was originally coined by the Navy to refer to Radio Detection And Ranging. A radar system is an electromagnetic device that emits radio waves to detect and locate objects. In most cases, basic radar systems operate by generating pulses of radio frequency energy and transmitting these pulses via directional antennae into space (Courbis, S., and G. Timmel, 2008). Some of this energy is reflected by the target back to the antenna, and the signal is processed to provide useful information to the operator. Radars come in a variety of sizes and power, ranging from wide-band milliwatt systems to very high-power systems that are used primarily for long-range search and surveillance (Courbis, S., and G. Timmel, 2008). In general, radars operate at radio frequencies that range between 300 megahertz and 300 gigahertz, and are often classified according to their frequency range.

3.0.2.3.5.2 Water-Based Assets

Navy vessels commonly operate radar systems, which include S-band (3 gigahertz) and X-band (10 gigahertz) electronically steered radar. Vessels and other water-based assets would primarily utilize energy-generating systems while operating within the Chesapeake Bay Water Range. Most of these transmissions (e.g., for routine surveillance, communications, and navigation) will be at low power. High-power settings are used for activities including system testing and signature analysis. These types of surface vessel tests are infrequent, intermittent, and based on customer requirements.

Water-based asset transmission of electromagnetic energy may be emitted into the water from the magnetic influence of mine neutralization systems (Table 3.0-16). These in-water devices simply mimic the electromagnetic signature of a vessel passing through the water. All events within the PRC involving these devices to date have been non-magnetized events (i.e., no electromagnetic field was generated). However, future customers may require testing the actual mine neutralization capabilities of these in-water electromagnetic devices. Generally, voltage used to power these systems is around 30 volts. Since saltwater is an excellent conductor, just 35 volts (capped at 55 volts) is required to generate the current.

The static magnetic field generated by the mine neutralization devices is of relatively minute strength (U.S. Department of the Navy, 2005c). Typically, the maximum magnetic field generated, such as those by OASIS, would be approximately 2,300 microteslas, with a microtesla being a unit of measurement of magnetic flux density, or "magnetic induction." This level of electromagnetic density is very low compared to magnetic fields generated by other everyday items. The magnetic field generated is between the levels of a refrigerator magnet (15,000 to 20,000 microteslas) and a standard household can opener (up to 400 microteslas at 4 inches). The strength of the electromagnetic field decreases rapidly with distance. The magnetic field generated is very weak, comparable to the earth's natural field (Hulot, Finlay, Constable, Olsen, & Mandea, 2010). At a distance of 4 meters from the source of a 2,300-microtesla magnetic field, the strength of the field is approximately 50 microteslas, which is within the range of the Earth's magnetic field (25 to 65 microteslas). At 24 meters away from the source, the strength of the field is approximately 10 percent of the Earth's magnetic field. At a distance of 200 meters, the magnetic field would be approximately 0.2 microteslas.

3.0.2.3.5.3 Land-Based Assets

Similar to air- and water-based assets, sources of electromagnetic energy are emitted from ground assets. For land-based systems and ground test facilities, electromagnetic emitters generating a single pulse below the Maximum Permissible Exposure (MPE) limit of 200 kilovolts per meter would not pose hazards to personnel, ordnance, fuel, and electromagnetic interference (U.S. Department of the Navy, 2016a). All activities coordinate with the Navy and Marine Corps Spectrum Center, who is responsible for coordinating access to use of the electromagnetic spectrum for Navy and Marine Corps Commands. Standard operating procedures (Table 2.5-1, Standard Operating Procedures) are established and maintained in accordance with Office of the Chief of Naval Operations Instruction 5100.23G, *Navy Safety and Occupational Health Program Manual*. In addition, the operation of all radiofrequency, microwave, or similar millimeter-wave systems must comply with Department of Defense Instruction 6055.11, *Protecting Personnel from Electromagnetic Fields*, to ensure the protection of the workers onsite, and Department of Defense Instruction 4650.01, *Policy and Procedures for Management and Use of the Electromagnetic Spectrum*, to ensure all ground test facilities have proper authorization.

The ground test facilities that emit electromagnetic energy in an open-air environment within the PRC are identified in Section 2.1.1.2 (Ground-Based Activities) and further described in Appendix A, Table A-5 (Ground Test Facility and Laboratory Testing). This includes facilities that may perform tests to determine aircraft system vulnerability to high-power microwave systems. All operate at power levels that are below the MPE, with the exception of the AN/FPN antenna located in Building 1183 (U.S. Department of the Navy, 2016a). However, the power level of the AN/FPN antenna falls below the MPE within a few feet of the transmitter and appropriate radiation hazard warning signs are posted to advise personnel of the electromagnetic radiation hazard. Since the outdoor ground test facilities typically perform electromagnetic radiation tests within MPE limits, quantification of their events is not necessary.

3.0.2.3.5.4 Directed Energy

Directed energy can include light amplification by stimulated emission of radiation (laser) and high-power microwave systems. For all directed energy systems, the highest potential level of exposure would be from an airborne or underwater system directed at a surface.

Lasers can be organized into low-energy and high-energy laser systems. Low-energy lasers can be used to illuminate or designate targets, measure the distance to a target, guide weapons, detect or classify mines, and aid in communication. High-energy laser systems can be used for communications relay or as weapons to create critical failures on targets in various environments. All classes of lasers (classes 1–4) are currently used or have been tested within the PRC (see Appendix A, Table A-8: Laser Classes), including all types of low-energy lasers and high-energy laser used for communications. Testing high-energy laser systems as directed energy weapons is being proposed under Alternatives 1 and 2.

High-energy laser weapons testing involves the use of up to 1 megawatt of directed energy (with wavelengths between 500 to 4,000 nanometers) against aerial, surface, or land targets, especially UAS targets. High-energy laser would be employed from air, land, or surface platforms and are designed to create small but critical failures in potential targets. Types of high-energy laser systems would include, but are not limited to, solid-state, fiber, carbon dioxide, and diode-pumped alkali lasers. Under Alternatives 1 and 2, high-energy laser tests would occur up to 50 days per year with up to two firing events per day (Table 2.3-2, Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems). Most high-energy laser testing is expected to be at short range.

High-power microwave systems are primarily designed to produce impacts on electronics systems but may also be used to provide non-lethal anti-personnel capability. These counter-electronics systems operate across a broad range of microwave frequencies and emit short, intense energy pulses that yield high voltage surges in targeted electronics resulting in neutralization or damage to those systems. Previous testing involving high-power microwaves was conducted within specialized ground test facilities. Testing high-power microwave systems as directed energy weapons is being proposed under Alternatives 1 and 2. High-power microwaves would be employed by air, land, or surface platforms against aerial, water, or land-based targets (e.g., UAS targets, infrastructure systems, vehicle/vessel targets). Types of high-power microwave systems would include, but are not limited to, narrowband, wideband, and ultra wideband; however, most testing would be in the narrowband and wideband categories between 1 gigahertz to 5 gigahertz and 100 megahertz to 500 megahertz respectively. High-power microwave weapons may be evaluated for health hazards using the same methodology used for other microwave systems, such as radars or communication systems, by characterizing the system's total power relative to its pulse width and repetition rates. Under Alternatives 1 and 2, high-power microwave tests would occur up to 120 days per year (Table 2.3-2, Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems). During testing, the high-power microwave system would be turned on an average of three seconds per firing event with up to two firing events per day. All high-power microwave events would be conducted in accordance with the electromagnetic safety radiation standard operating procedures and guidance documents indicated in Table 2.5-1 (Standard Operating Procedures).

3.0.2.3.6 Entanglement Stressors

This section describes the characteristics of entanglement stressors from Navy testing and training activities, including aircraft flight operation, surface and sub-surface testing and training, MCM, and ASW. This stressor may affect only biological resources in the PRC Study Area. Entangling materials represent a relatively small portion of MEM expended in the Chesapeake Bay Water Range. The only entangling materials that may be expended outside the Chesapeake Bay Water Range are the active sonobuoys that would be deployed under Alternatives 1 and 2 around the dip points north of the water range. Table 3.0-17 depicts the types and number of other MEM that are potential entangling materials. The number of other MEM accessories are equivalent to the number of expended materials that they are associated with.

The Navy deploys equipment designed for military purposes and strives to reduce the risk of accidental entanglement posed by any item it releases into the water. To assess the entanglement risk of materials expended during testing and training, the Navy examined the characteristics of these items (e.g., size and rigidity) for their potential to entangle animals in the Chesapeake Bay. Entangling materials associated with the Proposed Action alternatives include: (1) wires or cables on sonobuoys or Airborne Mine Neutralization System neutralizers, respectively, (2) parachutes associated with some MEM and aerial targets, and (3) flare O-rings.

Table 3.0-17 Potential Entangling Materials Released in the Chesapeake Bay Water Range

Material Types	*Recovery Rate*	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*
Wires/Cables				
Passive Sonobuoys	0%	122	122	134
Active Sonobuoys*	0%	0	24	26
AMNS Neutralizers	0%	2	4	5
Decelerators/Parachutes (Small)				
Passive Sonobuoys	0%	122	122	134
Active Sonobuoys*	0%	0	24	26
Lightweight Torpedoes	95%	37	37	41
Decelerators/Parachutes (Medium – Large)				
Flares (Illumination)	100%	51	40	44
Aerial Target - Large	100%	3	5	6
Other Materials: O-ring Seals				
Flares (Decoys)	0%	320	255	281

Key: AMNS = Airborne Mine Neutralization System.
Note:
* Released around dip points and not within the Chesapeake Bay Water Range

3.0.2.3.6.1 Wires and Cables

Sonobuoys consist of a surface antenna and float unit and a subsurface hydrophone assembly unit. The two units are attached through a thin-gauge, dual-conductor, and hard-draw copper strand wire, which is then wrapped by a hollow rubber tubing or bungee in a spiral configuration. The tensile breaking strength of the wire and rubber tubing is no more than 40 pounds. The length of the wire is housed in a plastic canister dispenser, which remains attached upon deployment. The length of wire that extends out is no more than 1,500 feet and is dependent on the water depth and type of sonobuoy. The wire runs through the stabilizing system and leads to the hydrophone array. The hydrophone array consists of five arms, each with five hydrophones, connected by thin plastic webbing that forms a pentagon-shaped framework. Each sonobuoy has a saltwater-activated polyurethane float that inflates when the sonobuoy is submerged, keeping the sonobuoy components floating vertically in the water column below it. Sonobuoys remain suspended in the water column for no more than eight hours, after which they sink to the seafloor. However, not all sonobuoys present an entanglement risk; up to 50 percent of practice sonobuoys used during deployment testing are not designed to open and do not present any entanglement risk.

Although not frequently used in the PRC Study Area, fiber optic cables associated with remotely operated mine neutralization systems (e.g., Airborne Mine Neutralization System), would also be expended. The length of the expended tactical fiber would vary (up to about 3,000 meters) depending on the activity. Tactical fiber has an 8-micrometer (0.008-millimeter [mm]) silica core and acrylate coating and looks and feels like thin monofilament fishing line. Other characteristics of tactical fiber are a 242-micrometer (0.24 mm) diameter, 12-pound tensile strength, and 3.4-mm bend radius (Corning Incorporated, 2005; Raytheon Company, 2015). Tactical fiber is relatively brittle; it readily breaks if knotted, kinked, or abraded against a sharp object. Deployed tactical fiber will break if looped beyond its bend radius (3.4 mm), or exceeds its tensile strength (12 pounds). If the fiber becomes looped around an underwater object or animal, it will not tighten unless it is under tension. Such an event would be unlikely based on its method of deployment and its resistance to looping after it is expended. The tactical fibers are often designed with controlled buoyancy to minimize the fiber's effect on vehicle movement. The tactical fiber would be suspended within the water column during the activity, and then be expended and sink to the seafloor (effective sink rate of 1.45 centimeters per second) where it would be susceptible to abrasion and burial by sedimentation.

3.0.2.3.6.2 Decelerators/Parachutes

Decelerators/parachutes used during testing and training activities are categorized based on size as small, medium, or large. Aircraft-launched sonobuoys and lightweight torpedoes (such as the MK 46 and MK 54) use nylon decelerators/parachutes ranging in size from 18 to 48 inches in diameter, respectively. These small decelerators/parachutes are made of cloth and nylon, and the sonobuoy parachutes have weights attached to their short attachment lines to speed their sinking. Range support boats recover approximately 95 percent of small parachutes associated with torpedoes. Upon impact with the water surface, the small sonobuoy decelerator/parachute assembly may remain at the surface for five to six minutes before sinking to the bay bottom (Environmental Sciences Group, 2005). Once settled on the bottom, the canopy may temporarily billow when bottom tidal currents are present, but flatten during the next slack period between tide changes. Tidal currents in the middle Chesapeake Bay average about 0.13 meter per second (Xiong & Berger, 2010), suggesting sonobuoy parachutes do not travel far (on average) from where they impact the Bay surface. Sonobuoy parachutes that settle in depositional habitats (e.g., subtidal flats) comprising the vast majority of deeper water habitats in the Chesapeake Bay Water Range (refer to Section 3.3, Water Resources and Sediments) will experience some degree of burial through time. Though relatively unlikely, sonobuoy parachutes may also land in erosional habitats (e.g., channels) and travel farther before coming to rest in a depositional habitat. A drifting sonobuoy parachute may also snag on a bottom feature (e.g., fixed target, shipwreck, oyster reef) and remain more or less open, but that is unlikely, considering the scarcity of such features in the Chesapeake Bay Water Range. As with other MEM on or under the sediment surface, some items may be covered or uncovered during storms that temporarily alter the pattern of deposition and erosion in the Bay.

Illumination flares use medium decelerators/parachutes, up to approximately 19 feet in diameter. Large aerial targets (e.g., BQM) use larger decelerators/parachutes, also made of cloth and nylon, with suspension lines of varying lengths (40 to 70 feet in length, with up to 28 lines per decelerator/parachute). Some aerial targets also use a small drag parachute (6 feet in diameter) to slow their forward momentum prior to deploying the larger primary decelerator/parachute. Unlike small decelerators/parachutes, medium and large parachutes do not have weights attached and will remain at the surface for some time. All medium and large parachutes released in the Chesapeake Bay Water Range are fully recovered by range support boats.

3.0.2.3.6.3 Flare O-rings

The air-borne release mechanism for flares includes an O-ring endcap seal that is expended and not recovered. The O-ring on a representative decoy flare is approximately 1.4 inches in diameter. The rubber O-ring seal may present an entangling risk to small organisms or the small parts of larger organisms.

3.0.2.3.7 Ingestion Stressors

This section describes the characteristics of ingestion stressors from Navy testing and training activities, including aircraft flight operations, surface vessel activities, and surface and sub-surface testing and training, and directed energy systems testing (e.g., counter-UAS). This stressor may affect only biological resources in the PRC Study Area.

Ingestible materials associated with the Proposed Action alternatives include: live-fire, non-explosive munitions (e.g., small-medium gun ammunition, rocket flechettes) and other MEM such as chaff (including cartridges, endcaps, and pistons), flares (including plastic endcaps, O-rings, and pistons), and small decelerator/parachutes (Table 3.0-18). Ingestible MEM would primarily be released over the Chesapeake Bay Water Range where it would be most common around the munition concentration areas depicted in Figure 2.1-3 (Chesapeake Bay Water Range Munition Concentration Areas).

Table 3.0-18 Potential Ingestible Materials Released in the Chesapeake Bay Water Range

Material Types	*Recovery Rate*	*No Action Alternative*	*Action Alternative 1*	*Action Alternative 2*
Air- or Water-Based Assets (Fragments)				
Small UAS Target*	40%	0	0	53
Surface Targets (Low-Cost Modular Target/PAX Pontoon Target)	95%	3	10	11
Live-Fired, Non-explosive Munitions				
Medium-caliber Projectiles	0%	8,961	17,150	18,865
Small-caliber Projectiles	0%	36,100	53,420	58,762
Rocket – Flechette Warheads	0%	33	46	51
Other Military Expended Materials				
Chaff Cartridges	0%	121	246	271
Chaff Accessories: Endcaps and Pistons	0%	121 x 2	246 x 2	271 x 2
Flare Accessories: Endcaps, Pistons, and O-rings	0%	320 x 3	255 x 3	281 x 3
Passive Sonobuoy Accessory: Small Decelerator/Parachutes	0%	122	122	134
Active Sonobuoy Accessory: Small Decelerator/Parachutes**	0%	0	24	26
Torpedo Accessory: Small Decelerator/Parachutes	95%	37	37	41

Key: PAX = Naval Air Station Patuxent River; UAS = unmanned aerial systems.
Notes:
* On portion expended in a surface danger zone
** Released around dip points and not within the Chesapeake Bay Water Range

With the exception of small torpedo decelerators/parachutes and target fragments that are mostly recovered, all ingestible items deposited in the Chesapeake Bay Water Range are not recovered. With the exception of small UAS, no mobile target is intentionally expended to the point of fragmentation within the PRC Study Area. For small UAS targets, 35 percent are expended over the surface danger zones (Chesapeake Bay Water Range and Bloodsworth Island surface danger zones) and 65 percent are expended and fully recovered from previously disturbed land areas. Of the targets expended in the surface danger zones, 40 percent are recovered. On the rare occasion that a towed or floating surface target, such as the Low-Cost Modular Target, is unintentionally damaged, pieces are generally large, float at the surface due to being foam-filled, and are mostly recovered by a range support boat. Most gun ammunition fired from the ATA is expended directly into the gunfiring tunnel and therefore is not an ingestion stressor. Chaff expended at the ATA remains within the area and is cleaned up following the event.

To assess the ingestion risk from MEM, subsequent analysis considers the buoyancy and size of the object relative to the animal's ability to swallow it. Less buoyant materials, such as solid metal materials (e.g., most munitions), sink rapidly to the bottom. More buoyant materials include less dense items (e.g., endcaps), which may be caught in currents. These materials can remain in the water column for an indefinite period, before sinking. Some items are too large to be ingested (e.g., non-explosive practice bombs and missiles) and impacts from these items are not discussed further. However, these items may potentially break down into smaller ingestible pieces over time. Items that are of ingestible size when they are introduced into the environment, and when they break down, are carried forward for analysis within each resource section, where applicable.

3.0.2.3.7.1 Live-Fired Munitions

Only small- or medium-caliber projectiles and flechettes (small metal darts) from some non-explosive rockets would be small enough for marine animals to ingest. Small- and medium-caliber projectiles include all sizes up to and including those that are 2.25 inches in diameter, though smallest dimensions are 0.3 x 1.4 and 0.8 x 3.3 inches in terms of projectile (i.e., bullet) size, respectively. Gun ammunitions cartridge cases are retained within the aircraft platform (and a portion retained within the vessel platform) after firing, while the projectiles are deposited into the Bay. Flechettes are approximately 2 inches in length and each non-explosive flechette rocket contains approximately 1,180 individual flechettes that are released. These solid metal materials would quickly move through the water column and settle to the seafloor.

3.0.2.3.7.2 Military Expended Materials Other Than Live-Fired Munitions

Several different types of materials other than munitions are expended in PRC waters during testing and training activities, including chaff, flares, and small decelerator/parachutes.

Chaff consists of reflective, aluminum-coated glass fibers used to obscure aircraft and ships from radar-guided systems. Chaff fibers stored in cartridges (dimensions: 1.4 x 5.8 inches) are dispensed from aircraft when an attack is imminent. Chaff is composed of an aluminum alloy coating on glass fibers of silicon dioxide (U.S. Department of the Air Force, 1997). Chaff is released or dispensed in cartridges that contain millions of fibers. When deployed, a diffuse cloud of fibers is formed that is undetectable to the human eye. Chaff is a very light material, similar to fine human hair. It can remain suspended in air anywhere from 10 minutes to 10 hours and can travel considerable distances from its release point, depending on prevailing atmospheric conditions (Arfsten, Wilson, & Spargo, 2002; U.S. Department of the Air Force, 1997). Doppler radar has tracked chaff plumes containing approximately 900 grams of chaff drifting 200 miles from the point of release, with the plume covering greater than 400 miles

(Arfsten, Wilson, & Spargo, 2002). Chaff cartridges, plastic endcaps, and pistons would also be released into the estuarine environment, where they would persist for long periods and could be ingested by organisms. Chaff endcaps and pistons eventually sink in water (Spargo, B.J. & Collins, M., 2007).

Decoy flares are pyrotechnic devices used to defend against heat-seeking missiles, where the missile seeks out the heat signature from the flare rather than the aircraft's engines. Similar to chaff, flares are also dispensed from aircraft. The flare device consists of a cylindrical cartridge approximately 1.4 inches in diameter and 5.8 inches in length. Flares are designed to burn completely. The only material that would enter the water would be the endcap, O-ring seal around the endcap, and the plastic compression pad or piston (0.45 to 4.1 grams depending on flare type). The plastic endcaps and pistons float in water but eventually sink.

Only the small-size decelerators/parachutes (18-inch diameter) expended with sonobuoys and lightweight torpedoes pose an ingestion risk to organisms. Medium to large parachutes are too large to pose an ingestion risk for organisms in the PRC affected environment.

3.0.2.4 Resource-Specific Impacts Analysis for Individual Stressors

The direct and indirect impacts of each stressor are analyzed in each resource section for which there may be an impact. Quantitative methods were used to the extent possible, but data limitations required the use of qualitative methods for most stressor/resource interactions. Resource-specific methods are described in their respective sections of Chapter 3 (Affected Environment and Environmental Consequences), where applicable. While specific methods used to analyze the impacts of individual stressors varied by resource, the following generalized approach was used for all stressor/resource interactions:

The frequency, duration, and spatial extent of exposure to stressors were analyzed for each resource and alternative. The frequency and duration of exposure to stressors or frequency of a proposed activity was characterized as "intermittent/continuous" or "infrequent/frequent" and was quantified in terms of number per unit of time when possible. Duration of exposure was expressed as short- or long-term and was quantified in units of time (e.g., seconds, minutes, and hours) when possible. The spatial extent of exposure was generally characterized as widespread or localized, and the stressor footprint or area (e.g., square feet, square nautical miles) was quantified when possible.

An analysis was conducted to determine whether and how resources are likely to respond to stressor exposure or be altered by stressor exposure based upon available scientific knowledge. This step included reviewing available scientific literature and empirical data. For many stressor/resource interactions, a range of likely responses or endpoints was identified.

The information obtained was used to analyze the likely impacts of individual stressors on a resource and to characterize the type, duration, and intensity (severity) of impacts. The type of impact was generally defined as beneficial or adverse and was further defined as a specific endpoint (e.g., change in behavior, mortality, change in concentration, loss of habitat, loss of fishing time). When possible, the endpoint was quantified. The duration of an impact was generally characterized as short term (e.g., minutes, days, weeks, months, depending on the resource), long-term (e.g., months, years, decades, depending on the resource), or permanent. The intensity of an impact was then determined.

3.0.2.5 Resource-Specific Impacts Analysis for Multiple Stressors

The stressors associated with the proposed testing and training activities could affect the environment individually or in combination. The impacts of multiple stressors may be different when considered collectively rather than individually. Therefore, following the resource-specific impacts analysis for individual stressors, the combined impacts of all stressors were analyzed for each resource and action alternative. This step determines the overall impacts of the alternatives on each resource, and it considers the potential for impacts that are additive (where the combined impacts on the resource are equal to the sum of the individual impacts), synergistic (where impacts combine in such a way as to amplify the effect on the resource), and antagonistic (where impacts will cancel each other out or reduce a portion of the effect on the resource). This analysis helps inform the cumulative impacts analysis and make overall impact conclusions for each resource.

Evaluating the combined impacts of multiple stressors can be complex, especially when the impacts associated with a stressor are hard to measure. Therefore, some general assumptions were used to help determine the potential for individual stressors to contribute to combined impacts. For this analysis, combined impacts were considered more likely to occur in the following situations:

- Stressors co-occur in time and space, causing a resource to be simultaneously affected by more than one stressor.
- A resource is repeatedly affected by multiple stressors or is re-exposed before fully recovering from a previous exposure.
- The impacts of individual stressors are permanent or long-term (years or decades) versus short term (minutes, days, or months).
- The intensity of the impacts from individual stressors contributes to a combined overall adverse impact.

The resource-specific impacts analysis for multiple stressors included the following steps:

- Information obtained from the analysis of individual stressors was used to qualitatively evaluate the combined impacts of all stressors on each resource. This evaluation incorporated factors such as the co-occurrence of stressors in space and time; the range of impacts or assessment endpoints of individual stressors (e.g., mortality, injury, changes in animal behavior or physiology, habitat alteration, or changes in human use); and the duration and intensity of the impacts of individual stressors.
- To the extent possible, additive impacts on a given resource were considered by summing the impacts of individual stressors. This summation is only possible for different stressors with identical and quantifiable assessment endpoints. For example, if one stressor alters 0.25 square nautical miles (nm^2) of benthic habitat, a second stressor alters 0.5 nm^2 in a non-overlapping area, and all other stressors did not disturb benthic habitat, then the total benthic habitat altered would be 0.75 nm^2.
- For stressors with qualitatively different impacts and assessment endpoints (which is most of them), the potential for additive, synergistic, and antagonistic effects were evaluated based on available scientific knowledge, professional judgment, and the general assumptions outlined above.

A cumulative impact is the impact on the environment that results when the incremental impact of an action is added to other past, present, and reasonably foreseeable future actions. The cumulative impacts analysis (Chapter 3, Cumulative Impacts) considers other actions regardless of what agency (federal or nonfederal) or person undertakes the actions. The goal of the analysis is to provide the decision makers with information relevant to reasonably foresee potentially significant impacts.

3.1 Ambient Airborne Noise

This discussion of noise includes types or sources of noise and the associated sensitive receptors in the human environment. Noise in relation to biological resources and wildlife species is discussed in Section 3.4 (Biological Resources). Underwater noise, which only has the potential to affect biological resources, is addressed in Section 3.4. In-water recreational activities, such as swimming and shipwreck diving by non-Navy persons, typically occur in areas distant from proposed Navy activities (e.g., close to beach areas) and would not be affected by in-water noise. Additional information on noise concepts and potential impacts, including those associated with underwater noise, can be found in Appendix B (A Noise Primer: Noise and Its Effect on the Environment).

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and are sensed by the human ear. Sound is all around us. The perception and evaluation of sound involves three basic physical characteristics:

- **Intensity:** the acoustic energy, which is expressed in terms of sound pressure, in decibels (dB)
- **Frequency:** the number of cycles per second the air vibrates, in hertz (Hz)
- **Duration:** the length of time the sound can be detected

Noise is defined as unwanted or annoying sound that interferes with or disrupts normal human activities. Although continuous and extended exposure to high noise levels (e.g., through occupational exposure) can cause hearing loss, the principal human response to noise is annoyance (see Appendix B, Noise Primer). The response of different individuals to similar noise events is diverse and is influenced by the type of noise, perceived importance of the noise, its appropriateness in the setting, time of day, type of activity during which the noise occurs, and sensitivity of the individual. While aircraft are not the only sources of noise in an urban or suburban environment, they are readily identified by their noise output and are given special attention in this Environmental Impact Statement (EIS). In-depth background information on noise, including its effect on many facets of the environment, is provided in Appendix B.

3.1.1 Basics of Sound and A-Weighted Sound Level

The loudest sounds that can be detected comfortably by the human ear have intensities that are a trillion times higher than those of sounds that can barely be detected. This vast range means that using a linear scale to represent sound intensity is not feasible. The dB is a logarithmic unit used to represent the intensity of a sound, also referred to as the sound level. Airborne noise levels are calculated relative to a reference pressure level of 20 micropascals (μPa), which differs from the reference pressure level of 1 μPa used for in-water sound levels. All noise levels stated in this section are airborne and, therefore, can be assumed to be referenced to 20 μPa. All sounds have a spectral content, which means their magnitude or level changes with frequency, where frequency is measured in cycles per second or Hz. To mimic the human ear's nonlinear sensitivity and perception of different frequencies of sound, the spectral content is weighted. For example, environmental noise measurements are usually on an "A-weighted" scale that filters out very low and very high frequencies in order to replicate human sensitivity. It is common to add the "A" to the measurement unit in order to identify that the measurement has been made with this filtering process (e.g., dBA [A-weighted decibels]). For clapping or banging sounds such as sonic booms, low-frequency noise energy is an important factor in determining noise impacts. These sounds are often described using C-weighted decibels, which deemphasize low-frequency sound to a lesser degree than A-weighting, or unweighted decibels, which do not make any adjustments based on frequency (see Appendix B, Noise Primer). Table 3.1-1 provides a comparison of how the human ear perceives changes in loudness on the logarithmic scale.

Table 3.1-1 Subjective Responses to Changes in A-Weighted Decibels

Change	*Change in Perceived Loudness*
3 dB	Barely perceptible
5 dB	Quite noticeable
10 dB	Dramatic – twice or half as loud
20 dB	Striking – fourfold change

Key: dB = decibels.

Figure 3.1-1 provides a chart of A-weighted sound levels from typical noise sources. Some noise sources (e.g., air conditioner, vacuum cleaner) are continuous sounds that maintain a constant sound level for some period of time (Cowan, 1994). Other sources (e.g., automobile, heavy truck) are the maximum sound produced during an event like a vehicle passing by. Other sounds (e.g., urban daytime, urban nighttime) are averages taken over extended periods of time. A variety of noise metrics have been developed to describe noise over different time periods, as discussed below.

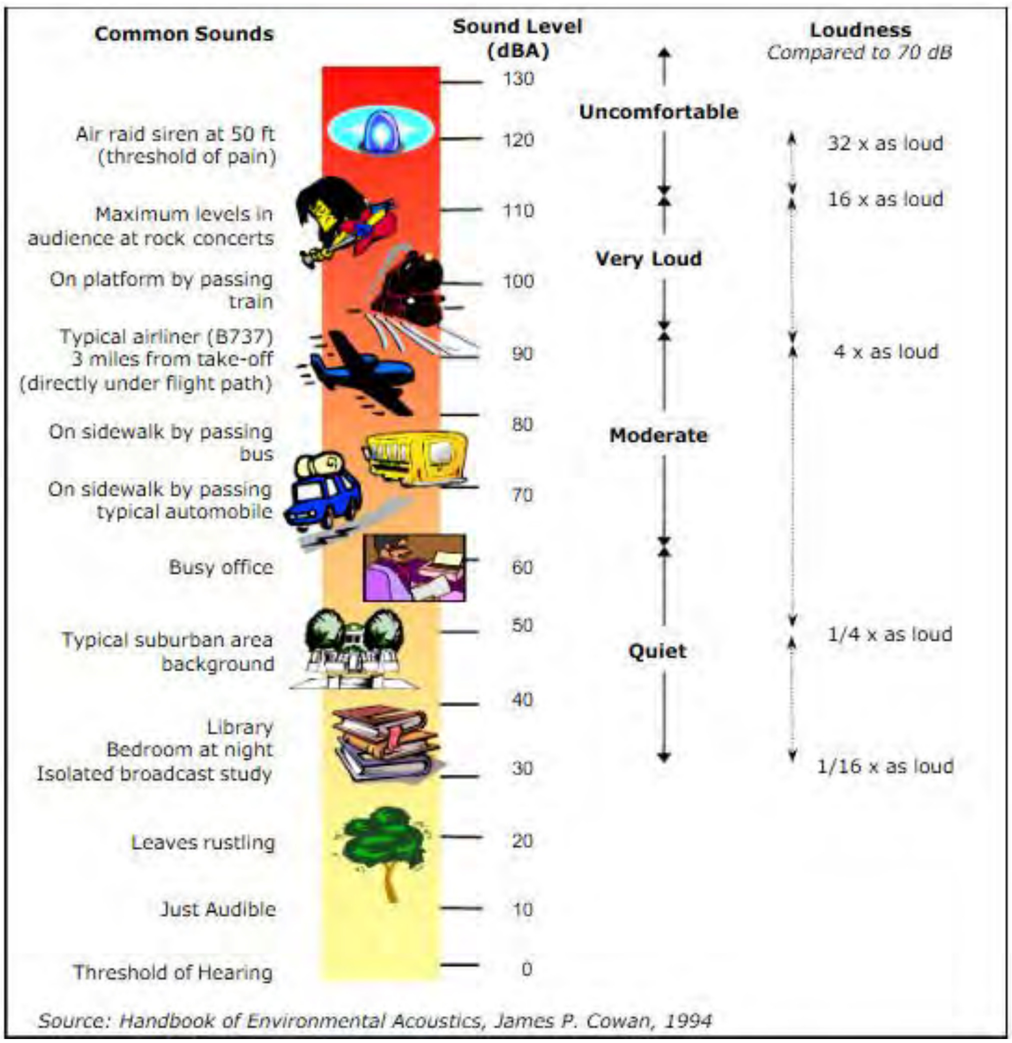


Figure 3.1-1 A-Weighted Sound Levels From Typical Sources

Noise levels from aircraft operations that exceed background noise levels at an airfield typically occur beneath main approach and departure corridors, in local air traffic patterns around the airfield, and in areas immediately adjacent to parking ramps and aircraft staging areas. As aircraft in flight gain altitude, their noise contributions drop to lower levels, often becoming indistinguishable from the background noise.

3.1.2 Noise Metrics

A metric is a system for measuring or quantifying a particular characteristic of a subject. Since noise is a complex physical phenomenon, different noise metrics help to quantify the noise environment. The noise metrics used in this EIS are described in summary format below and in a more detailed manner in Appendix C (Noise Study). While the Day-Night Average Sound Level (DNL) is the most commonly used tool for analyzing noise generated at an airfield, the Department of Defense (DoD) has been developing additional metrics (and analysis techniques). These supplemental metrics and analysis tools provide more detailed noise exposure information for the decision process and improve the discussion regarding noise exposure. The DoD Noise Working Group product, *Improving Aviation Noise Planning, Analysis and Public Communication with Supplemental Metrics* (U.S. Department of Defense Noise Working Group, 2009) was used to determine the appropriate metrics and analysis tools for this EIS.

3.1.2.1 Day-Night Average Sound Level

The DNL metric is the energy-averaged sound level measured over a 24-hour period, with a 10-dB penalty assigned to noise events occurring between 10:00 p.m. and 7:00 a.m. (acoustic night). DNL values are average quantities, mathematically representing the continuous sound level that would be present if all of the variations in sound level that occur over a 24-hour period were averaged to have the same total sound energy. The DNL metric quantifies the total sound energy received and is, therefore, a cumulative measure, but it does not provide specific information on the number of noise events or the individual sound levels that occur during the 24-hour day. DNL is the standard noise metric used by the United States (U.S.) Department of Housing and Urban Development, Federal Aviation Administration, U.S. Environmental Protection Agency (USEPA), and DoD. Studies of community annoyance in response to numerous types of environmental noise show that DNL correlates well with impact assessments; there is a consistent relationship between DNL and the level of annoyance (refer to Appendix B, Noise Primer). Most people are exposed to sound levels of 50 to 55 dBA DNL or higher. Research has indicated that about 87 percent of the population is not highly annoyed by outdoor sound levels below 65 dBA DNL (Federal Interagency Committee on Urban Noise, 1980). As stated in DoD Instruction 4165.57, *Air Installations Compatible Use Zones* (AICUZ)*,* DoD considers not all land uses to be compatible at noise levels exceeding 65 dBA DNL

The onset-rate adjusted, monthly DNL (L_{dnmr}) is a variant of the DNL metric used to describe noise levels near military testing and training airspace. This metric applies an adjustment of up to 11 dBA to account for the potential “startle effect” of sudden onset noise generated by aircraft flying low at high speeds. As an example, fighter aircraft, such as the F/A-18E/F, sometimes fly at low altitudes and high airspeeds (e.g., 1,000 feet above ground level and 350 knots) within the Patuxent River Complex (PRC) to perform airspeed calibrations. Direct overflights of this type of operation are experienced as a sudden and potentially surprising burst of noise followed by a quick return to ambient noise levels.

In this EIS, day-night average sound levels based on C-weighted noise levels are denoted as CDNL (C-weighted day-night average sound level). The CDNL metric is used in this EIS to describe sonic booms and weapons firing noise levels. Social surveys indicate that approximately the same percentage of people can be expected to be annoyed by impulsive noise (e.g., sonic booms, munitions firing) at 62 dB CDNL as are annoyed by non-impulsive noise (e.g., aircraft overflights) at 65 dBA DNL. As stated in Chief of Naval Operations Instruction (OPNAVINST) 3550.1A, *Range Air Installations Compatible Use Zones (RAICUZ) Program*, the Navy considers some land uses to be incompatible with noise louder than 62 dB CDNL.

3.1.2.2 Equivalent Sound Level

Equivalent sound level (L_{eq}) is the continuous sound level that would be present if all of the variations in sound level occurring over a specified time period were smoothed out while maintaining the same total sound energy. When calculated for a 24-hour time period—denoted as $L_{eq(24hr)}$—the metric is identical to DNL minus the "penalty" for late-night noise events. In this EIS, an eight-hour equivalent sound level, denoted as $L_{eq(8hr)}$, during a typical school day period (8:00 a.m. to 4:00 p.m.) is presented as part of classroom interference assessment.

3.1.2.3 Sound Exposure Level

The sound exposure level (SEL) metric is a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events (e.g., aircraft overflights) have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of total sound energy of the entire acoustic event, but it does not directly represent the sound level heard at any given time. During an aircraft flyover, SEL captures the total sound energy from the beginning of the acoustic event to the point when the receiver no longer hears the sound. It then condenses that energy into a one-second period of time, and the metric represents the total sound exposure received. Onset-rate adjusted SEL (SEL_r) is a variant of SEL in which a penalty of up to 11 dB is added to account for the "startle effect" associated with sudden onset of noise from fast-moving, low-flying aircraft. The SEL has proven to be a good metric to compare the relative exposure of transient sounds, such as aircraft overflights, and is the recommended metric for prediction of sleep disturbance (U.S. Department of Defense Noise Working Group, 2009). In this EIS, SEL is used in aircraft comparison and sleep disturbance analyses.

3.1.2.4 Maximum Sound Level

The highest A-weighted sound level measured during a single event where the sound level changes value with time (e.g., an aircraft overflight) is called the maximum A-weighted sound level or L_{max}. During an aircraft overflight, the noise level starts at the ambient or background noise level, rises to the maximum level as the aircraft flies closest to the observer, and returns to the background level as the aircraft recedes into the distance. L_{max} defines the maximum sound level occurring for a fraction of a second. For aircraft noise, the "fraction of a second" over which the maximum level is defined is generally 1/8 second (American National Standards Institute, 1988). For sound from aircraft overflights, the SEL is usually greater than the L_{max} because an individual overflight takes seconds and the L_{max} occurs instantaneously. In this EIS, L_{max} is used in the analysis of aircraft comparison and speech interference.

3.1.2.5 Number of Events Above a Threshold Level

The "Number of Events Above a Threshold Level" metric provides the total number of noise events that exceed a selected noise level threshold during a specified period of time (U.S. Department of Defense Noise Working Group, 2009). Combined with the selected noise metric, L_{max} or SEL, the number of events above a threshold level is symbolized as NAXXmetric (NA = number of events above, XX = decibel level, metric = L_{max} or SEL). For example, the L_{max} and SEL metrics are symbolized as NA75L_{max} and NA75SEL, respectively, with 75 dB as the example decibel level. For this EIS, an L_{max} threshold has been selected to analyze speech interference and an SEL threshold is selected for analysis of sleep disturbance.

3.1.2.6 Peak Sound Level

This metric is the highest instantaneous sound level of an event and is used in this EIS to describe events of extremely short duration, such as gunfire and sonic booms. Peak sound level describes a much shorter time period than the 1/8-second time period described by the metric L_{max}. Higher peak sound levels are associated with a greater likelihood of complaints.

3.1.3 Noise Effects

An extensive amount of research has been conducted regarding noise effects including annoyance, speech interference, interference with classroom learning, sleep disturbance, potential hearing loss, and nonauditory health effects. These effects are summarized below and described in greater detail in Appendix C (Noise Study).

3.1.3.1 Annoyance

As previously noted, the primary effect of aircraft noise on exposed communities is long-term annoyance, defined by USEPA as any negative subjective reaction on the part of an individual or group. The scientific community has adopted the use of long-term annoyance as a primary indicator of community response, and there is a consistent relationship between DNL and the level of community annoyance (Federal Interagency Committee on Noise, 1992).

3.1.3.2 Speech Interference

Speech interference associated with aircraft noise is a primary cause of annoyance for communities. Speech interference can cause disruption of routine activities, such as enjoyment of radio or television programs, telephone use, or family conversation, giving rise to frustration or irritation. In extreme cases, speech interference may cause fatigue and vocal strain to individuals who try to communicate over the noise. In this EIS, any aircraft noise event exceeding 50 dBA for even a moment (i.e., 50 dBA L_{max}) is assumed to have the potential to interfere with speech. In this EIS, the average number of potential aircraft speech interference events per hour is used to quantify speech interference. Sonic boom and munitions expenditure noise energy is concentrated at low frequencies (0.1 to 100 Hz), and does not typically interfere directly with speech, which centers at 1,000 Hz (U.S. Department of the Air Force, 2003; Army Research Laboratory, 2012). Anecdotally, people sometimes pause conversation when a sonic boom or munitions noise is heard because the sound is unfamiliar or startling. However, direct interference of sonic boom or munitions noise with speech is uncommon and is not specifically quantified in this EIS.

3.1.3.3 Interference With Classroom Learning

For school-aged children, noise interference with learning is of particular concern because noise can interrupt communication or interfere with concentration. The DoD Noise Working Group recommends using an outdoor $L_{eq(8hr)}$ during the school day of 60 dBA as an indicator that background noise levels indoors (i.e., in classrooms) are unacceptably high. For locations with noise levels exceeding 60 dBA $L_{eq(8hr)}$, the working group recommends calculating the number of events per hour exceeding 50 dBA L_{max} under the assumption that any event exceeding that level has the potential to interfere with speech (Department of Defense Noise Working Group, 2013).

3.1.3.4 Sleep Disturbance

The disturbance of sleep is a major concern for communities exposed to nighttime aircraft noise. The lack of quality sleep has the potential to affect health and concentration. The probability of being awakened at least once per night was calculated using a method described by the American National Standards Institute (2008). The method first predicts the probability of awakening associated with each type of flying event (higher SELs yield higher probability of awakening) and then sums the probabilities associated with all event types. The overall probability of awakening at least once per night reflects all flying events that occur between 10:00 p.m. and 7:00 a.m., when most people sleep. The American National Standards Institute recently withdrew the 2008 standard primarily due to concerns that the method overestimates impacts (American National Standards Institute, 2018). The method has not been replaced to date and remains a commonly used, conservative method for estimation of sleep disturbance.

3.1.3.5 Potential Hearing Loss

People living in high noise environments for an extended period of time (40 years) can be at risk for hearing loss called noise-induced permanent threshold shift (NIPTS). The NIPTS defines a permanent change in hearing level, or threshold, caused by exposure to noise (U.S. Environmental Protection Agency, 1982). According to USEPA (1974), changes in hearing level of less than 5 dB are generally not considered noticeable. There is no known evidence that an NIPTS of less than 5 dB is perceptible or has any practical significance for the individual affected (U.S. Environmental Protection Agency, 1974). Furthermore, the variability in audiometric testing is generally assumed to be plus or minus 5 dB. The preponderance of available information on hearing loss risk is from the workplace with continuous exposure throughout the day for many years. Occupational Safety and Health Administration Standard 1910.95 sets the upper limit for occupational noise exposure at 115 dB, and instantaneous noise levels below this threshold are not associated with risk of inducing changes in hearing level.

Based on a report by Ludlow and Sixsmith (1999), there were no major differences in audiometric test results between military personnel, who as children, had lived in or near installations where fast jet operations were based, and a similar group who had no such exposure as children (Ludlow & Sixsmith, 1999). Hence, for the purposes of this EIS, the limited data are considered applicable to the general population, including children, and are used to provide a conservative estimate of the risk of potential hearing loss.

DoD policy directive requires that hearing loss risk be estimated for the at-risk population, defined as the population exposed to DNL greater than or equal to 80 dBA (U.S. Department of Defense, 2009). To assess the potential for NIPTS, the Navy generally uses the 80 dBA DNL noise contour as a threshold to identify the exposed population who may be at the most risk of possible hearing loss from aircraft noise (U.S. Environmental Protection Agency, 1982; U.S. Department of Defense Noise Working Group, 2009).

3.1.3.6 Nonauditory Health Effects

Studies have been conducted to examine the nonauditory health effects of aircraft noise exposure, focusing primarily on stress response, blood pressure, birth weight, mortality rates, and cardiovascular health. Exposure to noise levels higher than those normally produced by aircraft in the community can elevate blood pressure and stress hormone levels. However, the response to such loud noise is typically short in duration: after the noise goes away, the physiological effects reverse, and levels return to normal. In the case of repeated exposure to aircraft noise, the connection is not as clear. The results of most cited studies are inconclusive, and it cannot be conclusively stated that a causal link exists between aircraft noise exposure and the various type of nonauditory health effects that were studied (U.S. Department of Defense Noise Working Group, 2009).

3.1.4 Noise Modeling

Computer modeling provides a tool to assess potential noise impacts. DNL noise contours are generated by a computer model that draws from a library of actual aircraft noise measurements. Noise contours produced by the model allow a comparison of existing conditions and proposed changes or alternative actions, even when the aircraft studied are not currently operating from the installation. For these reasons, on-site noise monitoring is seldom used at military air installations, especially when the aircraft mix and operational tempo are not uniform.

3.1.4.1 Airborne Noise Modeling

Modeling methods used for this EIS are described in Appendix C (Noise Study) and summarized below.

Aircraft noise in the airfield vicinity was modeled using the NoiseMap suite of computer programs. The Advanced Acoustic Model version 2, which is a part of the NoiseMap suite, was used to calculate noise associated with helicopter flyovers, and NoiseMap version 7.3 was used to model noise generated by stationary helicopters and all fixed-wing aircraft operations. NoiseMap analyzes operational data (types of aircraft, number of operations, flight tracks, altitude, speed of aircraft, engine power settings, and engine maintenance run-ups), environmental data (average humidity and temperature), and surface hardness and terrain. For this EIS, modeled operations tempos were based on 5 to 10 years of historical operations data and pilot interviews. Runway utilization patterns were based on records over a period of five years. Long periods of time were studied so that modeling would appropriately reflect variability in operations tempo over time. Flight parameters (e.g., climb rates) were derived from pilot interviews. NoiseMap was used to generate DNL contours, which are lines on a map connecting points of equal DNL value. The program was also used to generate supplemental noise metrics values at several representative noise-sensitive locations. These metrics provide a more complete description of noise levels or particular impact categories (e.g., speech interference) than is provided by DNL alone.

Subsonic airspace noise levels were modeled using the program Military Operations Area-Range NoiseMap (MRNMAP), which has the capability to model operations that occur anywhere within a defined volume of airspace. This model takes into account altitude bands usage patterns, typical airspeed, and typical engine power settings for each aircraft type and/or squadron. Operations tempo and flight parameters in the airspace areas were based on a combination of pilot interviews and operational records. Noise levels beneath airspace areas are presented in this EIS as uniform distributed time-average noise levels using the metric L_{dnmr}. Usage logs for military training routes (MTRs) that intersect with PRC airspace show usage rates at less than one sortie per day. Based on these usage rates, it was concluded that MTR operations would not affect overall L_{dnmr}, and no further analysis was conducted.

Supersonic airspace noise was modeled using PCBOOM. Ten years of supersonic flight segment telemetry records (e.g., locations, altitudes, airspeeds) were entered to the model PCBOOM to calculate sonic boom footprint extents and intensities. Time-averaged noise levels reflecting summation of individual sonic boom events are presented in map format using the noise metric CDNL.

Airborne noise from ground vehicles and vessels is temporary, localized, and similar to noise generated by civilian ground vehicles and vessels that operate in the region of influence. Therefore, noise associated with ground vehicles and vessels is described qualitatively in this EIS.

Munitions noise was modeled using the Air Gunnery Noise Model. The number of munitions expenditure events modeled was based on 10 years of munitions expenditure reports, and munitions expenditure parameters (e.g., altitudes, run-in headings) were based primarily on optimal release envelopes for each weapon. Noise energy generated by air gunnery was summed logarithmically with sonic boom noise energy using the program NMPLOT. Sonic boom and aerial gunnery noise are both communicated using the metric CDNL shown on a noise contour map. Munitions expenditures from surface vessels are substantially less common than aircraft munitions deliveries and the area impacted by elevated noise levels is smaller. Because munitions expenditures from surface vessels do not affect overall CDNL or the extent of peak noise level thresholds, surface vessel munitions expenditures were not included in noise modeling calculations. Aerial target launch noise levels at the closest noise-sensitive location were estimated based on measured aerial target launch noise levels and a conservative assumption that noise levels would decrease by 6 dB with each doubling of distance.

3.1.5 Ambient Airborne Noise, Regulatory Setting

Under the Noise Control Act of 1972, the Occupational Safety and Health Administration established workplace standards for noise. Threshold noise levels are set for several durations of exposure. The standards limit instantaneous exposure, such as impact noise, to 140 dB. If noise levels exceed an established standard, employers are required to provide hearing protection equipment that will reduce sound levels to acceptable limits. Although workplace noise on Navy installations is outside of the scope of this analysis, instantaneous exposure regulatory thresholds are referenced.

The joint instruction OPNAVINST 11010.36C and Marine Corps Order 11010.16, *Air Installations Compatible Use Zones (AICUZ) Program,* provides guidance on administering the AICUZ program, which recommends land uses that are compatible with aircraft noise levels. OPNAVINST 3550.1A and Marine Corps Order 3550.11 provide guidance for a similar program, RAICUZ. This program includes range safety and noise analyses and provides land use recommendations compatible with range compatibility zones and noise levels associated with military range operations. Per OPNAVINST 11010.36C, NoiseMap is to be used for developing fixed-wing noise contours, and it is the best noise-modeling science available today for fixed-wing aircraft until the new Advanced Acoustic Model is approved for use. Rotary-wing and tilt-rotor aircraft operations are to be modeled using the Rotorcraft Noise Model, which is functionally equivalent to the Advanced Acoustic Model in calculations of rotorcraft noise.

According to the Naval Air Station (NAS) Patuxent River *Air Operations Manual* (NASPAXRIVINST 3710.5X) (U.S. Department of the Navy, 2017a), supersonic flights must be conducted within the restricted areas of the PRC Study Area while aircraft are over the Chesapeake Bay and may only be conducted if certain conditions are met. With the exception of supersonic runs essential for weapons separation testing, supersonic flight is only permitted above 30,000 feet mean sea level (MSL).

3.1.6 Ambient Airborne Noise, Affected Environment

Many components may generate noise and warrant analysis as contributors to the total noise impact. The predominant noise sources consist of aircraft operations, both at and around the airfields, as well as in the airspace and on ranges. Other components such as construction, aircraft ground support equipment for maintenance purposes, and vehicle traffic produce noise, but such noise generally represents a transitory and negligible contribution to the average noise level environment. The federal government supports conditions free from noise that threaten human health and welfare and the environment. Response to noise varies, depending on the type and characteristics of the noise, distance between the noise source and whoever hears it (the receptor), receptor sensitivity, and time of day. A noise-sensitive receptor is defined as a land use where people involved in indoor or outdoor activities may be subject to stress or considerable interference from noise. Such locations or facilities often include residential dwellings, hospitals, nursing homes, educational facilities, and libraries. Sensitive receptors may also include noise-sensitive cultural practices, some domestic animals, or certain wildlife species.

The nearest sensitive receptors to NAS Patuxent River include residences, schools, churches, and parks. Several representative noise-sensitive locations were selected for further analysis as indicators for the potential noise levels in the surrounding areas and do not include all locations that could be considered noise sensitive (Figure 3.1-2). Potentially noise-sensitive wildlife species are discussed in Section 3.4 (Biological Resources).

3.1.6.1 Aircraft Noise

Existing noise on NAS Patuxent River stems primarily from aircraft operations, including flight operations and engine maintenance operations or run-ups (e.g., engine runs conducted at the Open-Air Engine Test Cell [OAETC]), which are described briefly in Sections 3.0.2.3.1.1 (Aircraft and Aerial Targets (Air-Based Assets) and 3.0.2.3.1.3 (Land-Based Assets). Current noise levels in the installation environment (i.e., NAS Patuxent River and Outlying Field [OLF] Webster) and in the range noise environment (i.e., beneath PRC airspace) were calculated as part of the *Aircraft Noise Study to Support the EIS for PRC*, which is included as Appendix C (Noise Study). The Noise Study describes a baseline operational scenario based on 10 years of operational records. This long span of operational data was used as the basis for the study so that the varying nature of test operations could be accurately captured. Impacts associated with current noise levels are described in Sections 3.1.6.3 (Installation Noise Environment) and 3.1.6.4 (Range Noise Environment) below.

3.1.6.2 Non-Aircraft Noise Sources

Noise levels generated by assets other than aircraft and aerial targets are characterized briefly in Section 3.0.2.3.1.2 (Vessels (and Other Water-Based Assets)), Section 3.0.2.3.1.3 (Land-Based Assets), and Section 3.0.2.3.1.4 (Non-explosive Munitions and Other Military Expended Materials). Their contributions to the baseline noise impacts in the PRC Study Area are discussed in in Sections 3.1.6.3 (Installation Noise Environment) and 3.1.6.4 (Range Noise Environment).

3.1.6.3 Installation Noise Environment

This section discusses impacts associated with current noise levels in terms of several categories of potential impacts: annoyance, speech interference, interference with classroom learning, sleep disturbance, potential hearing loss, and nonauditory noise impacts in the installation vicinity. As discussed in Section 3.1.2 (Noise Metrics), impact assessments use the primary noise metric (DNL) as well as several supplemental noise metrics.

Table 3.1-2 lists individual overflight noise levels (dBA SEL and L_{max}) generated by the aircraft types (i.e., fixed-wing jets) that contribute the most noise energy to overall noise levels near NAS Patuxent River. Noise levels are presented for the aircraft while conducting departures, maneuvers to a practice approach, and arrival operations and reflect the specific flight procedure that generates the highest SEL. Noise levels were calculated at Drum Point Club (representative location 3 in Figure 3.1-2) for the departure and closed pattern procedure and at Lexington Park Elementary School (representative location 7 in Figure 3.1-2) for the arrival operations. These locations (i.e., locations 3 and 7) were selected due to their proximity to frequently used flight paths of each operation type. The different climb-out rates for the departures of the various aircraft result in different aircraft altitudes above Drum Point Club. Actual individual overflight noise levels vary from the noise levels listed because of variations in aircraft configuration, flight track, altitude, and atmospheric conditions. Other aircraft, which include rotary-wing aircraft, fixed-wing propeller aircraft, and unmanned aerial systems (UAS), generate lower noise levels while conducting these operations types.

Table 3.1-2 Individual Overflight Noise Levels

Aircraft	*Operation Type*	*Engine Power*	*Airspeed (knots)*	*Altitude (feet MSL)*	*Slant Distance (feet)*	*SEL[1] (dBA)*	*L_{max}[1] (dBA)*
F/A-18E/F (afterburner)	Departure	95% NC	300	4,954	5,301	100	91
F/A-18C/D (afterburner)		96.5% NC	250	3,397	3,553	104	92
F-35B (afterburner)		72% ETR	300	2,503	2,660	103	93
F-35B (military)		72% ETR	300	1,829	2,044	106	97
F-35C (afterburner)		100% ETR	272	2,224	2,272	108	101
F-35C (military)		100% ETR	265	1,954	2,175	109	102
T-38 (afterburner)		100% RPM	230	1,846	2,032	99	88
F/A-18E/F	Maneuvering to practice approach	84% NC	130	640	717	113	104
F/A-18C/D		86.1% NC	140	556	550	111	108
F-35B		40% ETR	180	887	943	101	93
F-35C		28% ETR	200	910	964	98	89
T-38		90% RPM	180	1,039	1,409	86	64
F/A-18E/F	Straight-in arrival	85% NC	135	704	2,170	106	99
F/A-18C/D		88% NC	140	782	2,194	101	94
F-35B		35% ETR	160	910	2,237	90	79
F-35C		28% ETR	235	864	2,220	88	78
T-38		90% RPM	200	698	2169	80	71

Key: dBA = A-weighted decibels; ETR = engine thrust request; L_{max} = maximum A-weighted sound level; MSL = mean sea level; RPM = revolutions per minute; NC = core engine speed; SEL = sound exposure level.

Note:

1. Noise levels presented were calculated at Drum Point Club for the departure and closed pattern specific flight procedure that has the largest SEL at this location and at Lexington Park Elementary School for the arrival flight procedure that has the largest SEL at this location. Actual individual overflight noise levels vary from the noise levels listed because of variations in aircraft configuration, flight track, altitude, and atmospheric conditions. Representative noise levels were calculated using NoiseMap Version 7.3 and the same operational data (e.g., flight tracks and flight profiles) used to calculate the day-night average noise level noise contours. Individual overflight noise levels in this table are provided to allow comparisons between various types of representative aircraft and operations. Figure 3.1-1 lists sound levels (in decibels) generated by several common non-aircraft sound sources, which can be used as points of reference.

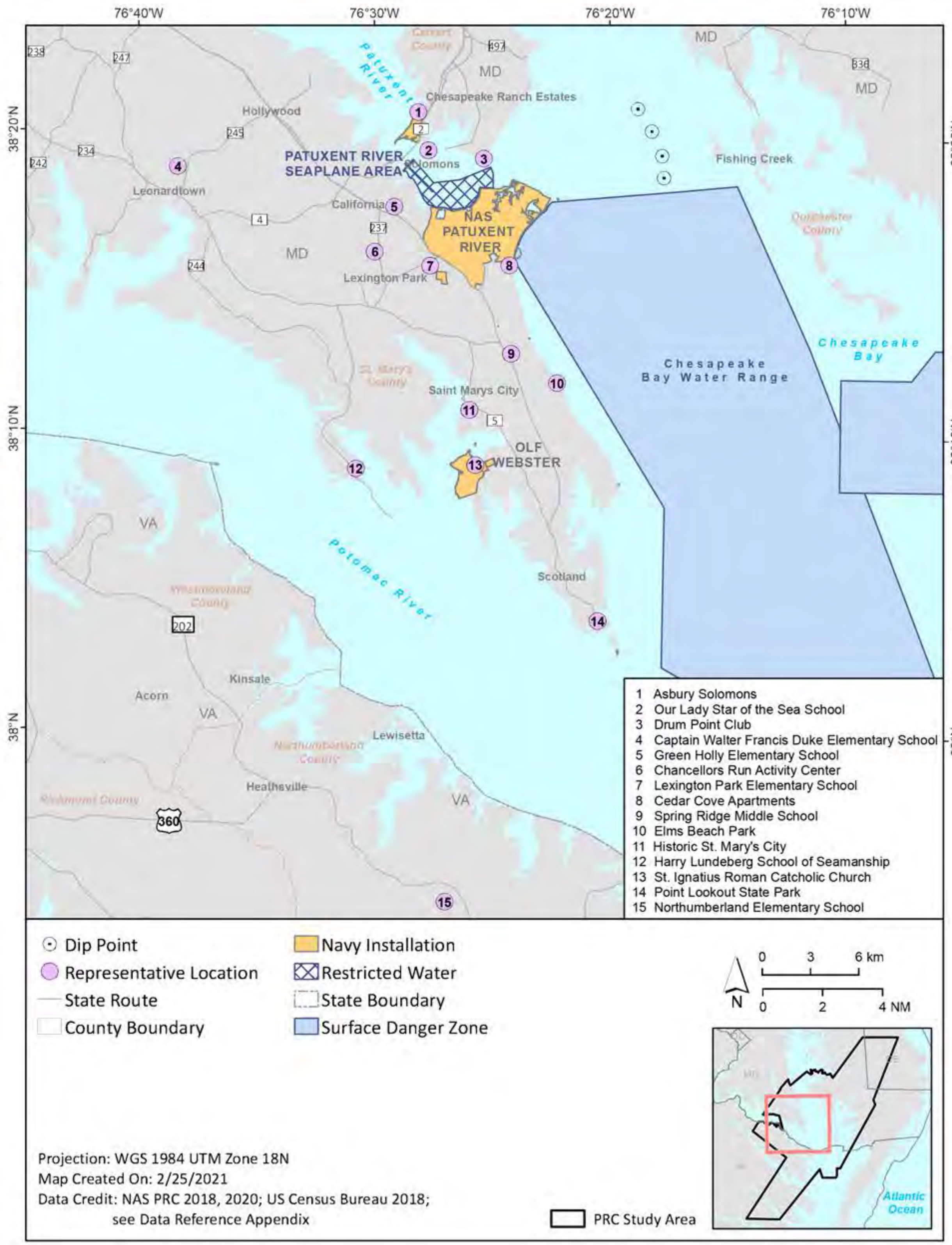


Figure 3.1-2 Representative Noise-Sensitive Locations

Static engine runs conducted as part of aircraft maintenance, pre-flight warmup, post-flight cool-down, and testing operations also generate elevated noise levels off the installation. Jet engine runs at the OAETC, which is located near the southern shore of the Patuxent River, have been the subject of noise complaints from residents on the north shore of the river. For example, runs of F/A-18E/F engines at the OAETC can generate noise levels of approximately 87 dBA at Drum Point Club. The ATR Sustainability Office is contacted prior to jet engine runs to determine if wind conditions are favorable for testing. Jet engine runs at the OAETC occur approximately 30 times per year (Table 3.0-11, Type and Number of Ground Test Facility Events).

Annoyance. Under baseline operational conditions (see Section 3.0.2.3.1 (Acoustic Stressors)), 594 acres of off-installation land and an estimated 1,290 residents are exposed to aircraft noise levels louder than 65 dBA DNL near NAS Patuxent River (see Table 3.1-3 and Figure 3.1-3). Aircraft noise levels are less than 65 dBA DNL at all locations on and near OLF Webster (Table 3.1-3). As discussed in Section 3.1.3.1 (Annoyance) and Appendix B (Noise Primer), people exposed to a higher DNL are more likely to become highly annoyed by the noise. At noise levels greater than 65 dBA DNL, certain noise-sensitive land uses (e.g., residential) are not considered to be compatible in accordance with DoD guidelines. Because noise is more likely to be considered a substantive community impact at levels above 65 dBA DNL, quantitative analysis focuses on areas exposed to levels greater than 65 dBA DNL. However, people outside the 65 dBA DNL contour do experience aircraft noise, and Figure 3.1-3 shows DNL contours in 5-dB increments ranging from 55 to 85 dBA DNL in order to more fully reflect the noise environment.

Table 3.1-4 lists DNLs as well as numbers of aircraft overflight noise events per year exceeding dBA L_{max} thresholds at representative noise-sensitive locations. Common non-aircraft noise sources that generate 80, 90, and 100 dBA (i.e., the threshold levels used in Table 3.1-4) are listed in Figure 3.1-1 as points of reference. Louder noise events (i.e., noise levels exceeding the 80, 90, or 100 dBA thresholds) are more likely to interrupt activities and trigger annoyance. Noise results presented in this EIS reflect all flight and static engine run operations unless a particular source is otherwise specified.

Table 3.1-3 Baseline Off-Installation Acres and Population Exposed to Noise Greater than 65 dBA DNL

Scenario	*Location*	*65–69 dBA DNL*		*70–74 dBA DNL*		*75 dBA and greater DNL*		*Total*	
		Land Area (acres)	*Population*	*Land Area (acres)*	*Population*	*Land Area (acres)*	*Population*	*Land Area (acres)*	*Population*
Baseline	NAS Patuxent River	541	1,290	45	0	8	0	594	1,290
	OLF Webster	0	0	0	0	0	0	0	0
	Total	541	1,290	45	0	8	0	594	1,290

Key: dBA = A-weighted decibels; DNL = day-night average sound level; NAS = Naval Air Station; OLF = Outlying Field.

Notes:

1. Acreage presented does not include areas over water or lands owned by the Navy.
2. The affected populations were estimated based on U.S. Census data at the block group level with adjustments to remove nonresidential areas from calculations (U.S. Census Bureau, 2017a).

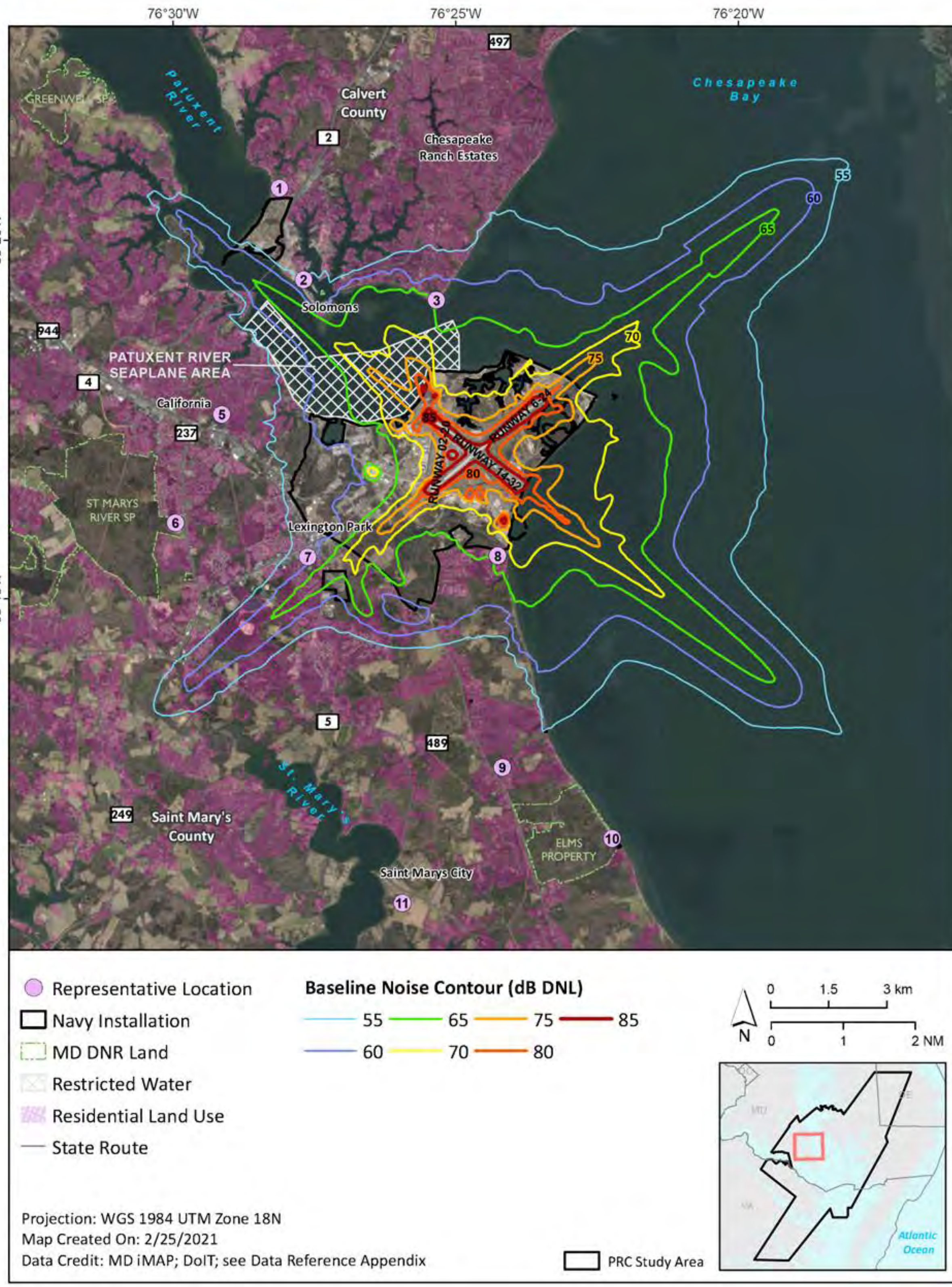


Figure 3.1-3 Baseline DNL Contours for NAS Patuxent River

Table 3.1-4 Baseline DNL and Number of Events Exceeding Decibel Thresholds

ID	Representative Location	dBA DNL	NA 80 dBA L_{max}[1]	NA 90 dBA L_{max}[1]	NA 100 dBA L_{max}[1]
1	Asbury Solomons	47	155	33	-
2	Our Lady Star of the Sea School	58	1,689	268	17
3	Drum Point Club	64	6,453	1,270	276
4	Captain Walter Francis Duke Elementary School	48	923	-	-
5	Green Holly Elementary School	48	310	-	-
6	Chancellors Run Activity Center	45	24	-	-
7	Lexington Park Elementary School	59	2,814	652	20
8	Cedar Cove Apartments	66	8,088	3,612	544
9	Spring Ridge Middle School	46	120	-	-
10	Elms Beach Park	52	1,064	162	-
11	Historic St. Mary's City	40	26	-	-
12	Harry Lundeberg School of Seamanship	42	-	-	-
13	St. Ignatius Roman Catholic Church	47	144	-	-
14	Point Lookout State Park	23	-	-	-
15	Northumberland Elementary School	24	-	-	-

Key: dBA = A-weighted decibels; DNL= day-night average sound level; ID = identification; L_{max} = maximum A-weighted sound level; NA = number of events above.

Note:

1. Dash indicates that exceedance of the L_{max} threshold is rare at this location but does not mean the threshold would never be exceeded. The number of events exceeding various decibel levels is provided as a description of noise conditions and not as a predictor of any particular types of impacts. Figure 3.1-1 lists sound levels (in decibels) generated by several common non-aircraft sound sources, which can be used as points of reference.

During scoping, concerns were raised about noise-induced structural vibration and secondary vibrations (i.e., "rattle") of objects within structures that can occur during loud overflights and static aircraft engine runs. Rattling of objects such as dishes, hanging pictures, and loose window panes can cause residents to have concerns regarding potential property damage. Actual damage to property as a result of noise is very rare, but if a person feels that their property has been damaged, they are encouraged to contact the NAS Patuxent River Noise Hotline (1-866-819-9028). Rattling objects have the potential to contribute to annoyance along with other potential noise effects (e.g., speech interference, sleep disturbance). Predicting whether an object will rattle when subjected to noise depends on several characteristics of the object and setting (e.g., mass of the object, firmness of fit of window panes) as well as characteristics of the noise (e.g., predominant frequencies). There is not a lower threshold noise level at which rattle is never possible but, as discussed in Appendix B (Noise Primer), rattling generally occurs with sounds that continue for several seconds at levels greater than 110 dB (unweighted). Noise events exceeding 100 dBA L_{max} (Table 3.1-4) would have a greater likelihood of inducing rattle of lightweight or loosely fitted objects than noise levels below 100 dBA L_{max}.

Aerial target launches from the Armament Test Area (ATA) generate an estimated 112 dBA L_{max} at Cedar Cove Apartments, located approximately 1,000 feet from the launch pad. Launch noise events likely interfere with speech as well as other activities and are likely to be considered annoying, but are not sufficiently loud to pose a risk to hearing at off-installation locations (Section 3.1.3, Noise Effects). Launch noise levels are comparable to noise levels generated by a direct overflight of a jet fighter aircraft (Table 3.1-2). However, jet aircraft overflights occur several times per day on average while aerial target launches occur less than three times per year. Aerial target launches do not add measurably to DNL, which is dominated by aircraft noise. Following launch, aerial targets move rapidly upward and away from shore, and noise levels at sensitive locations decrease quickly with this increasing distance.

Munitions firing at the ATA are much less frequent than aircraft operations noise but have the potential to disturb receptors in nearby areas. Firing noise levels for the representative ammunition type (i.e., 20 mm medium caliber rounds) were calculated using the Air Gunnery Noise Model. Test firing into the ATA firing tunnels generates peak noise levels between 115 and 130 decibels peak (dBP) at Cedar Cove Apartments (closest noise sensitive receptor) approximately 1,200 feet away. These noise levels, which are associated with a moderate probability of complaints, may occur up to 11 times per year. Because the events are infrequent, time-averaged noise levels do not exceed thresholds above which not all land uses are compatible (i.e., 62 dB CDNL) at off-installation locations (Section 3.6, Land Use). The number of rockets launched from the ATA is relatively small and infrequent, at 18 or less per year. Rockets that would be launched from the ATA are typically smaller and produce less thrust than aerial targets. Noise levels generated by rockets are similar to aerial target launch noise levels, which are comparable to L_{max} of a jet aircraft overflight (see Table 3.1-2). Rocket launches are infrequent and do not add measurably to overall DNL in the context of frequent aircraft overflights. Other military expended materials (MEM) employment in the installation vicinity (e.g., Cartridge Actuated Devices) does not generate noise that is intrusive in the context of an active airfield acoustic environment.

Speech Interference. As shown in Table 3.1-5, there are up to three noise events per average daytime hour (i.e., 7:00 a.m. to 10:00 p.m.) at representative locations with the potential to interfere with speech if windows are open, up to two events per average hour if windows are closed, and up to six events per hour for people outdoors. As noted above in Section 3.1.3.2 (Speech Interference), aircraft noise exceeding 50 dBA L_{max} has the potential to interfere, at least momentarily, with speech. Interior noise levels were estimated using the standard structural noise attenuation levels: 25 dB with windows closed and 15 dB with windows open. Non-aircraft noise sources that are loud enough to potentially interfere with speech off-installation (e.g., aerial target launches from ATA) would continue to be infrequent, as described under the *Annoyance* subsection above. Non-aircraft noise sources have minimal effect on the overall likelihood of speech interference in the context of frequent aircraft overflights.

Interference with Classroom Learning. As discussed in Section 3.1.3.3 (Interference With Classroom Learning), the DoD Noise Working Group has established 60 dBA $L_{eq(8hr)}$ as an exterior noise level indicating that classroom (i.e., indoor) noise levels likely exceed acceptable background noise criteria (Department of Defense Noise Working Group, 2013). Exterior $L_{eq(8hr)}$ at Lexington Park Elementary School is 60 dBA while levels at all the other schools studied are below 60 dBA (Table 3.1-6). The average number of aircraft noise events per daytime hour with the potential to interfere with speech is two or less with windows open and one or less with windows closed at the schools studied. Whereas aircraft fly overhead, non-aircraft noise sources (e.g., munitions firing at the ATA) occur relatively far from schools and do not typically generate noise levels with potential to interfere with classroom learning off the installation.

Table 3.1-5 Baseline Speech Interference Events per Average Daytime Hour

ID	Representative Location	Events per Average Daytime Hour with Potential to Interfere with Speech		
		Windows Open[1]	Windows Closed[1]	Outdoor
1	Asbury Solomons	1	- [2]	2
2	Our Lady Star of the Sea School	2	1	4
3	Drum Point Club	3	2	6
4	Captain Walter Francis Duke Elementary School	-	-	-
5	Green Holly Elementary School	1	-	3
6	Chancellors Run Activity Center	1	-	3
7	Lexington Park Elementary School	2	1	4
8	Cedar Cove Apartments	3	2	6
9	Spring Ridge Middle School	1	-	3
10	Elms Beach Park	1	-	3
11	Historic St. Mary's City	-	-	2
12	Harry Lundeberg School of Seamanship	1	-	1
13	St. Ignatius Roman Catholic Church	1	-	2
14	Point Lookout State Park	-	-	-
15	Northumberland Elementary School	-	-	-

Key: dB = decibels; dBA = A-weighted decibels; ID = identification; L_{max} = maximum A-weighted sound level.

Notes:

1. Standard structural noise attenuation levels are assumed: 25 dB with windows closed, 15 dB with windows open.
2. Dash indicates that the number of Patuxent River Complex aircraft noise events per hour exceeding 50 dBA L_{max} rounds to zero.

Table 3.1-6 Baseline Potential Classroom Interference

ID	Location Description	Outdoor $L_{eq(8hr)}$[1] (dBA)	Events per Hour, Windows Open[2]	Events per Hour, Windows Closed[2]
2	Our Lady Star of the Sea School	59	2	1
4	Captain Walter Francis Duke Elementary School	<45	- [3]	-
5	Green Holly Elementary School	49	1	-
6	Chancellors Run Activity Center	46	1	-
7	Lexington Park Elementary School	60	2	1
9	Spring Ridge Middle School	47	1	-
12	Harry Lundeberg School of Seamanship	<45	1	-
15	Northumberland Elementary School	<45	-	-

Key: < = less than; dB = decibels; dBA = A-weighted decibels; ID = identification; $L_{eq(8hr)}$ = eight-hour equivalent sound level; L_{max} = maximum A-weighted sound level.

Notes:

1. $L_{eq(8hr)}$ calculated for 8-hour typical school day from 8:00 a.m. to 4:00 p.m.
2. Number of events per hour exceeding 50 dBA L_{max}; standard structural noise attenuation levels are assumed: 25 dB with windows closed, 15 dB with windows open
3. Dash indicates that the number of PRC aircraft noise events per hour exceeding 50 dBA L_{max} rounds to zero.

Sleep Disturbance. As noted above in Section 3.1.3.4 (Sleep Disturbance), the lack of quality sleep has the potential to affect health and concentration. Late-night aircraft operations, which are required as part of certain missions, are more likely to disturb people's sleep. Based on typical flight patterns as documented in the *Aircraft Noise Study to Support the EIS for PRC* (see Appendix C, Noise Study), late-night flying (between 10:00 p.m. and 7:00 a.m.) makes up 1 percent of flying events at NAS Patuxent River and 0.1 percent of flying events at OLF Webster. Table 3.1-7 lists the probabilities that people will be awakened at least once per night by late-night aircraft operations (10:00 p.m. to 7:00 a.m.). Table 3.1-7 also lists sleep disturbance probabilities for parks and schools because results at those locations are indicative of impacts in nearby residential areas. Non-aircraft noise sources that are loud enough to potentially disturb sleep (e.g., aerial target launches from ATA) are infrequent and, therefore, have minimal effect on the overall likelihood of sleep disturbance in the context of frequent aircraft overflights.

Potential for Hearing Loss. Potential for hearing loss applies to people living in high noise environments where they can experience long-term hearing effects (duration of 40 years) resulting from DNL greater than 80 dBA (U.S. Department of Defense, 2009). Potential hearing loss was not analyzed because no community exposure occurs within 80 dBA DNL and greater noise contours.

Nonauditory Health Impacts. During scoping, the question of the potential for nonauditory health effects from noise (i.e., health effects other than hearing loss) was raised (see scoping comment in Appendix G, Public Involvement, Section G.2.7, Scoping Comment Summary). Potential nonauditory health effects that have been studied include, but are not limited to, cardiovascular health (e.g., hypertension), lack of sleep, stress, and anxiety. Research has indicated that an individual's health is greatly influenced by many non-noise factors such as heredity, medical history, and lifestyle choices regarding smoking, diet, and exercise. The Navy has conducted an extensive review of current studies on nonauditory health effects, and the literature review results are described in Appendix B (Noise Primer). The results of most cited studies are inconclusive and cannot identify a causal and consistent link between aircraft noise exposure and the various type of nonauditory health effects that were studied. Research has demonstrated that these factors have a larger and more direct effect on a person's health than aircraft noise.

Table 3.1-7 Baseline Probability of Awakening

ID	*Representative Location*	*Windows Open[1, 2]*	*Windows Closed[1, 2]*
1	Asbury Solomons	- [3]	-
2	Our Lady Star of the Sea School	1%	-
3	Drum Point Club	1%	1%
4	Captain Walter Francis Duke Elementary School	-	-
5	Green Holly Elementary School	1%	-
6	Chancellors Run Activity Center	-	-
7	Lexington Park Elementary School	1%	-
8	Cedar Cove Apartments	1%	-
9	Spring Ridge Middle School	-	-
10	Elms Beach Park	1%	-
11	Historic St. Mary's City	-	-
12	Harry Lundeberg School of Seamanship	-	-
13	St. Ignatius Roman Catholic Church	-	-
14	Point Lookout State Park	-	-
15	Northumberland Elementary School	-	-

Key: dB = decibels; ID = identification.
Notes:
1. Probability of being awakened at least once per night
2. Standard structural noise attenuation levels are assumed: 25 dB with windows closed, 15 dB with windows open.
3. Dash indicates that probability of awakening rounds to zero.

3.1.6.4 Range Noise Environment

Noise in the range (i.e., PRC Study Area) is generated primarily by subsonic/supersonic aircraft flying operations, and munitions expenditures. Noise generated by each of these sources is described below.

Subsonic Aircraft Noise. Noise levels generated by individual overflights in the PRC Study Area are listed in Table 3.1-8 in dBA SEL_r and $L_{max.}$ The noise levels listed reflect flight configurations representative of those currently used in PRC airspace, as documented in Appendix C (Noise Study). Aircraft types generating highest noise levels beneath the airspace are listed in in Table 3.1-8, while similar modeled aircraft types operating at the same altitudes in the same airspace units but generating lower noise levels are not listed. Aircraft operations in the PRC airspace are highly variable, with flight paths and altitudes being driven by the sortie's particular testing and training objectives. For a person on the ground, this means that aircraft may remain distant throughout the entire sortie duration generating relatively low noise levels, or aircraft may occasionally pass close by generating higher noise levels. Table 3.1-8 lists noise levels that would be generated if the aircraft were to pass directly overhead of a person at the lowest altitude at which the aircraft type would normally fly in the specified airspace. The vast majority of flights would be farther away and less loud.

Table 3.1-9 lists L_{dnmr} beneath the PRC airspace calculated based on current mission operations parameters. Operational parameters including flight altitudes, airspeeds, engine power settings, and operation tempos for each aircraft type are described in Appendix C (Noise Study). The relatively low L_{dnmr} values in PRC airspace reflect the fact that the airspace areas being used are very large and that many operations are conducted at relatively high altitudes. The missions of certain aircraft categories (notably rotary-wing aircraft) require low-altitude operations (see Appendix C, Noise Study, for description of altitude bands used by each squadron). Rotary-wing operations are conducted within wide areas (i.e., helicopter operating areas and restricted areas), and low-altitude overflight of any particular location is infrequent. Although individual overflights have the potential to be as high as 110 dBA L_{max} (see Table 3.1-8), time-averaged noise levels are 53 dBA L_{dnmr} or less. In areas where aircraft noise is below the ambient noise levels (i.e., noise levels when no aircraft are present), it does not constitute a defining feature of the acoustic environment. Ambient noise levels within PRC vary depending on many factors but primarily depend on the level of human activity. In urbanized areas, average ambient noise levels are often 55 dBA or higher while ambient noise levels in geographically remote areas are as low as 35 dBA (National Park Service, 2016a). In places where aircraft noise is less than 35 dBA L_{dnmr}, aircraft noise does not add substantively to overall noise levels (listed as "<35 dBA" in Table 3.1-9).

Table 3.1-8 Individual Overflight Noise Levels (dBA SEL_r and L_{max}) in the PRC Study Area

Aircraft[1]	*Airspace Area*	*Lowest Typical Flight Altitude*	*Power Setting*	*Airspeed (knots)*	*SEL_r (dBA)[2]*	*L_{max} (dBA)[2]*
H-60	Helo OPAREAs (all) / R-4005	100 ft AGL	N/A	120	97	93
CH-53	Helo OPAREAs (all) / R-4005	1,000 ft AGL	N/A	100	95	88
H-1	West Helo OPAREA	1,000 ft AGL	N/A	120	90	76
H-1	R-4005	100 ft AGL	N/A	100	101	91
F/A-18E/F	R-4005	1,000 ft AGL	90% NC	350	110	106
F/A-18C/D	R-4005	1,000 ft AGL	90% NC	350	104	99

Table 3.1-8 Individual Overflight Noise Levels (dBA SEL_r and L_{max}) in the PRC Study Area, Continued

Aircraft[1]	*Airspace Area*	*Lowest Typical Flight Altitude*	*Power Setting*	*Airspeed (knots)*	*SEL_r (dBA)[2]*	*L_{max} (dBA)[2]*
T-45	R-4005	1,000 ft AGL	92% RPM	325	91	86
F-35B	R-4005	1,000 ft AGL	90% ETR	300	114	108
F-35C	R-4005	1,000 ft AGL	90% ETR	300	115	110
F/A-18E/F	R-4006	3,500 ft AGL	90% NC	350	98	91
F/A-18C/D	R-4006	3,500 ft AGL	90% NC	350	91	83
T-45	R-4006	3,500 ft AGL	92% RPM	325	80	71
F-35B	R-4006	3,500 ft AGL	90% ETR	300	102	93
F-35C	R-4006	3,500 ft AGL	90% ETR	300	103	94
P-8	R-4005	600 ft AGL	13,000 LBS	225	110	107
P-3	R-4005	600 ft AGL	4,000 ESHP	225	96	92
C-130	R-4006	3,500 ft AGL	850 CTIT	225	78	70
T-6	R-4006	4,000 ft AGL	50% Torque	160	67	59
H-60	R-4006	1,000 ft AGL	N/A	100	85	76
T-38	R-4006	5,000 ft AGL	90% RPM	350	68	58

Key: AGL = above ground level; CTIT = Celsius turbine inlet temperature; dBA = A-weighted decibels; ESHP = engine shaft horsepower; ETR = engine thrust request; ft = feet; Helo OPAREA = Helicopter Operating Area; L_{max} = maximum A-weighted sound level; LBS = pounds (of thrust); N/A = not applicable; NC = core engine speed; PRC = Patuxent River Complex; R- = restricted area; RPM = revolutions per minute; SEL_r = onset-rate adjusted sound exposure level.

Notes:

1. Aircraft types generating highest noise levels beneath the airspace are listed. Similar aircraft types that operate at the same altitudes in the same airspace units and generate lower noise levels are not listed. Listed aircraft types reflect those used in noise modeling, and include some that are source noise level surrogates (e.g., C-21 is surrogate for C-38).
2. Individual overflight noise levels in this table are provided to allow comparisons between various types of representative aircraft and operations. Figure 3.1-1 lists sound levels (in decibels) generated by several common non-aircraft sound sources, which can be used as points of reference.

Table 3.1-9 Baseline Noise Levels Beneath PRC Airspace

Airspace Description	*Noise Level (dBA L_{dnmr})*
East Helicopter Operating Area (area outside of R-4006)	<35
South Helicopter Operating Area (area outside of R-4006)	<35
West Helicopter Operating Area	44.3
R-4005	52.9
R-4006 (area includes R-4006N but not including R-4005)	42.7
R-4008 (areas outside of R-4006)	<35
R-6609 (area outside of R-4006)	<35

Key: < = less than; dBA = A-weighted decibels; L_{dnmr} = onset-rate adjusted, monthly day-night average sound level; PRC = Patuxent River Complex; R- = restricted area.

Supersonic Aircraft Noise (Sonic Boom). Sonic booms are occasionally heard beneath the PRC airspace with up to 247 supersonic events conducted per year. Supersonic paths in the PRC Study Area are conducted almost exclusively above 30,000 feet MSL, and many sonic booms do not reach the ground (see Appendix B, Noise Primer). Sonic booms are projected forward and outward from the supersonic flight segment. The paths followed by sonic booms depend on atmospheric conditions (e.g., winds, air pressure, and temperature gradient), and sonic booms are sometimes “ducted” (i.e., transmitted with minimal loss of intensity) to distant locations as a result of unusual atmospheric patterns.

The highest sonic boom overpressures within a sonic boom footprint is directly beneath or forward of the supersonic flight path. Because supersonic flight paths are restricted to areas above the Chesapeake Bay, the highest overpressures at the surface occur on the water. On average, the highest overpressure within the boom footprints is 2.84 pounds per square foot. The remainder of the area exposed to the boom experiences much lower overpressures. For comparison, professional fireworks displays using ground-launching mortars have been measured to have peak overpressures of up to 12 pounds per square foot in public viewing areas (National Aeronautics and Space Administration, 1978). Sonic booms have the potential to startle people and animals that hear them and have resulted in complaints. Noise from sonic booms and munitions expenditures is similar to loud clapping or banging sounds and both types are often described using the time-averaged noise metric CDNL. Combined sonic boom and munitions noise levels exceed land use compatibility noise level thresholds (i.e., 62 dB CDNL) only in small areas of open water near Hooper and Hannibal Targets (Figure 3.1-4).

Munitions Noise. Munitions firing from aircraft is primarily conducted toward targets located near the center of Chesapeake Bay within the Chesapeake Bay Water Range (e.g., Hooper and Hannibal). Munitions fired include non-explosive small- and medium-caliber gun ammunition and rockets, as well as munitions, such as torpedoes and bombs, that do not generate substantial airborne noise (Table 2.3-2, Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems). As stated in *Supersonic Aircraft Noise (Sonic Boom)* above, the combined noise generated by munitions and sonic booms do not exceed land use compatibility threshold noise thresholds except in open water near the Hooper and Hannibal Targets (Figure 3.1-4).

Peak munitions noise levels were calculated for each combination of gun or rocket munitions type, aircraft, altitude, and firing location (see Appendix C, Noise Study, Section 5.2). As discussed in Section 3.0.2.3.1.4 (Non-explosive Munitions and Other Military Expended Materials), the impact of non-explosive munitions on the water’s surface generates a sound that is highly localized to the area of disturbance, and only noise associated with weapons firing was modeled. The loudest munitions firing events are below 115 dBP on land (Figure 3.1-5). As stated in Army Regulation 200-1, *Environmental Protection and Enhancement*, this peak noise level is associated with a low risk of complaints. Prior to non-explosive munitions firing events, Navy range personnel ensure that the open-water target areas and any areas exposed to hazards associated with the proposed munitions firing event are clear of non-participating watercraft (e.g., watermen, recreational boaters). Noise levels experienced by watermen and recreational boaters on the Chesapeake Bay depend on the distance to the firing event and the direction of fire. Noise levels experienced by these civilian boaters may sometimes exceed 115 dBP (associated with a moderate risk of complaints) or even 130 dBP (associated with a high risk of complaints). In compliance with safety precautions, aircraft would not fire non-explosive munitions from directly above boaters, but even if that were to occur, noise levels generated from that distance and direction of fire would be below 140 dBP, the regulatory threshold to protect against noise-induced permanent threshold shift (i.e., hearing loss) (Table 3.0-12, Airborne Noise from Representative Live-Fire and Launched Munitions). Potential impacts are limited to temporary disturbances of the typically small number of people that happen to be on the open water and relatively close to the firing event at the time the firing event occurs.

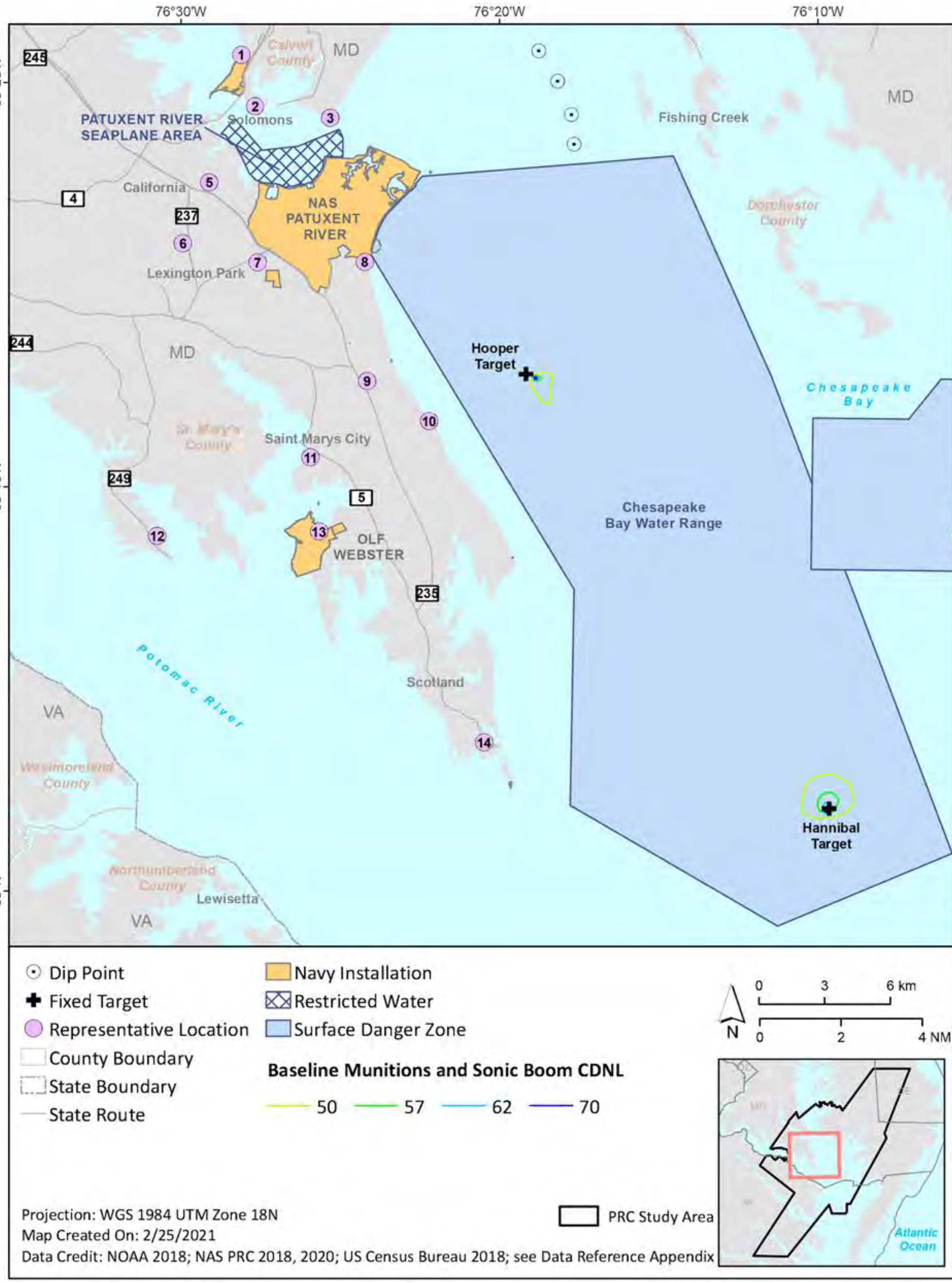


Figure 3.1-4 Baseline Sonic Boom and Munitions Noise Level (CDNL)

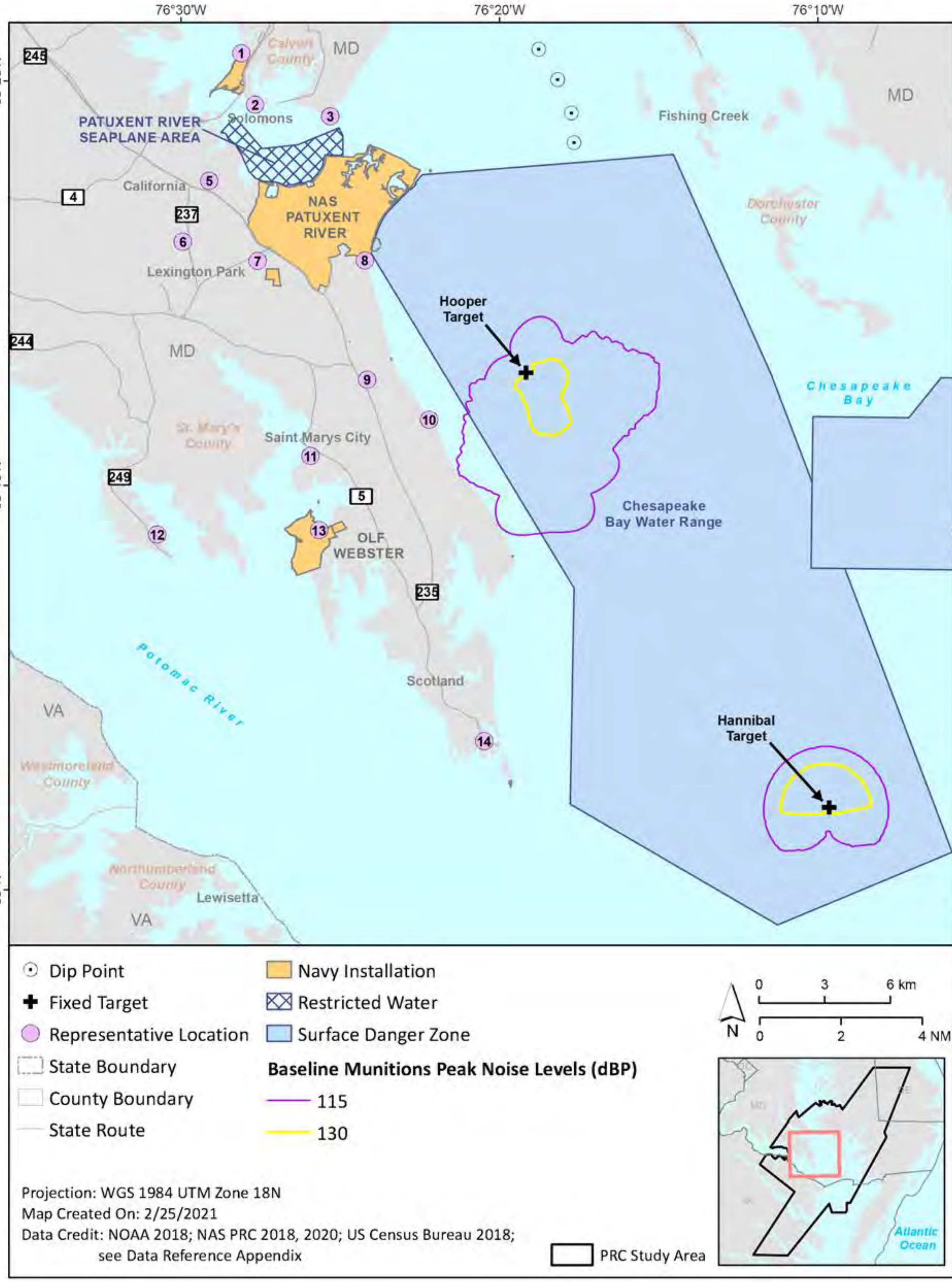


Figure 3.1-5 Baseline Munitions Peak Noise Levels (dBP)

3.1.7 Ambient Airborne Noise, Environmental Consequences

Analysis of potential noise impacts includes calculating noise levels that would be expected to occur from acoustic stressor sources and determining potential effects to sensitive receptor sites. Noise levels associated with each alternative were calculated reflecting existing noise mitigation measures identified in the 1998 PRC EIS and operating procedures designed with noise impact minimization in mind (Table 2.5-1, Standard Operating Procedures, and Table 3.10-1, Impact Avoidance and Minimization Measures). No additional noise mitigation measures over and above those described in previous NEPA documents are proposed at this time. The Navy will continue encroachment prevention efforts to minimize further development of noise-sensitive land uses in areas exposed to noise levels at which those land uses are considered incompatible. These efforts may include publication of an updated AICUZ study, RAICUZ study, or Joint Land Use Study.

3.1.7.1 Ambient Airborne Noise, No Action Alternative

Under the No Action Alternative, the proposed changes in operations tempo would not occur, and ambient airborne noise levels would remain as they are under baseline conditions. Noise impacts would continue to occur in the vicinity of the installation and beneath PRC airspace as described in Sections 3.1.6.3 (Installation Noise Environment) and 3.1.6.4 (Range Noise Environment), respectively.

3.1.7.2 Ambient Airborne Noise, Alternative 1 Potential Impacts

The region of influence for Alternative 1 is the entire PRC Study Area. As discussed in Section 2.1 (Proposed Action), operations in the PRC Study Area are highly variable due to the nature of the test mission, and noise levels will continue to undergo fluctuations in response to these changes. Aircraft models, series, or variants change in response to mission requirements, but the general types remain the same. Additional aircraft types will begin operations further in the future. Noise levels reported for Alternative 1 reflect a realistic future operations scenario developed using the best data currently available, which is described in Section 2.1 (Proposed Action) and Appendix C (Noise Study).

Under Alternative 1, the loudest aircraft types (i.e., fixed-wing jets) that currently operate in the PRC Study Area would continue operations, and noise levels associated with individual overflights by these aircraft would not change (Table 3.1-2). Static engine runs, including runs conducted at the OAETC, would also continue generating noise levels as described in Section 3.1.6.3 (Installation Noise Environment). Proposed changes in the frequency of operations would result in increased DNL at NAS Patuxent River and OLF Webster. The changes have the potential to affect impacts in several categories, which are discussed below.

Installation Noise Environment

Noise impacts in the installation environment under Alternative 1 are described below. Impacts would result from changes to the tempo of aircraft operations and activities involving non-aircraft noise sources. Alternative 1 also includes the operation of directed energy weapons. These changes are described in Section 2.1 (Proposed Action) and Appendix C (Noise Study).

Annoyance. Alternative 1 DNL contours are shown in Figure 3.1-6 and Figure 3.1-7 for NAS Patuxent River and OLF Webster, respectively. The number of off-installation land acres near NAS Patuxent River exposed to 65 dBA DNL and greater would increase from 594 to 1,158, and the estimated number of residents affected at these levels would increase from 1,290 to 2,640. At OLF Webster, off-installation aircraft noise levels would remain below 65 dBA DNL (Table 3.1-10).

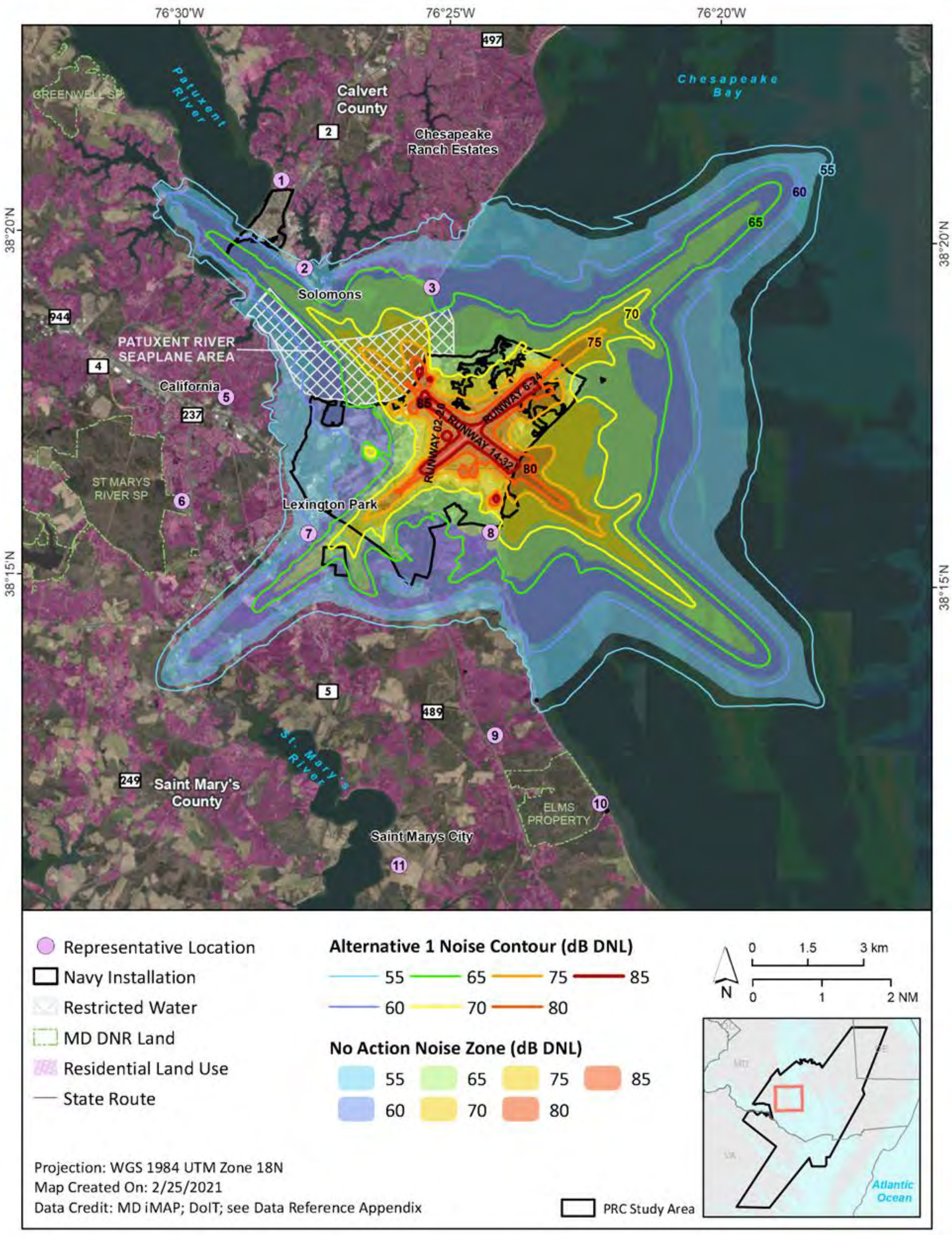


Figure 3.1-6 Alternative 1 DNL Contours for NAS Patuxent River

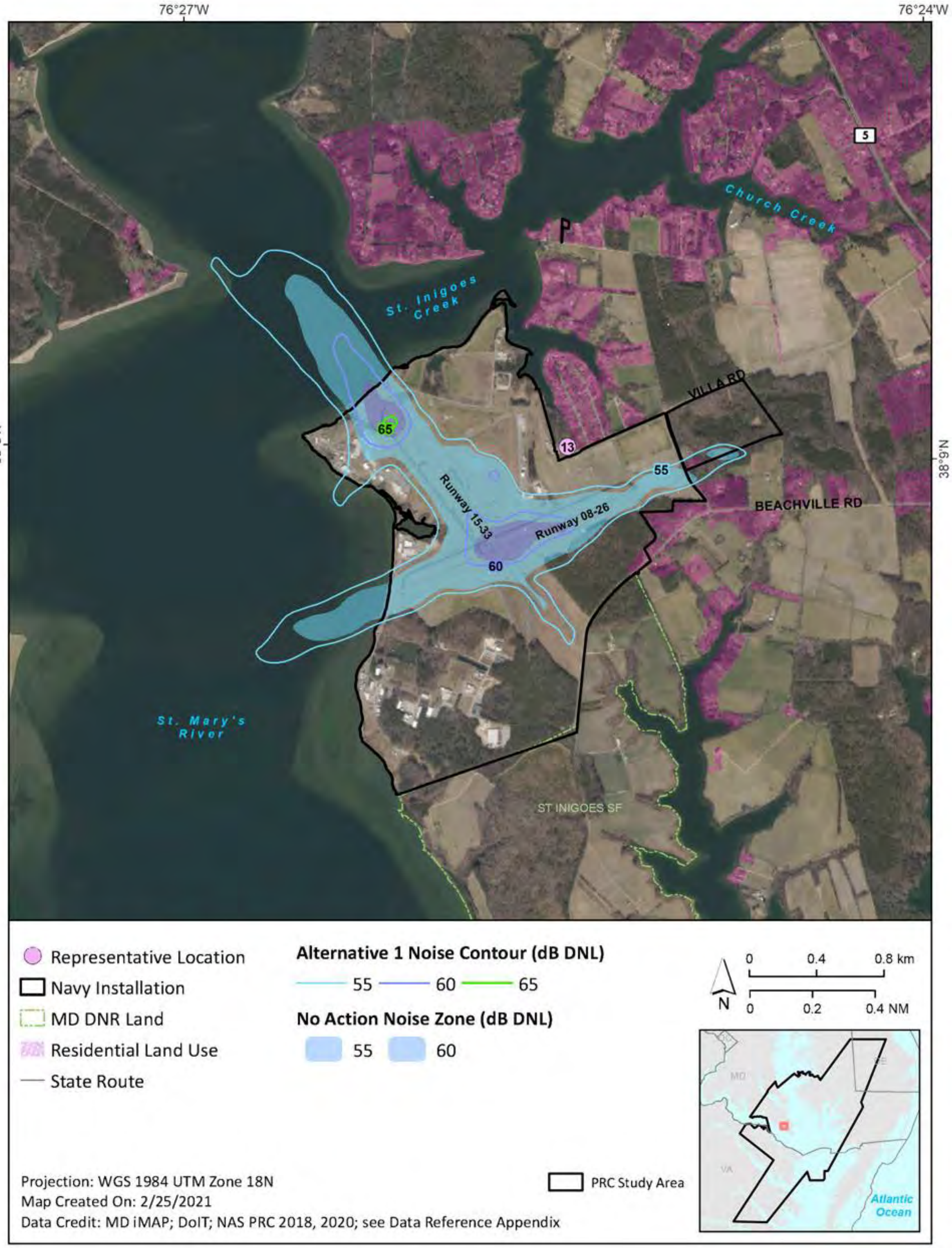


Figure 3.1-7 Alternative 1 DNL Contours for OLF Webster

Table 3.1-10 Off-Installation Acres and Population Exposed to Elevated Noise Levels Under Alternative 1

Scenario	*Location*	*65–69 dBA DNL*		*70–74 dBA DNL*		*75 dBA and Greater DNL*		*Total (All Areas at Greater than 65 dBA DNL)*	
		Land Area (acres)	*Population*	*Land Area (acres)*	*Population*	*Land Area (acres)*	*Population*	*Land Area (acres)*	*Population*
No Action Alternative	NAS Patuxent River	541	1,290	45	0	8	0	594	1,290
	OLF Webster	0	0	0	0	0	0	0	0
	Total	541	1,290	45	0	8	0	594	1,290
Alternative 1	NAS Patuxent River	1,044	2,636	106	4	8	0	1,158	2,640
	OLF Webster	0	0	0	0	0	0	0	0
	Total	1,044	2,636	106	4	8	0	1,158	2,640
Change	NAS Patuxent River	+503	+1,346	+61	+4	0	0	564	1,350
	OLF Webster	0	0	0	0	0	0	0	0
	Total	+503	+1,346	+61	+4	0	0	564	1,350

Key: dBA = A-weighted decibels; DNL = day-night average sound level; NAS = Naval Air Station; OLF = Outlying Field.

Notes:

1. Acreage presented does not include areas over water or lands owned by the Navy.
2. The affected populations were estimated based on U.S. Census data at the block group level with adjustments to remove nonresidential areas from calculations (U.S. Census Bureau, 2017a).

As discussed in Section 3.1.3 (Noise Effects) and Appendix B (Noise Primer), people exposed to higher DNL are more likely to become highly annoyed by the noise, and at noise levels greater than 65 dBA DNL, DoD considers noise to be sufficiently intrusive that some noise-sensitive land uses are considered to be incompatible with the noise. Quantitative analysis in this EIS focused on areas exposed to levels greater than 65 dBA DNL. However, people outside the 65 dBA DNL contour do experience aircraft noise, and Figure 3.1-6 and Figure 3.1-7 show DNL contours in 5-dB increments ranging from 55 to 85 dBA DNL in order to more fully reflect the noise environment.

As discussed in Section 2.3.2 (Action Alternative 1) and in more detail in Appendix C (Noise Study), Alternative 1 reflects a continuation of the types of aircraft operations conducted in the PRC Study Area in the past but with changes in operations tempo and replacement of certain aircraft types. Noise levels were calculated at several locations that, although they do not include all locations that could be considered noise-sensitive, are representative of noise-sensitive locations in PRC Study Area (see Figure 3.1-2). Noise levels at the representative noise-sensitive locations are indicative of noise levels in surrounding areas, which may also be noise sensitive.

As shown in Table 3.1-11, changes in operations tempo under Alternative 1 would result in increases up to 2 dBA DNL at the locations studied. However, because the loudest aircraft types currently operating in the area would not change, the highest SEL experienced at the representative locations would remain the same. Noise levels would remain below 65 dBA DNL (i.e., the noise level below which all land uses are considered to be compatible) at all locations except Drum Point Club and Cedar Cove Apartments. At Drum Point Club, the DNL would increase from 64 to 65 dBA, and at Cedar Cove Apartments, the DNL would increase from 66 to 68 dBA. Additional information on land use noise compatibility can be found in Section 3.6 (Land Use).

Table 3.1-11 DNL and Maximum SEL at Representative Locations Under Alternative 1

ID	Location Description	DNL (dBA)			Highest SEL (dBA) [1]		
		No Action Alternative	Alternative 1	Change	No Action Alternative	Alternative 1	Change
1	Asbury Solomons	47	47	0	103	103	0
2	Our Lady Star of the Sea School	58	59	+1	110	110	0
3	Drum Point Club	64	65	+1	113	113	0
4	Captain Walter Francis Duke Elementary School	48	49	+1	95	95	0
5	Green Holly Elementary School	48	49	+1	93	93	0
6	Chancellors Run Activity Center	45	46	+1	90	90	0
7	Lexington Park Elementary School	59	60	+1	107	107	0
8	Cedar Cove Apartments	66	68	+2	113	113	0
9	Spring Ridge Middle School	46	46	0	96	96	0
10	Elms Beach Park	52	53	+1	102	102	0
11	Historic St. Mary's City	40	41	+1	94	94	0
12	Harry Lundeberg School of Seamanship	42	42	0	86	86	0
13	St. Ignatius Roman Catholic Church	47	48	+1	95	95	0
14	Point Lookout State Park	23	24	+1	73	73	0
15	Northumberland Elementary School	24	25	+1	73	73	0

Key: dBA = A-weighted decibels; DNL = day-night average sound level; ID = identification; SEL = sound exposure level.
Note:
1. "Highest SEL" reflects modeled representative flight procedures. Actual flight procedures vary from representative procedures, and may generate louder SELs.

Increased DNL under Alternative 1 reflects increases in the frequency of loud aircraft noise events, as shown in Table 3.1-12. The table shows that some areas would experience greater numbers of loud events exceeding one threshold level (e.g., 80 dBA) while experiencing decreases in the number of events exceeding other thresholds (e.g., 100 dBA). Decreases in the number of loud events are possible where the operations tempo of particular squadrons or aircraft types would decrease despite the overall operations tempo increasing. The number of flying hours conducted by each squadron under Alternative 1 is listed in Appendix C (Noise Study), Table 4-1.

Locations with an increased frequency of loud noise events under Alternative 1 may also experience an increased frequency of structural vibration and objects rattling. Although damage claims associated with noise-induced vibration are rare, rattling of objects often makes people worry about breakage and increases the likelihood of annoyance. Predicting whether an object will rattle when subjected to noise depends on several characteristics of the object and setting (e.g., mass of the object, firmness of fit of window panes) as well as characteristics of the noise (e.g., predominant frequencies). There is not a lower threshold noise level below which rattle is never possible. As discussed in Appendix B (Noise Primer), rattling generally occurs with sounds that continue for several seconds at levels greater than 110 dB (unweighted). Noise events exceeding 100 dBA L_{max} would have a greater likelihood of inducing rattle of lightweight or loosely fitted objects than noise levels below 100 dBA L_{max}. The rattling of objects is more likely to occur during events with higher sound levels, as are quantified in Table 3.1-12.

Table 3.1-12 Number of Events Exceeding Decibel Thresholds Under Alternative 1

ID	Location Description	NA 80 L_{max} (dBA)			NA 90 L_{max} (dBA)			NA 100 L_{max} (dBA)		
		No Action	Alternative 1	Change	No Action	Alternative 1	Change	No Action	Alternative 1	Change
1	Asbury Solomons	155	258	103	33	27	-6	-	-	-
2	Our Lady Star of the Sea School	1,689	2,140	451	268	332	64	17	20	3
3	Drum Point Club	6,453	7,751	1,298	1,270	1,581	311	276	331	55
4	Captain Walter Francis Duke Elementary School	923	1,150	227	-	-	-	-	-	-
5	Green Holly Elementary School	310	250	-60	-	-	-	-	-	-
6	Chancellors Run Activity Center	24	43	19	-	-	-	-	-	-
7	Lexington Park Elementary School	2,814	3,582	768	652	805	153	20	40	20
8	Cedar Cove Apartments	8,088	9,386	1,298	3,612	4,566	954	544	921	377
9	Spring Ridge Middle School	120	103	-17	-	-	-	-	-	-
10	Elms Beach Park	1,064	1,444	380	162	263	101	-	-	-
11	Historic St. Mary's City	26	45	19	-	-	-	-	-	-
12	Harry Lundeberg School of Seamanship	-	-	-	-	-	-	-	-	-
13	St. Ignatius Roman Catholic Church	144	241	97	-	-	-	-	-	-
14	Point Lookout State Park	-	-	-	-	-	-	-	-	-
15	Northumberland Elementary School	-	-	-	-	-	-	-	-	-

Key: dBA = A-weighted decibels; ID = identification; L_{max} = maximum A-weighted sound level; NA = number of events above.

Note:

1. Dash (-) indicates that exceedance of the L_{max} threshold is rare at this location but does not imply that the threshold would never be exceeded. The number of events exceeding various decibel levels is provided as a description of noise conditions and not as a predictor of any particular types of impacts. Figure 3.1-1 lists sound levels (in decibels) generated by several common non-aircraft sound sources, which can be used as points of reference.

Aerial target launches from the ATA launch pad would continue to generate maximum noise levels at the closest residence comparable to L_{max} of a jet aircraft overflight (see Table 3.1-2). Aerial target launches from the ATA would occur five times or less annually under Alternative 1 and would not add measurably to DNL generated by aircraft operations, which occur several times per hour.

Firing of small- and medium-caliber guns at the ATA would continue to generate between 115 and 130 dBP at the closest residence (Cedar Cove Apartments). Noise levels in this range are associated with a moderate risk of complaints. The number of small-caliber rounds fired annually at the ATA would increase from 19,977 to 20,976, and the number of medium-caliber rounds fired annually would increase from 2,430 to 2,552 under Alternative 1 (Table 2.3-2, PRC Operational Tempo per Alternative: Munitions, Other MEM, and Directed Energy Weapons Systems). Time-averaged noise levels off the installation would remain below 62 dBA CDNL (i.e., threshold at which not all land uses are considered compatible). Rocket test launches would continue to generate noise levels that are variable by rocket type and less intense than aerial target launch noise. Rocket test launch noise would not add measurably to overall DNL in the context of frequent aircraft operations noise. The number of rockets launched would increase from 18 to 19 per year. Rockets would continue to generate maximum noise levels at the closest residence (i.e., Cedar Cove Apartments) that are similar to aerial target launch noise levels and comparable to L_{max} of a jet aircraft overflight (see Table 3.1-2). These events would not add to DNL in the context of frequent aircraft operations noise. Other MEM employment in the installation vicinity (e.g., Cartridge Actuated Device) does not generate noise that is intrusive in the context of an active airfield acoustic environment. As stated in Section 3.0.2.3.1.4 (Non-explosive Munitions and Other Military Expended Materials), the firing of directed energy weapons is typically silent.

Speech Interference. The number of indoor noise events per average daytime hour (7:00 a.m. to 10:00 p.m.) at representative locations with the potential to interfere with speech would change by less than one under Alternative 1 (Table 3.1-13). The number of outdoor potential speech interference events per average daytime hour would increase by one at Asbury Solomons, Our Lady Star of the Sea School, Captain Walter Francis Duke Elementary School, and Green Holly Elementary School (Table 3.1-13). Any increases in the frequency of disruptions in communication have a high likelihood of being annoying. Non-aircraft noise sources that are loud enough to potentially interfere with speech off the installation (e.g., aerial target launches from ATA) would continue to be infrequent (see *Annoyance* subsection above) and, therefore, have minimal effect on the overall likelihood of speech interference in the context of frequent aircraft overflights.

Table 3.1-13 Speech Interference Events Per Average Daytime Hour Under Alternative 1

ID	Location Description	Alternative 1			Increase Relative to No Action Alternative		
		Windows Open[1, 2]	Windows Closed[1, 2]	Outdoor	Windows Open[2]	Windows Closed[2]	Outdoor
1	Asbury Solomons	1	-[2]	3	-	-	+1
2	Our Lady Star of the Sea School	2	1	5	-	-	+1
3	Drum Point Club	3	2	6	-	-	-
4	Captain Walter Francis Duke Elementary School	-	-	1	-	-	+1
5	Green Holly Elementary School	1	-	4	-	-	+1
6	Chancellors Run Activity Center	1	-	3	-	-	-

Table 3.1-13 Speech Interference Events Per Average Daytime Hour Under Alternative 1, Continued

ID	Location Description	Alternative 1			Increase Relative to No Action Alternative		
		Windows Open[1, 2]	Windows Closed[1, 2]	Outdoor	Windows Open[2]	Windows Closed[2]	Outdoor
7	Lexington Park Elementary School	2	1	4	-	-	-
8	Cedar Cove Apartments	3	2	6	-	-	-
9	Spring Ridge Middle School	1	-	3	-	-	-
10	Elms Beach Park	1	-	3	-	-	-
11	Historic St. Mary's City	-	-	2	-	-	-
12	Harry Lundeberg School of Seamanship	1	-	1	-	-	-
13	St. Ignatius Roman Catholic Church	1	-	2	-	-	-
14	Point Lookout State Park	-	-	-	-	-	-
15	Northumberland Elementary School	-	-	-	-	-	-

Key: dB = decibels; dBA = A-weighted decibels; ID = identification; L_{max} = maximum A-weighted sound level.

Notes:

1. Number of events per hour exceeding 50 dBA L_{max}; standard structural noise attenuation levels are assumed: 25 dB with windows closed, 15 dB with windows open
2. Dash (-) indicates that the number of Patuxent River Complex aircraft noise events per hour exceeding 50 dBA L_{max} (or increase in the number of events) rounds to zero.

Interference with Classroom Learning. Exterior $L_{eq(8hr)}$ at representative schools would remain below 60 dBA at all of the schools studied except Our Lady Star of the Sea School and Lexington Park Elementary School (Table 3.1-14). At Our Lady Star of the Sea School, $L_{eq(8hr)}$ would increase from 59 to 61 dBA, and at Lexington Park Elementary School, $L_{eq(8hr)}$ would increase from 60 to 62 dBA. The numbers of potential speech interference events per hour were calculated, as prescribed by DoD Noise Working Group, and were found to change by less than one at all of the locations studied. Non-aircraft noise sources (e.g., aerial target launches from ATA) do not generate noise levels with potential to interfere with classroom learning.

Sleep Disturbance. The percentage of flying events at NAS Patuxent River conducted late at night (i.e., between 10:00 p.m. and 7:00 a.m.) would remain at 1 percent under Alternative 1, and the number of late-night flying events would increase in proportion to overall flying. The percentage at OLF Webster would increase from 0.1 to 0.2 percent. The probability of sleep being disturbed at least once per night would increase by 1 percent at the Cedar Cove Apartments with windows closed but would change by less than one at all other locations with windows open or closed (Table 3.1-15). Late-night flying operations are relatively rare at NAS Patuxent River and OLF Webster, and the probability of being awakened at least once per night is 1 percent or less at all of the locations studied. NAS Patuxent River would continue to publish notifications of upcoming late-night flying missions. Non-aircraft noise sources that are loud enough to potentially disturb sleep (e.g., aerial target launches from ATA) are infrequent and, therefore, have minimal effect on the overall likelihood of sleep disturbance in the context of frequent aircraft overflights.

Table 3.1-14 Potential Classroom Interference Under Alternative 1

ID	Location Description	*Alternative 1*			*Increase Relative to No Action Alternative*		
		Outdoor $L_{eq(8hr)}$ (dBA)[1]	*Events per Hour, Windows Open[2]*	*Events per Hour, Windows Closed[2]*	*Outdoor $L_{eq(8hr)}$ (dBA)[1]*	*Events per Hour, Windows Open*	*Events per Hour, Windows Closed*
2	Our Lady Star of the Sea School	61	2	1	+2	-	-
4	Captain Walter Francis Duke Elementary School	45	-	-	+1	-	-
5	Green Holly Elementary School	50	1	-	+1	-	-
6	Chancellors Run Activity Center	47	1	-	+1	-	-
7	Lexington Park Elementary School	62	2	1	+2	-	-
9	Spring Ridge Middle School	48	1	-	+1	-	-
12	Harry Lundeberg School of Seamanship	<45	1	-	-	-	-
15	Northumberland Elementary School	<45	-	-	+1	-	-

Key: < = less than; dB = decibels; dBA = A-weighted decibels; ID = identification; $L_{eq(8hr)}$ = eight-hour equivalent sound level; L_{max} = maximum A-weighted sound level.

Notes:

1. $L_{eq(8hr)}$ calculated for 8-hour typical school day from 8:00 a.m. to 4:00 p.m.
2. Number of events per hour exceeding 50 dBA L_{max}; standard structural noise attenuation levels are assumed: 25 dB with windows closed, 15 dB with windows open
3. Dash (-) indicates that the number of PRC aircraft noise events per hour exceeding 50 dBA L_{max} rounds to zero.

Table 3.1-15 Probability of Awakening Under Alternative 1

ID	Location Description	*Alternative 1*		*Increase Relative to No Action Alternative*	
		Windows Open[1, 2]	*Windows Closed[1, 2]*	*Windows Open*	*Windows Closed*
1	Asbury Solomons	-[3]	-	-	-
2	Our Lady Star of the Sea School	1%	-	-	-
3	Drum Point Club	1%	1%	-	-
4	Captain Walter Francis Duke Elementary School	-	-	-	-
5	Green Holly Elementary School	1%	-	-	-
6	Chancellors Run Activity Center	-	-	-	-
7	Lexington Park Elementary School	1%	-	-	-
8	Cedar Cove Apartments	1%	1%	-	+1%
9	Spring Ridge Middle School	-	-	-	-
10	Elms Beach Park	1%	-	-	-
11	Historic St. Mary's City	-	-	-	-
12	Harry Lundeberg School of Seamanship	-	-	-	-
13	St. Ignatius Roman Catholic Church	-	-	-	-
14	Point Lookout State Park	-	-	-	-
15	Northumberland Elementary School	-	-	-	-

Key: dB = decibels; ID = identification.

Notes:

1. Probability of being awakened at least once per night
2. Standard structural noise attenuation levels are assumed: 25 dB with windows closed, 15 dB with windows open.
3. Dashes (-) indicate that probability of awakening rounds to zero.

Potential for Hearing Loss. No off-installation residential areas are exposed to noise levels exceeding 80 dBA DNL under Alternative 1 (Figure 3.1-6 and Figure 3.1-7), and hearing loss risk would continue to be minimal. Non-aircraft noise sources do not generate noise levels off-installation associated with risk of potential hearing loss.

Nonauditory Health Impacts. The Navy has conducted an extensive review of current studies on nonauditory health effects, and the literature review results are described in Appendix B (Noise Primer). Potential nonauditory health effects that have been studied include, but are not limited to, cardiovascular health (e.g., hypertension), lack of sleep, stress, and anxiety. Research has indicated that an individual's health is greatly influenced by many non-noise factors such as heredity, medical history, and lifestyle choices regarding smoking, diet, and exercise. The results of most cited studies on nonauditory health effects of noise have not identified a causal and consistent link between aircraft noise exposure and the various type of nonauditory health effects that were studied.

Range Noise Environment

Noise impacts generated by changes to acoustic stressors from subsonic/supersonic aircraft flying operations and munitions firing under Alternative 1 are described below. Changes in the operational tempo under Alternative 1 that drive the changes in noise levels are described in Section 2.1 (Proposed Action) and Appendix C (Noise Study).

Subsonic Aircraft Noise. As discussed in Section 2.1 (Proposed Action) and in Section 3.1.6 (Ambient Airborne Noise, Affected Environment), the specific types of aircraft operating in the PRC Study Area changes over time, but the same general types of aircraft (e.g., fixed-wing jet, fixed-wing propeller, rotary-wing aircraft, and UAS) continue to operate. The MQ-25 is an example of a new aircraft type proposed to operate in the PRC Study Area in coming years. Measured noise levels generated by the MQ-25 are not available for use in this EIS but are expected to be similar to noise levels generated by a C-21 aircraft. The noise generated by a direct overflight of an MQ-25 at the lowest altitude at which they would typically be flown in the PRC Study Area is listed in Table 3.1-16 in dBA SEL_r and L_{max}. Noise generated by other aircraft types, which operate currently in the PRC Study Area and which would continue operations under Alternative 1, are listed in Table 3.1-8.

Table 3.1-16 Individual MQ-25 Overflight Noise Levels (dBA SEL_r and L_{max}) in Training Airspace

Aircraft	*Airspace Area*	*Lowest Typical Flight Altitude*	*Power Setting*	*Airspeed (knots)*	*SEL_r (dBA)*	*L_{max} (dBA)*
MQ-25 (C-21 surrogate)	R-4005	2,000 ft AGL	50% NC	200	68	57

Key: dBA = A-weighted decibels; AGL = above ground level; ft = feet; L_{max} = maximum A-weighted sound level; NC = core engine speed; R- = restricted area; SEL_r = onset-rate adjusted sound exposure level.

As is the case currently, flying operations under Alternative 1 would occur within very large areas, and any particular location would be directly overflown infrequently. Operational parameters, including the altitudes, airspeeds, and engine power settings used by each squadron and aircraft type are described in Appendix C (Noise Study).

Time-averaged noise levels (dBA L_{dnmr}) beneath the PRC airspace were calculated based on the intensity of overflight noise events, the frequency at which noise events are heard, and the time of day in which the events occur. Noise levels would increase by 1.8 dBA L_{dnmr} or less under Alternative 1 but would remain well below 65 dBA (Table 3.1-17 and Figure 3.1-8). Noise levels beneath several PRC airspace areas would be below or approximately the same as ambient noise levels and would have a minimal effect on overall levels. Ambient noise levels in rural areas are typically approximately 45 dBA, whereas noise levels in urbanized areas are often 55 dBA or higher, and noise levels in remote areas may be as low as 35 dBA (National Park Service, 2016a). In places where aircraft noise remains below 35 dBA L_{dnmr}, aircraft noise does not add substantively to overall noise levels (listed as "<35 dBA" in Table 3.1-17). Loud aircraft overflights would become slightly more frequent under Alternative 1 (as reflected by slightly increased L_{dnmr}), which could result in increased annoyance in areas beneath the airspace areas.

Table 3.1-17 Noise Levels Beneath PRC Airspace Areas Under Alternative 1

Airspace Description	***Noise Level (dBA L_{dnmr})***		
	No Action Alternative/ Baseline	***Alternative 1***	***Change***
Helicopter Operating Area East (area outside of R-4006)	<35	<35	0
Helicopter Operating Area South (area outside of R-4006)	<35	35.5	0.5
Helicopter Operating Area West	44.3	46.1	1.8
R-4005	52.9	54	1.1
R-4006 (not including R-4005)	42.7	43.7	1
R-4008 (areas outside of R-4006)	<35	<35	0
R-6609 (area outside of R-4006)	<35	<35	0

Key: < = less than; dBA = A-weighted decibels; L_{dnmr} = onset-rate adjusted, monthly day-night average sound level; PRC = Patuxent River Complex; R- = restricted area.

Supersonic Aircraft Noise (Sonic Boom). Supersonic events would decrease from 247 to 198 per year under Alternative 1, but individual supersonic flight profiles would not be expected to change. The slight decrease in the number of supersonic events within the PRC reflects a trend toward supersonic operations being conducted in offshore Warning Areas. The Warning Areas are larger than PRC airspace and include sufficient airspace dimensions to accommodate certain fifth-generation fighter aircraft (e.g., F-35) supersonic testing requirements. Supersonic flight paths would continue to be conducted almost entirely at altitudes higher than 30,000 feet MSL, with the result that most sonic booms would continue to not reach the ground (approximately 17 percent of total booms reach the ground). The intensity of individual booms would not change under Alternative 1. When they do occur, sonic booms have the potential to startle people and are a common cause of complaints. Under normal circumstances, property damage is not expected at boom overpressures that occur beneath PRC airspace. Combined sonic boom and munitions noise levels would exceed threshold noise levels in slightly smaller areas of open water near the Hooper and Hannibal Targets reflecting the slightly decreased frequency of booms (Figure 3.1-9). Decreases in the number of sonic booms would be expected to decrease the prevalence of annoyance, but sonic booms would remain relatively rare, as reflected by low CDNL.

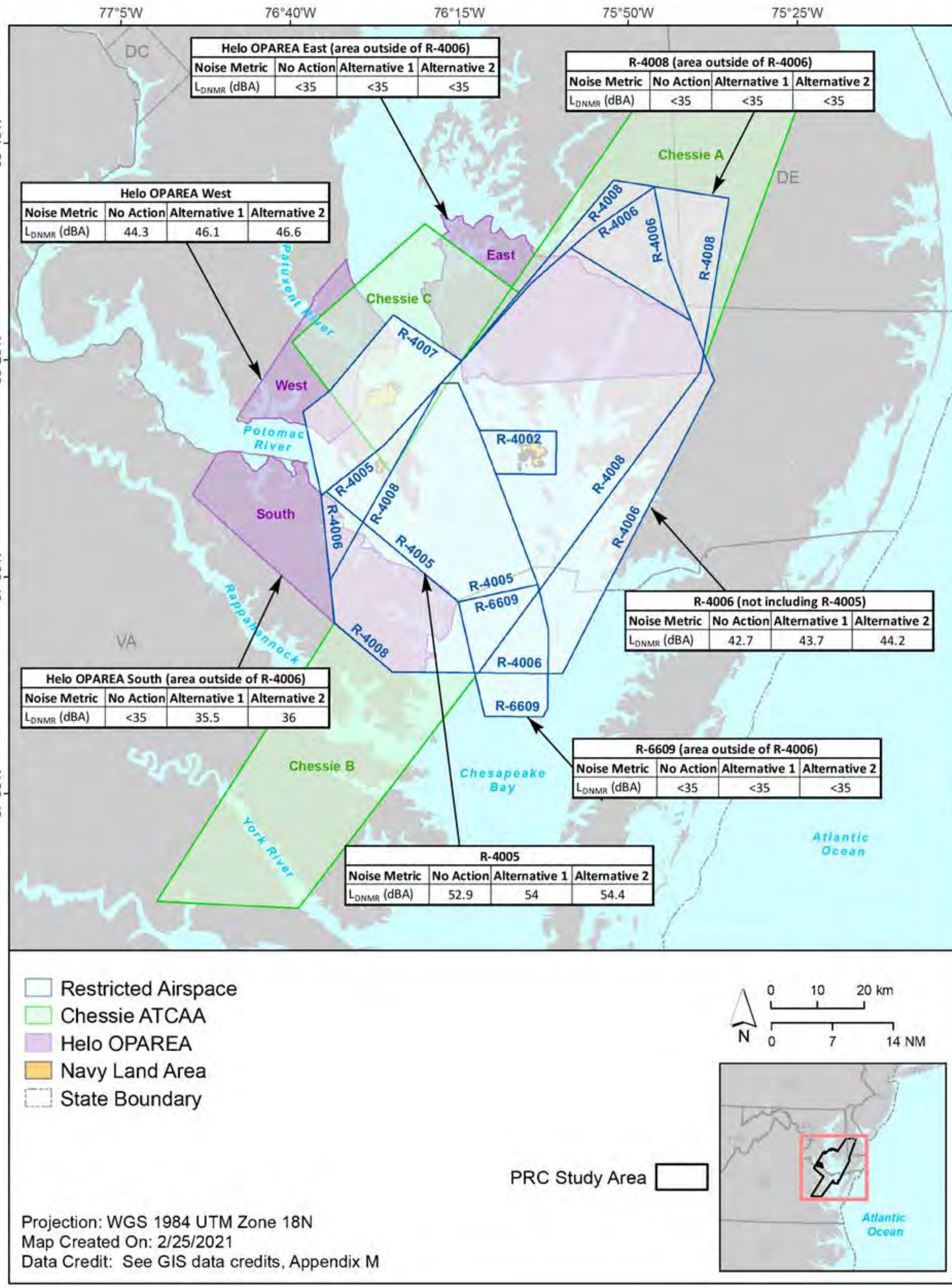


Figure 3.1-8 Noise Levels (dBA L_{dnmr}) Beneath PRC Airspace Areas

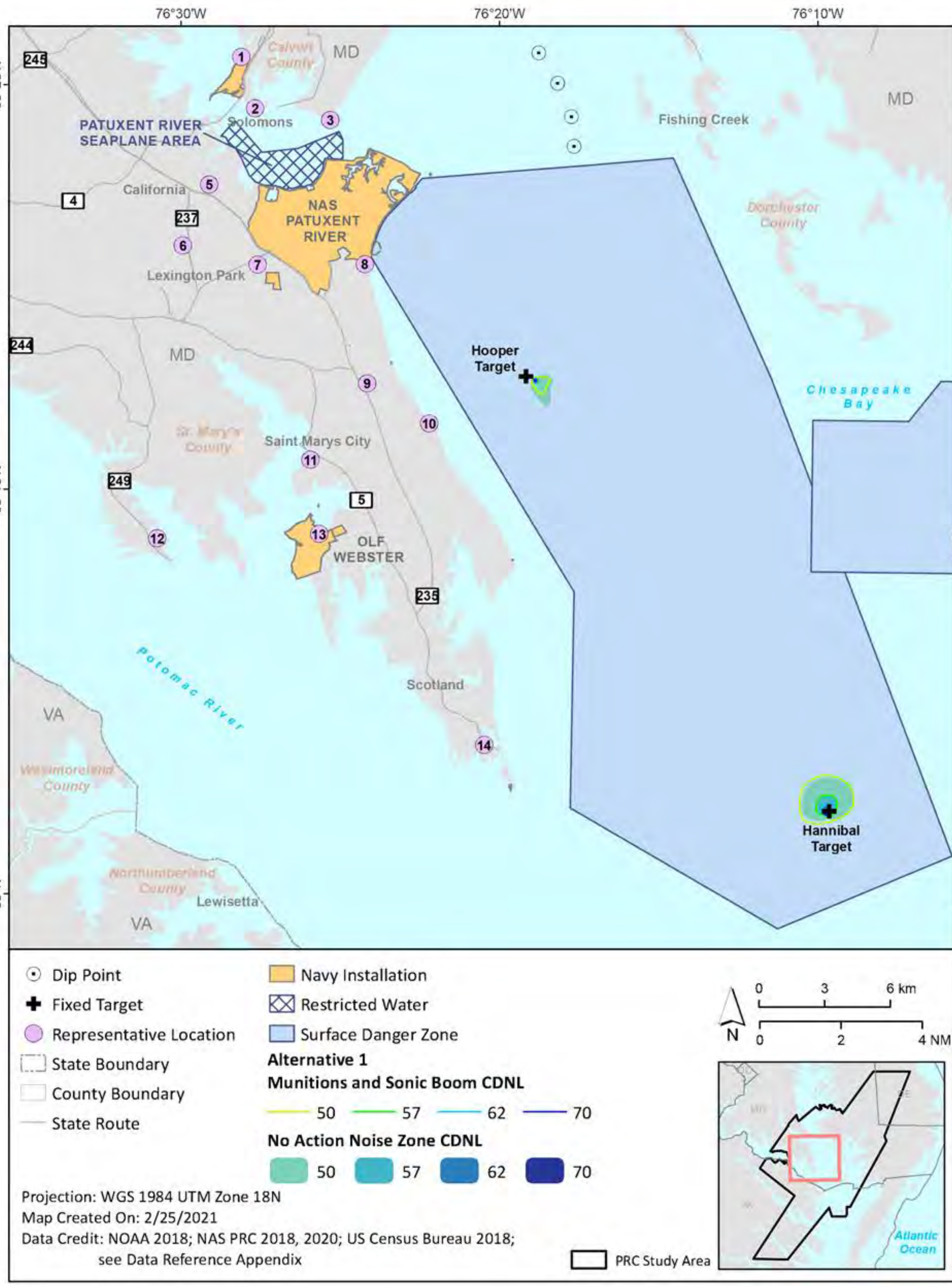


Figure 3.1-9 Alternative 1 Sonic Boom and Munitions Noise Level (CDNL)

Munitions Noise. Increased non-explosive munitions firing from aircraft under Alternative 1 would result in increases in time-averaged noise levels (CDNL), but firing is conducted far from shore, and all land areas would continue to be affected by noise levels below threshold noise levels (Figure 3.1-9). No new noise-generating munitions types or attack profiles would be conducted under Alternative 1. As stated in Section 3.0.2.3.1.4 (Non-explosive Munitions and Other Military Expended Materials), the firing of directed energy weapons is typically silent. Because firing would be conducted at the same locations and with the same munitions, peak sound levels would be the same as shown in Figure 3.1-5. Noise exceeding 115 dBP would continue to not affect any land areas. As described in Army Regulation 200-1, Environmental Protection and Enhancement, peak noise levels below 115 dBP have the potential to be disruptive but are typically associated with a low risk of complaints. Peak noise levels experienced by civilian boaters would continue to potentially exceed 115 dBP (associated with a moderate risk of complaints) or even potentially 130 dBP (associated with a high risk of complaints). The area near firing events is required to be confirmed clear of nonparticipants prior to firing. In compliance with safety precautions, aircraft would not fire non-explosive munitions from directly above boaters, but even if that were to occur, noise levels would not exceed 140 dBP, the regulatory threshold to protect against noise-induced permanent threshold shift (i.e., hearing loss) (see Table 3.0-12 Airborne Noise from Representative Live-Fire and Launched Munitions). Therefore, potential impacts would continue to be limited to temporary disturbances for the typically small number of people that happen to be on the open water and relatively close to the firing event at the time the firing event occurs. The increased numbers of munitions fired, described in Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems), may increase annoyance but would not be expected to result in other impacts.

3.1.7.3 Ambient Airborne Noise, Alternative 2 (Preferred Alternative) Potential Impacts

Alternative 2 includes the same types of operations as the No Action Alternative and Alternative 1 but increases the tempo of operations, which would affect the intensity of noise impacts. Similar to Alternative 1, Alternative 2 includes the operations of directed energy weapons technology. As was the case for the No Action Alternative and Alternative 1, the region of influence for Alternative 2 is the entire PRC Study Area. Alternative 2 noise levels were assessed for several categories of impacts, which are discussed below.

Installation Noise Environment

Noise impacts in the installation vicinity under Alternative 2 are discussed in this section. Impacts would result from changes to aircraft operations and activities involving non-aircraft noise sources described in Section 2.1 (Proposed Action) and Appendix C (Noise Study).

Annoyance. The loudest aircraft types that currently operate in the PRC Study Area would continue operations under Alternative 2. Noise levels associated with the flying operations of these aircraft types would be as described in Table 3.1-2. Static engine runs, including runs conducted at the OAETC, would also continue generating noise levels as described in Section 3.1.6.3 (Installation Noise Environment). Changes in operations tempo under Alternative 2 are described in Section 2.1 (Proposed Action) and in Appendix C (Noise Study). Alternative 2 noise contours at NAS Patuxent River and OLF Webster are shown in Figure 3.1-10 and Figure 3.1-11, respectively. As discussed in Section 3.1.3 (Noise Effects) and Appendix B (Noise Primer), people exposed to higher DNL are more likely to become highly annoyed by the noise, and at noise levels greater than 65 dBA DNL, DoD considers noise to be sufficiently intrusive that some noise-sensitive land uses are considered to be incompatible with the noise.

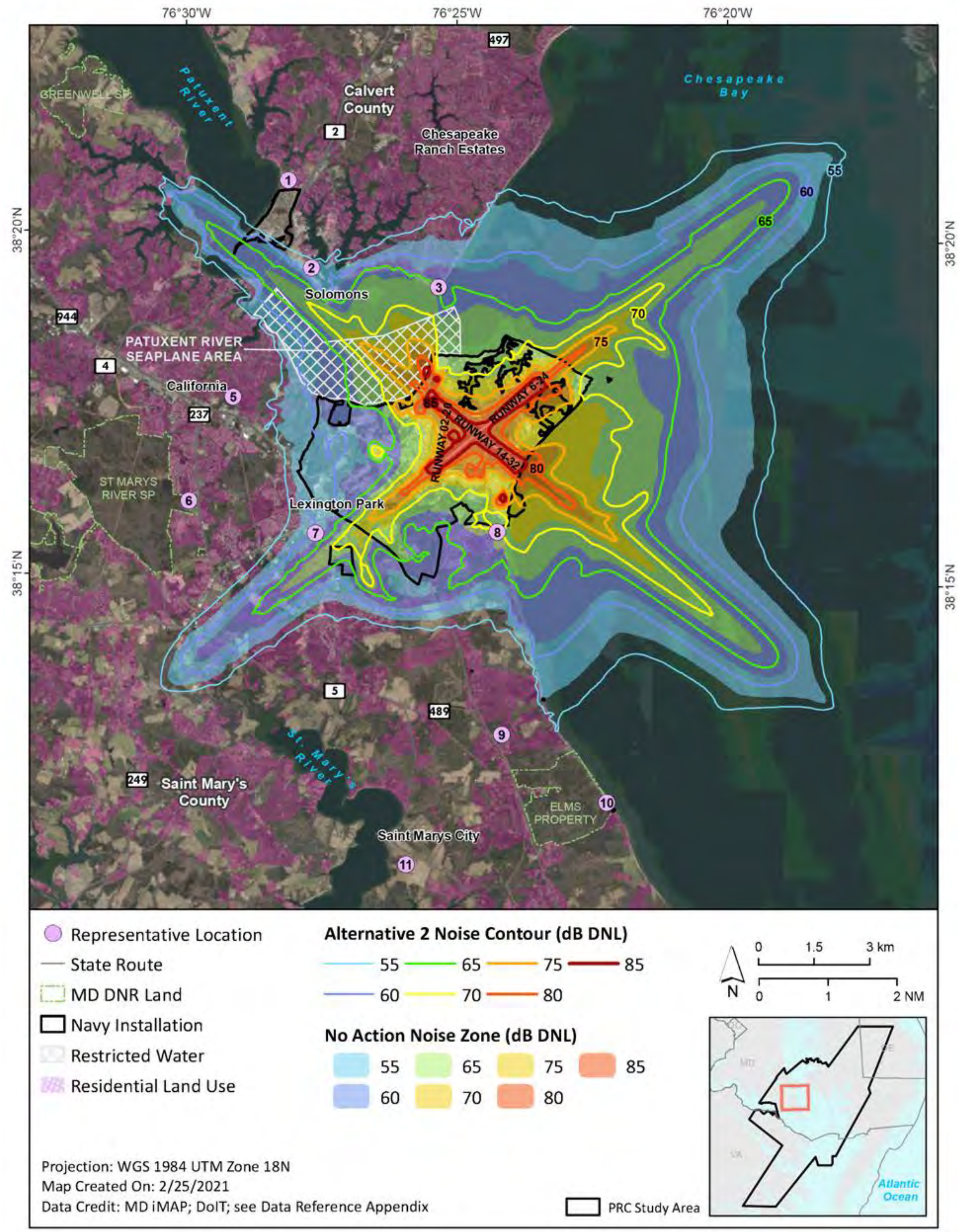


Figure 3.1-10 Alternative 2 DNL Contours for NAS Patuxent River

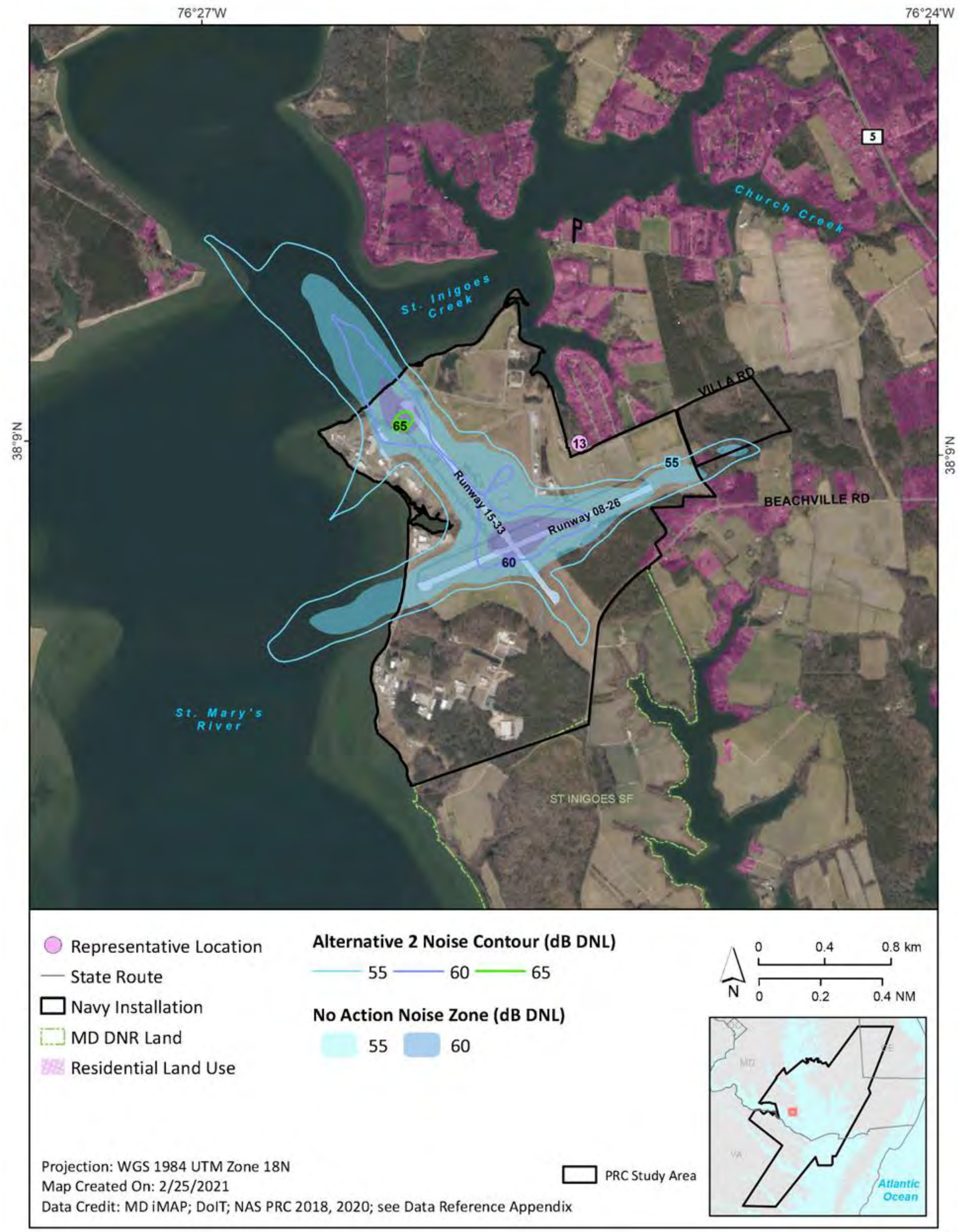


Figure 3.1-11 Alternative 2 DNL Contours for OLF Webster

Quantitative analysis in this EIS focuses on areas exposed to levels greater than 65 dBA DNL. However, people outside the 65 dBA DNL contour do experience aircraft noise, and Figure 3.1-10 and Figure 3.1-11 show DNL contours in 5-dB increments ranging from 55 to 85 dBA DNL in order to more fully reflect the noise environment. The acreage of off-installation land near NAS Patuxent River exposed to 65 dBA DNL and greater would increase from 594 to 1,370 acres, and the number of residents affected by noise levels louder than 65 dBA DNL would increase from 1,290 to 3,072. At OLF Webster, off-installation aircraft noise levels would remain below 65 dBA DNL (Table 3.1-18).

Table 3.1-18 Off-Installation Acres and Population Exposed to Elevated Noise Levels Under Alternative 2

Scenario	*Location*	*65–69 dBA DNL*		*70–74 dBA DNL*		*75 dBA and Greater DNL*		*Total*	
		Land Area (acres)	*Population*	*Land Area (acres)*	*Population*	*Land Area (acres)*	*Population*	*Land Area (acres)*	*Population*
No Action	NAS Patuxent River	541	1,290	45	0	8	0	594	1,290
	OLF Webster	0	0	0	0	0	0	0	0
	Total	541	1,290	45	0	8	0	594	1,290
Alternative 2	NAS Patuxent River	1,195	3,001	166	71	9	0	1,370	3,072
	OLF Webster	0	0	0	0	0	0	0	0
	Total	1,195	3,001	166	71	9	0	1,370	3,072
Change	NAS Patuxent River	+654	+1711	+121	+71	+1	+0	776	1,782
	OLF Webster	+0	+0	+0	+0	+0	+0	0	0
	Total	+654	+1,711	+121	+71	+1	+0	776	1,782

Key: dBA = A-weighted decibels; DNL = day-night average sound level; NAS = Naval Air Station; OLF = Outlying Field.

Notes:

1. Acreage presented does not include areas over water or lands owned by the Navy.
2. The affected population was estimated based on U.S. Census data at the block group level with adjustments to remove nonresidential areas from calculations (U.S. Census Bureau, 2017a).

As discussed in Section 2.1 (Proposed Action) and further details in Appendix C (Noise Study), the Proposed Action reflects a continuation of the types of flying activities conducted in PRC Study Area in the past but with changes in operations tempo and replacement of certain aircraft types. As listed in Table 3.1-19, the maximum SEL experienced at several representative locations near NAS Patuxent River and OLF Webster (see Figure 3.1-2 for map of locations) would not change under Alternative 2. The changes in operations tempo would result in increases in DNL of up to 2 dB at representative locations. Noise levels would remain below 65 dBA DNL (i.e., the noise level below which all land uses are considered to be compatible) at all locations except Drum Point Club and Cedar Cove Apartments, where they would increase to 65 and 68 dBA DNL, respectively. The representative locations do not include all locations that could be considered noise sensitive. However, noise levels at the representative noise-sensitive locations do provide an indication of noise levels in surrounding areas, which may also include noise-sensitive land uses.

Table 3.1-19 DNL and Maximum SEL at Representative Locations Under Alternative 2

ID	Location Description	DNL (dBA)			Highest SEL (dBA) [1]		
		No Action Alternative	Alternative 2	Change	No Action Alternative	Alternative 2	Change
1	Asbury Solomons	47	48	+1	103	103	-
2	Our Lady Star of the Sea School	58	60	+2	110	110	-
3	Drum Point Club	64	65	+1	113	113	-
4	Captain Walter Francis Duke Elementary School	48	49	+1	95	95	-
5	Green Holly Elementary School	48	50	+2	93	93	-
6	Chancellors Run Activity Center	45	46	+1	90	90	-
7	Lexington Park Elementary School	59	61	+2	107	107	-
8	Cedar Cove Apartments	66	68	+2	113	113	-
9	Spring Ridge Middle School	46	46	-	96	96	-
10	Elms Beach Park	52	53	+1	102	102	-
11	Historic St. Mary's City	40	42	+2	94	94	-
12	Harry Lundeberg School of Seamanship	42	42	-	86	86	-
13	St. Ignatius Roman Catholic Church	47	49	+2	95	95	-
14	Point Lookout State Park	23	24	+1	73	73	-
15	Northumberland Elementary School	24	26	+2	73	73	-

Key: dBA = A-weighted decibels; DNL = day-night average sound level; ID = identification; SEL = sound exposure level.
Note:
1. "Highest SEL" reflects modeled representative flight procedures. Actual flight procedures vary from representative procedures, and may generate louder SELs.

Increased DNL under Alternative 2 reflects increases in the number of loud aircraft noise events. The number of events per year exceeding 80, 90, and 100 dBA L_{max} at representative locations are listed in Table 3.1-20. Some areas would experience larger numbers of loud events exceeding a certain threshold noise level (e.g., 80 dBA) while simultaneously experiencing decreases in the frequency of noise events exceeding another threshold (e.g., 100 dBA). This is possible because the changes in operations tempo expected under Alternative 2 are not consistent across all squadrons, and different squadrons use different flight paths.

Noise-induced structural vibration and secondary vibrations (i.e., "rattle") of objects within structures would continue to occur during loud overflights and static aircraft engine runs under Alternative 2. Predicting whether an object will rattle when subjected to noise depends on several characteristics of the object and setting (e.g., mass of the object, firmness of fit of window panes) as well as characteristics of the noise (e.g., predominant frequencies). There is not a lower threshold noise level below which rattle is never possible. As discussed in Appendix B (Noise Primer), rattling generally occurs with sounds that continue for several seconds at levels greater than 110 dB (unweighted). Noise events exceeding 100 dBA L_{max} would have a greater likelihood of inducing rattle of lightweight or loosely fitted objects than noise levels below 100 dBA L_{max}. Rattling of objects is more likely to occur during events with higher sound levels, which are quantified in Table 3.1-20. Rattling of objects often makes people worry about breakage and increases the likelihood of annoyance.

Table 3.1-20 Number of Events Exceeding Decibel Thresholds Under Alternative 2

ID	Location Description	NA 80 L_{max} (dBA)			NA 90 L_{max} (dBA)			NA 100 L_{max} (dBA)		
		No Action Alternative	Alternative 2	Change	No Action Alternative	Alternative 2	Change	No Action Alternative	Alternative 2	Change
1	Asbury Solomons	155	287	132	33	30	-3	-	-	-
2	Our Lady Star of the Sea School	1,689	2,379	690	268	369	101	17	22	5
3	Drum Point Club	6,453	8,614	2,161	1,270	1,757	487	276	368	92
4	Captain Walter Francis Duke Elementary School	923	1,262	339	-	-	-	-	-	-
5	Green Holly Elementary School	310	278	-32	-	-	-	-	-	-
6	Chancellors Run Activity Center	24	48	24	-	-	-	-	-	-
7	Lexington Park Elementary School	2,814	3,981	1,167	652	894	242	20	44	24
8	Cedar Cove Apartments	8,088	10,458	2,370	3,612	5,074	1,462	544	1,023	479
9	Spring Ridge Middle School	120	114	-6	-	-	-	-	-	-
10	Elms Beach Park	1,064	1,605	541	162	292	130	-	-	-
11	Historic St. Mary's City	26	49	23	-	-	-	-	-	-
12	Harry Lundeberg School of Seamanship	-	-	0	-	-	-	-	-	-
13	St. Ignatius Roman Catholic Church	144	268	124	-	-	-	-	-	-
14	Point Lookout State Park	-	-	0	-	-	-	-	-	-
15	Northumberland Elementary School	-	-	0	-	-	-	-	-	-

Key: dBA = A-weighted decibels; ID = identification; L_{max} = maximum A-weighted sound level; NA = number of events above.

Note:

1. Dash indicates that exceedance of the L_{max} threshold is rare at this location but does not mean the threshold would never be exceeded. The number of events exceeding various decibel levels is provided as a description of noise conditions and not as a predictor of any particular types of impacts. Figure 3.1-1 lists sound levels (in decibels) generated by several common non-aircraft sound sources, which can be used as points of reference.

Launches of aerial targets from the ATA would increase in frequency from three or less per year to six or less per year under Alternative 2. Each launch would continue to generate maximum noise levels at the closest residence that comparable to L_{max} of a direct jet aircraft overflight (see Table 3.1-2). Because aerial target launches would occur much less frequently than aircraft operations, they would not add measurably to DNL generated by aircraft operations.

Firing of small- and medium-caliber guns at the ATA would continue to generate noise levels at the closest residence to the source that are associated with a moderate risk of complaints (i.e., between 115 and 130 dBP). The number of small-caliber rounds fired annually at the ATA would increase from 19,977 to 23,074, and the number of medium-caliber rounds fired annually would increase from 2,430 to 2,807 under Alternative 2. Time-averaged noise levels off the installation would remain below thresholds at which not all land uses are considered compatible (i.e., 62 dB CDNL).

Rocket test launches would continue to generate noise levels similar to aerial target launch noise, which would not add measurably to overall DNL in the context of frequent aircraft operations noise. The number of rockets launched would increase from 18 to 21 per year. Rockets would continue to generate maximum noise levels at the closest residence that are similar to aerial target launch noise levels and comparable to L_{max} of a jet aircraft overflight (see Table 3.1-2). These events would not add to DNL in the context of frequent aircraft operations noise. Other MEM employment in the installation vicinity (e.g., Cartridge Actuated Devices) does not generate noise that is intrusive in the context of an active airfield acoustic environment. As stated in Section 3.0.2.3.1.4 (Non-explosive Munitions and Other Military Expended Materials), the firing of directed energy weapons is typically silent.

Speech Interference. Under Alternative 2, the number of indoor noise events per average daytime hour (7:00 a.m. to 10:00 p.m.) with the potential to interfere with speech at representative locations would increase by one at Cedar Cove Apartments and Elms Beach Park with windows open (Table 3.1-21). The number of outdoor potential speech interference events per average daytime hour would increase by one at Asbury Solomons, Our Lady Star of the Sea School, Captain Walter Francis Duke Elementary School, Green Holly Elementary School, Lexington Park Elementary School, and Elms Beach Park (Table 3.1-21). Non-aircraft noise sources that are loud enough to potentially interfere with speech off the installation (e.g., aerial target launches from ATA) would continue to be infrequent (see *Annoyance* subsection above) and, therefore, have minimal effect on the overall likelihood of speech interference in the context of frequent aircraft overflights.

Table 3.1-21 Speech Interference Events Per Average Daytime Hour Under Alternative 2

ID	Location Description	Alternative 2			Increase Relative to No Action Alternative		
		Windows Open[1, 2]	Windows Closed[1, 2]	Outdoor	Windows Open[2]	Windows Closed[2]	Outdoor
1	Asbury Solomons	1	-	3	-	-	+1
2	Our Lady Star of the Sea School	2	1	5	-	-	+1
3	Drum Point Club	3	2	6	-	-	-
4	Captain Walter Francis Duke Elementary School	-	-	1	-	-	+1
5	Green Holly Elementary School	1	-	4	-	-	+1

Table 3.1-21 Speech Interference Events Per Average Daytime Hour Under Alternative 2, Continued

ID	Location Description	Alternative 2			Increase Relative to No Action Alternative		
		Windows Open[1, 2]	Windows Closed[1, 2]	Outdoor	Windows Open[2]	Windows Closed[2]	Outdoor
6	Chancellors Run Activity Center	1	-	3	-	-	-
7	Lexington Park Elementary School	2	1	5	-	-	+1
8	Cedar Cove Apartments	4	2	6	+1	-	-
9	Spring Ridge Middle School	1	-	3	-	-	-
10	Elms Beach Park	2	-	4	+1	-	+1
11	Historic St. Mary's City	-	-	2	-	-	-
12	Harry Lundeberg School of Seamanship	1	-	1	-	-	-
13	St. Ignatius Roman Catholic Church	1	-	2	-	-	-
14	Point Lookout State Park	-	-	0	-	-	-
15	Northumberland Elementary School	-	-	0	-	-	-

Key: dB = decibels; dBA = A-weighted decibels; ID = identification; L_{max} = maximum A-weighted sound level.

Notes:

1. Number of events per hour exceeding 50 dBA L_{max}; standard structural noise attenuation levels are assumed: 25 dB with windows closed, 15 dB with windows open
2. Dash (-) indicates that the number of Patuxent River Complex aircraft noise events per hour exceeding 50 dBA L_{max} (or increase in the number of events) rounds to zero.

Interference with Classroom Learning. Exterior $L_{eq(8hr)}$ at representative schools would remain below 60 dBA $L_{eq(8hr)}$ at all schools studied except Our Lady Star of the Sea School and Lexington Park Elementary School (Table 3.1-22). The number of potential speech interference events per hour would change by less than one under Alternative 2 at all of the locations studied. Non-aircraft noise sources (e.g., aerial target launches from ATA) do not typically generate noise levels with potential to interfere with classroom learning.

Sleep Disturbance. Although the flying operations tempo at NAS Patuxent River would increase under Alternative 2, the percent of flying events conducted during late-night hours (10:00 p.m. and 7:00 a.m.) would remain at 1 percent. At OLF Webster, the percentage would increase from 0.1 to 0.2. The probability of sleep being disturbed at least once per night with windows open would increase by 1 percent at Drum Point Club, Chancellors Run Activity Center, and Spring Ridge Middle School. The probability would increase by 1 percent if windows are closed at Lexington Park Elementary School and Cedar Cove Apartments. At all other locations, the probability would increase by less than 1 percent with windows open or closed (Table 3.1-23). Late-night flying operations are relatively rare at NAS Patuxent River and OLF Webster, and the probability of being awakened at least once per night is 2 percent or less at all of the locations studied. NAS Patuxent River would continue to publish notifications of upcoming late-night flying missions. Non-aircraft noise sources that are loud enough to potentially disturb sleep (e.g., aerial target launches from ATA) are infrequent and, therefore, have minimal effect on the overall likelihood of sleep disturbance in the context of frequent aircraft overflights.

Table 3.1-22 Potential Classroom Interference Under Alternative 2

ID	Description	*Alternative 2*			*Increase Relative to No Action Alternative*		
		Outdoor $L_{eq(8hr)}$ (dBA)[1]	*Events per Hour, Windows Open[2, 3]*	*Events per Hour, Windows Closed[2, 3]*	*Outdoor $L_{eq(8hr)}$ (dBA)[1]*	*Events per Hour, Windows Open[2, 3]*	*Events per Hour, Windows Closed[2, 3]*
2	Our Lady Star of the Sea School	61	2	1	+2	-	-
4	Captain Walter Francis Duke Elementary School	46	-	-	+1	-	-
5	Green Holly Elementary School	50	1	-	+1	-	-
6	Chancellors Run Activity Center	47	1	-	+1	-	-
7	Lexington Park Elementary School	62	2	1	+2	-	-
9	Spring Ridge Middle School	48	1	-	+1	-	-
12	Harry Lundeberg School of Seamanship	<45	1	-	+1	-	-
15	Northumberland Elementary School	<45	-	-	+1	-	-

Key: < = less than; dB = decibels; dBA = A-weighted decibels; $L_{eq(8hr)}$ = eight-hour equivalent sound; L_{max} = maximum A-weighted sound level.

Notes:

1. $L_{eq(8hr)}$ calculated for 8-hour typical school day from 8:00 a.m. to 4:00 p.m.
2. Number of events per hour exceeding 50 dBA L_{max}; standard structural noise attenuation levels are assumed: 25 dB with windows closed, 15 dB with windows open.
3. Dash (-) indicates that the number of Patuxent River Complex aircraft noise events per hour exceeding 50 dBA L_{max} (or increase in the number of events) rounds to zero.

Table 3.1-23 Probability of Awakening Under Alternative 2

ID	Location Description	*Alternative 2*		*Increase Relative to No Action Alternative*	
		Windows Open[1, 2, 3]	*Windows Closed[1, 2, 3]*	*Windows Open*	*Windows Closed*
1	Asbury Solomons	-	-	-	-
2	Our Lady Star of the Sea School	1%	-	-	-
3	Drum Point Club	2%	1%	+1%	-
4	Captain Walter Francis Duke Elementary School	-	-	-	-
5	Green Holly Elementary School	1%	-	-	-
6	Chancellors Run Activity Center	1%	-	+1%	-
7	Lexington Park Elementary School	1%	1%	-	+1%
8	Cedar Cove Apartments	1%	1%	-	+1%
9	Spring Ridge Middle School	1%	-	+1%	-
10	Elms Beach Park	1%	-	-	-
11	Historic St. Mary's City	-	-	-	-
12	Harry Lundeberg School of Seamanship	-	-	-	-
13	St. Ignatius Roman Catholic Church	-	-	-	-
14	Point Lookout State Park	-	-	-	-
15	Northumberland Elementary School	-	-	-	-

Key: dB = decibels; ID = identification.

Notes:

1. Probability of being awakened at least once per night
2. Standard structural noise attenuation levels are assumed: 25 dB with windows closed, 15 dB with windows open.
3. Dashes (-) indicate that probability of awakening rounds to zero.

Potential for Hearing Loss. Impacts would be the same as those discussed under Alternative 1.

Nonauditory Health Impacts. Impacts would be the same as those discussed under Alternative 1.

Range Noise Environment

Noise impacts generated by changes to subsonic/supersonic aircraft flying operations and munitions firing under Alternative 2 are described below. Changes in the operational tempo under Alternative 2 that drive the changes in noise levels are described in Section 2.1 (Proposed Action) and Appendix C (Noise Study).

Subsonic Aircraft Noise. The types of aircraft operating in the PRC Study Area under Alternative 2 would be the same as under Alternative 1, and noise levels experienced during individual overflights would be the same as listed in Table 3.1-8 and Table 3.1-16. The frequency of operations would increase under Alternative 2 relative to the No Action Alternative and Alternative 1. As a result, time-averaged noise levels (dBA L_{dnmr}) would increase by 2.3 dBA beneath the West Helicopter Operating Area (Helo OPAREA), by 1.5 dBA beneath restricted areas R-4005 and R-4006, and by 1 dBA beneath the South Helo OPAREA (Table 3.1-24 and Figure 3.1-8). Noise levels beneath PRC airspace under Alternative 2 would remain well below land use compatibility thresholds and would be comparable to ambient noise levels in some areas. Average ambient noise levels in the quietest portions of the PRC Study Area (e.g., areas far from human activities) are approximately 35 dBA, while average ambient noise levels in typical rural areas are approximately 45 dB, and average ambient levels in urbanized areas are often 55 dBA or higher (National Park Service, 2016a). In locations where aircraft noise is below 35 dBA L_{dnmr}, aircraft noise does not add substantively to overall noise levels (listed as "<35 dB" in Table 3.1-24). Loud aircraft overflights would become slightly more frequent under Alternative 2, which could result in increased annoyance in areas beneath the airspace areas.

Table 3.1-24 Noise Levels Beneath PRC Airspace Areas Under Alternative 2

Airspace Description	*Noise Level (dBA L_{dnmr})*		
	No Action Alternative (Baseline)	*Alternative 2*	*Change*
East Helicopter Operating Area (area outside of R-4006)	<35	<35	0
South Helicopter Operating Area (area outside of R-4006)	<35	36	1.0
West Helicopter Operating Area	44.3	46.6	2.3
R-4005	52.9	54.4	1.5
R-4006 (not including R-4005)	42.7	44.2	1.5
R-4008 (areas outside of R-4006)	<35	<35	0
R-6609 (area outside of R-4006)	<35	<35	0

Key: < = less than; dBA = A-weighted decibels; L_{dnmr} = onset-rate adjusted, monthly day-night average sound level; PRC = Patuxent River Complex; R- = restricted area.

Supersonic Aircraft Noise (Sonic Boom). Supersonic events would decrease from 247 to 198 per year under Alternative 2, but would be higher than under Alternative 1 (180 per year). The slight decrease in the number of supersonic events within the PRC relative to the No Action Alternative reflects a trend toward supersonic operations being conducted in offshore Warning Areas. The Warning Areas are larger than PRC airspace and can better accommodate certain fifth-generation fighter aircraft (e.g., F-35) testing requirements. Individual supersonic sortie flight profiles would remain the same. Supersonic flight paths would continue to be conducted almost entirely higher than 30,000 feet MSL, and many sonic booms do not reach the ground (see Appendix B, Noise Primer). The intensity of individual booms that do reach the ground would be the same under Alternative 2 as under Alternative 1 and the No Action Alternative. Sonic booms generated by flying activities conducted in accordance with flying regulations and under normal circumstances would continue to not cause damage to property. Non-explosive munition and other MEM noise are both described using the metric CDNL, and combined sonic boom and munitions noise levels under Alternative 2 are shown in Figure 3.1-12.

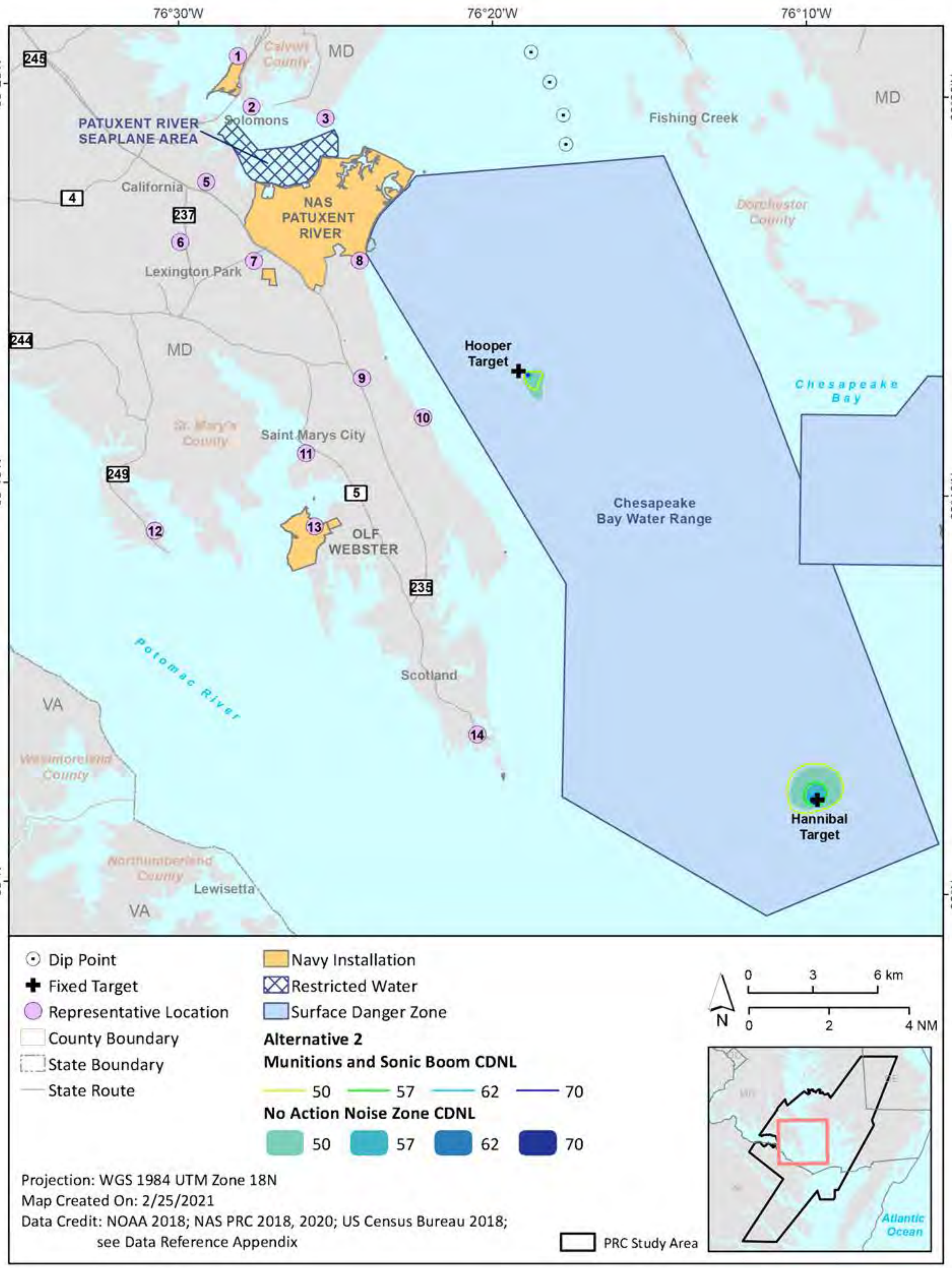


Figure 3.1-12 Alternative 2 Sonic Boom and Munitions Noise Level (CDNL)

Noise levels exceeding land use compatibility thresholds occur only in open water areas far from shore. When they do occur, sonic booms have the potential to startle people and are a common cause of complaints. Decreases in the number of sonic booms would be expected to decrease the prevalence of annoyance, but sonic booms would remain relatively rare, as reflected by low time-averaged noise levels (CDNL).

Munitions Noise. Increased non-explosive munitions firing from aircraft under Alternative 2 would result in increases in time-averaged noise levels (CDNL), but firing would be conducted far from shore, and land areas would continue to be affected by noise levels well below 62 dB CDNL (Figure 3.1-9). No new noise-generating munitions types or attack profiles would be conducted under Alternative 2. As stated in Section 3.0.2.3.1.4 (Non-explosive Munitions and Other Military Expended Materials), the firing of directed energy weapons is typically silent. Because firing would be conducted at the same locations and with the same munitions, peak sound levels would be the same as shown in Figure 3.1-5.

As stated in Army Regulation 200-1, Environmental Protection and Enhancement, noise exceeding 115 dBP would continue to not affect any land areas. Peak noise levels below 115 dBP have the potential to be disruptive but are typically associated with a low risk of complaints. Peak noise levels experienced by civilian boaters would continue to potentially exceed 115 dBP (associated with a moderate risk of complaints) or even potentially 130 dBP (associated with a high risk of complaints). The area near firing events is required to be confirmed clear of nonparticipants prior to firing. In compliance with safety precautions, aircraft would not fire non-explosive munitions from directly above boaters, but even if that were to occur, noise levels would not exceed 140 dBP, the regulatory threshold to protect against noise-induced permanent threshold shift (i.e., hearing loss) (Table 3.0-12, Airborne Noise from Representative Live-Fire and Launched Munitions). Therefore, potential impacts would continue to be limited to temporary disturbances for the typically small number of people that happen to be on the open water and relatively close to the firing event at the time the firing event occurs. The increased numbers of munitions fired, which is described in Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems), may increase annoyance but would not be expected to result in other impacts.

3.1.7.4 Alternatives Impact Summary

Summary of Impacts, Ambient Airborne Noise

Acoustic:

Noise levels associated with each alternative reflect existing noise mitigation measures identified in the 1998 PRC EIS and operating procedures designed with noise impact minimization in mind (Table 2.5-1, Standard Operating Procedures, and Table 3.10-1, Impact Avoidance and Minimization Measures).

<u>No Action Alternative</u>

- There would be no change from baseline conditions.
- The intensity and frequency of loud noise events would remain the same.
- Time-averaged noise level exceeding 65 dBA DNL would continue to affect 594 acres of land, encompassing an estimated 1,290 residents. DNL at the representative locations studied (i.e., selected sensitive locations) would continue to be as high as 66 dBA.

- The average number of speech interference events would remain at six per daytime hour or less outdoors, at three per hour or less indoors with windows open, and at two per hour or less with windows closed at the representative locations studied. $L_{eq(8hr)}$ would remain at 60 dBA at Lexington Park Elementary School and below 60 dBA at other schools studied. Classroom speech interference events per average hour would remain at two or fewer.
- The probability of sleep disturbance would remain at 1 percent or less at the locations studied. Hearing loss risk would remain low off the installation. Airspace overflight noise levels would continue to be as high as 110 dBA L_{max}. Time-averaged noise levels would continue to be below 55 dBA L_{dnmr}.
- Munitions and sonic boom time-averaged noise levels would continue to be below 50 dB CDNL on all land areas. Sonic boom intensity would remain the same, and munitions noise would remain below 115 dBP on land.

Alternative 1

- Intensity of loudest aircraft noise levels experienced would remain the same.
- Increased frequency of noise events would increase acreage of off-installation land near NAS Patuxent River exposed to 65 dBA DNL or greater, from 594 to 1,158. The number of residents exposed to levels greater than 65 dBA DNL would increase from 1,290 to 2,640. Noise levels on land near OLF Webster would remain uniformly less than 65 dBA DNL.
- DNL at representative locations would increase by up to 2 dBA.
- Average number of speech interference events per daytime hour would change by less than one indoors, and the average number of outdoor events would increase by one at 4 of the 15 locations studied.
- $L_{eq(8hr)}$ at two schools would increase by 2 dB to 61 and 62 dBA, respectively, while the $L_{eq(8hr)}$ at other schools studied would remain below 60 dBA. Classroom speech interference events per average hour would increase by less than one.
- Probability of sleep disturbance would increase by 1 percent at Cedar Cove Apartments and by less than 1 percent at other locations.
- Hearing loss risk would remain low off the installation; causal and consistent relationship between noise levels and risk of nonauditory health impacts is not supported by current knowledge.
- Airspace overflight noise levels would remain the same; the time-averaged noise level would increase by approximately 2 dB, remaining below 55 dBA L_{dnmr}.
- Munitions and sonic boom noise levels would remain below 50 dB CDNL on all land areas; sonic boom intensity would remain the same, and munitions noise would remain below 115 dBP on land.

Alternative 2 (Preferred Alternative)

- The loudest aircraft noise levels would not change, but the frequency of noise events would increase.

- Acreage of off-installation land near NAS Patuxent River exposed to 65 dBA DNL or greater would increase from 594 to 1,370 acres, and the number of residents exposed to levels above 65 dBA DNL would increase from 1,290 to 3,072.
- Average number of indoor speech interference events per daytime hour would increase by one at Cedar Cove Apartments and Elms Beach Park but change by less than one at other locations. The average number of outdoor events per hour would increase by one at 6 of the 15 representative locations studied.
- $L_{eq(8hr)}$ at two schools would increase by 2 dB to 61 and 62 dBA, respectively, while $L_{eq(8hr)}$ at other schools studied would remain below 60 dBA. Classroom speech interference events per average hour would increase by less than one.
- Probability of sleep disturbance would increase by 1 percent at three locations if windows are open, at two locations if windows are closed, and by less than 1 percent at other locations
- Airspace overflight noise levels would remain the same; the time-averaged noise level would increase by less than 3 dB, remaining below 55 dBA L_{dnmr}.
- All other impacts would be the same as under Alternative 1.

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3.2 Air Quality

This discussion of air quality includes criteria pollutants, standards, sources, permitting, and greenhouse gases (GHGs). Air quality in a given location is defined by the concentration of various pollutants in the atmosphere. A region's air quality is influenced by many factors, including the types and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions.

Most air pollutants originate from human-made sources, including mobile sources (e.g., cars, trucks, buses) and stationary sources (e.g., factories, refineries, power plants), as well as indoor sources (e.g., some building materials and cleaning solvents). Air pollutants are also released from natural sources such as forest fires.

3.2.1 Air Quality, Regulatory Setting

3.2.1.1 Criteria Pollutants and National Ambient Air Quality Standards

The principal pollutants defining the air quality, called "criteria pollutants," include carbon monoxide, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone, suspended particulate matter less than or equal to 10 microns in diameter, fine particulate matter less than or equal to 2.5 microns in diameter, and lead. Carbon monoxide, SO_2, lead, and some particulates are emitted directly into the atmosphere from emissions sources. Ozone, NO_2, and some particulates are formed through atmospheric chemical reactions that are influenced by weather, ultraviolet light, and other atmospheric processes.

Under the Clean Air Act, the U.S. Environmental Protection Agency (USEPA) has established National Ambient Air Quality Standards (NAAQS) (Title 40 Code of Federal Regulations [CFR] part 50) for these pollutants. NAAQS are classified as primary or secondary. Primary standards protect against adverse health effects; secondary standards protect against welfare effects, such as damage to farm crops and vegetation and damage to buildings. Some pollutants have long-term and short-term standards. Short-term standards are designed to protect against acute, or short-term, health effects, while long-term standards were established to protect against chronic health effects.

Areas that are and have historically been in compliance with the NAAQS are designated as attainment areas. Areas that violate a federal air quality standard are designated as nonattainment areas. Areas that have transitioned from nonattainment to attainment are designated as maintenance areas and are required to adhere to maintenance plans to ensure continued attainment.

The Clean Air Act requires states to develop a general plan to attain and maintain the NAAQS in all areas of the country and a specific plan to attain the standards for each area designated nonattainment for a NAAQS. These plans, known as State Implementation Plans, are developed by state and local air quality management agencies and submitted to USEPA for approval.

3.2.1.2 Mobile Sources

Hazardous air pollutants (HAPs) emitted from mobile sources are called Mobile Source Air Toxics (MSATs). MSATs are compounds emitted from highway vehicles and nonroad equipment that are known or suspected to cause cancer or other serious health and environmental effects. In 2001, USEPA issued its first MSAT Rule, which identified 201 compounds as being HAPs that require regulation. A subset of six of the MSAT compounds was identified as having the greatest influence on health and included benzene, butadiene, formaldehyde, acrolein, acetaldehyde, and diesel particulate matter. More recently, USEPA issued a second MSAT Rule in February 2007, which generally supported the findings in the first rule and provided additional recommendations of compounds having the greatest impact on health. The rule also identified several engine emission certification standards that must be implemented (40 CFR parts 59, 80, 85, and 86; Federal Register Volume 72, No. 37, pp. 8427–8570, 2007). Unlike the criteria pollutants, there are no NAAQS for benzene and other HAPs. The primary control methodologies for these pollutants for mobile sources involves reducing their content in fuel and altering the engine operating characteristics to reduce the volume of pollutant generated during combustion.

The USEPA developed rules that limit emissions of hazardous air pollutants from specific industrial sources. HAPs are analyzed qualitatively in relation to the prevalence of the sources emitting these pollutants during testing and training activities. These HAPs emissions are typically one or more orders of magnitude smaller than concurrent emissions of criteria air pollutants. Mobile sources operating as a result of the Proposed Action would be functioning intermittently over a large area and would produce negligible ambient HAPs primarily not located near any publicly accessible areas. For these reasons, HAPs are not further evaluated in the analysis.

3.2.1.3 General Conformity

The USEPA General Conformity Rule applies to those air emissions that result from federal actions that occur within areas designated as nonattainment or maintenance. The General Conformity Rule covers only those specific pollutant(s) or their precursors for which area(s) are designated as in nonattainment or maintenance status. The emissions thresholds that trigger requirements for a conformity analysis are called *de minimis* levels. *De minimis* levels (in tons per year) vary by pollutant and also depend on the severity of the nonattainment status for the air quality management area in question. *De minimis* threshold emissions are presented in Table 3.2-1.

Table 3.2-1 General Conformity *De Minimis* Levels

Pollutant	***Area Type***	***tpy***
Ozone (VOCs or NO_x)	Serious nonattainment	50
	Severe nonattainment	25
	Extreme nonattainment	10
	Other areas outside an ozone transport region	100
Ozone (NO_x)	Marginal and moderate nonattainment inside an ozone transport region	100
	Maintenance	100
Ozone (VOCs)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
Carbon monoxide, SO_2, and NO_2	All nonattainment and maintenance	100
PM_{10}	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
$PM_{2.5}$; Direct emissions, SO_2, NO_x (unless determined not to be a significant precursor), VOCs, or ammonia (if determined to be significant precursors)	All nonattainment and maintenance	100
Lead	All nonattainment and maintenance	25

Key: NO_2 = nitrogen dioxide; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

A conformity applicability analysis is the first step of a conformity evaluation and assesses if a federal action must be supported by a conformity determination. This is typically done by quantifying applicable emissions that are projected to result due to implementation of the federal action. If the results of the applicability analysis indicate that the total emissions would not exceed the *de minimis* emissions thresholds, then the conformity evaluation process is completed.

The Navy is evaluating a more realistic case by performing general conformity and National Environmental Policy Act (NEPA) air quality analysis on the basis of actual historical flight path data allocation of where aircraft emissions are being emitted, even though USEPA assigns all those emissions to St. Mary's County in the National Emissions Inventory (NEI).

3.2.1.4 Greenhouse Gases

GHGs are gas emissions that trap heat in the atmosphere. These emissions occur from natural processes and human activities. Scientific evidence indicates a trend of increasing global temperature over the past century due to an increase in GHG emissions from human activities. The climate change is predicted to produce negative economic and social consequences across the globe.

The Council on Environmental Quality has published draft guidance on how NEPA analysis and documentation should address GHG emissions. This *Draft National Environmental Policy Act Guidance on Consideration of Greenhouse Gas Emissions*, if finalized, would replace the guidance the Council on Environmental Quality issued on August 1, 2016, titled *Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in National Environmental Policy Act Reviews*, which was withdrawn effective April 5, 2017, for further consideration pursuant to Executive Order 13783 of March 28, 2017, Promoting Energy Independence and Economic Growth. The draft guidance suggests that agencies use the ''rule of reason'' that bounds all NEPA analysis, and impacts of a proposed action should be discussed in proportion to their significance. Agencies preparing NEPA analyses need not give greater consideration to potential effects from GHG emissions than to other potential effects on the human environment. A projection of a proposed action's direct and reasonably foreseeable indirect GHG emissions may be used as a proxy for assessing potential climate effects. Agencies should attempt to quantify a proposed action's projected direct and reasonably foreseeable indirect GHG emissions when the amount of those emissions is substantial enough to warrant quantification, and when it is practicable to quantify them using available data and GHG quantification tools. Therefore, GHGs were quantified for all alternatives and are presented for consideration as compared to baseline NEI GHGs for the affected air basins.

Revised draft guidance, dated December 18, 2014, recommends that agencies consider a proposed action's GHG emissions as a proxy for assessing potential climate effects. The guidance also suggests that agencies should attempt to quantify a proposed action's projected GHG emissions when the amount of those emissions is substantial enough to warrant quantification and when it is practicable to quantify those emissions using available data and GHG quantification tools. The guidance also emphasizes that agency analyses should be commensurate with projected GHG emissions and climate impacts and should employ appropriate quantitative or qualitative analytical methods to ensure useful information is available to inform the public and the decision-making process in distinguishing between alternatives and mitigations.

USEPA issued the Final Mandatory Reporting of Greenhouse Gases Rule on September 22, 2009. GHGs covered under the Final Mandatory Reporting of Greenhouse Gases Rule are carbon dioxide (CO_2), methane, nitrogen oxides, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and other fluorinated gases including nitrogen trifluoride and hydrofluorinated ethers. Each GHG is assigned a global warming potential. The global warming potential is the ability of a gas or aerosol to trap heat in the atmosphere. The global warming potential rating system is standardized to CO_2, which has a value of one. The equivalent CO_2 rate is calculated by multiplying the emissions of each GHG by its global warming potential and adding the results together to produce a single, combined emissions rate representing all GHGs. Under the rule, suppliers of fossil fuels or industrial GHGs, manufacturers of mobile sources and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions as carbon dioxide equivalent are required to submit annual reports to USEPA.

In an effort to reduce energy consumption, reduce GHGs, reduce dependence on petroleum, and increase the use of renewable energy resources, the Navy has implemented a number of renewable energy projects. The Navy has established Fiscal Year 2020 GHG emissions reduction targets of 34 percent from a Fiscal Year 2008 baseline for direct GHG emissions and 13.5 percent for indirect emissions. Examples of Navy-wide GHG reduction projects include energy-efficient construction, thermal and photovoltaic solar systems, geothermal power plants, and the generation of electricity with wind energy. The Navy continues to promote and install new renewable energy projects.

In January 2018, the Department of Defense (DoD) published the results of a global screening level assessment of installation vulnerabilities to climate-related security risks with the goal of identifying serious vulnerabilities and developing necessary adaptation strategies. The survey evaluated risk from flooding, extreme temperatures, wind, drought, and wildfire.

In June 2014, DoD released the *2014 Climate Change Adaptation Roadmap* to document DoD's efforts to plan for the changes that are occurring or expected to occur as a result of climate change. The Roadmap provides an overview and specific details on how DoD's adaptation will occur and describes ongoing efforts (U.S. Department of Defense, 2014).

In Maryland, the Greenhouse Gas Emissions Reduction Act requires the state to achieve a minimum 40 percent reduction in statewide GHGs from 2006 levels by 2030. In fall 2019, Maryland Department of the Environment released a comprehensive, economy-wide draft plan to dramatically reduce emissions of GHGs that contribute to climate change. The plan calls for a 44 percent reduction in GHG emissions by 2030, surpassing the 40 percent reduction goal required by state law. In addition to reducing emissions that contribute to climate change, following the plan also will produce better air quality by reducing emissions that contribute to ground-level ozone and fine particle pollution (Maryland Department of the Environment, 2021).

The Navy is committed to improving energy security and environmental stewardship by reducing reliance on fossil fuels. The Navy is actively developing and participating in energy, environmental, and climate change initiatives that will increase use of alternative energy and reduce emissions of GHGs. The Navy has adopted energy, environmental, and climate change goals that have attempted to reduce non-tactical petroleum use; ensure environmentally sound acquisition practices; and ensure environmentally compliant operations for ships, submarines, aircraft, and facilities operated by the Navy. Examples of Navy-wide GHG reduction projects include energy-efficient construction, thermal and photovoltaic solar systems, geothermal power plants, and the generation of electricity with wind energy. The Navy continues to promote and install new renewable energy projects. Equipment used by military units in the PRC Study Area, including aircraft, vessels, and other equipment, are properly maintained and fueled in accordance with applicable Navy requirements. Operating equipment meets federal and state emission standards, where applicable.

3.2.2 Air Quality, Affected Environment

Naval Air Station (NAS) Patuxent River is located in St. Mary's County, Maryland, which is within the Southern Maryland Intrastate Air Quality Control Region. St. Mary's County has been designated by USEPA as unclassified/attainment for all criteria pollutants (U.S. Environmental Protection Agency, 2019a). According to Title 40 CFR part 81, no Class I air quality protection areas are located within 62 miles of NAS Patuxent River.

NAS Patuxent River maintains a Title V operating permit (Permit # 24-037-0017). Air emissions from the permitted stationary sources on the installation are primarily generated by stationary fuel-burning equipment (e.g., boilers, heaters, emergency generator engines, aircraft engine test cells), painting and other corrosion control operations, abrasive blasting, degreasers, and gasoline storage tanks and filling stations. NAS Patuxent River is not listed in any of Maryland's State Implementation Plans as having a specific conformity budget.

Actual emissions for NAS Patuxent River from the NEI are listed below in Table 3.2-2. Also listed in Table 3.2-2 are the most recent emissions inventories for St. Mary's County and the Southern Maryland Intrastate Air Quality Control Region, which includes Calvert, Charles, and St. Mary's Counties in Maryland (U.S. Environmental Protection Agency, 2021). Included in the Proposed Action region of influence (ROI) (i.e., counties beneath the Patuxent River Complex [PRC] airspace) are additional air basins including several counties in Maryland, Virginia, and Delaware. These are further detailed in the following sections.

Table 3.2-2 NAS Patuxent River and Local and Regional Air Emissions Inventory (National Emissions Inventory 2017)

Location	*Pollutant (tpy)*								*CO_2e (MT/yr)*
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*	*CO_2e*[1]	
NAS Patuxent River[1]	17.94	22.88	0.53	1.49	1.11	15.26	--	14,895	13,513
NAS Patuxent River mobile aircraft[2] emissions[3]	910	681	45	43	64	332	250	-	-
NAS Patuxent River Total	928	704	46	44	65	347	250	14,895	13,513

Sources: (U.S. Environmental Protection Agency, 2021; U.S. Department of the Navy, 2018b)

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NAS = Naval Air Station; NEI = National Emissions Inventory; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Notes:

1. NAS Patuxent River represents five-year averages of only the stationary sources at the military base and does not include the mobile source airport operations portion that is in the NEI. Lead emissions were not reported in the ECR annual reports.
2. NEI data does not include vessel or other mobile source emissions.
3. GHG emissions for NAS Patuxent River mobile aircraft were not reported in the 2017 NEI.

3.2.2.1 Proposed Action ROI – Maryland Air Basin

In addition to St. Mary's County, where NAS Patuxent River is located, aircraft activities below the 3,000-foot above ground level (AGL) mixing layer (the layer above which pollutants would be dispersed and would not mix with or impact ground-level air quality) and other activities occur in Calvert, Dorchester, Somerset, and Wicomico Counties in Maryland. There are no flight activities that occur below the 3,000-foot AGL mixing layer in Caroline or Talbot Counties. However, because high-altitude flight activities occur over these counties, they are included in the GHG impacts analysis. Table 3.2-3 provides the latest NEI baseline data for each county within the Maryland portion of the project ROI (U.S. Environmental Protection Agency, 2021). All counties within the Maryland portion of the ROI are in attainment for all criteria pollutants except for Calvert County. Calvert County is classified as being in marginal nonattainment for the eight-hour ozone standard (2008 and 2015 standards (U.S. Environmental Protection Agency, 2019a). Therefore, a general conformity applicability analysis is required for the Proposed Action in Calvert County.

Table 3.2-3 Proposed Action ROI – Maryland Air Basin Air Emissions Inventory (National Emissions Inventory 2017)

County	*Pollutant (tpy)*								*CO_2e (MT/yr)*
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*	*CO_2e*	
Calvert	9,234	1,253	991	489.75	25.32	7,318	16.52	732,671	664,668
Caroline	NA	NA	NA	NA	NA	NA	NA	303,142	275,006
Dorchester	14,203	2,032	2,310	904	85.32	11,539	94.57	384,384	348,707
Somerset	6,716	1,039	1,107	272	16.05	6,842	21.60	221,007	200,494
St. Mary's	16,212	3,165	1,977	930	133	9,726	265	596,092	540,765
Talbot	NA	NA	NA	NA	NA	NA	NA	424,310	384,928
Wicomico	13,001	1,795	2,038	760	42.07	7,521	159	707,084	641,456

Source: (U.S. Environmental Protection Agency, 2021)

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NA = not applicable; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; ROI = region of influence; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

3.2.2.2 Proposed Action ROI – Virginia Air Basin

As discussed above, portions of Virginia would be included in the ROI for the Proposed Action due to airspace (i.e., aircraft activities below the 3,000-foot AGL mixing layer) and other activities. These counties in Virginia include Lancaster, Northumberland, and Westmoreland. Table 3.2-4 presents the most recent USEPA NEI baseline data for each county in the Virginia portion of the ROI (U.S. Environmental Protection Agency, 2021). All counties in the Virginia portion of the ROI are classified as being in attainment for all criteria pollutants (U.S. Environmental Protection Agency, 2019b). No flight operations occur below the 3,000-foot AGL mixing layer in Accomack, Charles City, Gloucester, James City, King and Queen, Mathews, Middlesex, New Kent, Richmond, Williamsburg, or York Counties. However, because high-altitude flight operations occur over these counties, they are included in the GHG impacts analysis. Charles City, Gloucester, James City, and York Counties are classified as being maintenance areas for ozone. Therefore, a general conformity applicability analysis is applicable to the Proposed Action in these counties. However, because no low-level flight operations (below the 3,000-foot AGL mixing layer) occur in that portion of the PRC Study Area, no criteria pollutants are emitted in those respective counties' maintenance areas, and no further conformity determinations are required.

Table 3.2-4 Proposed Action ROI – Virginia Air Basin Air Emissions Inventory (National Emissions Inventory 2017)

County	Pollutant (tpy)								CO_2e (MT/yr)
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs	Pb	CO_2e	
Accomack	NA	NA	NA	NA	NA	NA	NA	534,340	484,746
Charles City	NA	NA	NA	NA	NA	NA	NA	108,748	98,655
Gloucester	NA	NA	NA	NA	NA	NA	NA	384,638	348,938
James City	NA	NA	NA	NA	NA	NA	NA	522,806	474,281
King and Queen	NA	NA	NA	NA	NA	NA	NA	206,696	187,512
Lancaster	3,839	369	412	164	11.55	3,788	2.02	95,309	86,463
Mathews	NA	NA	NA	NA	NA	NA	NA	49,110	44,551
Middlesex	NA	NA	NA	NA	NA	NA	NA	74,579	67,657
New Kent	NA	NA	NA	NA	NA	NA	NA	381,419	346,018
Northumberland	3,879	480	729	215	9.25	4,665	8.06	78,436	71,156
Richmond	NA	NA	NA	NA	NA	NA	NA	80,312	72,858
Westmoreland	3,895	474	658	224	12.77	6,116	10.94	90,563	82,158
Williamsburg	NA	NA	NA	NA	NA	NA	NA	89,071	80,804
York	NA	NA	NA	NA	NA	NA	NA	538,869	488,854

Source: (U.S. Environmental Protection Agency, 2021)

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NA = not applicable; NOx = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; ROI = region of influence; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

3.2.2.3 Proposed Action ROI – Delaware Air Basin

Kent and Sussex Counties in Delaware are also included in the Proposed Action ROI. No flight activities occur below the 3,000-foot AGL mixing layer in either county. However, because high-altitude flight activities occur over these counties, they are included in the GHG impacts analysis. Table 3.2-5 presents the most recent USEPA NEI baseline data for each county in the Delaware portion of the ROI (U.S. Environmental Protection Agency, 2021). Kent County is classified as being in attainment for all criteria pollutants. Sussex County, however, is classified as being in marginal nonattainment for the eight-hour ozone standard (2008 standard) (U.S. Environmental Protection Agency, 2019c). Therefore, a general conformity applicability analysis is applicable to the Proposed Action in Sussex County. However, since no low-level flight operations (below the 3,000-foot AGL mixing layer) occur in that portion of the PRC Study Area, no criteria pollutants are emitted in the Sussex County, Delaware, nonattainment area, and no further conformity determination is required.

Table 3.2-5 Proposed Action ROI – Delaware Air Basin Air Emissions Inventory (National Emissions Inventory 2017)

County	Pollutant (tpy)								CO_2e (MT/yr)
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs	Pb	CO_2e	
Kent	NA	NA	NA	NA	NA	NA	NA	2,019,729	1,832,268
Sussex	NA	NA	NA	NA	NA	NA	NA	2,379,210	2,158,384

Source: (U.S. Environmental Protection Agency, 2021)

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NA = not applicable; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; ROI = region of influence; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

3.2.3 Air Quality, Environmental Consequences

Effects on air quality are based on estimated emissions associated with the action alternatives. The ROI for assessing air quality includes the three air basins described above (Maryland, Virginia, and Delaware Air Basins). Estimated emissions from a proposed federal action are typically compared with the relevant national and state standards to assess the potential for increases in pollutant concentrations.

This section evaluates how and to what degree the pollutant stressor associated with testing and training activities described in Chapter 2 (Proposed Action and Alternatives) potentially impact air quality within the PRC Study Area. The air quality pollutant stressors vary in intensity, frequency, duration, and location within the PRC Study Area.

Criteria Air Pollutants

In this analysis, criteria air pollutant emissions estimates were calculated for aircraft flight operations occurring below the 3,000-foot AGL standard mixing layer, open-air engine test cell runs, vessels (including motorized surface targets, and unmanned surface vehicles), ground support equipment (GSE), and munitions and other military expended materials (MEM) (including aerial target jet-assisted takeoff bottles). For each alternative, emissions estimates were developed for each representative source operating within the PRC Study Area. Details of the emission estimates are provided in Appendix D (Air Quality Calculations). Because the quantities of emissions vary greatly, quantities over 100 tons are presented rounded to the nearest integer while quantities below 100 are rounded to two decimal places. As such, some entries may show zeroes; however, in most cases this is because the quantities are smaller less than 0.01 ton.

Greenhouse Gases

In this analysis, greenhouse gas emissions estimates were calculated for open-air engine test cell runs, vessels (including motorized surface targets, and unmanned surface vehicles), GSE, and munitions and other MEM (including aerial target jet-assisted takeoff bottles). Because GHGs are not limited by the 3,000-foot AGL mixing layer, all aircraft activity, regardless of altitude, are used for estimating GHG emission. All values for CO_2e are depicted as whole numbers.

3.2.3.1 Air Quality, No Action Alternative

Under the No Action Alternative, there would be no change to baseline air quality, and emissions would continue at historical/baseline levels. However, because the annual emissions associated with the No Action Alternative have not previously been determined and to provide context for the potential increase in emissions under the action alternatives, No Action Alternative emissions are provided in this section, which is the NEPA analysis.

Aircraft

Aircraft operational emissions were calculated for flight operations occurring below the 3,000-foot AGL standard mixing layer. Times in mode (the number of minutes operating at various engine powers/flight modes [e.g., taxi, takeoff, afterburner]) for the various aircraft occurring below 3,000 feet AGL were based on the *Aircraft Noise Study to Support the Environmental Impact Statement for the Patuxent River Complex* (Appendix C, Noise Study). Because activities within the PRC Study Area are primarily related to testing, by nature, the numbers and types of operations vary greatly. To account for this, a conservative approach was used in which representative aircraft were chosen for each of four airframe classes (Section 3.0.2.3.1.1, Aircraft and Aerial Targets (Air-Based Assets)). Representative aircraft were selected based on the predominance of operations below 3,000 feet AGL (Table 3.2-6). For fixed-wing propeller aircraft, there were two airfames with similar operations minutes (T-6 and C-12), so the larger, twin engine airframe was selected in order to provide a more conservative analysis. For unmanned aerial systems, the T-34 was used as a surrogate since the Aircraft Environmental Support Office does not currently have finalized emission factors for the small, propeller-driven unmanned aerial systems.

Table 3.2-6 Representative Airframes and Emission Factor Sources

Airframe	*Representative Aircraft*	*Emission Factors Source*
Fixed-wing jet	F/A-18	*Aircraft Emission Estimates: F/A-18 Landing and Takeoff Cycle and In-Frame Maintenance Testing Using JP-5*, AESO Report 9815I (U.S. Department of the Navy, 2017b)
Fixed-wing propeller	C-12	*Aircraft Emission Estimates: C-12 Landing and Takeoff Cycle and In-Frame Maintenance Testing Using JP-5*, AESO Report 9910D (U.S. Department of the Navy, 2015b)
Rotary-wing	H-60	*Aircraft Emission Estimates: H-60 Landing and Takeoff Cycle, Cruise Time and In-Frame Maintenance Testing Using JP-5*, AESO Report 9929C (U.S. Department of the Navy, 2016b)
Unmanned aerial systems	T-34	*Aircraft Emission Estimates: T-34C Landing and Takeoff Cycle and In-Frame Maintenance Testing Using JP-5*, AESO Report 9921D (U.S. Department of the Navy, 2019c)

A portion of flight operations would occur in the Calvert County ozone nonattainment area. Of all flight operations, activities below 3,000 feet AGL represent approximately 41 percent of operations under the No Action Alternative and 51 percent under Alternatives 1 and 2 (Table 2.3-1, Annual PRC Operational Tempo per Alternative: Activities and Assets). Of that, approximately half of operations occur in the West Helicopter Operating Area (Helo OPAREA) and 0.83 percent occur in restricted area R-4007 (Section 3.0.2.3.4.1, Air-Based Assets). Approximately 25 percent of R-4007 and West Helo OPAREA airspaces overlap Calvert County (nonattainment area); therefore, emissions were weighted based on those factors to estimate the portion of emissions occurring in the nonattainment area. No low-level flights are anticipated in the portion of the PRC Study Area overlapping other nonattainment or maintenance areas. Therefore, as noted in Sections 3.2.2.2 and 3.2.2.3 (Proposed Action ROI – Virginia Basin and Proposed Action ROI – Delaware Air Basin, respectively), there are no concerns with respect to general conformity and this is not addressed further. Emissions were also calculated for aircraft ground operations such as pre-and post-flight checks, idling time, taxiing, turns, static tests, and maintenance. Aircraft emissions for both flight operations and ground operations occurring across the PRC Study Area (including all three air basins) are provided in Table 3.2-7.

Table 3.2-7 Aircraft Emissions Under the No Action Alternative

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*[1]
Aircraft flight and ground operations	2,628	338	205	205	42.93	765	0.03

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; tpy = tons per year; VOC = volatile organic compound.

Note:

1. Lead emissions are based on the peak total quantity of aviation gas dispensed annually over a five-year period (approximately 15,000 gallons per year).

These emissions have been occurring for many years, are part of the existing environment, and would not represent a new or additive impact to the air quality in the PRC Study Area. However, these data provide context for the comparison of the potential increase in emissions under Alternatives 1 and 2. Further, it is notable that ozone precursor (volatile organic compound and nitrogen oxide) emissions in the nonattainment area are well below the *de minimis* levels of 50 and 100 tons per year, respectively.

Aircraft In-Frame Maintenance

Emissions are also generated by aircraft conducting routine in-frame maintenance runs. In addition to aircraft ground operations such as taxiing, idling, etc., which are in the calculations above, aircraft routinely run their engines through various modes while on the ground. In-frame maintenance emissions (Table 3.2-8) were calculated per Aircraft Environmental Support Office (AESO) Memorandum Report No. 2020-14, *Averaged In-frame Maintenance Emission Rates for F/A-18, C-12, H-60, and T-34* (U.S. Department of the Navy, 2020a).

Table 3.2-8 Aircraft In-Frame Maintenance Emissions Under the No Action Alternative

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Aircraft in-frame maintenance operations	151	29.61	34.05	12.58	7.79	7.79	0.00

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; tpy = tons per year; VOC = volatile organic compound.

Open-Air Engine Test Cell Facility

Emissions are also generated by aircraft engine testing at the Open-Air Engine Test Cell (OAETC) facility. During tests, engines are operated approximately half of the time at idle and half at high power. Further, OAETC test activities are conducted intermittently, with many days of no activity (see Section 3.0.2.3.1.3, Land-Based Assets). Table 3.2-9 shows the emissions associated with the baseline activities representing a five-year average. The majority of emissions are generated by the Jet Engine Test Instrumentation (JETI) test cells. However, emissions are minimal and operating hours are well below levels permitted under the Title V Air Operating Permit (Part 70 Operating Permit 24-037-0017).

Table 3.2-9 OAETC Emissions Under the No Action Alternative

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb[1]*
Jet engine test cells	7.36	6.07	0.88	0.01	0.66	0.84	0.00
Helicopter engine test cells	0.07	0.08	0.02	0.00	0.02	0.01	0.00
Turboshaft engine test cell	0.05	0.16	0.00	0.00	0.01	0.01	0.00
OAETC total emissions	**7.48**	**6.31**	**0.90**	**0.01**	**0.69**	**0.86**	**0.00**

Key: CO = carbon monoxide; NO_x = nitrogen oxides; OAETC = Open-Air Engine Test Cell Facility; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Note:

1. Aviation fuels used in the OAETC do not contain lead, so there are no lead emissions associated.

Ground Support Equipment

GSE includes various gasoline or diesel equipment to support aircraft ground activities. Test stands, tow tractors, generators, loaders, and trucks are examples of regularly used equipment. Parts-specific emission factors were not available and, therefore, USEPA standard diesel emissions for the age-appropriate tier for the part (Tier 1 or Tier 2) were used to estimate emissions. GSE annual emissions are provided in Table 3.2-10.

Table 3.2-10 Annual Ground Support Equipment Emissions Under the No Action Alternative

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Ground support equipment	26.63	54.42	1.64	1.64	0.06	2.38	0.00

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; tpy = tons per year; VOC = volatile organic compound.

Vessels

A variety of vessels support operations in the PRC Study Area, including range support vessels, combatant and patrol craft, and motorized surface targets. These vessels vary greatly in size, engine power, fuel consumption, and associated emissions. Therefore, vessels were classified by their length as being either small (less than 50 feet long), medium (50 to 100 feet long), or large (more than 100 feet, but less than 400 feet long) (Section 3.0.2.3.1.2, Vessels (and Other Water-Based Assets)). For each category, a representative vessel was selected based on highest historical use to provide conservative emission factors and estimates. Detailed characteristics of these representatives are provided in Appendix A (Patuxent River Complex Activity and Asset Descriptions). Table 3.2-11 provides the estimated annual pollutant emissions associated with vessel operations.

Table 3.2-11 Annual Vessel Emissions Under the No Action Alternative

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Range support boats	631	33.41	1.48	1.48	3.28	258	0.00
Combatant and patrol craft	1.92	3.64	0.12	0.12	0.70	0.30	0.00
Motorized surface targets	232	23.92	1.05	1.05	2.54	94.34	0.00
Unmanned surface vehicles	0.01	0.11	0.00	0.00	0.01	0.00	0.00
Vessel totals	**865**	**61.08**	**2.65**	**2.65**	**6.53**	**353**	**0.00**

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Non-explosive Munitions and Other Military Expended Materials

A wide variety of munitions and other MEM are employed during testing and training activities in the PRC Study Area. Emissions were only calculated for MEM that are live-fired, include a detonation or spotting charge, or combust propellants (non-explosive bombs, mines, torpedoes, etc., were excluded from analysis). MEM were grouped by type, and a representative was chosen for each type based on the highest historical use and/or for which associated constituents were available (Section 3.0.2.3.3.4, Non-explosive Munitions and Other Military Expended Materials). These representatives are displayed in Appendix D (Air Quality Calculations). Annual emissions from munitions and other MEM use (provided in Table 3.2-12) were calculated based on emission factors from USEPA's *AP-42: Compilation of Air Emissions Factors* (various dates) and vetted through Naval Ordnance Safety and Security Activity.

Table 3.2-12 Annual Munitions and Other MEM Emissions Under the No Action Alternative

Source	Annual Pollutant Emissions (tpy)						
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs	Pb
Small-caliber gun ammunition	0.05	0.00	0.00	0.00	0.00	0.00	0.00
Medium-caliber gun ammunition	0.48	0.01	0.02	0.01	0.00	0.00	0.00
Missiles/rockets/JATO bottles	0.24	0.00	0.07	0.08	0.00	0.00	0.03
Marine marker	0.01	0.00	0.33	0.25	0.00	0.00	0.00
Countermeasure flare	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Illumination flare	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rocket (flechette warhead)	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Launchers/pods	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**0.80**	**0.01**	**0.42**	**0.34**	**0.00**	**0.00**	**0.03**

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; JATO = jet-assisted takeoff; MT/yr = metric tons per year; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Summary – No Action Alternative

Table 3.2-13 provides a summary of emissions from all sources under the No Action Alternative as well as a comparison to the three relevant air basins and the overall PRC Study Area. These emissions are included in current air quality monitoring in each of these air basins and are not causing violations of state or federal criteria pollutant standards in most counties. Emissions nonattainment and maintenance counties are further evaluated in the following section, *General Conformity – No Action Alternative*.

Table 3.2-13 Annual Emissions Summary, No Action Alternative

Source	Annual Pollutant Emissions (tpy)						
	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC	Pb
Aircraft operations	2,628	338	205	205	42.93	766	0.03
Aircraft in-frame maintenance	151	13	8	8	1.77	34	0.00
OAETC	7.48	6.31	0.90	0.01	0.69	0.86	0.00
GSE	26.63	54.42	1.64	1.64	0.06	2.38	0.00
Vessels	865	61.08	2.65	2.65	6.53	353	0.00
Munitions and other MEM	0.80	0.01	0.42	0.34	0.00	0.00	0.03
No Action Alternative total	**3,679**	**473**	**219**	**218**	**51.98**	**1,156**	**0.06**
Air Basin 1 (MD)	59,366	9,284	8,423	3,356	302	42,946	557
Air Basin 2 (VA)	11,613	1,323	1,799	603	34	14,569	21
Study Area total	**70,979**	**10,607**	**10,222**	**3,959**	**336**	**57,515**	**578**
Percentage of Study Area	*5.18%*	*4.46%*	*2.14%*	*5.50%*	*15.47%*	*2.01%*	*0.01%*

Key: CO = carbon monoxide; GSE = ground support equipment; MD = Maryland; MT/yr = metric tons per year; NO_x = nitrogen oxides; OAETC = Open-Air Engine Test Cell Facility; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; PRC = Patuxent River Complex; SO_2 = sulfur dioxide; tpy = tons per year; VA = Virginia; VOC = volatile organic compound.

Greenhouse Gases – No Action Alternative

Because GHGs are not limited by the 3,000-foot AGL mixing layer, they are emitted over a larger area that the criteria pollutants discussed above. In addition to the affected counties described previously, aircraft emissions from high-altitude operations also impact Caroline and Talbot Counties in Maryland, Kent and Sussex Counties in Delaware, and Accomack, Charles City, Gloucester, James City, King and Queen, Mathews, Middlesex, New Kent, Richmond, Williamsburg, and York Counties in Virginia. Table 3.2-14 provides annual GHG emissions from PRC operations, compared with this larger study area's baseline annual GHG emissions.

Table 3.2-14 Greenhouse Gas Annual Emissions, No Action Alternative

Source	*Annual Pollutant Emissions (tpy)*	
	CO_2e (tons/yr)	*CO_2e (MT/yr)*
Aircraft operations	226,071	205,088
Aircraft in-frame maintenance	4,259	3,864
OAETC	1,389	1,260
GSE	2,072	1,880
Vessels	4,011	3,638
Munitions	3	2
No Action Alternative total	**237,805**	**215,732**
Air Basin 1 (MD)	3,368,690	3,056,025
Air Basin 2 (VA)	3,234,896	2,934,649
Air Basin 3 (DE)	4,398,940	3,990,652
Study Area total	**11,002,526**	**9,981,326**
Percentage of Study Area	*2.16%*	*2.16%*

Key: CO_2e = carbon dioxide equivalent; DE = Delaware; GSE = ground support equipment; MD = Maryland; MT/yr = metric tons per year; OAETC = Open-Air Engine Test Cell Facility; tpy = tons per year; VA = Virginia.

General Conformity – No Action Alternative

Because GSE is only operated within St. Mary's County, Maryland (an attainment area) and no vessels or munitions are operated or expended in the nonattainment areas, these activities are not subject to general conformity. Only aircraft flight hours have the potential to impact general conformity in the Calvert and Sussex County nonattainment areas and Kent County (Delaware) and Charles City, Gloucester, James City, and York County (Virginia) maintenance areas. Table 3.2-15 compares the potential air emissions from PRC flight operations over these counties to the *de minimis* levels set by USEPA. Pollutant emissions under the No Action Alternative are well below the *de minimis* levels; therefore, a general conformity determination is not required. There are no aircraft or other operations occurring below 3,000 feet AGL in any of the other counties. However, because PRC airspace partially overlaps these counties, they were included in the conformity applicability assessment because they are classified as being in nonattainment or maintenance. Since there are no emissions, emissions are below the *de minimis* levels and a general conformity determination is not applicable to the Proposed Action under the No Action Alternative.

Table 3.2-15 Conformity Analysis for the No Action Alternative

Source	*No Action Alternative Annual Pollutant Emissions (tpy)*						
	CO	*NO_X*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOC*	*Pb*
No Action Alternative aircraft emissions in the Calvert County nonattainment area	75.4	9.61	5.81	5.81	1.2	22.00	0.00
De minimis levels		100				50	
Exceeds de minimis levels?		No				No	

Table 3.2-15 Conformity Analysis for the No Action Alternative, Continued

Source	*No Action Alternative Annual Pollutant Emissions (tpy)*						
	CO	*NO_X*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOC*	*Pb*
No Action Alternative aircraft emissions in the Sussex County nonattainment area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		100				50	
Exceeds de minimis levels?		No				No	
No Action Alternative aircraft emissions in the Kent County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		100				50	
Exceeds de minimis levels?		No				No	
No Action Alternative aircraft emissions in the Charles City County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		100				50	
Exceeds de minimis levels?		No				No	
No Action Alternative aircraft emissions in the Gloucester County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		100				50	
Exceeds de minimis levels?		No				No	
No Action Alternative aircraft emissions in the James City County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		100				50	
Exceeds de minimis levels?		No				No	
No Action Alternative aircraft emissions in the York County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		100				50	
Exceeds de minimis levels?		No				No	

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

3.2.3.2 Air Quality, Alternative 1 Potential Impacts

Under Alternative 1, the Navy would conduct the same types of testing and training activities within the PRC Study Area as the No Action Alternative but with higher annual flight hours as well as adjustments to current aircraft mix, non-explosive munitions numbers, and systems to accommodate the projected testing and training requirements identified by Navy subject matter experts for the foreseeable future.

Table 2.3-1 (Annual PRC Operational Tempo per Alternative: Activities and Assets) and Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems) provide the operational metrics including the numbers of flight hours, OAETC events/hours, vessels, GSE hours, non-explosive munitions, and other MEM.

Aircraft

Aircraft emissions for both flight operations and ground operations are provided in Table 3.2-16.

Table 3.2-16 Aircraft Emissions Under Alternative 1

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Aircraft flight and ground operations	3,349	441	269	269	58.38	961	0.04

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; tpy = tons per year; VOC = volatile organic compound.

Aircraft In-Frame Maintenance

Emissions associated with aircraft in-frame maintenance are provided in Table 3.2-17.

Table 3.2-17 Aircraft In-Frame Maintenance Emissions Under Alternative 1

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Aircraft in-frame maintenance operations	154.07	29.94	34.43	12.92	7.95	7.95	0.00

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; tpy = tons per year; VOC = volatile organic compound.

Open-Air Engine Test Cell Facility

Under Alternative 1, the annual hours of operation for the OAETC would not increase and would remain at baseline levels. Table 3.2-18 shows the emissions associated with Alternative 1, which are the same as those for the baseline activities representing a five-year average. The majority of emissions would be generated by the JETI test cells. However, emissions would remain minimal and operating hours would be well below levels permitted under the Title V Air Operating Permit (Part 70 Operating Permit 24-037-0017).

Table 3.2-18 OAETC Emissions Under Alternative 1

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_X*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Jet engine test cells	7.36	6.07	0.88	0.01	0.66	0.84	0.00
Helicopter engine test cells	0.07	0.08	0.02	0.00	0.02	0.01	0.00
Turboshaft engine test cell	0.05	0.16	0.00	0.00	0.01	0.01	0.00
OAETC total emissions	**7.48**	**6.31**	**0.90**	**0.01**	**0.69**	**0.86**	**0.00**

Key: CO = carbon monoxide; NO_x = nitrogen oxides; OAETC = Open-Air Engine Test Cell Facility; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Ground Support Equipment

GSE annual emissions and net change from baseline conditions under Alternative 1 are provided in Table 3.2-19. The increase in emissions for all pollutants under Alternative 1 would be extremely small.

Table 3.2-19 Annual Ground Support Equipment Emissions Under Alternative 1

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Ground support equipment	30.39	62.10	1.87	1.87	0.07	2.72	0.00

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; tpy = tons per year; VOC = volatile organic compound.

Vessels

The types of vessels would be the same as under the No Action Alternative; however, annual use would increase. Vessel annual emissions under Alternative 1 are provided in Table 3.2-20.

Table 3.2-20 Annual Vessel Emissions Under Alternative 1

Source	Annual Pollutant Emissions (tpy)						
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs	Pb
Range support boats	631	33.41	1.48	1.48	3.28	258	0.00
Combatant and patrol craft	2.02	4.30	0.16	0.16	0.70	0.31	0.00
Mobile surface targets	240	241	242	243	244	245	0.00
Unmanned surface vehicles	0.09	0.85	0.02	0.02	0.12	0.03	0.00
Vessel totals	**866**	**62.50**	**2.71**	**2.71**	**6.63**	**353**	**0.00**

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Non-explosive Munitions and Other Military Expended Materials

Annual emissions from munitions and other MEM use under Alternative 1 were calculated and are provided in Table 3.2-21. The increase in emissions for all pollutants under Alternative 1 would be extremely small.

Table 3.2-21 Annual Munitions and Other MEM Emissions Under Alternative 1

Source	Annual Pollutant Emissions (tpy)						
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOCs	Pb
Small-caliber gun ammunition	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Medium-caliber gun ammunition	0.84	0.01	0.03	0.02	0.00	0.00	0.00
Missiles/rockets/JATO bottles	0.30	0.00	0.09	0.10	0.00	0.00	0.04
Marine marker	0.02	0.00	0.51	0.39	0.00	0.00	0.00
Countermeasure flare	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Illumination flare	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rocket (flechette warhead)	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Launchers/pods	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**1.26**	**0.01**	**0.63**	**0.51**	**0.00**	**0.00**	**0.04**

Key: CO = carbon monoxide; JATO = jet-assisted takeoff; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Summary – Alternative 1

Table 3.2-22 provides a summary of emissions calculated in the NEPA analysis. It includes emissions from all sources under Alternative 1 as well as a comparison to the three relevant air basins and the overall PRC Study Area. The minor increase in emissions compared to the No Action Alternative correlates to the proposed increase in testing and training activities. Emissions from the Proposed Action would be a small percentage of the overall emissions in the PRC Study Area and would not cause or contribute to any violation of the NAAQS or have any significant impact on regional air quality.

Table 3.2-22 Annual Emissions Summary, Alternative 1

Source	Annual Pollutant Emissions (tpy)						
	CO	*NO_X*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOC*	*Pb*
Aircraft operations	3,349	441	269	269	58.38	961	0.04
Aircraft in-frame maintenance	154	13	8	8	1.86	34	0.00
OAETC	7.48	6.31	0.90	0.01	0.69	0.86	0.00
GSE	30.39	62.10	1.87	1.87	0.07	2.72	0.00
Vessels	866	62.50	2.71	2.71	6.63	353	0.00
Munitions	1.26	0.01	0.63	0.51	0.00	0.00	0.04
Alternative 1 total	**4,408**	**585**	**283**	**283**	**67.95**	**1,353**	**0.08**
Net Change from Baseline	728.15	113.44	65.22	65.17	15.98	197.23	0.02
Air Basin 1 (MD)	59,366	9,284	8,423	3,356	302	42,946	557
Air Basin 2 (VA)	11,613	1,323	1,799	603	34	14,569	21
Study Area total	**70,979**	**10,607**	**10,222**	**3,959**	**336**	**57,515**	**578**
Net Change as Percentage of Study Area	*1.03%*	*1.07%*	*0.64%*	*1.65%*	*4.77%*	*0.34%*	*0.00%*

Key: CO = carbon monoxide; GSE = ground support equipment; MD = Maryland; NO_x = nitrogen oxides; OAETC = Open-Air Engine Test Cell Facility; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; PRC = Patuxent River Complex; SO_2 = sulfur dioxide; tpy = tons per year; VA = Virginia; VOC = volatile organic compound.

Greenhouse Gases – Alternative 1

Because GHGs are not limited by the 3,000-foot AGL mixing layer, they are emitted over a larger area that the criteria pollutants discussed above. In addition to the affected counties described previously, aircraft emissions from high-altitude operations also impact Caroline and Talbot Counties in Maryland, Kent and Sussex Counties in Delaware, and Accomack, Charles City, Gloucester, James City, King and Queen, Mathews, Middlesex, New Kent, Richmond, Williamsburg, and York Counties in Virginia. Table 3.2-23 provides annual GHG emissions from PRC operations associated with Alternative 1, compared with this larger study area's baseline annual GHG emissions.

Table 3.2-23 Greenhouse Gas Annual Emissions, Alternative 1

Source	Annual Pollutant Emissions (tpy)	
	CO_2e (tons/yr)	*CO_2e (MT/yr)*
Aircraft operations	247,758	224,762
Aircraft in-frame maintenance	4,468	4,053
OAETC	1,389	1,260
GSE	2,365	2,145
Vessels	4,066	3,689
Munitions	3	3
Alternative 1 total	**260,049**	**235,912**
Net Change from Baseline	22,244	20,179
Air Basin 1 (MD)	3,368,690	3,056,025
Air Basin 2 (VA)	3,234,896	2,934,649
Air Basin 3 (DE)	4,398,940	3,990,652
Study Area total	**11,002,526**	**9,981,326**
Net Change as Percentage of Study Area	*0.20%*	*0.20%*

Key: CO_2e = carbon dioxide equivalent; DE = Delaware; GSE = ground support equipment; MD = Maryland; MT/yr = metric tons per year; OAETC = Open-Air Engine Test Cell Facility; Pb = lead; PRC = Patuxent River Complex; tpy = tons per year; VA = Virginia.

General Conformity – Alternative 1

Because GSE is only operated within St. Mary's County, Maryland (an attainment area) and no vessels or munitions are operated or expended in the nonattainment areas, these activities are not subject to general conformity. Only aircraft flight hours have the potential to impact general conformity in the Calvert and Sussex County nonattainment areas and Kent County (Delaware) and Charles City, Gloucester, James City, and York County (Virginia) maintenance areas. Table 3.2-24 compares the potential air emissions from PRC flight operations over these counties to the *de minimis* levels set by USEPA. Pollutant emissions under Alternative 1 would be well below the *de minimis* levels; therefore, there would be no negative impact on regional air quality and a general conformity determination is not applicable to the Proposed Action under Alternative 1. There are no aircraft or other operations occurring below 3,000 feet AGL in any of the other counties. However, because PRC airspace partially overlaps these counties, they wereincluded in the conformity applicability assessment because they are classified as being in nonattainment or maintenance. Since there are no emissions, emissions are obviously below the *de minimis* levels and a general conformity determination is not applicable to the Proposed Action under Alternative 1.

Table 3.2-24 Conformity Analysis for Alternative 1

Source	*Alternative 1 Annual Pollutant Emissions (tpy)*						
	CO	*NO_X*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOC*	*Pb*
Alternative 1 aircraft emissions in the Calvert County nonattainment area	96.49	12.58	7.63	7.63	1.64	27.81	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 1 aircraft emissions in the Sussex County nonattainment area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 1 aircraft emissions in the Kent County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 1 aircraft emissions in the Charles City County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 1 aircraft emissions in the Gloucester County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 1 aircraft emissions in the James City County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	

Table 3.2-24 Conformity Analysis for Alternative 1, Continued

Source	*Alternative 1 Annual Pollutant Emissions (tpy)*						
	CO	*NO_X*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOC*	*Pb*
Exceeds de minimis levels?		**No**				**No**	
Alternative 1 aircraft emissions in the York County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

3.2.3.3 Air Quality, Alternative 2 (Preferred Alternative) Potential Impacts

Alternative 2 includes the same types of testing and training activities and mix of aircraft, non-explosive munitions, and systems as Alternative 1 but with a 10 percent increase in the annual number of flight hours and increases in other operational metrics as well as the expanded use of directed energy technology testing to the PRC Study Area.

Aircraft

Aircraft emissions for both flight operations and ground operations under Alternative 2 are provided in Table 3.2-25.

Table 3.2-25 Aircraft Emissions Under Alternative 2

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Aircraft flight and ground operations	3,721	491	299	299	65.23	1,068	0.04

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; tpy = tons per year; VOC = volatile organic compound.

Aircraft In-Frame Maintenance

Emissions associated with aircraft in-frame maintenance are provided in Table 3.2-26.

Table 3.2-26 Aircraft In-Frame Maintenance Emissions Under Alternative 2

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Aircraft in-frame maintenance operations	171	14	9	9	2.06	38	0.00

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; tpy = tons per year; VOC = volatile organic compound.

Open-Air Engine Test Cell Facility

Under Alternative 2, the annual hours of operation for the OAETC would be expected to increase by approximately 10 percent over baseline levels. Table 3.2-27 shows the emissions associated with Alternative 2. The majority of emissions would be generated by the JETI test cells. However, emissions would remain minimal, and operating hours would be well below levels permitted under the Title V Air Operating Permit (Part 70 Operating Permit 24-037-0017).

Table 3.2-27 OAETC Emissions Under Alternative 2

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Jet engine test cells	8.09	6.68	0.96	0.02	0.73	0.92	0.00
Helicopter engine test cells	0.07	0.08	0.03	0.00	0.02	0.01	0.00
Turboshaft engine test cell	0.06	0.18	0.00	0.00	0.01	0.01	0.00
OAETC total emissions	**8.22**	**6.94**	**0.99**	**0.02**	**0.76**	**0.94**	**0.00**

Key: CO = carbon monoxide; NO_x = nitrogen oxides; OAETC = Open-Air Engine Test Cell Facility; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Ground Support Equipment

Annual emissions from GSE under Alternative 2 are provided in Table 3.2-28.

Table 3.2-28 Annual Ground Support Equipment Emissions Under Alternative 2

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Ground support equipment	32.68	66.78	2.01	2.01	0.07	2.92	0.00

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Vessels

Table 3.2-29 provides the estimated annual pollutant emissions associated with vessel operations under Alternative 2.

Table 3.2-29 Annual Vessel Emissions Under Alternative 2

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Range support boats	695	36.77	1.63	1.63	3.61	284	0.00
Combatant and patrol craft	2.22	4.72	0.17	0.17	0.77	0.34	0.00
Mobile surface targets	257	26.35	1.16	1.16	2.79	104	0.00
Unmanned surface vehicles	0.10	0.94	0.02	0.02	0.13	0.04	0.00
Vessel totals	**954**	**68.77**	**2.98**	**2.98**	**7.30**	**389**	**0.00**

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Non-explosive Munitions and Other Military Expended Materials

Annual emissions from munitions use under Alternative 2 were calculated based on emission factors from USEPA's *AP-42: Compilation of Air Emissions Factors* (various dates) and vetted through Naval Ordnance Safety and Security Activity and are provided in Table 3.2-30. The increase in emissions for all pollutants under Alternative 2 would be extremely small.

Table 3.2-30 Annual Munitions and Other MEM Emissions Under Alternative 2

Source Category	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*
Small-caliber gun ammunition	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Medium-caliber gun ammunition	0.92	0.02	0.04	0.02	0.00	0.00	0.00
Missiles/rockets/JATO bottles	0.33	0.00	0.10	0.11	0.00	0.00	0.04
Marine marker	0.02	0.00	0.56	0.43	0.00	0.00	0.00
Countermeasure flare	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Illumination flare	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rocket (flechette warhead)	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Launchers/pods	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**1.38**	**0.02**	**0.70**	**0.56**	**0.00**	**0.00**	**0.05**

Key: CO = carbon monoxide; JATO = jet-assisted takeoff; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns in diameter; Pb = lead; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Summary – Alternative 2

Table 3.2-31 provides a summary of emissions from all sources under Alternative 2 as well as a comparison to the three relevant air basins and the overall PRC Study Area. The minor increase in emissions compared to the No Action Alternative correlates to the proposed increase in testing and training activities. Emissions from the Proposed Action would be a small percentage of the overall emissions in the PRC Study Area and would not cause or contribute to any violation of the NAAQS and would not have any significant impact on regional air quality.

Table 3.2-31 Annual Emissions Summary, Alternative 2

Source	*Annual Pollutant Emissions (tpy)*						
	CO	*NO_X*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOC*	*Pb*
Aircraft operations	3,721	491	299	299	65.23	1,068	0.05
Aircraft in-frame maintenance	171	14	9	9	2.06	38	0.00
OAETC	8.22	6.94	0.99	0.02	0.76	0.94	0.00
GSE	32.68	66.78	2.01	2.01	0.07	2.92	0.00
Vessels	954	68.77	2.98	2.98	7.30	389	0.00
Munitions	1.38	0.02	0.70	0.56	0.00	0.00	0.05
Alternative 2 total	**4,888**	**648**	**315**	**315**	**75.42**	**1,500**	**0.09**
Net Change from Baseline	1,209	176	97	97	23.44	344	0.03
Air Basin 1 (MD)	59,366	9,284	8,423	3,356	302	42,946	557
Air Basin 2 (VA)	11,613	1,323	1,799	603	34	14,569	21
Study Area total	**70,979**	**10,607**	**10,222**	**3,959**	**335**	**57,515**	**578**
Percentage of Study Area	*1.70%*	*1.66%*	*0.95%*	*2.44%*	*7.00%*	*0.60%*	*0.00%*

Key: CO = carbon monoxide; GSE = ground support equipment; MD = Maryland; NO_x = nitrogen oxides; OAETC = Open-Air Engine Test Cell Facility; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; PRC = Patuxent River Complex; SO_2 = sulfur dioxide; tpy = tons per year; VA = Virginia; VOC = volatile organic compound.

Greenhouse Gases – Alternative 2

Because GHGs are not limited by the 3,000-foot AGL mixing layer, they are emitted over a larger area that the criteria pollutants discussed above. In addition to the affected counties described previously, aircraft emissions from high-altitude operations also impact Caroline and Talbot Counties in Maryland, Sussex and Kent Counties in Delaware, and Accomack, Charles City, Gloucester, James City, King and Queen, Mathews, Middlesex, New Kent, Richmond, Williamsburg, and York Counties in Virginia. Table 3.2-32 provides annual GHG emissions from PRC operations associated with Alternative 2, compared with this larger study area's baseline annual GHG emissions.

Table 3.2-32 Greenhouse Gas Annual Emissions, Alternative 2

Source	***Annual Pollutant Emissions (tpy)***	
	CO_2e (tons/yr)	***CO_2e (MT/yr)***
Aircraft operations	275,293	249,742
Aircraft in-frame maintenance	4,967	4,506
OAETC	1,528	1,386
GSE	2,543	2,307
Vessels	4,473	4,058
Munitions	4	3
Alternative 2 total	**288,808**	**262,002**
Net Change from Baseline	51,003	46,269
Air Basin 1 (MD)	3,368,690	3,056,025
Air Basin 2 (VA)	3,234,896	2,934,649
Air Basin 3 (DE)	4,398,940	3,990,652
Study Area total	**11,002,526**	**9,981,326**
Percentage of Study Area	*0.46%*	*0.46%*

Key: CO_2e = carbon dioxide equivalent; DE = Delaware; GSE = ground support equipment; MD = Maryland; MT/yr = metric tons per year; OAETC = Open-Air Engine Test Cell Facility; Pb = lead; PRC = Patuxent River Complex; tpy = tons per year; VA = Virginia.

General Conformity – Alternative 2 (Preferred Alternative)

Because GSE would be operated only in St. Mary's County, Maryland, and no vessels or munitions would be operated or expended in the nonattainment areas, only aircraft flight hours have the potential to impact general conformity in the Calvert and Sussex County nonattainment areas and Kent County (Delaware) and Charles City, Gloucester, James City, and York County (Virginia) maintenance areas. Table 3.2-33 compares the potential air emissions from PRC flight operations over Calvert County to the *de minimis* levels set by USEPA. Pollutant emissions under Alternative 2 would be well below the *de minimis* levels; therefore, there would be no negative impact on regional air quality and a general conformity determination is not applicable to the Proposed Action under Alternative 2. There are no aircraft or other operations occurring below 3,000 feet AGL in any of the other counties. However, because PRC airspace partially overlaps these counties, they were included in the conformity applicability assessment because they are classified as being in nonattainment or maintenance. Since there are no emissions, emissions are obviously below the *de minimis* levels and a general conformity determination is not applicable to the Proposed Action under the Alternative 2.

Table 3.2-33 Conformity Analysis for Alternative 2

Source	***Alternative 2 Annual Pollutant Emissions (tpy)***						
	CO	***NO_X***	***PM_{10}***	***$PM_{2.5}$***	***SO_2***	***VOC***	***Pb***
Alternative 2 aircraft emissions in the Calvert County nonattainment area	107	13.99	8.49	8.49	1.83	30.97	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 2 aircraft emissions in the Sussex County nonattainment area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 2 aircraft emissions in the Kent County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 2 aircraft emissions in the Charles City County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 2 aircraft emissions in the Gloucester County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 2 aircraft emissions in the James City County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**No**	
Alternative 2 ircraft emissions in the York County maintenance area	0.00	0.00	0.00	0.00	0.00	0.00	0.00
De minimis levels		**100**				**50**	
Exceeds de minimis levels?		**No**				**NO**	

Key: CO = carbon monoxide; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

3.2.3.4 Alternatives Impact Summary

Summary of Impacts, Air Quality

Pollutants:

The greatest source of pollutants that potentially impact air quality is aircraft operations. Because GSE is operated only at the installations in St. Mary's County, Maryland (in attainment), and no vessels or munitions are operated or expended in the nonattainment areas, only aircraft flight hours have the potential to impact general conformity in the Calvert and Sussex County nonattainment areas and Kent County (Delaware) and Charles City, Gloucester, James City, and York County (Virginia) maintenance areas. A General Conformity applicability analysis was conducted, and pollutant emissions are well below the *de minimis* level. Thus, a formal General Conformity determination is not applicable.

No Action Alternative

- There would be no change to baseline historical levels of criteria pollutant or GHG emissions. All criteria pollutants from PRC testing and training reflect less than 16 percent of the PRC Study Area emissions.

Alternative 1

- Pollutant emissions would increase; however, they would not be expected to exceed any regulatory thresholds and would continue to represent a very small portion of overall PRC Study Area annual emissions that contribute to regional air quality. Specifically, all criteria pollutants from PRC testing and training reflect less than a 5 percent change of the PRC Study Area emissions from the baseline.

Alternative 2 (Preferred Alternative)

- Pollutant emissions would represent a slightly larger increase than under Alternative 1 but would still not exceed regulatory thresholds and would continue to represent a very small portion of overall PRC Study Area annual emissions that contribute to regional air quality. Specifically, all criteria pollutants from PRC testing and training reflect a 7 percent or less change of the PRC Study Area emissions from the baseline.

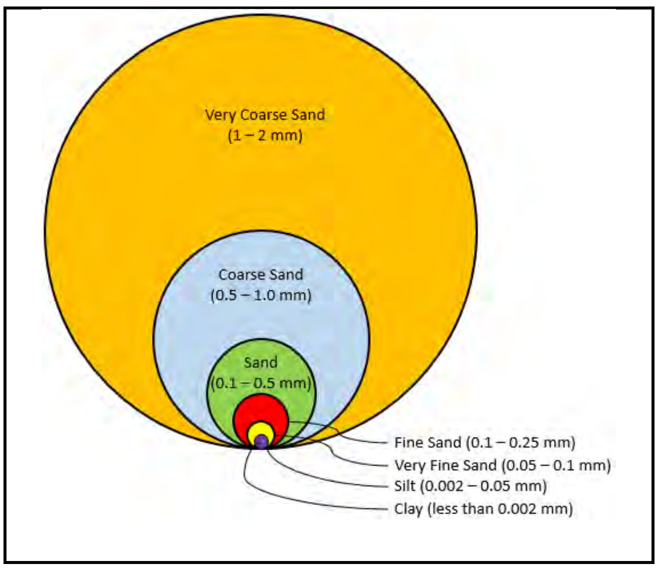
3.3 Water Resources and Sediments

This discussion addresses surface water and sediment quality, including their chemical and physical composition as affected by natural conditions and human activities. This section does not address groundwater because the Proposed Action would not include construction or other ground-disturbing activities that would affect groundwater resources, such as drinking water supplies. Similarly, the Proposed Action or alternatives would not require any new construction or testing and training activities with the potential to physically alter the shorelines at Naval Air Station (NAS) Patuxent River or at Outlying Field (OLF) Webster in a manner that would affect stability (e.g., erosion) or susceptibility to inundation from storm surges or sea level rise within the Patuxent River Complex (PRC) Study Area. In addition, this section does not address freshwater resources, wetlands, or floodplains because the Proposed Action would not occur in freshwater bodies, involve construction or modification of any structures within a wetland or floodplain, or include modifying lands in a manner that would affect stormwater runoff flows or risks of flooding (Section 3.0.2.2, Resources and Issues Eliminated from Further Consideration).

Proposed Action testing and training activities with the potential to affect surface water and sediments would occur in estuarine waters of the Chesapeake Bay and tributaries. The Chesapeake Bay is the largest estuary in North America. The surface area of the Chesapeake Bay and its tidal tributaries encompasses approximately 4,480 square miles. An estuary is generally defined as a partially enclosed, coastal water body where freshwater from rivers and streams mixes with salt water from the ocean. Although influenced by the tides, estuaries typically are protected from the full force of ocean waves, winds, and storms by landforms such as barrier islands or peninsulas. Estuaries are considered highly productive environments that support unique communities of plants and animals specially adapted for life at the margin of the sea (U.S. Environmental Protection Agency, 2018).

Sediments consist of solid fragments of organic and inorganic matter at the bottom of water bodies. Sediments in the aquatic environment are either terrigenous, meaning that they originate from land, or are biogenic (i.e., formed from the remains of marine organisms). Terrigenous sediments come from the weathering of rock and other substrates and are transported by water, wind, and ice (glaciers) to the sea floor.

Sands range in size from 0.05 millimeter (mm) (very fine sands) to 2 mm (very coarse sands) in diameter (Figure 3.3-1). For comparison, the thickness of a nickel is approximately 2 mm. Sediment types smaller than sands are silts (0.002 to 0.05 mm in diameter) and clays (particles less than 0.002 mm in diameter). Silts, clays, and any combinations thereof are often referred to as mud. Sediments larger than very coarse sands (2 to 76 mm) include gravels, cobbles, and boulders (United States Department of Agriculture, 2017). Through the downward movement of organic and inorganic particles in the water column, many substances that are otherwise scarce in the water column are concentrated in bottom sediments (Chapman et al., 2003).



Source: (U.S. Department of the Navy, 2018a)
Key: mm = millimeter.

Figure 3.3-1 Sediment Particle Size

3.3.1 Water Resources and Sediments, Regulatory Setting

The Clean Water Act of 1972 (CWA) (33 United States Code section 1251 et seq.), and subsequent amendments, was designed to assist in restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. This covers the discharge of pollutants into navigable waters, wastewater treatment management, and protection of relevant fish, shellfish, and wildlife.

The CWA requires states to specify aquatic life and recreation as designated uses but leaves specification of other uses up to the states. A *designated use* is a goal for water quality. Typically, the goal is the description of an appropriate intended use by humans and/or aquatic life for a water body. The designated uses established may or may not be met currently but must be attainable.

In addition, the CWA requires that states establish a Section 303(d) list to identify impaired waters and total maximum daily loads (TMDLs) for the sources causing the impairment. A water body can be deemed impaired if water quality analyses conclude that exceedances of water quality standards occur. A TMDL is the maximum amount of a substance that can be assimilated by a water body without causing impairment.

The Department of Defense (DoD) recognizes that munitions used as intended on a military range have the potential to enter the environment and potentially endanger public health or the environment. To ensure responsible management of military ranges, DoD requires that the military services conduct Operational Range Assessments (DoD Instruction 4715.14) to determine if unacceptable risk to human health and the environment, including water quality, is occurring at the operational range. The Office of the Chief of Naval Operations Manual (OPNAV-M) 5090.1, Chapter 15, Operational Range Environmental Sustainment, addresses the Navy's requirements for implementing DoD Instruction 4715.14. The Navy has established water resource policies to ensure its compliance with federal regulations.

3.3.2 Water Resources and Sediments, Affected Environment

The following sections provide a description of the existing conditions for water resources and sediments at NAS Patuxent River, OLF Webster, and the Chesapeake Bay Water Range. Freshwater bodies at NAS Patuxent River and OLF Webster as well as the Bloodsworth Island Range are not part of the affected environment nor included in this analysis because testing or training activities associated with the Proposed Action would not affect those waters.

3.3.2.1 Surface Water

NAS Patuxent River

NAS Patuxent River is situated on a peninsula at the mouth of the Patuxent River (Figure 1.3-3, NAS Patuxent River). The tidally influenced portion of the Lower Patuxent River adjacent to NAS Patuxent River is referred to as the Patuxent River Mesohaline (PAXMH) segment. The designated use class for this segment is Class II – Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting. Maryland Department of the Environment's *2016 Integrated Report of Surface Water Quality,* which was prepared in accordance with Section 303(d) of the CWA, identified the PAXMH segment as impaired with respect to polychlorinated biphenyls (PCBs) in fish tissue with a requirement for a water quality analysis (Maryland Department of the Environment, 2017a). Both point and non-point sources of PCBs have been identified throughout the tidal portions of the watersheds. Non-point sources include direct atmospheric deposition to the river, runoff from regulated and nonregulated watershed areas, one contaminated site (the Patuxent Wildlife Research Center), and tidal influence from the Chesapeake Bay main stem. Point sources include regulated discharges within the watershed, permitted municipal wastewater treatment plants, and one permitted industrial process water facility. The Maryland Department of the Environment developed a TMDL to address water quality impairments due to PCBs, and it was approved by the U.S. Environmental Protection Agency (USEPA) in 2017 (Maryland Department of the Environment, 2017b).

The PAXMH segment of the Patuxent River Lower watershed is also impaired with respect to nutrients (nitrogen and phosphorus), total suspended solids (TSS)/sediment, and coliform bacteria. Point sources and agriculture are major sources of nutrients, and agriculture and urban runoff are primary sources of suspended sediments. Coliform bacteria sources include runoff from agriculture, pet and wildlife waste, failing septic systems, and recreational vessel discharges. The Maryland Department of Natural Resources describes efforts to reduce nutrient and sediment loadings that include upgrades to wastewater treatment plants, septic system retrofits, improved control of stormwater runoff, and implementation of agricultural best management practices (Maryland Department of Natural Resources, 2015). Nutrient and TSS/sediment loadings were addressed as part of the 2010 Chesapeake Bay TMDL (U.S. Environmental Protection Agency, 2010a).

Multiple subsegments of the PAXMH segment were identified as impaired with respect to fecal coliform bacteria. Recreational and commercial shellfish harvesting currently are not permitted at NAS Patuxent River (U.S. Department of the Navy, 2017c).

OLF Webster

OLF Webster is situated on a peninsula at the mouth of the St. Mary’s River, which is a tributary of the Potomac River, within the St. Mary’s River watershed (Figure 1.3-4, OLF Webster). Surface waters adjacent to OLF Webster include the St. Mary’s River, St. Inigoes Creek, and Molls Cove (U.S. Department of the Navy, 2017c).

The Maryland surface water use designation for the tidal portions of the St. Mary’s River watershed is Class II – Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting. Water quality of the adjacent tidal portions of St. Mary’s River, St. Inigoes Creek, and Lower Potomac River Mesohaline segments of the St. Mary’s watershed is impaired by one or more of the following: nutrients (nitrogen and phosphorus), fecal bacteria, and TSS/sediments, primarily from agricultural runoff. While the St. Mary’s River was formerly listed as impaired due to PCBs in fish tissues, PCBs levels in the river currently meet the water quality standard (Maryland Department of the Environment, 2014). Furthermore, TMDLs have addressed the impairments due to nutrients, coliform bacteria, and TSS/sediments (Maryland Department of the Environment, 2014).

Chesapeake Bay Water Range

The Chesapeake Bay Water Range is located in the middle bay portion of the Chesapeake Bay. The Chesapeake Bay receives freshwater inflows from 150 major rivers and streams, although approximately 80 percent of the freshwater input is from three rivers: the Susquehanna, Potomac, and James Rivers (Chesapeake Bay Program, 2019a). Water depths in the Chesapeake Bay Water Range vary from about 3 feet along the shoreline to over 160 feet in the middle portions of the Bay associated with the shipping channel (National Oceanic and Atmospheric Administration, 2006). The tidal range in Chesapeake Bay varies from about 3 feet near the mouth of the Bay to 1 foot in the northern Bay. Average tidal current velocities decrease from a maximum of 1.03 meters per second (3.38 feet per second) at the mouth to a minimum of 0.13 meter per second (0.43 foot per second) in the middle Bay (Xiong & Berger, 2010).

The Chesapeake Bay Water Range is located in the Lower Chesapeake Bay Mesohaline Maryland (CB5MH_MD) basin. Designated uses of this segment are open-water fish and shellfish, deep-water seasonal fish and shellfish, deep-channel seasonal refuge, and shallow-water bay grass. These are described in Table 3.3-1 below.

Table 3.3-1 Designated Uses in the Chesapeake Bay Water Range

Designated Use	***Chesapeake Bay Habitats and Communities Protected***
Open-water fish and shellfish	Diverse populations of sport fish, including striped bass, bluefish, mackerel, and sea trout, as well as important bait fish such as menhaden and silversides in surface water habitats within tidal creeks, rivers, embayments, and the main stem Chesapeake Bay year-round
Deep-water seasonal fish and shellfish	Animals inhabiting the deeper transitional water column and bottom habitats between the well-mixed surface waters and the very deep channels during the summer months (e.g., bottom-feeding fish, crabs, and oysters, as well as other important species, including the bay anchovy)
Deep-channel seasonal refuge	Bottom-sediment-dwelling worms and small clams that serve as food for bottom-feeding fish and crabs in the very deep channels in summer
Shallow-water bay grass	Underwater bay grasses and fish and crab species that depend on the shallow-water habitat provided by underwater bay grass beds

Source: (U.S. Environmental Protection Agency, 2010a)

The flow of ocean waters into the Chesapeake Bay tends to be stronger along the Bay's eastern shore as a result of the earth's rotation while simultaneously forcing the freshwater flowing from the Bay's major tributaries along the western shore to the south, generating a counterclockwise circulation pattern (Boicourt et al., 1999). This results in typically higher salinities in the eastern portion of the Bay than in the western portion of the Bay. Salinity also displays a vertical gradient in the Bay, with less saline surface and near-surface waters compared to bottom waters. Salinities are typically lower in the spring, when freshwater inflows are highest due to melting snow and increased rainfall, and higher in the autumn, when freshwater flows are lowest (Xu et al., 2012). Salinity differences between surface and bottom water layers contribute to density stratification of the water column, which can inhibit vertical mixing (Boicourt et al., 1999). The portion of the Chesapeake Bay in the vicinity of the Chesapeake Bay Water Range is characterized by brackish, mesohaline waters, with salinity levels typically in the range of 13 to 17 parts per thousand and naturally high turbidity levels.

Concentrations of dissolved oxygen (DO) are typically low when water salinity is high and vice versa. Hypoxic conditions (DO less than 2 milligrams per liter [mg/L]) recur annually in the Bay, typically during summer and coinciding with increasing salinity stratification along with higher seasonal riverine input and nutrient loadings (Sanford, 1990). For most or all of the summer, moderate hypoxia to anoxia is characteristic of the deep waters of the shipping channel. Normal conditions (i.e., DO concentrations greater than 5 mg/L) typically return in the early fall and persist through the winter months. Figure 3.3-2 depicts warm season salinities and DO concentrations in the Bay. More detailed discussions of hypoxia are provided in Section 3.4 (Biological Resources).

In 1998 most of the Chesapeake Bay and its tidal waters were listed as impaired due to excess nitrogen, phosphorus, and suspended sediment. These pollutants cause algae blooms that consume oxygen and create "dead zones" where fish and shellfish cannot survive, block sunlight that is needed for underwater Bay grasses, and smother aquatic life on the bottom. The high levels of nitrogen, phosphorus, and suspended sediment are from agricultural operations, urban and suburban stormwater runoff, wastewater facilities, air pollution, and other sources, including onsite septic systems (Boynton, 2000).

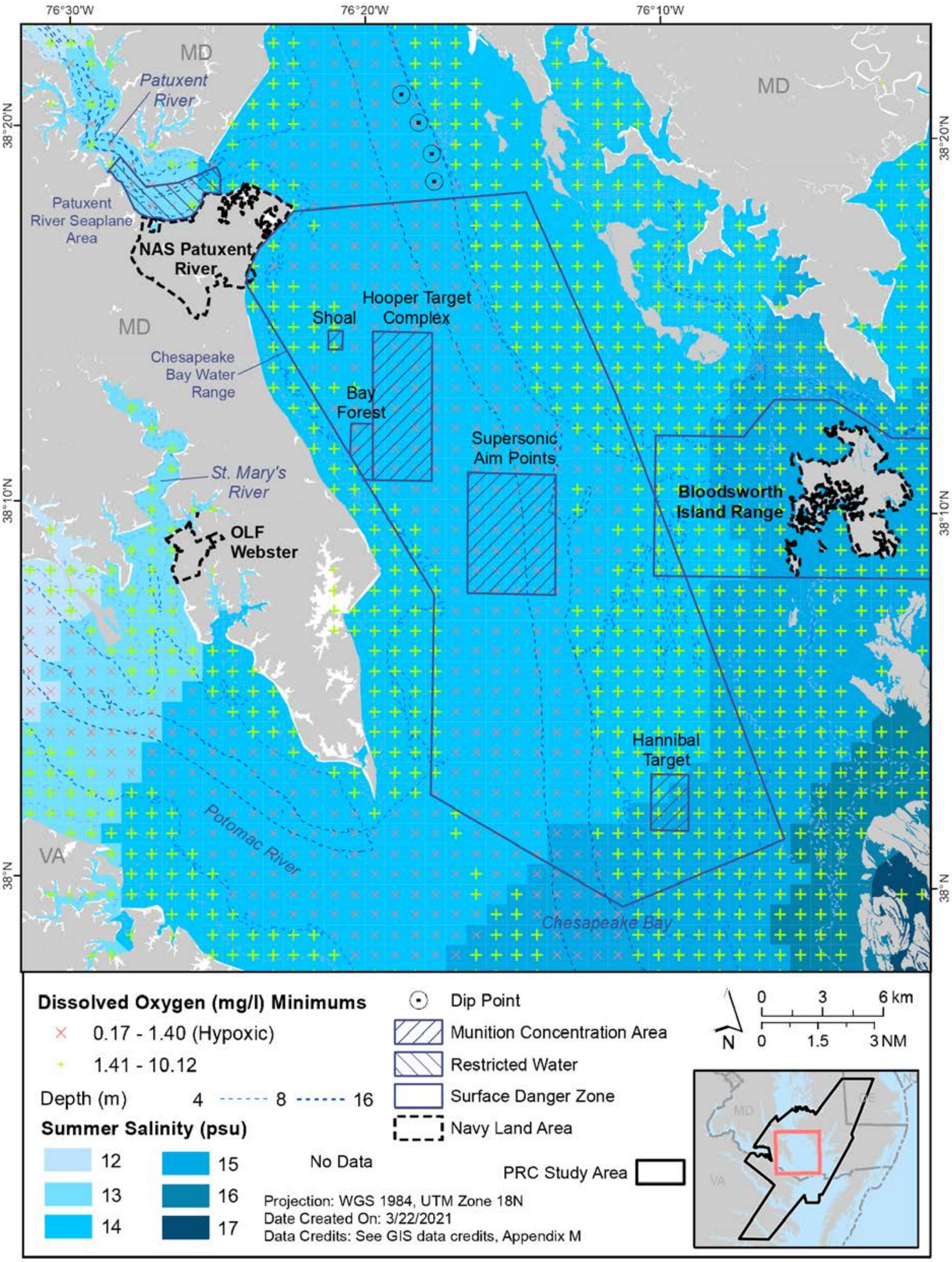


Figure 3.3-2 Characterization of the PRC Water Column During the Warm Season in Terms of Salinity and Dissolved Oxygen (Minimums)

Due to insufficient progress toward meeting the water quality goals for the Chesapeake Bay and its tidal waters, the Chesapeake Bay TMDL was established by USEPA in December 2010. The TMDL was designed to achieve significant reductions in nitrogen, phosphorus, and suspended sediment pollution throughout individual Chesapeake Bay tidal segments and included pollution limits that are sufficient to meet state water quality standards for DO, water clarity, underwater Bay grasses, and chlorophyll *a* (U.S. Environmental Protection Agency, 2010a).

Water quality impairments within the CB5MH_MD basin, including the Chesapeake Bay Water Range, associated with excess nutrient and suspended sediment loadings were addressed in the 2010 Chesapeake Bay TMDL report (U.S. Environmental Protection Agency, 2010a). Portions of the CB5MH_MD basin are listed in the most recent water quality report, the *Final 2018 Maryland Integrated Report of Surface Water Quality*, as Category 5 waters (requiring development of a TMDL) related to low index of biological integrity scores due to unknown causes (Maryland Department of the Environment, 2018).

In addition to water quality issues related to excess nutrients and suspended sediments, surface waters throughout the Chesapeake Bay are affected by plastic pollution (Yonkos et al., 2014; Chesapeake Bay Program, 1999). Concentrations of plastics vary widely, but comparatively higher concentrations are associated with higher population densities and proportions of urban and suburban development within individual watersheds. Concentrations of plastics in surface waters of the Bay also tend to be higher following major rain/runoff events (Yonkos et al., 2014). Microplastic concentrations ranging from 0.009 to 1.245 particles per cubic meter have been reported for Chesapeake Bay waters, with concentrations ranging from 0.009 to 0.532 particles per cubic meter along the northern boundary of the Chesapeake Bay Water Range (Bikker et al., 2020). Currently, there is no water quality standard for plastics.

Watershed sources are also responsible for metals loading to the Chesapeake Bay. Primary sources include point source effluents (industrial operations and municipal treatment plant discharges), non-point source runoff (boating and shipping activities, urban stormwater, agricultural runoff, mining operations, and weathering), and atmospheric deposition (wet and dry deposition from evaporation of leaded fuel and coal combustion) (U.S. Environmental Protection Agency et al., 2012). It is estimated that these sources combined add 560,000 pounds of lead, 9,500 pounds of mercury, 710,000 pounds of copper, and 94,000 pounds of cadmium per year to the Chesapeake Bay (Chesapeake Bay Program, 1999). According to USEPA, between 2008 and 2011, the Virginia Department of Environmental Quality collected dissolved metals samples from near-surface waters at 130 sites within tidal portions of the Chesapeake Bay watershed. No exceedances of chronic saltwater standards were observed for any of the metals evaluated, including copper and lead (U.S. Environmental Protection Agency et al., 2012). Thus, waters within the Chesapeake Bay Water Range are not impaired due to metals.

3.3.2.2 Sediments

Chesapeake Bay Water Range

Sediments in the Chesapeake Bay are largely terrigenous and contain only 1 to 3 percent organic material (U.S. Geological Survey, 2003). The geologic profile (i.e., profile of the land surface, rock, and sediment formations) of the middle Chesapeake Bay is primarily influenced by stormwater runoff and stream bank and upland erosion processes that move sediments (e.g., silts, clays and rock fragments) into the Bay and its tributaries. This influx results in sediment transitions from sand in shallow regions to clay-sand and sand-silt-clay composites (i.e., mud) as depths increase (U.S. Geological Survey, 2003). The bottom areas of the Chesapeake Bay Water Range, which underlie water depths exceeding 50 feet, are predominantly characterized by silty-clay sediments (Figure 3.3-3).

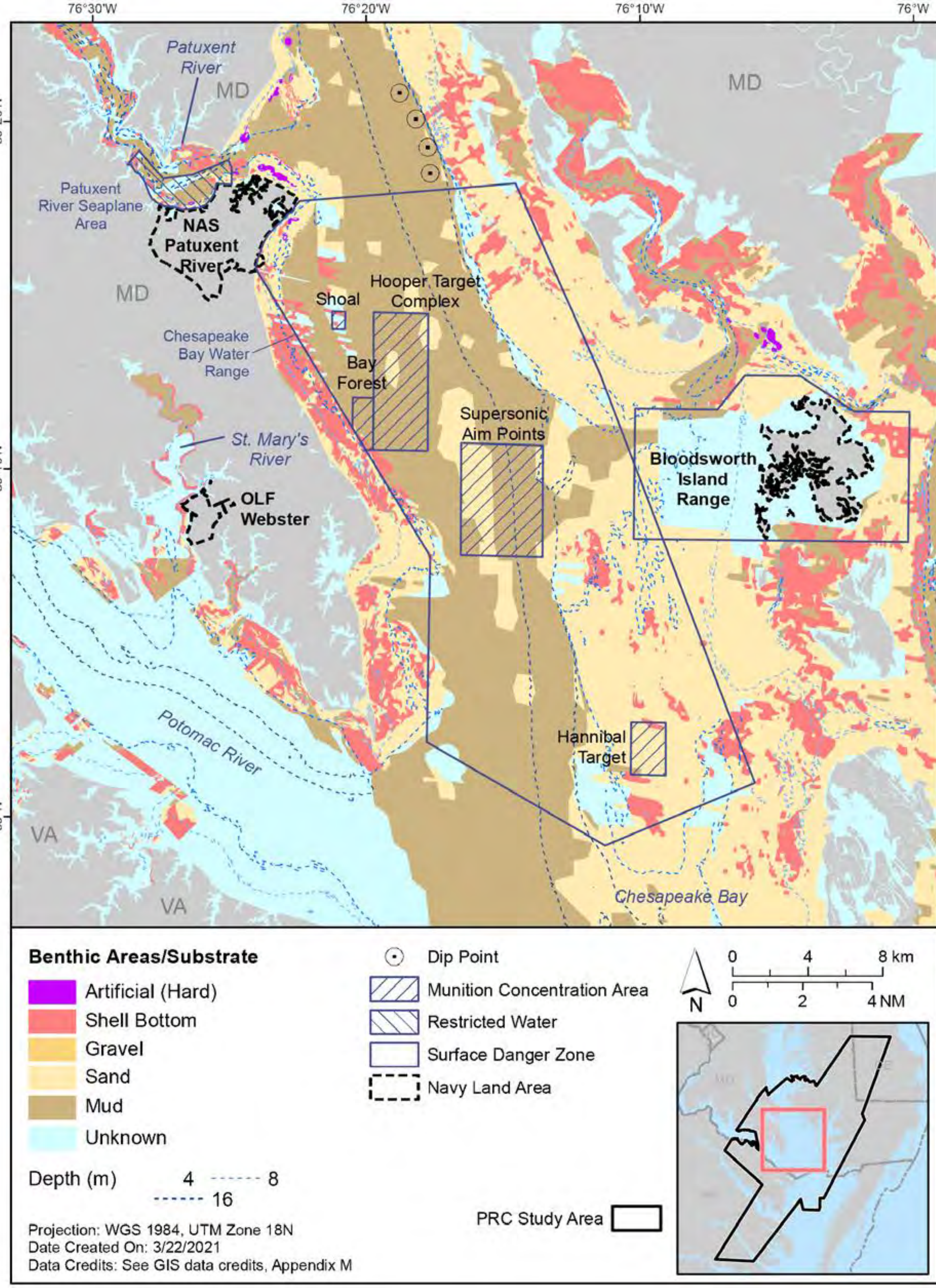


Figure 3.3-3 Characterization of Chesapeake Bay Water Range Bottom Types

The predominant surface sediment makeup for each of the Chesapeake Bay Water Range areas of concentrated use are as follows (Maryland Department of Natural Resources, 1999):

- The Shoal Impact and Recovery Area has a sandy bottom. The Bay Forest Impact and Recovery Area is primarily characterized by silty-clay (mud) sediments, and the Hooper Target Complex exhibits features of sand, silt, and clay sediments in various proportions and composites.
- The primary supersonic aim point, SS1, has a sandy bottom; SUP has a clay bottom, whereas SS2 and SS3 are characterized by silty-clay bottom sediments.
- The Hannibal Target is moored in an area of shallow water with a sand bottom, with approximately 3.5 nautical miles of sandy bottom stretching out from the target in all directions.

Sedimentation rates in the Bay are relatively high—on the order of 0.1 to 1 centimeter per year—and sedimentation rates vary widely depending on the region. For example, sedimentation rates can easily vary five- to tenfold over small and large spatial scales. Spatial variability is evident, especially throughout the main stem of the middle bay where the Chesapeake Bay Water Range is located (U.S. Geological Survey, 2003). Results of testing indicate that most of the sediments within the main stem of the Bay are relatively uncontaminated, whereas sediments within tributaries have higher contaminant concentrations (Hartwell & Hameedi, 2007).

3.3.3 Water Resources and Sediments, Environmental Consequences

This section evaluates how and to what degree the testing and training activities may impact water resources and sediments in the PRC Study Area. Activities associated with air- and land-based testing and training and directed energy weapons testing listed in Table 2.3-1 (Annual PRC Operational Tempo per Alternative: Activities and Assets) and Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems) would not affect water resources or sediments and, therefore, are not included in the subsequent discussion.

The two stressors from the Proposed Action and alternatives that may impact water resources and sediments are physical disturbance and pollutants (Table 3.0-2, Stressor Potential to Impact Resource Areas). Physical disturbance primarily focuses on the potential impacts to sediments from testing and training activities that interact with the Bay floor. The potential impacts of pollutant stressors under conditions associated with the No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative) are evaluated based on the extent to which the release of military expended material constituents (MEMCs) could directly or indirectly impact sediments or water quality such that beneficial uses would be adversely affected. Table 2.3-1 (Annual PRC Operational Tempo per Alternative: Activities and Assets) and Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems) identify the materials recovered and the corresponding recovery rate for military expended materials (MEM). The term “stressor” is used because the MEMCs present in some munitions may affect water quality and/or sediment by altering the chemical characteristics. Stressors associated with Navy testing and training activities do not typically occur in isolation but rather occur in some combination. An analysis of the combined impacts of both stressors on water resources and sediments considers the potential consequences of aggregate exposure to all stressors and the repetitive or additive consequences of exposure over multiple years.

Factors considered when assessing impacts include context and intensity of any chemical, physical, or biological changes in sediment or water quality, violations of applicable water quality standards, and/or any changes to designated uses. Duration is characterized as either short term or long term. “Short term" is defined as days or months. "Long term" is defined as months or years, depending on the type of activity or the materials involved.

3.3.3.1 Water Resources and Sediments, No Action Alternative

Physical Disturbance

The only physical disturbance to water resources and sediments would be associated with the initial impact and recovery (where appropriate) of munitions and other MEM from the Bay floor and, secondarily, anchor deployments (vessels and stationary targets) and similar activities. As noted in Section 3.0 (Introduction), munitions and other MEM that may cause physical disturbance include live-fired (e.g., gun ammunition and rockets) and non-explosive munitions (e.g., bombs, mines, and missiles). Release of these assets would primarily occur in the Chesapeake Bay Water Range and would be focused around targets within the munition concentration areas shown in Figure 2.1-3 (Chesapeake Bay Water Range Munition Concentration Areas). Testing and training activities would be distributed throughout the year and, thus, the potential for physical disturbance would occur throughout the year.

The potential for MEM to physically impact marine substrates as they come into contact with the bottom depends on several factors, such as the size, shape, type, density, and speed of the material through the water column; the amount of the material expended; the frequency of testing or training; water depth, water currents, or other disturbances; and the type of substrate. Most of the kinetic energy of the expended material, however, is dissipated within the first few feet of the object entering the water, causing it to slow considerably by the time it reaches the substrate. Because the substrate disturbance caused by a strike is proportional to the force of the strike, smaller/lighter materials moving at slower speeds result in lesser direct strike impacts. In softer substrates (e.g., sand, mud, silt, clay, and composites), the impact of the expended material coming into contact with the bottom, if large enough and striking with sufficient momentum, may result in a depression and a localized redistribution of sediments as they are temporarily suspended in the water column.

Another potential physical disturbance that MEM could have on substrates would be to cover them or to alter the type of substrate and, therefore, its function as habitat. MEM that settle on intermediate, hard or artificial substrates, while covering the bottom, may serve a similar habitat function as the substrate it is covering by providing a hard surface on which organisms can attach. Most MEM that settle on soft bottom habitats, while not damaging the actual substrate, would inhibit the substrate's ability to function as a habitat by covering it with a hard surface. This would effectively alter the substrate from a soft surface to a hard structure and, therefore, would alter the habitat to be more suitable for organisms more commonly associated with hard surface environments. See Section 3.4 (Biological Resources) for discussion on bottom habitat impacts.

To estimate the magnitude of potential impacts on topography and abiotic substrate (e.g., sediments), an analysis was conducted using the two-dimensional footprint of MEM types relative to mapped substrate types (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis). For locations where MEM may be expended, 0.2 acre of impacted bottom potentially would be affected by MEM expenditures under the No Action Alternative. Therefore, the area potentially impacted represents a small (less than 0.0002 percent) portion of the bottom where impacts could occur. Cartridge casings are included in the footprint calculations, which yields conservative results since all casings from small-caliber gun ammunition fired from aircraft are retained within the aircraft and a portion of those fired from vessel platforms are retained within the vessel.

Based on the analysis, the highest percentage (0.008 percent) of bottom impacted occurs in the Hannibal Target munition concentration area, where the bottom is mostly sandy. Small arms ammunition have poor energy retention when fired into water, losing most of their energy within a few feet of entering the water (Noonan & Steves, 1970). This decrease in energy results in a slowed speed prior to impact with the bottom. Therefore, small arms ammunition does not impact the bottom with great velocity, resulting in only minor physical disturbance to sediments.

Depending on density of the material and substrate properties (including natural disturbance from waves and currents), MEM may become buried quickly, while in other areas they may persist on the sediment surface until they degrade over the long term. The majority of munition concentration areas have muddy substrate in deeper water, where heavier items would sink quickly below the sediment surface. The smaller portion of MEM landing on firm sand or shell bottom would take relatively longer to become buried. Approximately 65 percent of MEM falling on sandy substrate areas (e.g., Hannibal Target) would become buried in 90 days (Inman & Jenkins, 2002). MEM that settle in the shallower, more dynamic environments of the PRC Study Area (e.g., also Hannibal Target area) eventually could be covered over by sediments moving with currents and other coastal processes (e.g., storms and hurricanes).

Inadvertent contacts or strikes of firm or hard bottom substrates by vessels, anchors, or in-water devices could also cause physical disturbance to the Bay floor. However, contact could also cause damage to the vessel or device and, in most cases, is avoided when possible. The recovery of high-value, in-water devices (e.g., torpedoes) on firm, sandy substrate is an exception to a general avoidance of substrate impacts. An in-water device coming to rest on firm, sandy bottom would cause a localized disturbance of the substrate and the temporary replacement of soft substrate with artificial substrate. Recovery of the device by range support boat personnel or divers could also create another localized disturbance during removal activities. Soft sediment shoals are subject to natural, physical processes (e.g., currents and turbulence from waves and storms) that can quickly alter their form after such minor disturbances. Soft substrate in inshore waterways may also be subjected to physical disturbance due to propeller wash (e.g., turbulence from a vessel propeller) where the safety of the vessel is not imperiled but the sediment is physically disturbed. Bottom sediments in nearshore areas are also subject to constant influences from natural physical processes, such as currents, waves, and sedimentation, and biological activities that have a much greater effect on sediment stability than intermittent disturbances from testing and training activities.

Devices such as bottom crawlers would not permanently impact the substrate on which they are placed since deployment is temporary. Mine shapes are typically deployed over soft substrates in navigation corridors, where there is minimal risk of an anchor getting stuck on the bottom; deployment in rugged bottom areas with hard or artificial substrate are avoided. When dropping anchor, vessel crews also target soft substrate for the same reason. The substrate disturbance from mine shapes and anchors would likely be temporary and minimal based on the size of the Chesapeake Bay Water Range and low number of bottom devices deployed in the PRC Study Area.

Vessel operations, target deployments, and physical effects of munitions striking the water surface or descending through the water column would not result in any changes to the physical properties of marine waters that would alter natural mixing or circulation processes or generate wakes or waves with the potential for eroding adjacent shorelines due to the small vessel wakes and distance from shore. Due to the exposed and relatively high-energy shorelines in the PRC Study Area where testing and training activities take place, erosion due to vessel transit wakes would not be discernable from natural erosive forces (Zabawa & Ostrom, 1980).

Pollutants

Concerns regarding longer-term impacts to water and sediment quality are primarily related to pollutant stressors associated with metals released from the physical/chemical decomposition of MEM (which are not pollutants themselves) and other MEMCs (e.g., plastic and chemical constituents) into the water column and sediments. As discussed in Section 2.1.3.4 (Munitions and Other MEM), munitions used within the PRC are non-explosive steel shapes and contain steel, concrete, vermiculite, or other non-explosive materials (U.S. Department of the Navy, 1998). Although non-explosive munitions do not contain explosive warheads, some may contain propellant (e.g., live rocket or missile motors), fuse sensors, signal cartridges (also referred to as spotting charges), or other energetic materials. The majority of the constituents that make up the non-explosive munitions are not of potential concern (e.g., steel and iron). However, some inert munitions used on the range may contain a small percentage of constituents of potential concern, such as metals or plastic.

Metals

Metal surfaces such as munitions casings are susceptible to physical and chemical decomposition when immersed in water. The decomposition process has the potential to leach metals to the environment. However, this is a relatively slow process that is related to the density and surface area of the object, the mass loss, and the duration of exposure. Rates of mass loss vary, depending on whether the metal object is exposed or buried and environmental conditions (e.g., oxygen levels). Expended munitions present on the sediment surface have the greatest potential for corrosion, whereas the rate of metal corrosion of buried munition casings is reduced due to the lower DO concentrations. Munitions expended in an area with a sandy bottom are less likely to bury upon impact than those expended in an area with soft mud substrate. Therefore, for a sandy bottom, it is anticipated that more expended munitions would remain unburied on the Bay floor and have a comparatively greater exposure to corrosion than that of munitions expended in areas with a mud substrate (U.S. Department of the Navy, 2013c).

Because recovered munitions are removed from the water shortly after they are expended, the release of metals from these munitions are not a concern as they will not be in the water long enough for meaningful releases to occur. As indicated in Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems), typical recovery rates for expended munitions during the 10-year baseline were 55 percent and 80 percent for missiles and torpedoes, respectively, but 0 percent for bombs, rockets, chaff, and gun ammunition.

Overall, MEMC metals of potential concern (copper and lead) deposition under the No Action Alternative represent negligible to minor increases of annual metal inputs into the Bay due to continuation of testing and training activities. The greatest source of MEMC metals of potential concern (copper and lead) is primarily small-caliber gun ammunition.

The Navy performed predictive modeling (U.S. Department of the Navy, 2013c) to evaluate risks to human health and the environment under current operating conditions for the Chesapeake Bay Water Range. The predictive modeling found that it would take over 100 years of releases at current rates to exceed screening value levels in sediment and over 1,000 years to exceed screening values in water at the Hannibal Target area, which has the highest expected concentration of munitions and greatest mass of metal munition constituents. Other munitions release areas would be less affected.

Based on the modeling results (U.S. Department of the Navy, 2013c), the Navy concluded that the continuation of operations at the Chesapeake Bay Water Range would not pose unacceptable risks to human health or the environment and would not exceed water and sediment quality criteria. The study also concluded that the current range management and environmental compliance procedures were adequately protective and in compliance with applicable regulations (U.S. Department of the Navy, 2013c).

Because chaff contains aluminum and is released as part of previous and ongoing testing and training exercises, there is a potential that it could present a source of aluminum to Bay waters and sediment. Wilson et al. (2002) evaluated impacts from the Navy's chaff releases over the Chesapeake Bay and determined that releases resulted in minimal and statistically insignificant increases in aluminum concentrations in Bay sediments and sediment pore waters (i.e., water between sediment grains). They concluded that chaff releases did not adversely affect aluminum concentrations within the testing and training areas.

Other MEMCs

Other types of MEM, including flares, jet-assisted takeoff (JATO) bottles, signal cartridges/spotting charges, marine markers, sonobuoys, and chaff used during training and testing activities represent potential sources of MEMCs to the PRC. Flares are typically one of two types: decoy or illumination flares. Pyrophoric decoy flares are commonly based on magnesium or another hot-burning, highly reactive metal that ignites when exposed to air. Marine markers contain phosphorus and are designed to fully combust while on the water's surface. Illumination flares do not contain phosphorus.

The use of marine markers during testing and training activities associated with the Proposed Action represents a negligible source of phosphorus to the PRC Study Area because phosphorus contained in the markers typically is fully combusted during use. As discussed in Section 3.5 (Public Health and Safety), the dud rate (i.e., markers that do not ignite during deployment) is typically low, such that no residual reactive phosphorus remains. Phosphorus contained in a dud is consumed in an oxidizing environment (i.e., environment with oxygen), although it can be persistent in an anoxic environment (i.e., environment without oxygen). An extensive literature review and controlled experiments conducted by the U.S. Air Force revealed that decoy flare use poses little risk to the environment or animals (U.S. Department of the Air Force, 1997). Accordingly, the impact of phosphorus on water resources in the PRC Study Area is considered negligible.

Sonobuoys typically contain both metal and nonmetal components, such as nickel-plated/steel-coated housing covered with polyvinyl chloride plastic to reduce corrosion, containing approximately 1 pound of metals (i.e., lead and copper) per buoy. Lithium batteries used in sonobuoys normally consist of a nickel-plated steel jacket containing sulfur dioxide, lithium, carbon, acetonitrile, and lithium bromide. During battery operation of the sonobuoy, the lithium reacts with the sulfur dioxide and forms lithium dithionite. Once the cell is activated, the reaction proceeds nearly to completion prior to battery termination and only a small amount of reactants remain when the battery life ends. These residual materials are expected to gradually dissolve and/or become diluted by Bay tides and currents. After battery life expires (which takes no more than eight hours), the sonobuoy scuttles itself and sinks to the bottom. Once scuttled, the outside metal case may become encrusted from seawater processes and marine organisms, further slowing the rate of corrosion. Expended sonobuoys would not be expected to pose any risk to human health or the environment.

A JATO bottle consists of an aluminum body. The rocket propellant of bottles used at the Chesapeake Bay Water Range is an energetic of nitrocellulose and nitroglycerin. Certain types of bottles contain ammonium perchlorate; however, these types of bottles are not and have not been expended in the Chesapeake Bay Water Range in over a decade. Due to the energetics being consumed during firing and subsequent dilution by Bay waters, a minute fraction of total perchlorate may have been deposited at the firing points; therefore, energetics from JATO units would not be expected to pose any risk to human health or the environment.

Most of the MEMCs in rockets, flares, signal cartridges/spotting charges, and marine markers are consumed during use. Any residual constituents would be diluted by the waters of the Chesapeake Bay to extremely low concentrations. Further chemical breakdown and degradation would further reduce any effects to water or sediment quality.

Some munitions and other MEM used for testing and training in the Chesapeake Bay Water Range contain small amounts of plastic, such as that associated with chaff cartridge end caps and flare pads and pistons. The plastic residuals are not recovered after the munitions are expended. Given the limited numbers of munitions and MEM expended, the small amounts of plastic contained in the munitions, and intermittent use, this represents a negligible contribution to loadings. As mentioned in Section 3.3.2.1 (Surface Water), concentrations of microplastics in Chesapeake Bay vary widely, but higher concentrations are associated with higher population densities and urban and suburban development within individual watersheds (Yonkos et al., 2014). Also, microplastic concentrations in water samples from the northern portion of the Chesapeake Bay Water Range generally were in the lower end of the range of concentrations for the larger Chesapeake Bay study area (Bikker et al., 2020), suggesting that prior testing and training in the Chesapeake Bay Water Range has not resulted in elevated microplastic concentrations.

Combined Stressors

A number of activities related to the No Action Alternative, including anchor deployment and recovery activities (e.g., vessels and stationary targets), bottom crawlers, impacts of sinking non-explosive munitions and other MEM and target fragments on the Bay floor, would result in both minor physical disturbances to bottom sediments as well as short-term changes in water quality. These changes primarily would be related to resuspension of bottom sediments, which would result in localized increases in suspended sediment concentrations and turbidity levels in near-bottom water layers.

The amount of sediment resuspended into the water column from disturbances to the Bay floor would depend on a number of factors, such as the composition of the substrate (e.g., proportions of sand, silt, and clay, water content, and cohesion), the size and mass of an anchor or MEM impacting the bottom, and methods used for MEM recovery. In general, sediments resuspended into the water column would resettle rapidly (within minutes to hours) to the Bay floor depending on sediment properties (sand would settle faster than silt or clay particles), height of particles resuspended above the bottom, density stratification of the water column, and current strength. During the settling period, suspended particles may be transported laterally by currents.

These minor and temporary increases in turbidity would occur within the MEM disturbance/strike footprints. As discussed in Appendix E (Military Expended Materials and Physical Disturbance and Strike Analysis) and shown in Table 3.3-2, bottom disturbance footprints represent only a minor portion of the target areas. In addition, small arms ammunition have poor energy retention when fired into water, losing most of their energy within a few feet of entering the water (Noonan & Steves, 1970) and therefore would not impact the bottom with great velocity. Excluding the contributions to bottom disturbance from small-arms ammunition would result in comparatively smaller footprints. When coupled with the sand bottom present at the site (sand settles out of the water column relatively quickly when compared to silts and clays), only minor, temporary increases in turbidity would result from expended munitions. These disturbances would be localized, and the spatial extent would be limited to a few meters from where the bottom was impacted. As testing and training activities would be distributed throughout the year and at different locations, it is unlikely that turbidity impacts from separate activities or exercises would merge or interact.

Sediment disturbance could also result in minor decreases in DO concentrations as a result of resuspension of sediments with an oxygen demand. However, the Chesapeake Bay is subject to large, short-term variability in DO concentrations associated with physical processes in the Bay (Sanford, 1990). It is unlikely that short-term and localized sediment resuspension events associated with the No Action Alternative would measurably reduce DO concentrations in Bay waters. The No Action Alternative would not affect Chesapeake Bay sedimentation rates or loading (e.g., not add sediments). Most of the PRC Study Area shorelines are either highly developed with artificial structures or relatively exposed with a mixture of sediment shorelines and fringing wetlands. Due to the exposed and relatively high-energy shorelines, vessel transit wake would not be expected to contribute to Chesapeake Bay sediment loading (Zabawa & Ostrom, 1980).

Table 3.3-2 Annual Physical Disturbance Footprints for the Hannibal and Hooper Target Areas

Ordnance Concentration Area/Target	*No Action Alternative MEM footprint (square feet)*	*% of Target Area*	*Alternative 1 MEM footprint (square feet)*	*% of Target Area*	*Alternative 2 MEM footprint (square feet)*	*% of Target Area*
Hannibal	4,130	0.008	6,323	0.011	7,323	0.012
Hooper	4,866	0.002	9,829	0.004	11,343	0.005

Key: MEM = military expended materials.

Therefore, under the No Action Alternative, physical disturbance and pollutant stressors would not adversely affect designated beneficial use or pose unacceptable risks to human health or the environment.

3.3.3.2 Water Resources and Sediments, Alternative 1 Potential Impacts

Physical Disturbance

Under Alternative 1, potential impacts would be similar to but slightly higher (due to increased testing and training activities and non-explosive munitions and other MEM) than those described for the No Action Alternative. Table 3.3-2 presents annual physical disturbance footprints of the alternatives for the Hannibal and Hooper Target areas.

Although the disturbance area associated with the Alternative 1 footprints would be larger than those associated with the No Action Alternative, the overall physical disturbance effect on sediment in the PRC Study Area would be negligible due to the relatively small affected areas when compared to the size of the target areas and Chesapeake Bay.

Pollutants

Due to the increased testing and training activities, pollutant impacts from non-explosive munitions and other MEM would be similar to but slightly higher than those described for the No Action Alternative. Alternative 1 would include the use of marine markers within the Patuxent River Seaplane Area and sonobuoys at the dip points, which would not be included for the No Action Alternative. However, because marine markers would be consumed during use and sonobuoys would be scuttled, impacts to water and sediment quality would be the same as those for the Chesapeake Bay Water Range under the No Action Alternative. Under Alternative 1, impacts from pollutant stressors to water quality and sediments would not adversely affect a designated beneficial use or pose unacceptable risks to human health or the environment.

Combined Stressors

As shown in Table 3.3-2, the physical disturbance footprints under Alternative 1 would be comparatively higher than those associated with the No Action Alternative. Regardless, the portion of the areas affected would remain small. Changes to water quality due to sediment resuspension related would remain temporary and localized. Consequently, the effects of the combined stressors of physical disturbance and pollutants would not adversely affect a designated beneficial use or pose unacceptable risks to human health or the environment.

3.3.3.3 Water Resources and Sediments, Alternative 2 (Preferred Alternative) Potential Impacts

Physical Disturbance

Due to increased testing and training activities under Alternative 2, physical disturbance from non-explosive munitions and other MEM would be similar to but slightly higher than those described for the No Action Alternative. Table 3.3-2 presents annual physical disturbance footprints for each of the alternatives for the Hannibal and Hooper Target areas.

Although the disturbance area associated with the Alternative 2 footprints would be larger than those associated with the No Action Alternative, the overall physical disturbance effect on sediment in the PRC Study Area would be negligible due to the relatively small affected areas when compared to the size of the target areas and Chesapeake Bay.

Pollutants

Due to the increased testing and training activities under Alternative 2, pollutant impacts from non-explosive munitions and other MEM impacts would be similar to but slightly higher than those described for the No Action Alternative. Alternative 2 would include the use of marine markers within the Patuxent River Seaplane Area and sonobuoys at the dip points, which would not be included for the No Action Alternative. However, because marine markers would be consumed during use and sonobuoys would be scuttled, impacts to water and sediment quality would be the same as those for the Chesapeake Bay Water Range under the No Action Alternative. Regardless, under Alternative 2, impacts from pollutant stressors to water quality and sediments would not adversely affect designated beneficial use or pose unacceptable risks to human health or the environment.

Combined Stressors

As shown in Table 3.3-2, the physical disturbance footprints under Alternative 2 would be comparatively higher than those associated with both the No Action Alternative and Alternative 1. Regardless, the portion of the areas affected would remain small. Changes to water quality due to sediment resuspension related would remain temporary and localized. Consequently, the effects of the combined stressors of physical disturbance and pollutants would not adversely affect a designated beneficial use or pose unacceptable risks to human health or the environment.

3.3.3.4 Alternatives Impact Summary

Summary of Impacts, Water Resources and Sediments

Physical Disturbance:

No Action Alternative

- Impacts would consist of minor, localized, and short-term (depending on sedimentation rate) changes to bottom contours and bottom type due to initial impact and recovery of munitions and other MEM from the Chesapeake Bay floor as well as from anchor deployments and similar activities.

Alternative 1

- Impacts would be similar to but slightly higher (due to increased testing and training activities and non-explosive munitions and other MEM) than those described for the No Action Alternative.

Alternative 2 (Preferred Alternative)

- Due to increased testing and training activities under Alternative 2, physical disturbance from non-explosive munitions and other MEM would be similar to but slightly higher than those described for the No Action Alternative.

Pollutants (Military Expended Material Constituents):

No Action Alternative

- Impacts would include minor, localized, and short-term increases in turbidity associated with resuspended sediments from physical disturbance to bottom sediments.
- Impacts to beneficial uses of water resources would include a minor potential for releases of MEMCs.
- Pollutant stressors would not adversely affect designated beneficial use or pose unacceptable risks to human health or the environment.

Alternative 1

- Due to increased testing and training activities, impacts from non-explosive munitions and other MEM would be similar to but slightly higher than those described for the No Action Alternative.

Alternative 2 (Preferred Alternative)

- Due to the increased testing and training activities under Alternative 2, pollutant impacts from non-explosive munitions and other MEM would be similar to but slightly higher than those described for the No Action Alternative.

Combined Stressors:

No Action Alternative

- Impacts would consist of minor, localized, and short-term increases in turbidity and decreases in dissolved oxygen due to resuspension of bottom sediments related to physical disturbances.

Alternative 1

- Impacts would be similar to but slightly higher (due to slightly greater physical disturbance footprints) than those described for the No Action Alternative.

Alternative 2 (Preferred Alternative)

- Due to increased testing and training activities and slightly greater physical disturbance footprints under Alternative 2, changes to water quality would be slightly greater than those described for the No Action Alternative and Alternative 1, but would remain short term and localized.

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3.4 Biological Resources

Biological resources include living, native, or naturalized plant and animal species and their habitats. Whereas there are a wide variety of species that may occur in the Patuxent River Complex (PRC) Study Area, the focus of discussions in this section will be on those species and habitat features deemed of particular importance (e.g., threatened or endangered species, fishery species, species structuring the ecosystems) or interest (e.g., high relative abundance, unique stressor vulnerabilities). The biological resources section is organized differently than other resources in this document to accommodate a number of regulatory settings that require separate analysis.

The background information and analysis for biological resources in the PRC Study Area proceeds in the following order:

- Section 3.4.1 (Regulatory Setting) describes federal and state regulations pertaining to biological resources;
- Section 3.4.2 (Affected Environment) describes the affected biological sub-resource groups (e.g., vegetation, invertebrates, fishes) and the environmental baseline. The environment baseline describes the primary impacts on biological resources from human activities that provide important context for the subsequent analysis sections;
- Section 3.4.3 (Environmental Consequences) describes the generic approach to stressor-based analysis and provides the impact analysis for Proposed Action alternatives as required by the National Environmental Policy Act (NEPA); and
- Sections 3.4.4 through 3.4.7 (Federal Endangered Species Act – Biological Assessment, Marine Mammal Protection Act – Biological Assessment, and Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment) address special status species and habitats that may require consultations that are clearly identified in the Environmental Impact Statement (EIS).

The primary subcategories describing both the environmental baseline and affected biological sub-resources are habitat-based and include estuarine and aerial/terrestrial/freshwater communities. The habitat-based subcategories are consistent with federal agency jurisdictions; National Marine Fisheries Service (NMFS) has jurisdiction over estuarine aquatic species and/or habitats (e.g., sea turtles in the water), whereas the United States (U.S.) Fish and Wildlife Service (USFWS) has jurisdiction over terrestrial/aerial/freshwater species and/or habitats[2] (e.g., sea turtles nesting on the land).

3.4.1 Biological Resources, Regulatory Setting

Regulatory settings that apply to federal actions and biological resources include the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), the Migratory Bird Treaty Act (MBTA), Bald and Golden Eagle Protection Act (BGEPA), and other federal and state regulations. Habitat for some species is federally protected by the ESA (estuarine and terrestrial/freshwater) and Magnuson-Stevens Fishery Conservation and Management Act (estuarine only).

[2] With the exception of manatees that may inhabit marine, estuarine, and freshwater habitats (mostly nearshore or inshore).

3.4.1.1 National Environmental Policy Act

NEPA requires a comprehensive analysis of the impact of proposed action alternatives on biological resources including the factors that would be considered in a determination of significance and whether they may result in significant impacts (e.g., long-term/population-level impacts). Significance is described in terms of context and intensity of potential impacts. For biological resources, context can refer to the significance of an action relative to overall threats to the plant or animal populations inhabiting the affected environment of a study area (i.e., the environmental baseline). Context could also include the spatial scale and temporal frequency of a proposed action (e.g., localized and infrequent effects within a region) relative to the characteristics of affected plants and animals (e.g., short and long-term responses to acoustic stressors). Intensity refers to the severity and extent of the potential environmental impact, which can be thought of in terms of the potential magnitude of the likely effects (e.g., a loud and sharp noise within an animal's hearing range or a quiet and dull noise outside of their hearing range).

Refer to Section 3.4.3 (Environmental Consequences) for analysis with respect to the Proposed Action alternatives and NEPA. Sections 3.4.4 to 3.4.7 cover the analysis details for species and habitats with one or more special regulatory designations. Whereas specific regulatory determinations are not required by NEPA, the analysis of Proposed Action alternatives represents a minimum level of analysis for all biological resources in the PRC Study Area. Analysis conclusions for all biological resources at a NEPA-level of analysis are summarized in Section 3.4.3.4 (Alternative Impact Summary).

3.4.1.2 Endangered Species Act

The purpose of the ESA is to conserve and recover federally listed threatened and endangered species and the ecosystem upon which they depend. Section 7 of the ESA requires action proponents to consult with the USFWS or National Oceanic and Atmospheric Administration (NOAA) Fisheries to ensure that their actions are not likely to jeopardize the continued existence of federally listed threatened and endangered species, or result in the destruction or adverse modification of designated critical habitat. Critical habitat cannot be designated on any areas owned, controlled, or designated for use by the Department of Defense (DoD) where an Integrated Natural Resources Management Plan (INRMP) has been developed that, as determined by the Department of Interior or Department of Commerce Secretary, provides a benefit to the species subject to critical habitat designation.

Refer to Sections 3.4.4.1 and 3.4.4.2 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction and U.S. Fish and Wildlife Service Jurisdiction, respectively) for more information and analysis with respect to the Preferred Alternative and the ESA.

3.4.1.3 Marine Mammal Protection Act

All marine mammals are protected under the provisions of the MMPA. The Act prohibits any person or vessel from "taking" marine mammals in the United States or the high seas without authorization. The Act defines "take" to mean "to harass, hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal." Under the Act, for military readiness activities, such as the U.S. Department of the Navy (the Navy) testing and training, behavioral "harassment" is: "any act that *disturbs* or is likely to *disturb* a marine mammal or marine mammal stock in the wild by causing disruption of natural behavioral patterns, including, but not limited to, migration, surfacing, nursing, breeding, feeding, or sheltering*, to a point where such behavioral patterns are abandoned or significantly altered*" (16 U.S. Code (U.S.C.) section 1362(3)(18)(B)). Regulatory conclusions for the MMPA are made in terms of whether the Preferred Alternative will result in the unintentional taking of one or more individual marine mammals, thus requiring a take authorization pursuant to section 101(a)(5)(A) of the Act.

Refer to Section 3.4.5 (Marine Mammal Protection Act – Biological Assessment) for analysis and conclusions with respect to the Preferred Alternative and the MMPA.

3.4.1.4 Bird Protection Acts

Federal bird protection acts include the MBTA and the BGEPA. Refer to Section 3.4.3 (Environmental Consequences) for analysis and conclusions with respect to the Proposed action alternatives and the bird protection acts. Refer to Section 3.4.6 (Bird Protection Acts – Regulatory Conclusions) for regulatory conclusions with respect to the Proposed Action alternatives and these acts.

Migratory Bird Treaty Act

Most migratory and resident bird species that are considered native are protected under the MBTA, and their conservation by federal agencies is mandated by Executive Order (EO) 13186 (Responsibility of Federal Agencies to Protect Migratory Birds). Nonnative birds that were introduced by humans (intentionally or unintentionally) are not protected by the Act.

Under the MBTA, it is unlawful by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, [or] possess migratory birds or their nests or eggs at any time, unless permitted by regulation. The 2003 National Defense Authorization Act gave the Secretary of the Interior authority to prescribe regulations to exempt the Armed Forces from the incidental taking of migratory birds during authorized military readiness activities. The final "Readiness" rule authorizing the DoD to take migratory birds in such cases includes a requirement that the Armed Forces must confer with the USFWS to develop and implement appropriate conservation measures to minimize or mitigate adverse effects of the Proposed Action if the action will have a significant negative effect on the sustainability of a population of a migratory bird species.

Bald and Golden Eagle Protection Act

Bald and golden eagles are protected by the BGEPA. This Act prohibits anyone, without a permit issued by the Secretary of the Interior, from taking bald eagles, including their parts, nests, or eggs (16 U.S.C. sections 668–668c). The Act defines "take" as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb." "Disturb" is further defined as "to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, injury to an eagle, a decrease in productivity by substantially interfering with the eagle's normal breeding, feeding or sheltering behavior, or nest abandonment by substantially interfering with the eagle's normal breeding, feeding or sheltering behavior." Additionally, the Act prohibits activities around an unoccupied nest site if, upon the eagle's return, the activities are shown to have resulted in an adverse impact on the eagle. Under the BGEPA, a federal permit may be issued to authorize specific activities including the take, possession, and transportation of specimens for scientific or exhibition purposes, for the religious purposes of Indian tribes, or when a take is necessary to protect wildlife or agriculture in a particular area.

3.4.1.5 Magnuson-Stevens Fishery Conservation and Management Act

Essential Fish Habitat (EFH) is defined under the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. sections 1801–1882), as amended by the Sustainable Fisheries Act of

1996 (Public Law 104-267), as "those waters and substrate necessary to fish[3] for spawning, breeding, and feeding or growth to maturity." Title 50 of the Code of Federal Regulations (CFR), sections 600.05 through 600.930, further interprets the definition of EFH in 16 U.S.C. sections 1801–1882 to mean "waters including aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem; and spawning, breeding, feeding, or growth to maturity covers a species' full life cycle." The MSA requires that EFH be identified for those species actively managed under federal fishery management plans. This includes species managed by the regional fishery management councils established under the MSA, as well as highly migratory species managed by the NMFS.

Refer to Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment) for analysis and conclusions with respect to the Preferred Alternative and the MSA.

3.4.1.6 Other Federal and State Regulatory Settings

Other federal and state regulatory settings such as the Fish and Wildlife Conservation Act and state threatened or endangered species regulations do not require consultation documents but do merit some attention in Section 3.4.3 (Environmental Consequences). Compliance with the Coastal Zone Management Act, with regard to biological resources, is covered in Chapter 5 (Other Considerations Required by NEPA).

Fish and Wildlife Conservation Act

As part of the 1988 amendment to the Fish and Wildlife Conservation Act (Public Law 100-653), the USFWS is required to identify Birds of Conservation Concern, which are species, subspecies, and populations of migratory nongame birds that, without additional conservation actions, are likely to become candidates for listing under the ESA (U.S. Fish and Wildlife Service, 2008). The USFWS published the most recent list of Birds of Conservation Concern in 2008, which identified specific species within 37 Bird Conservation Regions across North America. The goal envisioned by the USFWS in identifying these species is to stimulate the implementation of coordinated proactive management and conservation actions among federal, state, tribal, and private partners to prevent these species from being listed under the ESA. Additionally, the Bird Conservation Region lists (U.S. Fish and Wildlife Service, 2008) are intended to assist federal land managing agencies and their partners in their efforts to abide by the bird conservation principles embodied in the MBTA and EO 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds). The PRC study area is located within Bird Conservation Region 30, the New England/Mid-Atlantic Coast.

Birds of Conservation Concern are highlighted in Section 3.4.2.6 (Affected Environment, Birds), and they are included generically with "uncommon/specialist species" of animals referred to in Section 3.4.3 (Environmental Consequences).

State Threatened or Endangered Species

The Maryland Department of Natural Resources has designations for special status species including endangered, threatened, species in need of conservation, rare species, and watch list species (Maryland

[3] To include fish, invertebrates, and vegetation

Department of Natural Resources, 2020a). Delaware threatened or endangered species do not intersect with the relevant affected environment of the study area, though there is a minor intersection with high-altitude airspace. Species with a special status designated by Virginia may occur outside the Naval Air Station (NAS) Patuxent River, but in only the southern margins of the PRC Study Area. Special designations by the state of Virginia include endangered, threatened, and Virginia Wildlife Action Plan tiered species (Virginia Department of Game and Inland Fisheries, 2018).

Potential effects to State or territory listed species and their habitats must be evaluated and mitigations proposed in environmental planning analyses, as appropriate. Conservation of these species and any other species at risk and their habitats should be addressed in INRMPs and per State wildlife action plans to the extent practicable and in ways that support the Navy mission. State-listed plants and animals are highlighted in the affected environment subsection of Section 3.4.4 (Federal Endangered Species Act – Biological Assessments), and they are included generically with "uncommon/specialist species" in the environmental consequences subsections. State-listed species may also be considered special coastal resources protected under state coastal zone resource protection plans, which derive authority from the federal Coastal Zone Management Act and the requirement for Federal Consistency Determinations (refer to Chapter 5, Other Considerations Required by NEPA).

3.4.2 Biological Resources, Affected Environment

The affected environment for biological resources, by sub-resource, inhabiting different PRC environments is summarized in Table 3.4-1, with supporting narratives and analysis provided in the following sub-resource sections.

Table 3.4-1 Summary of Proposed Action Stressors Affecting Biological Resources in PRC Study Area Environments

Stressor ***Sub-stressor***	***Primary Environments Study Area Locations***		
	Estuarine ***Chesapeake Bay Water Range and Other Waters***	***Aerial*** ***Restricted Airspace and Helo OPAREAs***	***Terrestrial/Freshwater*** ***NAS Patuxent River and OLF Webster***
Acoustic			
Air-Based Assets	I, F, H, B, M	I, B, M	I, F, H, B, M
Water-Based Assets	I, F, H, B, M	I, B, M	-
Land-Based Assets	-	I, B, M	I, H, B, M
Weapons Firing/Impact Noise	I, F, H, B, M	I, B, M	I, H, B, M
Physical Disturbance and Strike			
Air-Based Assets	-	I, B, M	-
Water-Based Assets	V, I, F, H, B, M	I, B, M	-
Land-Based Assets	-	I, B, M	V, I, H, B, M
Military Expended Materials	V, I, F, H, B, M	I, B, M	-
Pollutants			
Air Pollutants[1]	H, B, M	I, B, M	I, H, B, M
Water Pollutants[2]	V, I, F, H, B, M	-	-

Table 3.4-1 Summary of Proposed Action Stressors Affecting Biological Resources in PRC Study Area Environments, Continued

Stressor *Sub-stressor*	*Primary Environments* *Study Area Locations*		
	Estuarine *Chesapeake Bay Water Range and Other Waters*	*Aerial* *Restricted Airspace and Helo OPAREAs*	*Terrestrial/Freshwater* *NAS Patuxent River and OLF Webster*
Energy			
Air-Based Assets	-	I, B, M	I, H, B, M
Water-Based Assets	I, F, H, B, M	-	-
Land-Based Assets	-	I, B, M	I, H, B, M
Directed Energy[3]	I, F, H, B, M	I, B, M	V, I, H, B, M
Entanglement, Ingestion			
Military Expended Materials	I, F, H, B, M	-	-
Indirect/Secondary			
Assets and/or Military Expended Materials	V, I, F, H, B, M	I, B, M	V, I, H, B, M

Key: B = Birds; F = Fishes; H = Reptiles/Amphibians (i.e., Herpetofauna); Helo OPAREA = Helicopter Operating Area; I = Invertebrates; M = Mammals; MEM = military expended materials; NAS = Naval Air Station; OLF = Outlying Field; PRC = Patuxent River Complex; V = Vegetation.

Notes:

1. From fuel-burning activities and some MEM (e.g., rockets); refer to Section 3.2 (Air Quality) for baseline analysis
2. From some MEM constituents (e.g., lead); refer to Section 3.3 (Water Resources and Sediment) for baseline analysis
3. Includes both non-weaponized directed energy (all alternatives), and weaponized high-energy lasers and high-power microwaves (Alternatives 1 and 2)

The biological communities in the PRC Study Area are of a dynamic nature — changes may come about through inadvertent introduction of nonindigenous species, as well as through the natural decline of others, due to vegetation/habitat succession and climate change. The NAS Patuxent River Natural Resources Program continually updates its understanding of biological resources now known to be present in and around PRC land and water areas, as well as those claimed to occur there based on past inventories and reports for which no vouchers were collected or retained. The results of this monitoring are provided where they help define the affected environment and environmental consequences of the Proposed Action alternatives within the entire PRC Study Area. The exception to this general approach applies to protected species that have been documented within the PRC Study Area, but do not necessarily occur in or around PRC land and water areas.

The description of the affected environment for plants and animals is divided between estuarine and terrestrial/freshwater communities. The boundary between these communities is the mean high tide line, below which, salinities during inundation are greater than 0.5 parts per thousand (ppt). The boundary between estuarine and terrestrial/freshwater communities is not explicitly depicted in this section, but is generally located along the boundary separating the following: (1) wetland-edged creeks/shorelines adjoining the Chesapeake Bay and its major estuarine tributaries (e.g., lower Patuxent and Potomac Rivers) and (2) streams or ponds draining watershed areas landward of this boundary.

3.4.2.1 Environmental Baseline

The environmental baseline is described in terms of primary threats to the basic dimensions of estuarine and terrestrial/freshwater habitat present in the PRC Study Area. A habitat-based approach to the environmental baseline is used because the taxonomic and jurisdictional categories employed for analysis overlap the most, in terms of habitat (e.g., seagrass beds are inhabited by invertebrates, fish, reptiles, birds, and mammals). Habitat degradation and loss is also considered the greatest threat to biodiversity worldwide (Hanski, 2011; Newbold et al., 2015). Repeating the same or similar environmental baseline is therefore minimized across biological sub-resource sections that reference up to this section.

The significance of Proposed Action stressors must be considered in the context of the primary threats to habitats and inhabiting species (refer to respective biological sub-resource sections for resource-specific threats). The primary threats to habitats and inhabiting species recognized by experts in the field also serves to moderate the level of analysis afforded Proposed Action stressors contributing only marginally to insignificant threats (e.g., sound effects from high-altitude aircraft). The environmental baseline also accounts for the impact of over 75 years of testing and training activities in the PRC Study Area. Over the previous 20 years, testing and training activities covered in the No Action Alternative have not been identified as a major, population-level threat to any biological resource in the region due to the nature of the activities as well as ongoing management of natural resources in and around PRC land and water areas.

NAS Patuxent River has an active natural resources management program and a bird/animal aircraft strike hazard (BASH) management program. Management of vegetation and wildlife in the PRC has the goal of achieving a stewardship program that highlights natural biodiversity and resource use, while providing best guidance for the military mission to continue uninterrupted. INRMPs address the policies and practices that eliminate or reduce conflicting natural resources and mission goals in PRC jurisdictions. In addition, these plans propose to enhance natural diversity and reduce overall management costs. Details of the management program and the known plant and animal species can be found in the *INRMP for NAS Patuxent River, Webster Field Annex, and Minor Properties, Maryland* (U.S. Department of the Navy, 2017c) (hereinafter referred to as the "2017 INRMP") and the *INRMP for the Bloodsworth Island Range, Maryland* (U.S. Department of the Navy, 2017d). These plans have also resulted in definitive actions. For example, PRC natural resources staff have achieved a significant amount of shoreline stabilization that improves water quality as well as conducted biological monitoring to guide development away from sensitive biological resources (Smith, 2021a). Details of the BASH program and the BASH Plan can be found in the NAS Patuxent River Instruction 3750.5J, *Bird/Animal Aircraft Strike Hazard Program*.

Estuarine Habitats

The basic dimensions of estuarine habitat are: (1) water column, (2) topography and substrate, and (3) biotic habitat features (e.g., marshes, seagrass, shellfish beds). The health of estuarine habitats is becoming increasingly degraded by stressors associated with human activities. Those stressors include marine debris, ship traffic, pervasive pollution, introduction of exotic invasive species, destructive fishing practices, shoreline hardening, and global climate change (Bozhko, 2019; Crain et al., 2009; Halpern et al., 2008; Lotze et al., 2006). Military activities did not make the list of impact sources in the aforementioned references, though testing and training activities may contribute to stressors associated with shipping (e.g., vessel movement in transit), disturbing or destructive fishing gear (relative to MEM and seafloor devices), and direct human impacts in terms of population density (e.g., marine debris and vessel traffic relative to MEM and military vessel movement, respectively). Kunc et al. (2016) also identified noise from human activities (including military activities) as a stressor on the aquatic environment that was not explicitly included in Halpern et al. (2008). Most stressors associated with human activities are not distributed randomly across the patchwork of habitat types and ecosystems (Halpern et al., 2008); most stressors are more prevalent closer to highly developed landscapes, including some military installations.

Estuarine habitats of the PRC Study Area are part of the Chesapeake Bay—the largest estuary along the Atlantic coast and home to many highly developed landscapes, including NAS Patuxent River. The waters of the Chesapeake Bay have been the subject of extensive monitoring and regulatory efforts starting in the early 1970s (Chesapeake Bay Foundation, 2018). The system was substantially degraded at that time and has seen marginal improvements since then. The major causes of degradation are similar to what is happening globally to estuarine systems described in the previous paragraph. According to the Chesapeake Bay Foundation's "State of the Bay" report (Chesapeake Bay Foundation, 2018), the estuarine environment is currently rated a D+ on a scale from A (fully recovered) to F (out of balance/substantially degraded). A rating of A (100 percent) means the system has recovered to a condition similar to what Captain John Smith depicted in his exploration narratives from the early 1600s. Based primarily on monitoring data, particularly problematic areas are pollution (nitrogen, phosphorus, and suspended sediment) and fisheries (oysters and shad) (Chesapeake Bay Program, 2018a; University of Maryland Center for Environmental Science, 2018; Maryland Department of Natural Resources, 2020b; Maryland.gov, 2018; Testa et al., 2018; Chesapeake Bay Program, 2006; ECONorthwest, 2018; Lefcheck, 2018; Bay Journal, 2018) (Chesapeake Bay Program, 2015). The major contributors to the state of pollutants and fisheries in the Chesapeake Bay are a legacy of overfishing and hydrologic modifications (e.g., dams, culverts, ditching/channelization), along with ever-increasing population growth and residential/commercial development—all exacerbated by accelerating climate change (Pyke et al., 2008; Najjar et al., 2010).

By the end of this century, the Bay region will have experienced significant changes in carbon dioxide (CO_2) concentrations from 50 to 160 percent, sea level from 2.3 to 5.6 feet (0.7 to 1.6 meters), and water temperatures from 2 to 6 degrees Celsius (°C) (35.6 to 42.8 degrees Fahrenheit [°F]) (Najjar et al., 2010). Other changes include increasing precipitation amount and intensity, and hurricane intensity. In 2018, the Chesapeake Bay watershed experienced record-setting rainfall that carried pollutants into the Bay, causing surface algae blooms and lowered water visibility below the surface (Chesapeake Bay Program, 2018a). The ongoing and predicted changes associated with climate change are exacerbating the influx of pollutants and other stressors on the estuarine environment.

Various pollutants from land-based sources are the primary threats to water-column habitat (Chesapeake Bay Program, 2006; Lefcheck, 2018; Testa et al., 2018; University of Maryland Center for Environmental Science, 2020); nutrient enrichment from nitrogen and phosphorus were rated the lowest (F) in terms of health indicators (and getting worse), along with suspended sediment/water clarity (Chesapeake Bay Foundation, 2018). However, the Chesapeake Bay Program (2018b) reported declining trends in nitrogen and phosphorus loads in the Chesapeake Bay from 2018 to 2019. Despite forecasts of record "dead zones" (i.e., zones of no dissolved oxygen) on the Bay bottom, actual data from 2017 and 2018 indicated relatively small dead zones (Maryland.gov, 2018; University of Maryland Center for Environmental Science, 2018; Bay Journal, 2018). The discrepancy could be due to elevated wind mixing and a potential change in the feedback loop of nutrients for algae and oxygen-consuming bacteria (Testa et al., 2018). The overall trend in Chesapeake Bay hypoxia[4] from 1985 to 2009 has been increasing in early summer and decreasing in late summer (Murphy et al., 2011). More recent trends suggest a leveling out of hypoxic durations due perhaps to a declining trend in nutrient enrichment (Chesapeake Bay Program, 2018b). Trends in toxic chemical pollutants are more difficult to assess comprehensively, due to lack of watershed-wide monitoring (Chesapeake Bay Program, 2006; Chesapeake Bay Program, 2015). The current level of toxic chemicals in the estuarine environment is rated next to lowest (D), but no different from previous assessments (Chesapeake Bay Foundation, 2018).

Marine debris exacerbates pollutant effects and introduces physical disturbance, entanglement, and ingestion stressors to the estuarine environment. The Marine Debris Act (33 U.S.C. sections 1951 et seq.) defines marine debris as any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment. A multiyear study conducted from 1997–2007 along the Atlantic coast concluded that marine debris was either land-based (38 percent), general-source (42 percent), or ocean-based (e.g., items originating from recreational and commercial fishing, shipping, and tourism activities) (20 percent) (Ribic et al., 2010); no items of military origin were differentiated. Marine debris that is plastic can also degrade through time into microplastic particles that may concentrate pollutants and present nonfood items to filter-feeding organisms and associated predators. In the Chesapeake Bay water column, microplastic concentrations ranged from 0.009 to 1.245 particles per cubic meter (less than 0.001 to 0.005 particles per gallon) and were highest near major cities and where large rivers or tributaries met the Chesapeake Bay (Bikker et al., 2020). Sampling points along the northern boundary of the Chesapeake Bay Water Range ranged from 0.009 to 0.532 particles per cubic meter.

Direct human-caused threats on topography and substrate include shoreline/channel development, conversion of wetlands to uplands, and introductions of artificial material (e.g., artificial reefs, marine debris). Though not specifically rated by Chesapeake Bay Foundation (2018), other data sources suggest that trends in these threats are increasing in Chesapeake Bay. Eight sub-estuaries of Chesapeake Bay are more than 50 percent hardened/armored (e.g., bulkheads, rip-rap), and 23 more are between 30 and 50 percent hardened/armored (Patrick et al., 2014; Erdle et al., 2008). Armoring will probably increase through this century (Dugan et al., 2008) as coastal zone populations increase (Small & Nicholls, 2003; Curtis & Schneider, 2011) and as sea level rises in response to global climate change (Dugan et al., 2008). The development of small channels connecting expanding shoreline developments (e.g., marinas, community docks) with established navigation channels will likely increase as well.

The forces of erosion and sea level rise along increasingly armored shoreline will likely continue reducing the area of suitable habitat for biotic features such as marsh grass and seagrass (Berman et al., 2007; Patrick et al., 2016). Increased storm intensities also cause shoreline recession or nearshore deepening where shoreline recession is blocked by man-made features (e.g., bulkheads, fill for upland developments). The threats facing migration of shallow coastal habitats along the Atlantic coast are further exacerbated by estimates that 60 percent of land below 3.3 feet (1 meter) in elevation is open for development, with only 10 percent set aside for conservation (Titus et al., 2009); with sea level rise, shallow coastal habitats need higher-elevation wetlands and low-elevation uplands to migrate into. Bloodsworth Island, for example, has been shrinking in size for many year (Downs et al., 1994);

[4] Hypoxia is a shortage in dissolved oxygen in the water column, though levels of dissolved oxygen vary for different taxonomic groups, body sizes, and skeletal types have varying oxygen tolerances and thresholds.

between 1849 and 1992, the area of Bloodsworth Island has declined by 1,431 acres, or 26 percent of the land area in 1849.

Direct threats to biotic habitat features (e.g., living oysters, marshes, seagrass) from human activities were rated by Chesapeake Bay Foundation (2018); the health of oysters was rated the worst (F), followed by underwater grasses (D), and wetlands (C). The trend in these resources over the last two years was described as either “no change” or “+1” (for underwater grasses). The poor rating for oysters is based on harvests of wild oysters that were down 45 percent in 2016 and 2017, after having remained stable during prior years (Chesapeake Bay Foundation, 2018). However, this rating is not consistent with an increase in their microalgae food sources from nutrient enrichment without a decline in dissolved oxygen also reported in Chesapeake Bay Foundation (2018). Oysters and oyster habitats are impacted mostly by destructive fishing practices, diseases, direct impacts associated with human population density, organic pollution, climate change, ocean acidification, and species invasions.

For wetlands, the average rating (C) was based on a slow rate of restoration from a coverage diminished by upland developments and drainage of working lands (e.g., agricultural fields, forestlands). The current rate of decline for estuarine wetlands is attributed more to a combination of poor management practices, encroachment by development, and sea level rise than conversions to upland development (Wilson et al., 2007; Beckett et al., 2016). Between the mid-1950s and early 1980s, the Chesapeake Bay lost approximately 9 percent of its saltmarsh coverage to mostly dredging, impoundment, and fill for upland development (Wilson et al., 2007). The annual loss rate for estuarine wetlands thereafter is estimated at 0.5 percent based on data from the 1980s. Chesapeake Bay wetlands are also gained as low-elevation uplands have been inundated with rising sea level (Schieder et al., 2018), though encroachment of development is confining this upslope migration of marshes.

For seagrass, the primary causes of decline have been a combination of nutrient-enriched runoff from agriculture (Orth & Moore, 1988; Kemp et al., 2005) and rising temperatures (Moore & Jarvis, 2008). Lefcheck et al. (2018) concluded that sustained management action, responsible for reduced nitrogen concentrations in the Bay, have increased seagrass extent to its highest coverage in half a century. PRC natural resources staff monitor seagrass in PRC water areas and report the water quality as consistently good (Smith, 2021b)

Terrestrial/Freshwater Habitats

The Chesapeake Bay watershed is under increasing pressure from human activities causing degradation or loss of streamside (i.e., riparian) forest buffers and resource lands (e.g., farmland, forests, grasslands) (Chesapeake Bay Foundation, 2018). The loss of forested riparian zones and resource lands affects the quality and quantity of terrestrial/freshwater habitat for wildlife and degrades water quality in the Chesapeake Bay. The threats facing riparian buffers and resource lands include changing hydrology and soils, and land use/land cover. However, only threats from land-use changes apply to the Proposed Action because they only include increases in military testing and training activities on established installation ranges and infrastructure.

An analysis of urbanization and loss of resource lands in the Chesapeake Bay watershed between 1990 and 2000 observed a 61 percent increase (79,000 acres per year) in developed lands (Jantz et al., 2005). Most of this new development (64 percent) occurred on agricultural fields and grasslands. The concurrent loss of forestland to development was 33 percent. Fast-growing urban areas surrounded by forestland experienced the most loss of resource lands to development. From 2007 to 2017, developed land across the Chesapeake Bay watershed increased at a slower rate of 40,000 acres annually (Chesapeake Bay Foundation, 2018). The largest losses, as a percentage, were to agricultural fields and grasslands at 4 percent per year (27,000 acres per year). Forests were lost at less than 1 percent of their coverage per year (64,000 acres per year).

The land use trends in low-elevation coastal areas are particularly important for the migration of wetlands with sea level rise (Titus et al., 2009). Considering the relative concentration of development in coastal areas and along rivers, it is reasonable to assume a trend toward development that is more severe in these areas. The threats facing low-elevation uplands along the Atlantic coast are further exacerbated by estimates that 60 percent of land below 3.3 feet (1 meter) in elevation is open for development and, with only 10 percent set aside for conservation (Titus et al., 2009), though protected lands in the Chesapeake Bay watershed have been increasing in recent years (Chesapeake Bay Foundation, 2018). Moreover, between 2011 and 2017, permanently protected lands in the Chesapeake Bay watershed increased by 150,000 acres per year. Mapping of development trends in the Chesapeake Bay watershed suggests a relatively low rate of development in the PRC Study Area (Jantz et al., 2005), which may attract biological resources that typically avoid more developed landscapes (e.g., endangered species).

Within PRC land areas, there has been no significant loss in quantity of either terrestrial or freshwater habitat—with the exception of land losses due to shoreline erosion and the very minor loss (likely only a fraction of an acre) of non-tidal wetlands due to construction activities (Rambo, 2021a; Smith, 2021b).

3.4.2.2 Vegetation

Broadly speaking, vegetation is a relatively stationary feature of both aquatic and terrestrial habitats that includes many growth forms and species forming the foundation of the food chain and biotic habitat for animal populations. Vegetation species growing within PRC land and water areas has been extensively catalogued in the *Biodiversity Database for NAS PRC* (U.S. Department of the Navy, 2017c); there are close to 700 species of plants documented within PRC land areas. The vegetation community within PRC land and water areas is monitored by installation natural resources staff on a regular basis, with monitoring results provided where they help define the affected environment and environmental consequences. The overall distribution of vegetation types in the PRC Study Area is depicted in Figure 3.4-1. The distribution of vegetation types within NAS Patuxent River and Outlying Field (OLF) Webster are depicted in Figure 3.4-2.

Estuarine Plants

Estuarine plants include phytoplankton, macroalgae (i.e., seaweed), and various tidal marsh or submerged grasses. Estuarine plants are associated, to some degree, with estuarine waters of the PRC Study Area (e.g., Chesapeake Bay, Patuxent River, Potomac River). There are no estuarine plants that are state- or federally listed threatened or endangered species either documented (U.S. Department of the Navy, 2017c) or expected in the PRC Study Area. However, tidal marsh plants, seaweeds and seagrasses are designated as EFH for summer flounder. For a more detailed overview of estuarine plants in the PRC Study Area, please refer to the affected environment described in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment).

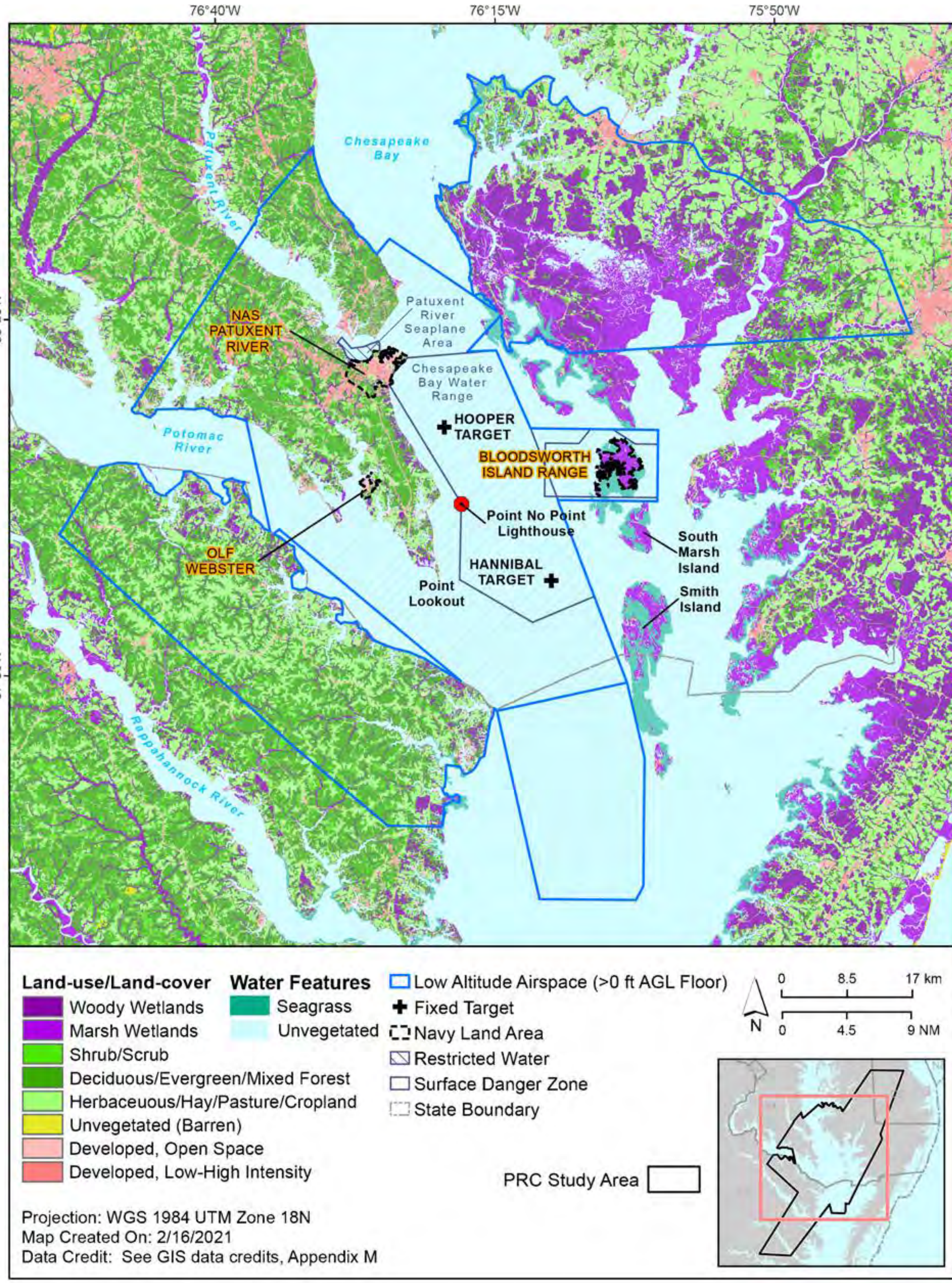


Figure 3.4-1 Distribution of Vegetated Habitats (Land Cover and Seagrass) Within the PRC Study Area

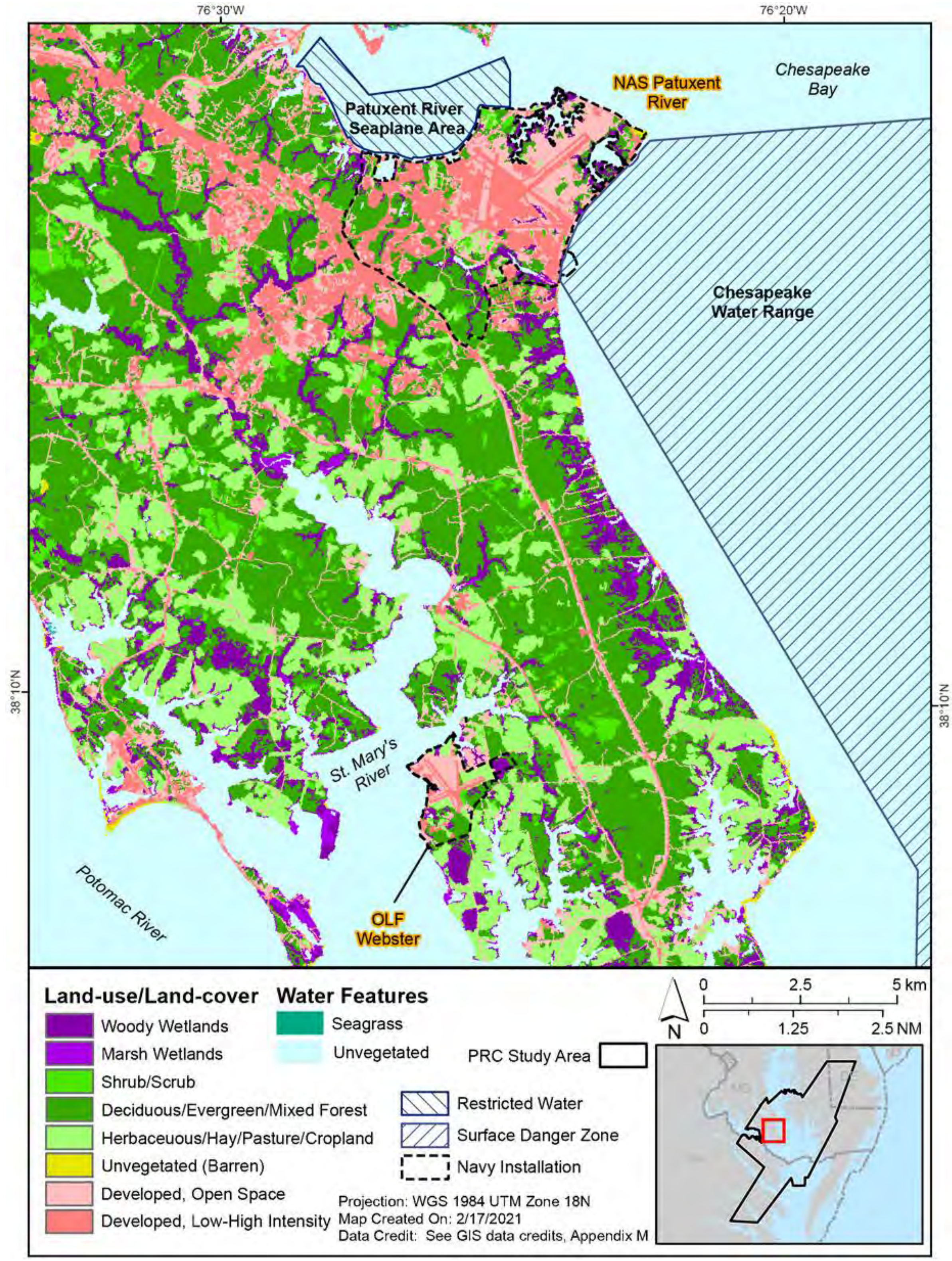


Figure 3.4-2 Distribution of Land Cover and Vegetation in the PRC Study Area Focused on NAS Patuxent River and OLF Webster

Terrestrial and Freshwater Plants

There are several general types of terrestrial and freshwater vegetative communities or habitats found on PRC land areas. These include forests, fields, marshes and freshwater aquatic communities, and scrub/shrub areas. Appendices in the 2017 INRMP list a multitude of abundant and common plant species found in these habitats. There are also 11 state-listed threatened or endangered plant species documented within PRC land area boundaries (U.S. Department of the Navy, 2017c). The species occupy a range of habitats from uplands to wetlands and shallow freshwater habitats. No federally listed threatened or endangered plant species have been documented on the PRC land areas, and none are expected. The latest comprehensive mapping for terrestrial and freshwater vegetation communities in the PRC Study Area is depicted in Figure 3.4-1 and Figure 3.4-2.

A **forest** is defined as a biological community dominated by trees and other woody plants. Forested areas comprise 2,346 acres on NAS Patuxent River and 215 acres on OLF Webster (220 and 79 acres are wetland forest, respectively) (U.S. Department of the Navy, 2017c). Of its 5,379 acres, Bloodsworth Island Range has only 30 acres of uplands, and no forest. Several specific forest types are found on PRC land areas. These types can be further divided according to a variety of characteristics, such as size, species composition, canopy closure, and height (U.S. Department of the Navy, 2017c).

Agricultural fields represent tilled and intensively managed lands for the production of agricultural commodities such as corn (*Zea* species [spp.]), soybeans (*Glycine max*), wheat (*Triticum* spp.), barley (*Hordeum vulgare L.*), and grain sorghum (*Sorghum bicolor*). These comprise 390 acres on NAS Patuxent River and 122 acres on OLF Webster. During periods of active farming, an agricultural crop dominates each of these areas with some annual and perennial weed species present. When not in production, cover crops are used in the fields. When left fallow, these fields can support dense herbaceous growth of species typical of young successional (seral) stages, such as crabgrass (*Digitaria* spp.), ragweed (*Ambrosia* spp.), aster (*Aster* spp.), and Yellow Foxtail (*Setaria lutescens*) (U.S. Department of the Navy, 2017c). These parcels are very important to the maintenance of desirable vegetation surrounding the airfield.

Old-field areas are found primarily as linear features associated with agriculture and abandoned wildlife food-patch development areas, utility rights-of-way, and recent timber clear-cuts. Perennial grasses and composites, with legumes (Fabaceae family) and sedges (Cyperaceae family) as associates, dominate these disturbed areas. These cover types comprise 238 acres on NAS Patuxent River and 6 acres on OLF Webster (U.S. Department of the Navy, 2017c).

Nontidal freshwater marshes and **aquatic vegetation** are associated mostly with freshwater pond and stream systems. Freshwater marshes comprise 25 acres on NAS Patuxent River and 43 acres on OLF Webster (U.S. Department of the Navy, 2017c). The location of streams and named freshwater ponds is depicted on Figure 3.4-3.

Scrub/shrub areas have some herbaceous vegetation like that occurring in old-field communities, but mostly shrubs and young trees. This successional cover type represents an advanced old field and, without management, will naturally progress into a young woodland cover type. Scrub/shrub communities comprise 931 acres on NAS Patuxent River and 19 acres on OLF Webster (86 and 11 acres are scrub/shrub wetlands, respectively) (U.S. Department of the Navy, 2017c). No scrub/shrub acreage was identified on Bloodsworth Island Range.

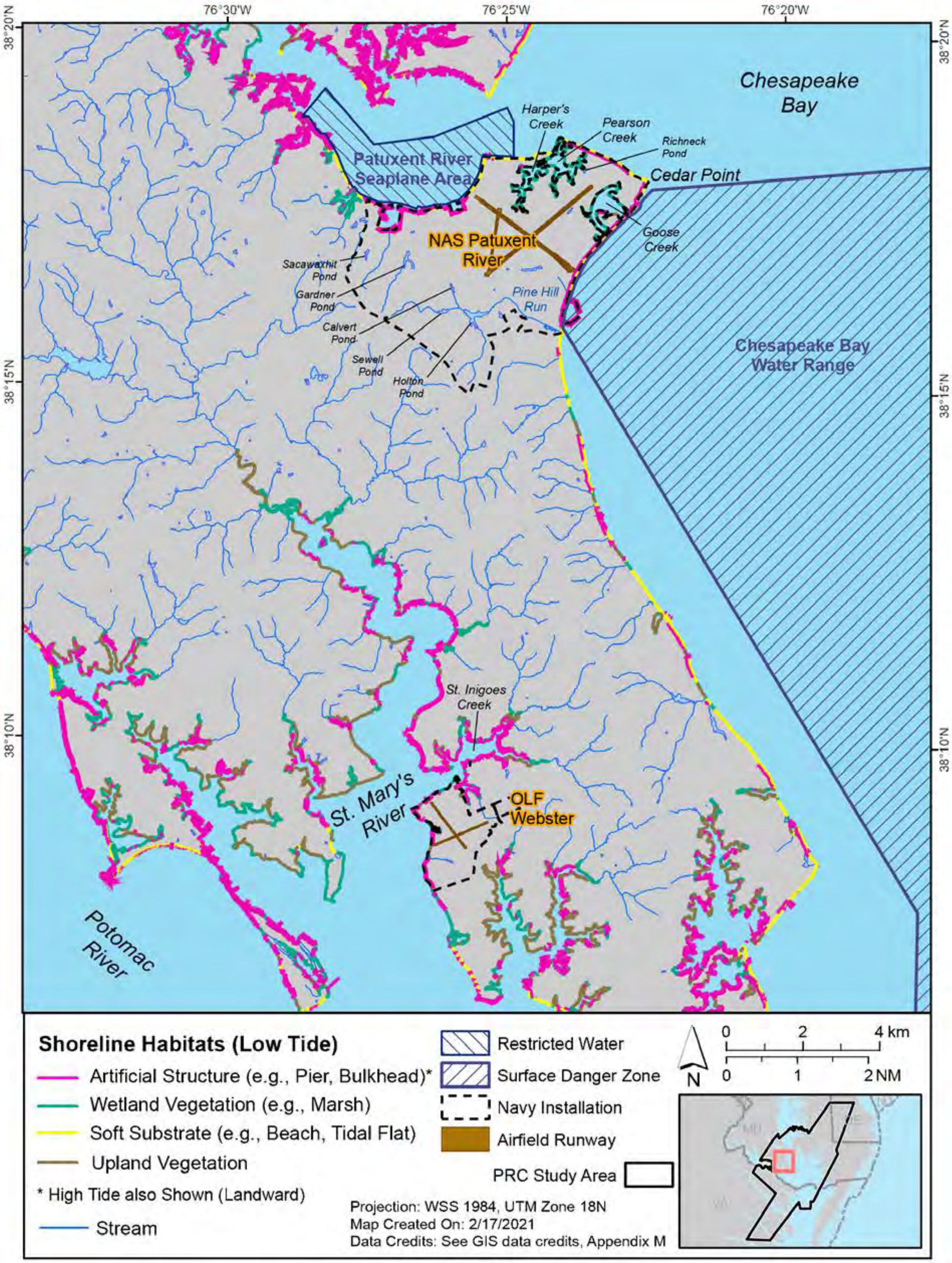


Figure 3.4-3 Hydrology and Shoreline Features of the PRC Study Area Focused Around NAS Patuxent River and OLF Webster

3.4.2.3 Invertebrates

Broadly speaking, invertebrates are relatively small animals lacking a backbone, with various forms of a soft-hard exoskeleton (e.g., insects, spiders, snails, shellfish, worms). Invertebrates in the PRC Study Area are a relatively undocumented group of organisms in the *Biodiversity Database for NAS PRC* (U.S. Department of the Navy, 2017c). Exceptions include aerial/terrestrial insects (e.g., beetles, moths, butterflies, dragonflies), and to a lesser extent estuarine invertebrates (e.g., oysters, blue crabs). These species are monitored by installation natural resources staff on a regular basis, with monitoring results provided where they help define the affected environment and environmental consequences. There are over 100 invertebrate species documented in and around PRC land areas (U.S. Department of the Navy, 2017c). Other data sources are also used to corroborate/supplement the 2017 INRMP for estuarine invertebrates (Chesapeake Bay Program, 2018c; National Oceanic and Atmospheric Administration Office of Response and Restoration, 2016; Stone et al., 1994).

Some aerial/terrestrial insects (e.g., beetles, moths, butterflies, dragonflies), and to a lesser extent estuarine invertebrates (e.g., oysters, blue crabs), within PRC land and water areas are monitored by installation natural resources staff on a regular basis, with monitoring results provided where they help define the affected environment and environmental consequences.

Estuarine Invertebrates

Benthic and pelagic invertebrates live in/on or above the estuarine bottom, respectively. Stone et al. (1994) documented prominent benthic invertebrate species occupying estuaries of the mid-Atlantic region, including the PRC Study Area. Species considered common to abundant between the Patuxent and Potomac Rivers include eastern oyster (*Crassostrea virginica*), softshell clam (*Mya arenaria*), grass shrimp (*Palaemonetes pugio*), sand shrimp (*Crangon septemspinosa*), and blue crab (*Callinectes sapidus*). A more extensive listing of estuarine invertebrates that are common in the middle Chesapeake Bay is catalogued in Table 3.4-2. There are no state or federal threatened or endangered estuarine invertebrate species in the PRC Study Area. However, shellfish beds/reefs formed by eastern oysters describe a component of EFH (Section 3.4.7, Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). Eastern oysters and blue crabs are also state-managed fishery species.

Table 3.4-2 Common Invertebrate Species Present in the Estuarine Environment of the PRC Study Area

Mobility	*Habitats*	*Common Name*	*Scientific Name*
Drifting	Pelagic	Comb jelly	Phylum: Ctenophora
		Jellyfish	Order: Semaeostomeae
		Planktonic larvae	Various species and orders
		Zooplankton	Plankton (Kingdoms: Animalia, Protista)
Sedentary	Benthic (structures only)	Barnacle	Order: Sessilia
		Boring sponge	*Cliona* species
		Eastern oyster[1]	*Crassostrea virginica*
		Ghost anemone	*Diadumene leucolena*
		Gould's shipworm	*Bankia gouldi*
		Hooked mussel	*Ischadium recurvum*
		Red beard sponge	*Microciona prolifera*
		Ribbed mussel[1]	*Geukensia demissa*

Table 3.4-2 Common Invertebrate Species Present in the Estuarine Environment of the PRC Study Area, Continued

Mobility	*Habitats*	*Common Name*	*Scientific Name*
		Sea squirt	*Molgula manhattensis*
	Benthic (partially buried)	Macoma clam	*Macoma* species
		Softshell clam	*Mya arenaria*
		Stout razor clam	*Tagelus plebeius*
Slow-moving	Benthic (open or structured)	Bristle worm	Class: Polychaeta
		Flatworm	Order: Polycladida
		Marsh periwinkle	*Littorina irrorata*
		Oyster drill	*Urosalpinx cinerea*
		Sea slug	Class: Gastropoda
Active/Mobile	Pelagic	Blue crab (females)	*Callinectes sapidus*
		Brief squid	*Lolloguncula brevis*
	Benthic (open or structured)	Blue crab	*Callinectes sapidus*
		Fiddler crab	*Uca* species
		Grass shrimp	*Palaemonetes* species
		Horseshoe crab	*Limulus Polyphemus*
		Mantis shrimp	*Squilla empusa*
		Mud crab	*Panopeus* species
		Marsh crab	*Sesarma reticulatum*
		Sand shrimp	*Crangon septemspinosa*
		Skeleton shrimp	*Caprella* species
		Spider crab	*Libinia* species

Sources: (U.S. Department of the Navy, 2017c; Chesapeake Bay Program, 2018c; National Oceanic and Atmospheric Administration Office of Response and Restoration, 2016; Stone et al., 1994)
Key: PRC = Patuxent River Complex.
Note:
1. Essential fish habitat (i.e., shellfish beds)

Horseshoe crabs (*Limulus polyphemus)* are another species of interest in the PRC Study Area by virtue of their "living fossil" status, uses in medical research and the eel pot fishery, and importance as a food resource for migratory birds (Walls et al., 2002). Horseshoe crabs are large, slow-moving, and heavily armored invertebrates that lay eggs on sandy beaches (Figure 3.4-3).

The biodiversity of marine benthic communities, including estuarine invertebrates, has experienced dramatic declines worldwide (Worm et al., 2006). The loss of species has consisted mostly of uncommon or specialist varieties. For estuarine invertebrates (e.g., benthic communities), the decline has been documented in numerous studies (Snelgrove et al., 2004; Solan et al., 2004; Worm et al., 2006; Fautin et al., 2010) and primarily attributed to pollutants, eutrophication and hypoxia (i.e., nutrient enrichment and low dissolved oxygen), physical habitat destruction, and invasive species. Long-term trends in invertebrate diversity and abundance in the Chesapeake Bay are not available, but the primary stressors are present (Section 3.4.2.1, Affected Environment, Environmental Baseline).

Estuarine invertebrates occupy a variety of habitats in the Chesapeake Bay, including intertidal marsh grass or sediment flats, seagrass beds, shallow subtidal margins, oyster reefs, shipwrecks, artificial reefs, and deeper channels (Figure 3.3-3, Figure 3.4-1, Figure 3.4-3, and Figure 3.4-4). The abundance and diversity of estuarine invertebrates also varies according to season, with the highest values occurring during the warm season. Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment) provides the assessment of habitat for estuarine invertebrates. Many of the active/mobile benthic invertebrates are generally most abundant in the shallowest margins of the Bay, whereas structural refuge in deeper water is relatively sparse (Ruiz et al., 1993). Hypoxia in deep water habitats of the Chesapeake Bay can also reduce benthic invertebrate productivity up to 90 percent (Sturdivant et al., 2014). Hypoxic conditions in the estuarine environment, including the PRC Study Area (Figure 3.3-2, Characterization of the PRC Water Column During the Warm Season in Terms of Salinity and Dissolved Oxygen (Minimums)), may occur from May to September, but vary in severity, locality, and duration between years based on hypoxic volume, nitrogen loads, and stratification resulting from the extremely large variability in freshwater flow through the Bay's major tributaries (Murphy et al., 2011).

Growth and reproduction of species is also relevant to all Proposed Action stressors. Most estuarine invertebrates produce a large number of young (i.e., larvae) that experience a correspondingly high natural mortality rate. Smaller estuarine invertebrates (e.g., zooplankton, worms, shrimp) are also mostly annual in terms of growth to maturity. Maturation can take more than a year for larger invertebrates (e.g., blue crabs, oysters, horseshoe crabs).

Aerial, Terrestrial, and Freshwater Invertebrates

Terrestrial, aerial, and freshwater invertebrates are species that lack a backbone and live on or over the land, or in freshwater bodies. Common/important taxonomic groups possible or documented in PRC land and water areas include approximately 150 species of beetles, butterflies, moths, and dragonflies (U.S. Department of the Navy, 2017c), including two federally threatened species and numerous state threatened or endangered species (Table 3.4-3).

Table 3.4-3 State (Maryland/Virginia) or Federally Listed Threatened or Endangered Terrestrial and Aerial Invertebrates That May Occur in PRC Land and Water Areas

Taxa Grouping	*Common Name*	*Scientific Name*	*MD/VA T&E*	*Federal T&E*
Butterfly/Skipper	Bog copper	*Lycaena epixanthe*	E/-	
	Chermock's mulberry wing	*Poanes massasoit chermocki*	E/-	
	Dusky azure	*Celastrina ebenina*	E/-	
	Early hairstreak	*Erora laeta*	E/-	
	Edward's hairstreak	*Satyrium edwardsii*	E/-	
	Frosted elfin[1]	*Incisalia irus*	E/-	
	Golden-banded skipper	*Autochton cellus*	E/-	
	Harris checkerspot	*Chlosyne harrisii*	T/-	
	Hickory hairstreak	*Satyrium caryaevorum*	E/-	
	King's hairstreak	*Satyrium kingi*	T/-	
	Northern metalmark	*Calephelis borealis*	T/-	
	Palamedes swallowtail	*Papilio palamedes*	E/-	
	Rare skipper	*Problema bulenta*	T/-	R
	Regal fritillary	*Speyeria idalia*	E/-	
Beetle	Northeastern beach tiger beetle[1]	*Cicindela dorsalis*	E/T	T
	Puritan tiger beetle	*Cicindela puritan*	E/-	T

Key: E = endangered; MD = Maryland; VA = Virginia, PRC = Patuxent River Complex; R = under review; T = threatened; T&E = threatened and endangered.

Note:

1. Species has been documented on the PRC land and water areas (U.S. Department of the Navy, 2017c).

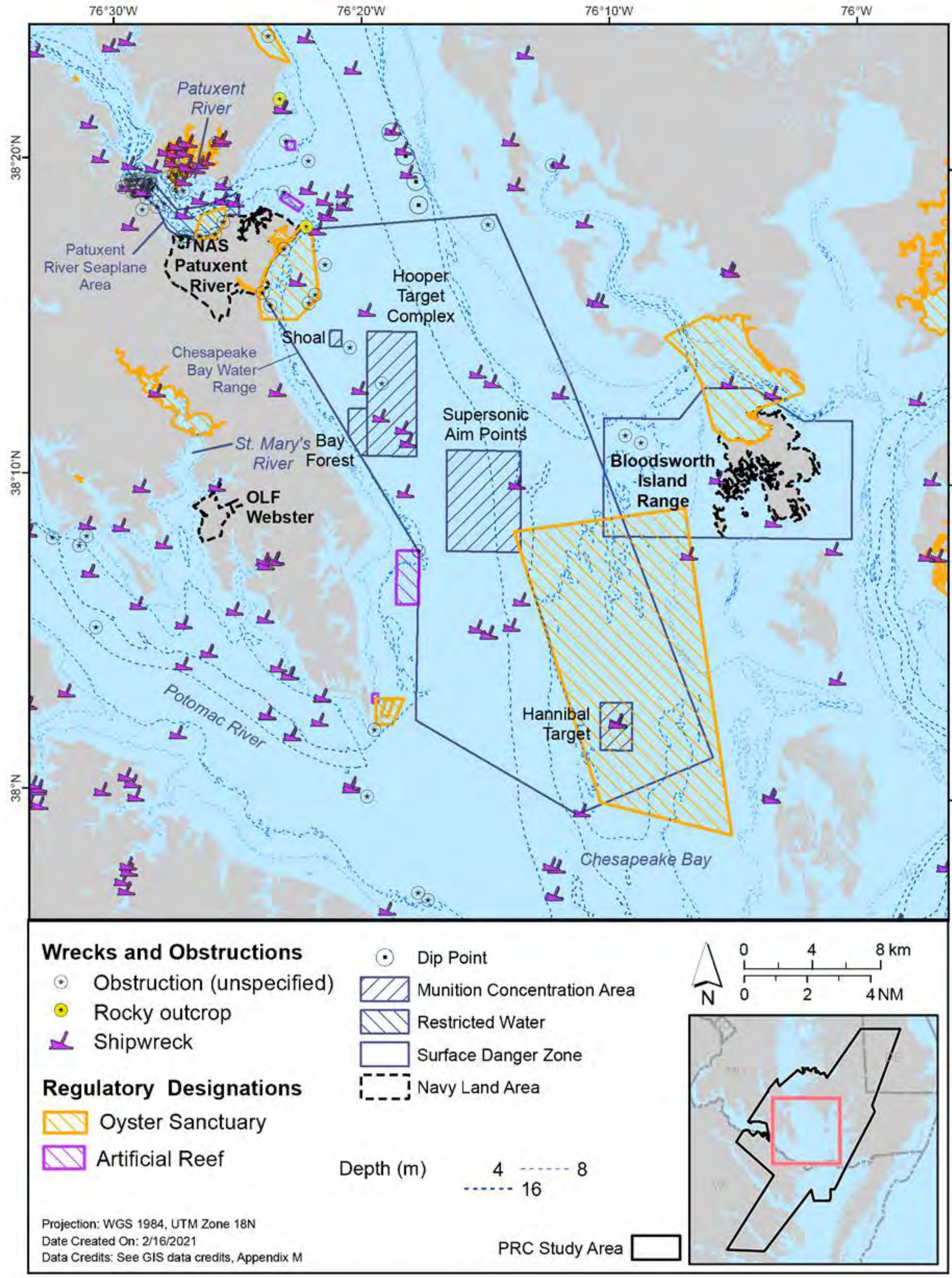


Figure 3.4-4 Submerged and Emergent Artificial Features (e.g., Shipwrecks, Artificial Reefs, Buoys) of the Estuarine Environment, Including the PRC Study Area

There are approximately 36 common species of beetles, butterflies, moths, and dragonflies documented on PRC land and water areas (U.S. Department of the Navy, 2017c). Some of the less common species are listed in Table 3.4-3. Of the state-listed threatened or endangered species that may occur in the PRC Study Area, only the frosted elfin (*Incisalia irusirus*) (a butterfly*)* has actually been documented on PRC lands (U.S. Department of the Navy, 2017c). Of the two federally listed threatened species that may occur in the PRC Study Area, only the northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*) has been documented on a PRC lands (U.S. Department of the Navy, 2017c); the puritan tiger beetle (*Cicindela puritan*) has been documented within the PRC Study Area along Calvert County beaches, north of NAS Patuxent River. No other federally listed threatened or endangered invertebrate species have been documented in the PRC Study Area, and none are expected. Section 3.4.4.2 (Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction) provides more information and analysis regarding the federally listed threatened species.

Terrestrial, aerial, and freshwater invertebrate biodiversity (primarily insects) has been in a dramatic decline that could lead to 40 percent of insect species going extinct over the next few decades, worldwide (Sanchez-Bayo & Wyckhuys, 2019). Affected insect groups include many that have been documented in the PRC Study Area (e.g., butterflies) that are uncommon or specialists. As these less common/specialist species decline, the abundance of some common/generalist species, including many pest species (e.g., cockroaches), has actually increased. The main drivers of decline in insect species (in order of importance) include habitat loss and conversion to intensive agriculture and development, pollution (e.g., synthetic pesticides and fertilizers), biological factors (e.g., pathogens, introduced species), and climate change. Long-term trends in insect diversity and abundance in the Chesapeake Bay watershed are not available, but the primary stressors are present (Section 3.4.2.1, Affected Environment, Environmental Baseline).

Most terrestrial, aerial, and freshwater invertebrate activity is generally limited to the warm season where they occupy a variety of habitats in the PRC Study Area (Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3), including upland forests, shrub/scrub thickets, agricultural fields, beaches, and developments (e.g., roads, parking lots, buildings). Aerial invertebrates (mostly insects) are capable of flying over terrestrial, freshwater, or estuarine habitats. However, the density of flying insects over open waters during the day is probably low compared to nearshore and terrestrial habitats that are more sheltered from the wind and exposure (Kings & Wrubleski, 1998; Taylor, 1960). Other flying insects are common above open waters at night, such as night-flying moths (Ahlén et al., 2009), though most relatively weak flying insects tend to avoid exposure to high winds and aerial predators over open habitats (Taylor, 1960). Flying insects, in general, have been collected at altitudes of 20 to 5,000 feet, with the highest concentrations closer to 20 feet (Glick, 1939; Taylor, 1960). However, some butterflies and moths make spring migrations at higher altitudes where there are favorable wind speeds and temperatures (Chapman et al., 2010).

Active beetles, butterflies, moths, and dragonflies can be virtually anywhere on or over the ground, though some habitat preferences have been documented (Cowley et al., 2000). For example, butterflies and other pollinators (e.g., bees) are attracted to flowering plants. Butterflies and bees are therefore active mostly during the day. Most moth species are active at night. Beetles can be active either day or night. Dragonflies are typically active during the day in or near freshwater wetlands (nymphs and adults, respectively) during the day. Note that Proposed Action stressors do not occur in close proximity to freshwater invertebrate habitats (e.g., streams, ponds), and less information on this affected environment is therefore warranted.

The reproduction and growth of species is also important for evaluating the impact of multiple stressors. Most insects produce a large number of young (i.e., larvae) that experience a correspondingly high natural mortality rate. Most insects are also annual in terms of growth to maturity.

3.4.2.4 Fishes

Broadly speaking, fish are cold-blooded, limbless vertebrates that live and breathe fully submerged in water. The description of the affected environment for fishes is divided between estuarine and freshwater communities. There is more known about fishes in the PRC Study Area than is known about invertebrates. Many species of fish have been documented in the *Biodiversity Database for NAS PRC* in the 2017 INRMP (U.S. Department of the Navy, 2017c); there are 75 species of fish documented in and around land and water areas. Other data sources were also used to corroborate/supplement the 2017 INRMP for estuarine fishes (National Oceanic and Atmospheric Administration Office of Response and Restoration, 2016; Stone et al., 1994; Virginia Institute of Marine Science, 2018; Murdy et al., 1997).

Estuarine Fishes

Whereas demersal fish are oriented to the bottom, pelagic species or life stages are oriented to open Bay waters above the bottom. Stone et al. (1994) catalogue prominent pelagic and demersal species occupying estuaries of the mid-Atlantic region, including the PRC Study Area. Species considered abundant to highly abundant between the Patuxent and Potomac Rivers include the following: Atlantic menhaden (*Brevoortia tyrannus)*, bay anchovy (*Anchoa mitchilli)*, bluefish (*Pomatomus saltatrix)*, silverside species (*Membras* species), goby species (*Gobiosoma* species), hogchoker (*Trinectes maculatus)*, killifish species (*Fundulus* species), sheepshead minnow (*Cyprinodon variegatus)*, and white perch (*Morone americana)*. Fish species that are either commonly documented or given a special regulatory status in the middle Chesapeake Bay are catalogued in Table 3.4-4.

Table 3.4-4 Abundant-Common or Rare/Protected Fish Species that May Occur in the Estuarine Environment of the PRC Study Area

Taxa Grouping	*Common Name*	*Scientific Name*	*Abundance[1]*	*State & Federal[2]*	*EFH*
Diadromous Fish[3]	Alewife	*Alosa pseudoharengus*	Common		
	American eel	*Anguilla rostrata*	Common		
	Atlantic sturgeon	*Acipenser oxyrhynchus*	Uncommon	E	
	Blueback herring	*Alosa aestivalis*	Common		
	Shortnose sturgeon	*Acipenser brevirostrum*	Uncommon	E	
	Striped bass	*Morone saxatilis*	Common		
	White perch	*Morone americana*	Abundant-common		
Benthic Fish	Atlantic croaker	*Micropogonias undulatus*	Common		
	Atlantic spadefish	*Chaetodipterus faber*	Common		
	Black sea bass	*Centropristus striatus*	Common-rare		Yes
	Bluntnose stingray	*Dasyatis sayi*	Common		
	Clearnose skate	*Raja eglanteria*	Rare		Yes
	Cownose ray	*Rhinoptera bonasus*	Common		
	Hogchoker	*Trinectes maculatus*	Abundant-common		
	Mummichog	*Fundulus heteroclitus*	Common		
	Naked goby	*Gobiosoma bosci*	Common		
	Northern pipefish	*Syngnathus fuscus*	Common-uncommon		
	Northern puffer	*Sphoeroides maculatus*	Common		
	Northern searobin	*Prionotus carolinus*	Common		

Table 3.4-4 Abundant-Common or Rare/Protected Fish Species that May Occur in the Estuarine Environment of the PRC Study Area, Continued

Taxa Grouping	*Common Name*	*Scientific Name*	*Abundance[1]*	*State & Federal[2]*	*EFH*
	Oyster toadfish	*Opsanus tau*	Common		
	Scup	*Stenotomus chrysops*	Common		Yes
	Sheepshead minnow	*Cyprinodon variegatus*	Abundant-common		
	Silver perch	*Bairdiella chrysoura*	Common		
	Skilletfish	*Gobiesox strumosus*	Common		
	Spot	*Leiostomus xanthurus*	Common		
	Spotted hake	*Urophycis regia*	Common		
	Striped blenny	*Chasmodes bosquianus*	Common		
	Summer flounder	*Paralichthys dentatus*	Common		Yes
	Weakfish	*Cynoscion regalis*	Common		
	Windowpane	*Scopthalmus aquosus*	Uncommon-absent[4]		Yes
Pelagic Fish	Atlantic menhaden	*Brevoortia tyrannus*	Abundant-common		
	Atlantic silverside	*Menidia*	Common		
	Bay anchovy	*Anchoa mitchilli*	Abundant-common		
	Bluefish	*Pomatomus saltatrix*	Abundant-common		Yes
	Butterfish	*Peprilus triacanthus*	Uncommon-rare		Yes
	Cobia	*Rachycentron canadum*	Uncommon		Yes
	Harvestfish	*Peprilus alepidotus*	Common		

Key: EFH = Essential Fish Habitat; PRC = Patuxent River Complex.
Notes:
1. Sources: (U.S. Department of the Navy, 2017c; National Oceanic and Atmospheric Administration Office of Response and Restoration, 2016; Stone et al., 1994; Virginia Institute of Marine Science, 2018; Murdy et al., 1997)
2. E = Endangered (Federal, Virginia, and Maryland status)
3. Species moves between freshwater and saltwater.
4. Not documented in the PRC Study Area.

Species listed with a special regulatory status in Table 3.4-4 include Atlantic and shortnose sturgeon (*Acipenser oxyrhynchus* and *Acipenser brevirostrum*, respectively), and eight federally managed fish species with EFH described/designated in the PRC Study Area (bluefish, [*Pomatomus saltatrix*], butterfish [*Peprilus triacanthus*], clearnose skate [*Raja eglanteria*], cobia [*Rachycentron canadum*], scup [*Stenotomus chrysops*], black sea bass [*Centropristus striatus*], summer flounder [*Paralichthys dentatus*], and windowpane [*Scopthalmus aquosus*]). Additional details and analysis of effects on federal endangered estuarine fish species and EFH are located in Sections 3.4.4.1 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction) and 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment), respectively. There are no state-listed threatened or endangered fish species that are not also federally listed in the estuarine environment of the PRC Study Area, but there are some common state-managed species with commercial and/or recreational value (e.g., striped bass [*Morone saxatilus*], Atlantic menhaden [*Brevoortia tyrannus*], weakfish [*Cynoscion regalis*], Atlantic croaker [*Micropogonias undulatus*], spot [*Leiostomus xanthurus*], red drum [*Sciaenops ocellatus*], black drum [*Pogonias cromis*]).

The biodiversity of marine fish communities, including estuarine fishes, have experienced dramatic declines worldwide (Arthington et al., 2016). The loss of species has been mostly of uncommon or specialist varieties, and those of commercial/recreational value. The primary threats to marine/estuarine fishes are, in order of importance: over-exploitation, habitat loss/degradation, pollution, invasive species, and climate change. Long-term trends in overall fish diversity and abundance in the Chesapeake Bay are not available, but the primary stressors are present (Section 3.4.2.1, Affected Environment, Environmental Baseline).

Fishes occupy a variety of habitats in the Chesapeake Bay, including intertidal marsh grass or sediment flats, seagrass beds, shallow subtidal margins, oyster reefs, and deeper channels (Figure 3.3-3, Figure 3.4-1, Figure 3.4-3, and Figure 3.4-4). The abundance and diversity of estuarine fishes also varies according to season, with the highest numbers occurring during the warm season. Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment) provides the assessment of impacts on fish habitats that are all represented in the assessment. Hypoxia can reduce the quality of foraging habitat for benthic fish in some deep water habitats of the Chesapeake Bay (Sturdivant et al., 2014). Hypoxic conditions in the estuarine environment, including the PRC Study Area (Figure 3.3-2, Characterization of the PRC Water Column During the Warm Season in terms of Salinity and Dissolved Oxygen (Minimums)), may occur from May to September, but vary in severity, locality, and duration between years based on hypoxic volume, nitrogen loads, and stratification resulting from the extremely large variability in freshwater flow through the Bay's major tributaries (Murphy et al., 2011). Even without hypoxia, many demersal and pelagic prey species are most abundant in the shallowest margins of the Bay due to various factors (Ruiz et al., 1993; Clark et al. , 2003; Lankowicz et al., 2020).

Growth and reproduction of species is also relevant to all No Action Alternative stressors. In that regard, most fish produce a large number of young that experience a correspondingly high natural mortality rate. However, only small prey species are annual in terms of growth to maturity.

Freshwater Fishes

Various species of fish, such as largemouth bass, sunfish, crappie, minnows, common carp, and bullhead catfish, can be found in freshwater ponds and streams (i.e., hydrographic features) within PRC land area boundaries (U.S. Department of the Navy, 2017c) (Figure 3.4-3). However, no Proposed Action stressors occur in close proximity to freshwater ponds and streams. The impact of distant overflight noise and other Proposed Action stressors on freshwater fishes is likely negligible (refer to Acoustic stressor analysis in Section 3.4.3, Environmental Consequences).

3.4.2.5 Reptiles and Amphibians

Broadly speaking, amphibians have soft skin, easily penetrated by water. They lay their eggs in water or damp places to keep them moist. In contrast, reptiles have dry, scaly skin, impervious to water. Most reptiles lay shell-encased eggs on land that hold moisture for the developing young; however, some reptile species also give live birth. A diversity of reptile (snake, lizard, and turtle) and amphibian (frog, toad, and salamander) species occur within the PRC Study Area. Twenty-four species of amphibians and 39 species of reptiles have been documented in and around PRC land areas (U.S. Department of the Navy, 2017c). These species occupy a diversity of habitats (freshwater wetlands, estuarine and upland terrestrial habitats) and serve as important components of ecosystem integrity and health.

Estuarine Reptiles

With the exception of sea turtles covered in Section 3.4.4.1 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction), the diamondback terrapin (*Malaclemys terrapin*) is the only reptile species that primarily occupies brackish marshes, mud flats, and islands of the Chesapeake Bay. This species is confirmed present at NAS Patuxent River, OLF Webster, and the Bloodsworth Island Range (U.S. Department of the Navy, 2017c). Surveys for terrapin nests have been ongoing at NAS Patuxent River since 2013. The diamondback terrapin is not ESA-listed, but all states within this species' range (except New York) have designated this species as a Species of Conservation Need (Nanjappa & Conrad, 2011). Most diamondback terrapin populations range from stable to declining.

One of the major threats to diamondback terrapins is incidental drowning in crab traps (Seigel & Gibbons, 1995; Hoyle & Gibbons, 2000). Estimates of the effects of crab trapping on a Chesapeake Bay population suggest that 15 to 78 percent of a local population dies annually in shallow-water crab-trapping localities and that a population can be decimated in three to four years (Roosenburg et al., 1997). New crab traps with terrapin exclusions have greatly reduced terrapin bycatch (Lester, 2013; Pfau & Roosenburg, 2010; University of Georgia, 2019). Commercial harvesting for meat and pet trade is also a threat to this species. Up until the beginning of the 20th century, diamondback terrapins were in great demand by gourmet restaurants in major metropolitan areas of the United States, but demand has generally subsided (Pfau & Roosenburg, 2010). However, there was an increase in terrapin exports to China from the U.S. in the late 1980s; however, by 2007, all of the states within the range of this species had prohibited commercial harvest of terrapins (Pfau & Roosenburg, 2010). Lastly, additional threats to this species may include oil spills in coastal areas (Michel et al., 2001); mortality of nesting females from vehicle strikes while searching for nesting sites on land (NatureServe Explorer, 2019); loss of nesting habitat due to erosion, shoreline hardening, residential development, and climate change; and nest and hatchling predation.

Diamondback terrapins are discontinuously distributed along the eastern and gulf coasts of the United States, from Cape Cod (Massachusetts) to Texas. They are most common in salt marshes and shallow bays, and are usually found in brackish water. Diamondback terrapins hibernate both individually or in large groups (Sheridan et al., 2010). Pfau and Roosenburg (2010) used harvesting records in the Chesapeake Bay to estimate that large hibernating groups may number as many as 200 individuals. Although diamondback terrapins are an aquatic turtle and spend the majority of their life in water, they do leave the water to bask and lay eggs.

Preferred nesting areas for terrapins have loose sand or gravel that is easy to dig for a nest and open enough for sun exposure to keep the nests warm, but with some vegetation to discourage predators. Nesting sites in close proximity to marsh habitat offers cover and feeding areas for terrapin hatchlings. Eggs are typically laid in late May through August, and generally take 50 to 80 days to hatch.

Since 2013, the NAS Patuxent River Natural Resources Program has been conducting terrapin nest surveys and protection efforts on the installation, including areas within and around Golf and Bravo helicopter landing zones associated with Harper's and Pearson Creeks (Figure 3.4-3). The objectives of the project are to: identify important nesting sites used by terrapins; reduce nest predation rates; evaluate the success of predator exclusion devices; and document nest survivorship using hatching success. The installation also supports and assists with terrapin research conducted by the University of Maryland Center for Environmental Science's Chesapeake Biological Laboratory.

Terrestrial and Freshwater Reptiles and Amphibians

There are 50 species of terrestrial reptiles (turtles, lizards and snakes) and 43 species of amphibians (salamanders, frogs and toads) confirmed present in Maryland (Maryland Biodiversity Project, 2019). Common reptile and amphibian species within the PRC Study Area include the following:

- eastern box turtle (*Terrapene carolina carolina*)
- common five-lined skink (*Plestiodon fasciatus*)
- northern black racer (*Coluber constrictor constrictor*)
- northern water snake (*Nerodia sipedon sipedon*)
- green tree frog (*Hyla cinerea*)
- eastern cricket frog (*Acris crepitans crepitans*)
- green frog (*Lithobates clamitans melanota*)
- eastern red-backed salamander *(Plethodon cinereus*)
- spotted salamander (*Ambystoma maculatum*)
- northern two-lined salamander (*Eurycea bislineata*)

None of the terrestrial amphibians within the PRC Study Area has an ESA designation. However, the spotted turtle (*Clemmys guttata*), confirmed present at NAS Patuxent River and OLF Webster, has been petitioned for ESA listing and is currently under review by the USFWS. State-listed species with the potential to be present in the PRC Study Area include the barking tree frog (*Hyla gratiosa*), eastern narrow-mouthed toad (*Gastrophryne carolinensis*), and the eastern tiger salamander (*Ambystoma tigrinum tigrinum*). Of these species, the eastern narrow-mouthed toad is confirmed present on NAS Patuxent River (U.S. Department of the Navy, 2017c). None of the terrestrial reptiles and amphibians at this time have a state or ESA designation.

Threats to terrestrial amphibians and reptiles are diverse, but generally fall into the following categories: climate change, non-native predators, over collection, habitat destruction, and disease (Amphibiaweb, 2017). These threats are similar for estuarine herpetofaunal species, with the addition of degraded water quality. Of the approximately 10,900 species of reptiles globally, the International Union for Conservation Red List considers 1,311 species threatened with extinction (those listed as critically endangered, endangered, or vulnerable). Amphibians are even more imperiled, with more than 2,157 species of amphibians (approximately 31 percent of the world's amphibians) at risk of becoming extinct (International Union for Conservation of Nature, 2019). Long-term trends in amphibian and reptile diversity and abundance in the Chesapeake Bay watershed are not available, but the primary stressors are present (Section 3.4.2.1, Affected Environment, Environmental Baseline).

The terrestrial reptiles and amphibians within the PRC Study Area occupy a diversity of habitat types, including upland forests, scrub-shrub, emergent habitats, and freshwater wetlands (such as streams, ponds, and flooded forests). Habitats used by amphibian species include marshes, streams, ponds, forested wetlands, and ditches. Amphibians within the PRC Study Area have periods of activity related to reproduction, foraging, and migration. Activity periods are species-specific and may occur throughout the year. Reptile species also have active periods, however they are typically between the months of April to October because of the thermoregulatory requirements of these species. Habitats used by these reptilian species include fields, forests, dunes, and wetlands. Both amphibians and reptiles are generally secretive animals and spend a significant amount of time hiding within their habitats.

Based on the 2017 INRMP (U.S. Department of the Navy, 2017c) and Department of Natural Resources Maryland Amphibian and Reptile Atlas Database (Maryland Department of Natural Resources, 2019a), the majority of the frogs, toads and salamanders confirmed present on the various PRC land areas are very common throughout eastern Maryland. Amphibian species adapted to developed environments, those similar to where land-based activities would occur, include the bullfrog (*Lithobates catesbeianus*) and Fowler's toad (*Anaxyrus fowleri*). The turtles, lizards and snakes confirmed present on PRC land areas are species that are common to eastern Maryland and the mid-Atlantic region. Reptile species common in developed areas include the common garter snake (*Thamnophis sirtalis*), five-lined skink (*Plestiodon fasciatus*), and red-eared slider (*Trachemys scripta elegans*).

3.4.2.6 Birds

Broadly speaking, birds are warm-blooded, flying vertebrates characterized by feathers, toothless beaked jaws, and laying of hard-shelled eggs. Of all the higher taxonomic categories in the PRC Study Area (e.g., fish, reptiles, mammals), birds occupy the most varied range of habitats because most can fly, many swim, and all lay eggs on land. Birds are a highly diverse group of vertebrates. Bird species documented on PRC land and water areas are cataloged in the *Biodiversity Database for NAS PRC* (U.S. Department of the Navy, 2017c); over 280 bird species have been documented in and around PRC land and water areas at some time during the year, with 18 of these species abundant, 82 common, and 96 uncommon. The rest are rare or occasional visitors, with several species only having been observed once.

Since 1970, North American birds have experienced losses of approximately 3 billion birds or 29 percent of their population (Rosenberg et al., 2019). The losses include once-common species from a range of habitats. A continent-wide weather radar network also reveals a similarly steep decline in biomass of migrating birds over a recent 10-year period (Rosenberg et al., 2019). The primary causes of decline over the last 50 years have been habitat loss, climate change, unregulated harvest, and other forms of human-caused mortality (e.g., feral and domestic cats, building strike). Trends in the overall bird diversity and abundance in the Chesapeake Bay area are not available, but the stressors affecting North American birds are present (Section 3.4.2.1, Affected Environment, Environmental Baseline). Documented trends in individual bird groups are discussed in their respective subsections.

Birds occupy a variety of habitats in the PRC Study Area, including freshwater, terrestrial, and estuarine environments. Section 3.4.2.2 (Affected Environment, Vegetation) and Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment) provide the assessment of freshwater/terrestrial and estuarine habitats, respectively. The wetlands and shallow water in and around Bloodsworth Island Range are located within the Atlantic Flyway, which is a major migration route for migratory birds along the U.S. east coast. Large numbers of birds are found in this corridor during the spring and fall migration periods. Radar-validated habitat modeling shows that the land areas within the PRC Study Area overlap fall stopover locations with relatively high densities of migratory birds in the northeastern region of the U.S. (Buler & Dawson, 2014). Large areas of regionally important avian stopover sites are located throughout the Delmarva Peninsula (including Bloodsworth Island Range) and in areas surrounding Baltimore and Washington, based on statistical models predicting potentially important stopover sites across the region according to land cover, ground elevation, and geographic location. Locally important stopover sites were generally associated with deciduous forests embedded within landscapes dominated by developed or agricultural lands or near the shores of major water bodies. The shallow waters surrounding Bloodsworth Island Range (during winter months) are also included in Maryland's Resources of Special State Concern for large concentrations of waterfowl (Rambo, 2020a).

While foraging birds will be present near the surface, migrating birds may fly at various altitudes. Some species of waterfowl (e.g., sea ducks) are commonly seen flying just above the water's surface, but the same species can also be spotted flying high enough (5,800 feet) that they are barely visible through binoculars (Lincoln et al., 1988). While there is considerable variation, the favored altitude for most small birds appears to be 500 feet (152 meters) to 1,000 feet (305 meters). Radar studies have demonstrated that 95 percent of the migratory movements occur at less than 10,000 feet (3,050 meters) with the bulk of the movements occurring under 3,000 feet (914 meters) (Lincoln et al., 1988).

The following subsections discuss seasonal distribution patterns and growth/reproduction characteristics that are specific to the different bird groups and member species present in the PRC Study Area. The primary taxonomic groups representing bird species in the PRC Study Area include (1) raptors; (2) waterfowl; (3) wading birds; (4) shorebirds, seabirds, diving birds; (5) songbirds; and (6) upland game birds.

Raptors

Raptors include eagles, ospreys, hawks, falcons, kites, and other carnivorous birds (e.g., owls, vultures). The Navy (2017c) details the documented occurrence of 24 raptor species on PRC land and water areas. The MBTA protects all native raptor species, and some species have additional state or federal protections or designation as Birds of Conservation Concern (Table 3.4-5). None of the raptor species in Table 3.4-5 are listed or proposed candidate species under the federal ESA. The habitats and locations listed in this subsection and Table 3.4-5 are visually represented in Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3.

The bald eagle (*Haliaeetus leucocephalus*) is found throughout the Chesapeake Bay region, including PRC land areas and the habitats surrounding those areas. In addition to MBTA listing, bald (and golden) eagles are protected by the BGEPA (16 U.S.C. sections 668–668d) and the Lacey Act of 1900 (16 U.S.C. sections 3371–3378). Nesting sites have been documented on and around PRC land areas by installation natural resource staff. In 2012, there were three confirmed and active bald eagle nests on PRC land areas, with at least two additional active nests within 0.5 mile of the NAS Patuxent River boundary (Rambo, 2020a). Of the three eagle nests located in PRC land areas, all nests have remained active through the 2019 season (Smith J. , 2020a). Bald eagle nesting sites were confirmed in survey flights over Bloodsworth Island in 2012 and 2013. A nesting site was also confirmed on Adam Island (south central island in Bloodsworth Island Range) during a 2012 site visit (Smith, 2012). The nest at Bloodsworth Island have remained active through the 2020 season, and the Adam Island nest was last active in 2018. There is also a nest at OLF Webster as of the 2019 and 2020 seasons (Smith, 2020).

Peregrine falcons (*Falco peregrinus*) are considered rare in the PRC Study Area. This species was federally delisted in 1999, but is still listed as endangered and in need of conservation by the state of Maryland and protected under the MBTA. Recent surveys have identified peregrine falcon nests on Bloodsworth Island, the Hannibal Target ship, and the Point No Point Lighthouse (Figure 3.4-1). While peregrine falcons have been observed near NAS Patuxent River during migration, they have not been observed nesting there.

Table 3.4-5 Raptor Species (All Native) with a Special Designation in Addition to Listing by the Migratory Bird Treaty Act That May Occur on PRC Land and Water Areas

Common Name	*Scientific Name*	*Abundance and Seasonality/Breeding*	*Habitat: Location*	*Fed/ MD/VA T&E*
Bald Eagle[1]	*Haliaeetus leucocephalus*	Uncommon resident, breeding	Throughout: PAX, OLF Webster, BIR – documented	-/-/-
Golden Eagle[1]	*Aquila chrysaetos*	Rare winter resident	Throughout: PAX – documented	-/-/-
Long-Eared Owl[1]	*Asio otus*	Rare winter resident	Forest, open fields, marshes: PAX – documented, OLF Webster – probable	-/-/-
Northern Goshawk	*Accipiter gentilis*	Rare migrant/winter resident	Open field, forest: PAX – documented, OLF Webster – possible	-/E/-
Peregrine Falcon[2]	*Falco peregrinus*	Rare resident, breeding	Open field, bluff: PAX, OLF Webster, BIR – documented	-/E/T
Short-Eared Owl	*Asio flammeus*	Uncommon winter resident	Marshes, open field/grassland: PAX – documented, OLF Webster –probable	-/T/-

Source: (U.S. Department of the Navy, 2017c; Maryland Natural Heritage Program, 2016; Virginia Department of Game and Inland Fisheries, 2018)

Key: BIR = Bloodsworth Island Range; E = endangered; Fed = Federal; MD/VA T&E = Maryland or Virginia Threatened and Endangered Species; OLF = Outlying Field; PAX = Naval Air Station Patuxent River; PRC = Patuxent River Complex; T= threatened.

Notes:

-/-/- means there is no listing status.

1. Bird of Conservation Concern or protected under the Bald and Golden Eagle Protection Act
2. Also documented on Hannibal Target

Wading Birds

Ten species of wading birds are known to nest in the PRC Study Area, including large numbers of great blue heron (*Ardea herodius*), green heron (*Butorides virescens*), black-crowned night heron (*Nycticorax nycticorax*), and yellow-crowned night heron (*Nycticorax violacea*). Other wading birds that nest on the Bloodsworth Island Range include little blue heron (*Egretta caerulea*), great egret (*Ardea alba*), tri-colored heron (*Egretta tricolor*), glossy ibis (*Plegadis chihi*), and snowy egret (*Egretta thula*). The PRC Study Area also supports nesting populations of rails, although their presence at the Bloodsworth Island Range is more extensive during the migratory season. Clapper rails (*Rallus longirostris*) are known to nest in relatively high numbers within the PRC Study Area, with migrating king rails (*Rallus elegans*), Virginia rails (*Rallus limicola*), and sora rails (*Porzana carolinus*) also present during the fall, winter, and spring months. Native wading bird species with a special designation in addition to listing by the MBTA are described in Table 3.4-6. The habitats and locations listed in this subsection and Table 3.4-6 are visually represented in Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3, which includes NAS Patuxent River as well as the Bloodsworth Island Range.

The eastern black rail (*Laterallus jamaicensis jamaicensis*) has been proposed for listing as threatened, and is therefore covered in Section 3.4.4.2 (Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction).

Table 3.4-6 Wading Bird Species (All Native) with a Special Designation in Addition to Listing by the Migratory Bird Treaty Act That May Occur on PRC Land and Water Areas

Common Name	*Scientific Name*	*Abundance and Seasonality/Breeding*	*Habitat: Location*	*Fed/ MD/VA T&E*
Clapper Rail[1]	*Rallus longirostris*	Uncommon resident, breeding	Bay marshes: PAX, BIR – documented	-/-/-
Eastern Black Rail[1]	*Laterallus j. jamaicensis*	Rare	Marshes: PAX, OLF Webster – unlikely	P/E/E
King Rail[1]	*Rallus elegans*	Rare migrant, breeding	Marshes: PAX – documented	-/-/-

Source: (U.S. Department of the Navy, 2017c; Maryland Natural Heritage Program, 2016; Virginia Department of Game and Inland Fisheries, 2018; Audubon Society, 2019)

Key: BIR = Bloodsworth Island Range; E = Endangered; Fed = Federal; MD/VA T&E = Maryland or Virginia Threatened and Endangered Species; OLF = Outlying Field; P = proposed candidate; PAX = Naval Air Station Patuxent River; PRC = Patuxent River Complex.

Notes:
-/-/- means there is no listing status
1. Bird of Conservation Concern

Historically, wading bird nests on the Bloodsworth Island Range have been successful despite the heavy use of the Bloodsworth Island Range for military testing and training during the summer months. However, the area of Fin Creek Ridge (where most wading birds nest) in the northern portion of the island has been closed to range use and bombardment for the past 30 to 35 years, so birds there have not been exposed to much range activity other than active wildlife management practices (Rambo, 2012).

All of the wading bird species at the Bloodsworth Island Range are sustained by a variety of foods, including various invertebrates, fishes, and crabs, associated with a variety of habitats from the interior marsh to offshore waters. Island habitats, such as those provided at the Bloodsworth Island Range, are attractive to these wading birds because they tend to have fewer predators, they place the birds in proximity to food resources, they improve the efficiency of foraging during the nesting season, and they reduce the probability of human disturbance. Most herons breed in communal colonies of up to hundreds of nesting pairs in what is often referred to as a rookery. Nesting sites are primarily trees (both living and dead tree snags) and bushes.

The heron rookery located in the northern portion of Bloodsworth Island Range includes artificial nesting platforms that were installed by the Navy in the early 1980s to address an observed decline in the number of heron nesting pairs. The poles supporting the nesting platforms were repaired/replaced in 2002 (Smith J. , 2020a). The decline was primarily due to a loss of nesting habitat, namely loblolly pines and other trees that were dying because of rising water levels and increasing salinity levels. A survey completed in May 2012 identified 66 heron nests on 65 pole platforms (Swift, 2013). To protect the heron rookery, the Navy designated the northern portion of Bloodsworth Island as a "No Fire Area" in 1983. Regular survey of heron rookeries have been conducted by installation natural resources staff since 2014 (Smith J. , 2020a). The results of these surveys suggest the rookery population has been trending downward, though trajectory could be due to eagles nesting nearby.

Shorebirds, Seabirds, and Diving Birds

The PRC Study Area supports nesting populations of shorebirds, although their presence at the Bloodsworth Island Range is more extensive during the migratory season. Shorebird species known to use the PRC Study Area include the common tern (*Sterna hirundo*), Forster's tern (*Sterna forsteri*), royal tern (*Sterna maxima*), willet (*Catoptrophorus semipalmatus*), greater yellowlegs (*Tringa melanoleuca*), black-bellied plover (*Pluvialis squatarola*), ruddy turnstone (*Arenaria interpres*), least sandpiper (*Calidris minutilla*), western sandpiper (*Calidris mauri*), American oystercatcher (*Haematopus palliates*), and others. Of these, willets are the most common and, together with the American oystercatcher, are the only species that breed in the PRC Study Area. Native shorebirds, seabirds, and diving bird species with a special designation in addition to listing by the MBTA are described in Table 3.4-7. The habitats and locations listed in this subsection and Table 3.4-7 are visually represented in Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3, which include NAS Patuxent River as well as the Bloodsworth Island Range.

Table 3.4-7 Shorebirds, Seabirds, and Diving Species (All Native) With a Special Designation in Addition to Listing by the Migratory Bird Treaty Act That May Occur on PRC Land and Water Areas

Common Name	*Scientific Name*	*Abundance and Seasonality/Breeding*	*Habitat: Location*	*Fed/ MD/VA T&E*
American Oystercatcher[1]	*Haematopus palliatus*	Uncommon summer resident, breeding	Beach, jetty, and mudflats: PAX, BI – documented, OLF Webster – unlikely	-/-/-
Black Skimmer[1]	*Rynchops niger*	Rare summer resident	Open bay, along coasts, beaches: PAX – documented, OLF Webster – probable	-/T/-
Buff-Breasted Sandpiper[1]	*Calidris subruficollis*	Vagrant fall migrant	Mowed field, shortgrass fields, wet rice fields: PAX – documented	-/-/-
Dunlin[1]	*Calidris alpina*	Uncommon winter resident	Beach: PAX, BI – documented	-/-/-
Least Tern[1]	*Sternula antillarum*	Uncommon migrant, breeding	Along coast, beaches, salt water: PAX – documented, OLF Webster – probable	-/T/-
Lesser Yellowlegs[1]	*Tringa flavipes*	Uncommon migrant	Marshes, beach, open woodlands, sheltered tundra: PAX – documented	-/-/-
Red Knot	*Calidris canatus rufa*	Rare migrant	Coastal, sandy habitats near tidal bays, inlets, and estuaries: PAX, BI – documented	T/-/T
Red-Throated Loon[1]	*Gavia stellata*	Uncommon winter resident	Open water: PAX – documented	-/-/-
Royal Tern	*Thalasseus maxima*	Rare summer resident	Open water, along coast, beaches, salt water: PAX, OLF Webster – documented	-/E/-
Ruddy Turnstone[1]	*Arenaria interpres*	Rare migrant	Beach: PAX, OLF Webster, BI – documented	-/-/-
Semipalmated Sandpiper[1]	*Calidris pusilla*	Uncommon migrant	Beach: PAX, BI – documented	-/-/-
Short-Billed Dowitcher[1]	*Limnodromus griseus*	Rare migrant	Beach, mudflat: PAX – documented	-/-/-

Table 3.4-7 Shorebirds, Seabirds, and Diving Species (All Native) With a Special Designation in Addition to Listing by the Migratory Bird Treaty Act That May Occur on PRC Land and Water Areas, Continued

Common Name	*Scientific Name*	*Abundance and Seasonality/Breeding*	*Habitat: Location*	*Fed/ MD/VA T&E*
Upland Sandpiper	*Bartramia longicauda*	Uncommon migrant	Old field: PAX – documented	-/E/-
Whimbrel[1]	*Numenius phaeopus*	Rare migrant	Beaches, mud flats, wet fields: PAX – documented	-/-/-
Willet[1]	*Tringa semipalmatus*	Uncommon summer resident, breeding	Wet fields, marshes, beaches: PAX, OLF Webster, BI – documented	-/-/-

Source: (U.S. Department of the Navy, 2017c; Maryland Natural Heritage Program, 2016; Virginia Department of Game and Inland Fisheries, 2018; Rambo, 2020a)

Key: BI = Bloodsworth Island; E = endangered; Fed = Federal; MD/VA T&E = Maryland or Virginia Threatened and Endangered Species; OLF = Outlying Field; P = proposed for listing; PAX = Naval Air Station Patuxent River; PRC = Patuxent River Complex; T= threatened.

Notes:

-/-/- means there is no listing status

1. Bird of Conservation Concern

The only shorebird with a federal status is the red knot (*Calidris canatus rufa*) (Table 3.4-7); it is listed as threatened. The species is therefore covered in Section 3.4.4.2 (Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction). Whereas piping plover are also federally threatened and documented in the PRC Study Area, suitable habitat (e.g., coastal beaches) is currently lacking and the last observation was over 40 years ago (U.S. Department of the Navy, 2017c).

Various species of gulls are common in the PRC Study Area during the summer months, including the laughing gull (*Larus atricilla*), great black-backed gull (*Larus marinus*), herring gull (*Larus argentatus*), and ring-billed gull (*Larus delawarensis*). None of these species is currently known to nest at the Bloodsworth Island Range. Future nesting activity by these species, if it occurred, would likely be limited to the sandy beaches and shoals at the southern end of the Bloodsworth Island Range. Herring gull and great black-backed gull (*Larus marinus*) nest have been documented on Adam Island (Smith J. , 2020a). Of the diving bird species, brown pelicans (*Pelecanus occidentalis*), double-crested cormorants (*Phalacrocorax auritus*) and American oystercatchers (*Haematopus palliatus*) have documented breeding colonies on Bloodsworth and Adam Islands. Double-crested cormorants are the most abundant breeders on the Bloodsworth Island Range, with close to 1,000 nesting pairs (Rambo, 2020a). In terms of food/ingestion stressors, American oystercatcher are one of few birds in the PRC Study Area that consume hard-shelled invertebrates (e.g., oysters, clams).

Waterfowl

None of the native waterfowl species that may occur on PRC land and water areas have any special protective designation other than coverage by the MBTA. The habitats and locations listed in this subsection are visually represented in Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3.

Ponds, impoundments, and tidal creeks on the NAS Patuxent River provide resting areas for waterfowl, as do the adjacent Bay waters. Waterfowl nesting activity at Bloodsworth Island Range is limited by the lack of vegetation diversity (specifically uplands), vulnerability of nests to storm tides, competition from gulls and crows, and, infrequently, predation by the red fox. However, nesting records exist for both the black duck (*Anas rubripes*), blue-winged teal (*Anas discors*) (U.S. Department of the Navy, 2017c), and gadwall (*Mareca strepera*) (Smith J. , 2020a). Furthermore, Haramis et al. (2000) completed a study on the breeding ecology of black ducks on Bloodsworth, Smith, and South Marsh Islands (Figure 3.4-1). Their study found that the salt marsh habitats composing the majority of the islands are of minimal value for black duck nesting. This conclusion was based on a low frequency of nesting, limited return nesting, low hatching success caused by predation, and vulnerability of nests to storm tides. Surveys completed by NAS Patuxent River natural resources personnel also have indicated that resident breeding black ducks are not nesting in large numbers on the upland ridges and hummocks of the Bloodsworth Island Range. The PRC Study Area serves as an important overwintering and stopover area for migratory waterfowl. Large numbers of tundra swans (*Cygnus columbianus*), Canada geese, and over 15 species of ducks have been observed in the PRC Study Area during the wintering period. Many of the waterfowl species use the estuarine marsh and submerged aquatic vegetation (SAV) within the PRC Study Area as a source of food. Species such as the long-tailed duck (*Clangula hyemalis*), scoters (*Melanitta* spp.), common goldeneye (*Bucephla clangula*), and bufflehead (*Bucephala albeola*) are common in the deeper open waters in the Bloodsworth Island Range. Nearshore waters, especially around Bloodsworth Island, are important feeding and resting areas for diving bay ducks such as the canvasback (*Aythya valisneria*), scaup (*Aythya* spp.), and redhead (*Aythya americana*). Puddle duck species such as the northern pintail (*Anas acuta*), gadwall (*Anas strepera*), American wigeon (*Anas americana*), American black duck, and mallard (*Anas platyrhynchos*) also use interior wetlands and nearshore waters. The natural pockets, coves, and tidal guts that occur at the PRC Study Area also provide abundant cover for idle or resting waterfowl.

Since 1965, the Navy (via letter notification) has voluntarily discontinued most exercises at the Bloodsworth Island Range during the migratory bird season in recognition of the importance of the Bloodsworth Island Range as an overwintering area for waterfowl. Normally, closure has occurred from mid-October through mid-February, although actual closure dates have varied from year to year. During this period, the Navy has also suspended all overflights below 3,500 feet in order to minimize the potential for bird strike hazard to aircraft. These restrictions in effect, have created a large, undisturbed refuge for migratory waterfowl during the migration season. The Atlantic Test Ranges Sustainability Office and natural resources management at NAS Patuxent River work together to determine what, if any, restriction should be applied to a proposed test event on a case-by-case basis.

Song Birds and Other Passerines

About 150 species of migratory songbirds have been identified at PRC land and water areas. Common breeding songbirds include the red-winged blackbird (*Agelaius phoeniceus*), marsh wren (*Cistothorus palustris*), seaside sparrow (*Ammodramus maritimus*), and saltmarsh sharp-tailed sparrow (*Ammodramus caudacutus*). Native songbird species with a special designation in addition to listing by the MBTA are described in Table 3.4-8. The habitats and locations listed in this subsection and Table 3.4-8 are visually represented in Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3.

Although no longer a Navy possession, the tip of Point Lookout (Figure 3.4-1) has been observed to have large congregations of migratory songbirds during the fall and spring.

Table 3.4-8 Songbird Species (All Native) With a Special Designation in Addition to Listing by the Migratory Bird Treaty Act That May Occur on PRC Land and Water Areas

Common Name	*Scientific Name*	*Abundance and Seasonality/Breeding*	*Habitat: Location*	*Fed/ MD/VA T&E*
Black-Billed Cuckoo[1]	*Coccyzus erythropthalmus*	Uncommon migrant	Forest - woodlands and along streams: PAX – documented	-/-/-
Blackburnian Warbler	*Setophaga fusca*	Rare migrant	Forest, coniferous or mixed woodlands: PAX – documented, OLF Webster – probable	-/T/-
Bobolink[1]	*Dolichonyx oryzivorus*	Uncommon migrant	Old field, hayfields, weedy meadows: PAX – documented	-/-/-
Canada Warbler[1]	*Cadellina canadensis*	Uncommon migrant	Forest, dense woodlands, and brush: PAX – documented, OLF Webster – probable	-/-/-
Cerulean Warbler[1]	*Setophaga cerulea*	Rare migrant	Forest, tall tree swamps, bottomlands: PAX – documented, OLF Webster – probable	-/-/-
Evening Grosbeak[1]	*Coccothraustes vespertinus*	Rare winter visitor	Throughout, woodlots, shade trees, mixed woods: PAX – documented	-/-/-
Kentucky Warbler[1]	*Geothlypis formosus*	Uncommon summer resident, breeding	Rich, moist woodlands: PAX – documented	-/-/-
Loggerhead Shrike	*Lanius ludovicianus*	Rare vagrant	Open and bushy areas: PAX – documented, OLF Webster – probable	-/E/T
Mourning Warbler	*Geothlypis philadelphia*	Rare migrant	Forest, dense undergrowth, thickets, moist areas: PAX – documented, OLF Webster – probable	-/E/-
Olive-Sided Flycatcher	*Contopus cooperi*	Rare migrant	Coniferous forests, bogs: PAX – documented, OLF Webster probable	-/E/-
Prairie Warbler[1]	*Setophaga discolor*	Common summer resident, breeding	Forest, open woodland, scrublands: PAX, OLF Webster – documented	-/-/-
Prothonotary Warbler[1]	*Protonotaria citrea*	Uncommon summer resident, breeding	Forest, low site along streams or surrounding: PAX – documented	-/-/-
Red-Headed Woodpecker[1]	*Melanerpes erythrocephalus*	Uncommon summer resident, breeding	Open woods, dead timber, farmlands, backyards: PAX, OLF Webster – documented	-/-/-
Rusty Blackbird[1]	*Euphagus carolinus*	Rare winter resident	Forest, wet woodlands, swamps, open fields: PAX – documented	-/-/-

Table 3.4-8 Songbird Species (All Native) With a Special Designation in Addition to Listing by the Migratory Bird Treaty Act That May Occur on PRC Land and Water Areas, Continued

Common Name	*Scientific Name*	*Abundance and Seasonality/Breeding*	*Habitat: Location*	*Fed/ MD/VA T&E*
Saltmarsh Sharp-Tailed Sparrow[1]	*Ammodramus caudacutus*	Rare migrant, breeding	Old field, salt marshes, lakeshores, *Spartina* stand: PAX – documented, OLF Webster – probable	-/-/-
Seaside Sparrow[1]	*Ammodramus maritimus*	Common summer resident, breeding	Beach, dune, grassy tidal marshes: PAX, BIR – documented	-/-/-
Sedge Wren[1]	*Cistothorus platensis*	Rare migrant, breeding	Marsh, wet, grassy meadows; shallow: PAX, OLF Webster, BIR – documented	-/T/-
Wood Thrush[1]	*Hylocichla mustelina*	Abundant, breeding	Swamps, moist deciduous forests: PAX, OLF Webster – documented	-/-/-

Source: (U.S. Department of the Navy, 2017c; Maryland Natural Heritage Program, 2016; Virginia Department of Game and Inland Fisheries, 2018; Maryland Department of Natural Resources, 2020d)

Key: BIR = Bloodsworth Island Range; E = endangered; Fed = Federal; MD/VA T&E = Maryland or Virginia Threatened and Endangered Species; OLF = Outlying Field; P = proposed for listing; PAX = Naval Air Station Patuxent River; PRC = Patuxent River Complex; T = threatened.

Notes:

-/-/- means there is no listing status.

1. Bird of Conservation Concern

Upland Game Birds

Upland habitats are undeveloped areas landward of water and wetlands (e.g., forests, scrubland, grassland). Upland game birds receive protection under the MBTA, with the exception of regulated hunting. Table 3.4-9 documents the upland game birds that have been documented on PRC land areas. The habitats and locations listed in Table 3.4-9 are visually represented in Figure 3.4-1 and Figure 3.4-2.

Table 3.4-9 Upland Game Bird Species on PRC Land Areas

Common Name	*Scientific Name*	*Abundance and Seasonality*	*Habitat: Location*
Mourning Dove	*Zenaida macroura*	Common resident	Throughout, grassy fields, farm fields, backyard: PAX, OLF Webster, BIR – documented
Northern Bobwhite	*Colinus virginianus*	Rare resident	Old field, young woods: PAX, OLF Webster – documented
Ring-Necked Pheasant	*Phasinanus colchicus*	Former rare resident	Marsh, open fields, woodland edges: PAX – documented
Wild Turkey	*Meleagris gallopavo*	Uncommon resident	Open forested areas: PAX, OLF – documented

Source: (U.S. Department of the Navy, 2017c; Swift, 2020)

Key: BIR = Bloodsworth Island Range; OLF = Outlying Field; PAX = Naval Air Station Patuxent River; PRC = Patuxent River Complex.

3.4.2.7 Mammals

Broadly speaking, mammals are warm-blooded vertebrates that nourish their young with milk and have skin generally covered in hair. Bats are small winged mammals, whereas some terrestrial and freshwater mammals (e.g., deer, otter) are among the largest and most highly mobile of animals in the PRC Study Area. Over 30 mammal species have been documented in and around PRC land and water areas, with 11 of these species considered abundant, 13 common, and 5 uncommon or rare (U.S. Department of the Navy, 2017c). Most of the documented mammal species are bats and common terrestrial (upland) species. Certain mammals generally considered to be terrestrial/freshwater may also occur nearshore waters of the estuarine environment of the PRC Study Area (e.g., otter, raccoon, muskrat). Mammals protected under the MMPA (e.g., bottlenose dolphins) and/or listed under the ESA (e.g., manatees) are addressed in Section 3.4.5 (Marine Mammal Protection Act – Biological Assessment) or Section 3.4.4.2 (Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction), respectively.

The PRC Study Area is home to populations of a variety of mammal species which are distributed based on their habitat needs (Table 3.4-10 and Table 3.4-11). General information about the distribution of land cover and aquatic and vegetated habitats that are occupied by these mammals can be found in Section 3.4.2.2 (Affected Environment, Vegetation). The description of the affected environment for mammals distinguishes between bats and terrestrial/freshwater mammals due to differing analysis considerations in the aerial environment.

Table 3.4-10 Bat Species That May Occur in PRC Land and Water Areas

Common Name	*Scientific Name*	*Abundance*	*Habitat: Location*	*State & Federal*[1]
Cave Bats				
Big Brown Bat	*Eptesicus fuscus*	Common	Developed (low-high intensity), forest: PAX, OLF Webster - documented	
Keen's Myotis	*Myotis keeni*	Unknown	Developed (low-high intensity), forest: PAX, OLF Webster – probable	
Little Brown Bat	*Myotis lucifugus*	Uncommon	Developed (low-high intensity), forest, near water: PAX - documented, OLF Webster – probable	
Northern Long-Eared Bat	*Myotis septentrionalis*	Unknown	Forest: PAX, OLF Webster – possible	T
Tri-colored Bat	*Pipistrellus subflavus*	Uncommon	Developed (low-high intensity), forest: PAX, OLF Webster - documented	
Southeastern Myotis	*Myotis austroiparius*	Rare	Developed (low-high intensity), forest, near water: PRC Study Area - documented	
Tree Bats				
Eastern Red Bat	*Lasiurus borealis*	Common	Forest, near water: PAX, OLF Webster – documented	
Evening Bat	*Nycticeius humeralis*	Unknown	Developed (low-high intensity), forest: PAX, OLF Webster - documented	
Hoary Bat	*Lasiurus cinereus*	Rare	Developed (low-high intensity), forest, near water: PAX - documented, OLF Webster - probable	
Silver-Haired Bat	*Lasionycteris noctivagans*	Uncommon	Forest, near water: PAX, OLF Webster - documented	

Source: (U.S. Department of the Navy, 2017c; Smith J. , 2020c)

Key: OLF = Outlying Field; PAX = Naval Air Station Patuxent River; PRC = Patuxent River Complex; T = threatened.

Notes:

1. Federal and Maryland/Virginia State Threatened and Endangered Species

Table 3.4-11 Terrestrial and Freshwater Mammals Species Documented on PRC Land and Water Areas

Common Name	*Scientific Name*	*Abundance*	*Habitat: Location*
Terrestrial Mammals			
Coyote	*Canis latrans*	*	Field, forest, marsh: PAX, OLF Webster – documented
Eastern Cottontail	*Sylvilagus floridanus*	Common	Field (upland, wetland): PAX, OLF Webster, BIR – documented
Eastern Gray Squirrel	*Sciurus carolinensis*	Abundant	Forests: PAX, OLF Webster – documented
Eastern Mole	*Scalopus aquaticus*	Abundant	Forest, field, lawn (upland): PAX, OLF Webster – documented
Gray Fox	*Urocyon cinereoargenteus*	Abundant	Forests: PAX, OLF Webster – documented
House Mouse	*Mus musculus*	Common	Houses (associated with humans): PAX, OLF Webster - documented
Least Shrew	*Cryptotis parva*	Common	Upland forest, field, wetland: PAX, OLF Webster – documented
Long-Tailed Weasel	*Mustela frenata*	Unknown	Marsh: OLF Webster – documented, PAX - probable
Masked Shrew	*Sorex cinereus*	Rare	Upland forest, field, wetland: PAX, OLF Webster - documented
Meadow Vole	*Microtus pennsylvanicus*	Abundant	Upland, field, wetland: PAX, OLF Webster - documented
Norway Rat	*Rattus norvegicus*	*	Marsh, forest, lawn (throughout): PAX – documented, OLF Webster - probable
Opossum	*Didelphis virginiana*	Abundant	Forest (upland, wetland): PAX, OLF Webster – documented
Pine Vole/ Woodland Vole	*Microtus pinetorum*	Common	Forest (coniferous): PAX, OLF Webster - documented
Raccoon	*Procyon lotor*	Common	Forest, marsh, wetland: PAX, OLF Webster, BIR – documented
Red Fox	*Vulpes*	Common	Field, forest (upland): PAX, OLF Webster, BIR – documented
Rice Rat	*Oryzomys palustris*	Abundant	Marsh, wetland: BIR – documented, PAX, OLF Webster – possible
Short-Tailed Shrew	*Blarina brevicauda*	Common	Forest, field (upland, wetland): PAX, OLF Webster – documented
Sika deer	*Cervus nippon yakushimae*	*	Marsh: BIR – documented
Southeastern shrew	*Sorex longirostris*	Rare/ uncommon	Forest, field (upland, wetland): PAX – documented, OLF Webster - probable
Southern flying squirrel	*Glaucomys volans*	Common	Forest (upland): PAX – documented, OLF Webster - probable
Striped skunk	*Mephitis*	Common	Forest (upland): PAX, OLF Webster, BIR - documented
White-footed mouse	*Peromyscus leucopus*	Common	Forest, field (upland): PAX, OLF Webster - documented
Whitetail deer	*Odocoileus virginianus*	Abundant	Forest, field (throughout): PAX, OLF Webster, BIR - documented

Table 3.4-11 Terrestrial and Freshwater Mammals Species Documented on PRC Land and Water Areas, Continued

Common Name	*Scientific Name*	*Abundance*	*Habitat: Location*
Woodchuck/ groundhog	*Marmota monax*	Abundant	Forest, field (upland): PAX, OLF Webster, BIR - documented
Freshwater Mammals			
Beaver	*Castor canadensis*	Common	Marsh, wetland (freshwater): PAX, OLF Webster - documented
Mink	*Mustela vison*	*	Marsh: PAX, OLF Webster – documented
Muskrat	*Ondatra zibethica*	Abundant	Marsh: BIR - documented
River otter	*Lutra canadensis*	Uncommon	Marsh, stream/river: BIR – documented

Source: (U.S. Department of the Navy, 2017d; 2017c)

Key: BIR = Bloodsworth Island Range; OLF = Outlying Field; PAX = Naval Air Station Patuxent River; PRC = Patuxent River Complex.

Notes:

* means no abundance was provided for this species in the source reference.

Bats

All of the bats analyzed within the PRC Study Area are Microchiroptera bats (Table 3.4-10), which primarily feed on insects and rely on echolocation to navigate and locate food (Maryland Department of Natural Resources, 2016). Both cave and tree bats can be found within the PRC Study Area.

There is only one common tree bat: eastern red bat (*Lasiurus borealis*). The abundance of other tree bats is either unknown (evening bat [*Nycticeius humeralis*], Seminole bat [*Lasiurus seminolus*]), or uncommon-rare (silver-haired bat [*Lasionycteris noctivagans*], and hoary bat [*Lasiurus cinereus*]. Since insects are not active during winter, in general, tree bats either migrate south (outside of the PRC Study Area), or spend the winter in tree cavities, under bark, or even under leaf litter.

The most common and abundant cave bat species is the big brown bat (*Eptesicus fuscus*). Less common to rare cave bat species include the tri-colored bat (*Pipistrellus subflavus*) and little brown bat (*Myotis lucifugus*), both of which are under review for listing under the ESA, and southeastern myotis (*Myotis austroiparius*). Keen’s myotis (*Myotis keeni*) is another cave bat that is likely present in the PRC Study Area, but has not yet been documented (U.S. Department of the Navy, 2017c). Northern long-eared bat (*Myotis septentrionalis*) is the only bat species that may occur that is federally listed under the ESA (Section 3.4.4.2, Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction) but has not been documented. Cave bats in the PRC Study Area tend to fly to overwinter in hibernating areas such as caves, tunnels, and abandoned surface mines, none of which are located within the PRC Study Area (Maryland Department of Natural Resources, 2016).

All 10 species of bats that may be present are listed by the State of Maryland as Species in Need of Conservation. Unlike many other mammals, bats have a low reproductive rate and make up for it by living long lives. Stressors and other hazards and diseases in their environment that prevent this from happening pose long-term threats for many species of bats (Maryland Department of Natural Resources, 2016). These stressors include pesticide use that impacts their food source, disruptions in hibernation and maternity roosting, and the removal of large trees and forest cover that provide habitat. The PRC Study Area is located within the “white-nose syndrome zone” (U.S. Fish and WIldlife Service, 2018a). White-nose syndrome is a disease caused by the fungus *Pseudogymnoascus destructans* that impacts cave-hibernating bats. It does so by altering their hibernation abilities, causing erratic behavior during the winter months, and depleting necessary fat storage. The disease has killed millions of bats in North America, wiping out 90 to 100 percent of bats at some sites (White Nose Sydrome Response Team, 2018), and is likely the reason why many of the cave bats that used to frequent the PRC Study Area in the summer months are now rarely present.

Bat species present are expected to occur only at NAS Patuxent River and OLF Webster (Table 3.4-10). Due the lack of suitable roosting habitat, bats have not been documented at Bloodsworth Island Range (U.S. Department of the Navy, 2017d), and it is not considered further in this analysis.

Bats tend to select roosts in mature forest stands near permanent water such as streams, rivers, ponds, and lakes (McGowan & Hogue, 2016). The oldest mature forest stands that remain at NAS Patuxent River are scattered throughout, but the majority are found in very narrow corridors along streams and within a small semi-contiguous forest on the southern and western boundaries of the installation. Eastern red bats prefer to roost in mature deciduous trees during the summer (Limpert et al., 2007), while big brown bats like to roost in buildings, in hollow trees, and under loose bark (Maryland Department of Natural Resources, 2016).

Bat foraging activity is generally higher in riparian areas than in upland areas (Menzel et al., 2005). The flight altitudes of foraging bats varies among individuals as well as their surroundings. Bats are known to adjust their foraging behavior to fly at altitudes necessary to capture prey, which can fluctuate seasonally based on insect migrations (Krauel et al., 2018). Bat flight altitudes also vary depending on the configuration of their surrounding environment, as they fluctuate flight patterns based on landscape topography (Roeleke et al., 2018), forest clutter (Menzel et al., 2005), and forest canopy (Yang et al., 2013). A study of big brown bats showed a direct correlation to surroundings and forest canopy, where maximum flight altitudes among bats emerging to forage from a barn approximately 26 feet (8 meters above ground level [AGL]) were no higher than the barn (8 meters AGL), with average flight altitudes at approximately 20 feet (6 meters AGL) that corresponded to an average of approximately 21 feet (6.5-meter) surrounding forest canopy height (Yang et al., 2013). In riparian areas, bat foraging activity decreases significantly at altitudes above the forest canopy (Menzel et al., 2005). Refer to Section 3.4.4.2 (Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction, Affected Environment, Vegetation) and Figure 3.4-1 for forested area locations and descriptions as found in the PRC Study Area.

Most bats do not occur in the area year-round. Bat migration activity is influenced by nightly temperature and wind speeds and appears to be greater in autumn (Johnson et al., 2011). Of the tree bats, eastern red bats (the most common in the study area) have been documented year-round in Maryland, and thus presumably in the study area where they overwinter under leaf litter in the fall and winter. Biologists think that silver-haired and hoary bats migrate south in the fall to areas where insects are active all year; however, much is still unknown about these species because they tend to roost singly or in family groups, are small in size, and are secretive in nature (Maryland Department of Natural Resources, 2016).

Cave bats hibernate during the winter months when food is not available. These species winter in caves, mines, and abandoned railroad tunnels outside of the PRC Study Area, although big brown bats will sometimes overwinter in buildings or bat boxes and could potentially find a place to overwinter. Not much is known about where evening bats spend the winter outside of the study area. Bats in this group may travel a hundred miles or more between their summer and winter roosts. Tri-colored bats were once the most abundant wintering species in Maryland’s caves, mines, and tunnels, but populations of this species, as well as little brown bats and northern long-eared bats, have been decimated by white-nose syndrome. While these species are now all uncommon or rare in the study area, during the summer breeding season, most of these species form loose colonies of females and pups (maternity colonies) in snags and hollow trees, under loose bark, in buildings, and in bat roosting boxes (Maryland Department of Natural Resources, 2016).

While much of the available data on bat migration focuses on migration distances rather than migration flight altitudes, eastern red bats originating from the U.S. Mid-Atlantic states, have been observed off the Atlantic Seaboard at altitudes greater than approximately 1,970 feet (600 meters) above sea level during autumn migration (Hatch et al., 2013). Though these altitudes may be correlated with their migration over the open ocean at distances greater than 1,000 kilometers (km), it is assumed that, while only occurring twice a year rather than nightly, bat migration flight altitudes occur at higher altitudes than nightly foraging altitudes.

Terrestrial and Freshwater Mammals

Terrestrial and freshwater mammal species include both game and nongame animals that inhabit various vegetative communities or habitat types, such as forest, scrub/shrub, field, marshes, beaches, and freshwater streams (U.S. Department of the Navy, 2017c). Some of the more familiar animals include white-tailed deer (*Odocoileus virginianus*), gray squirrel (*Sciurus carolinensis*), eastern cottontail (*Sylvilagus floridanus*), red fox (*Vulpes vulpes*), muskrat (*Ondatra zibethicus*), river otter (*Lontra canadensis*), mink (*Mustela vison*), and beaver (*Castor canadensis*) (U.S. Department of the Navy, 2017c). Table 3.4-11 lists the terrestrial and freshwater mammals that may be found in the PRC Study Area along with their habitat associations. Some freshwater species that occur in marsh habitats (e.g., river otter, muskrat) may also occur in the nearshore estuarine environment. There are no federally listed or state-listed terrestrial or freshwater mammals in the PRC Study Area.

Worldwide, habitat loss and degradation and harvesting (hunting or gathering for food, medicine, fuel, and materials) are by far the main threats to land mammals (Schipper et al., 2008). However, the greatest threats are occurring in the tropics with species having highly localized distributions. For the Chesapeake Bay region, Schipper et al. (2008) indicated a relatively low number of land mammal species threatened by habitat loss, harvesting, accidental mortality, and pollution.

In addition to habitat associations listed in Table 3.4-11, most land mammals in the Chesapeake Bay region are nocturnal (Bennie et al., 2014). Most terrestrial/freshwater mammals in the PRC Study Area are also active, year-round residents that are considered to be common to abundant.

3.4.3 Biological Resources, Environmental Consequences

The following analyses focus on species that are not addressed by federal legislation apart from NEPA (e.g., ESA, MSA) and the potential for long-term/population-level effects. Likely effects of the No Action and Action Alternatives on species with special regulatory designations are summarized under each alternative and stressor, with references to the consultation sections for analysis details. The stressor-based summary for the No Action and Action Alternatives and all biological resources is provided in Section 3.4.3.4 (Alternative Impact Summary).

Prior to detailed analysis, some biological resources can be discounted with regard to potential impacts from all Proposed Action stressors. and alternatives. Microscopic algae forming the base of aquatic food webs overlap various stressors, but any potential impact from the No Action Alternative would be discountable relative to their vast populations and extremely high growth rates (Caceres et al., 2013).

Floating microalgae also moves with the surface tension of the water and tends to flow around physical disturbances. Microalgae will therefore not be discussed further. Freshwater plants do not occur in close proximity to the proposed activities. This section therefore only covers potential impacts on animals and terrestrial vegetation.

The stressors associated with the Proposed Action alternatives were described in Section 3.0.2.3 (Identifying Stressors for Analysis) from a resource-generic perspective. This following paragraph describes the stressor-based analysis considerations for biological resources in general. As such, the background information presented does not require a detailed accounting of the PRC affected environment that is provided in subsequent sections. This information may be referenced in subsequent analyses of the PRC affected environment to reduce repetition of analysis background information that applies to multiple sub-resource areas. The general background for analysis includes guidance in identifying immediate and short-term consequences as well long-term consequences.

As described in Section 3.0.2.4 (Resource-Specific Impacts Analysis for Individual Stressors), immediate and short-term consequences of a stressor on biological resources persist for only a short time, which may be minutes for some resources and as long as months for other resources, depending on the specific resource and stressor. Long-term consequences to individuals can translate into consequences for populations dependent upon population abundance, structure, growth rate, and carry capacity. Carrying capacity describes the theoretical maximum number of organisms of a particular species that the environment can support. When a population nears its carrying capacity, available resources and predator pressure naturally limit its growth. If one, or a few individuals, in a population are removed or gather fewer resources, then other individuals in the population can take advantage of the freed resources and potentially increase their health and lifetime reproductive success. Abundant populations that are near their carrying capacity (theoretical maximum abundance) that suffer consequences on a few individuals may not be affected overall. Populations that exist well below their carrying capacity may suffer greater consequences from any lasting consequences to even a few individuals. Population-level consequences can include a change in the population dynamics, a decrease in the growth rate, or a change in geographic distribution.

The potential long-term consequences from behavioral responses are difficult to discern. Animals displaced from their normal habitat due to an avoidance reaction may return over time and resume their natural behaviors. This is likely to depend upon the severity of the reaction and the frequency the activity is repeated in the area. In areas of repeated and frequent acoustic disturbance, some organisms may habituate to the new baseline; conversely, species that are more sensitive may not return, or return but not resume use of the habitat in the same manner. For example, an animal may return to an area to feed but no longer rest in that area. Long-term abandonment or a change in the utilization of an area by enough individuals can change the distribution of the population. Frequent disruptions to natural behavior patterns may not allow an animal to recover between exposures, which increase the probability of causing long-term consequences to individuals.

The magnitude and type of effect and the speed and completeness of recovery (i.e., return to baseline conditions) must be considered in predicting long-term consequences to the individual organisms. The rate at which an organism makes a full recovery is related to the cost to the organism from any reactions, behavioral or physiological. Available resources fluctuate by season, location, and year and can play a major role in an organism’s rate of recovery. Recovery can occur more quickly if plentiful food resources, many potential mates, or refuge or shelter are available. An organism’s health, energy reserves, size, life history stage, and resource gathering strategy affect the speed and completeness of its recovery. Plants and animals that are in good health and have abundant energy reserves before an effect takes place will likely recover more quickly.

Organisms that recover quickly and completely are unlikely to suffer reductions in their health or reproductive success, or experience changes in habitat utilization. No population-level effects would be expected if individual plant or animals do not suffer reductions in their lifetime reproductive success or change their habitat utilization. Plants or animals that do not recover quickly and fully could suffer reductions in their health and lifetime reproductive success, could be permanently displaced or change how they use the environment, or could die. Although these long-term consequences to the individual can lead to consequences for the population, population dynamics and abundance also play a role in determining how many individuals would need to suffer long-term consequences before there was an effect on the population. For example, the chance of affecting individuals of uncommon species is relatively low, whereas affecting a few individuals of common species would have a negligible impact on their population. All the stressor-based conclusions in Section 3.4.3 (Environmental Consequences) are made with reference to population-level effects that would be, in most cases, long-term.

3.4.3.1 Biological Resources, No Action Alternative

The subsequent stressor-based analysis sections for the No Action Alternative merge the analysis for biological sub-resources in an orderly fashion. For example, the impact of air-based acoustic stressors in PRC airspaces is characterized for aerial invertebrates, bats, and birds in the same section, with factors affecting multiple sub-resource stated at the beginning and not repeated. To reduce the duplication/overlap of analysis in this section and Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment), the primary discussion of direct impacts on fish (e.g., physical strike and disturbance, acoustic stressors, pollutants, ingestion, entanglement) is covered in this section. The indirect impact of stressors on plants and animals through effects on predator or prey species is also covered in this section. The indirect impact of stressors on fish and other estuarine animals through association with estuarine habitat features (e.g., sandy bottom, seagrass beds, shellfish beds/reefs) is covered in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). To facilitate a single analysis that serves both sections, fish species with EFH (including their prey species) will represent the entire estuarine fish assemblage with additional species of importance included, where appropriate.

Note the threat to biological resources from the No Action Alternative of proposed activity is mostly reflected in Section 3.4.2 (Affected Environmental) because it has been occurring for many years. The environmental baseline also did not list military activities among the significant threats to biological resource in the PRC study area—a fact that weighs on the analysis conclusions under the No Action Alternative subsection.

Acoustic

Generic Background for Analysis

A potential impact on animals from acoustic stressors generated by the Proposed Action alternatives depends on the interplay of the following aspects: (1) stressor characteristics (e.g., spatial distribution of different sound sources; Section 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors) and (2) response of individual organisms and populations (e.g., distribution/density, masking, physiological stress, behavioral responses).

The potential effects from exposure to acoustic activities and the accompanying short-term consequences to animals (e.g., expended energy or missed feeding opportunity) are described in this section. There is no evidence that acoustic stressors impact vegetation that lack both air spaces and a central nervous system that could be meaningfully affected by sound-induced vibrations. Effects of acoustic stressors on vegetation are, therefore, not further analyzed. Within each animal sub-resource section, the detailed methods to predict effects on specific species or species groups are derived from the following conceptual framework. An animal is considered “exposed” to a sound if the received sound level at the animal’s location is above the background ambient noise level within a similar frequency band. A variety of effects (including no effect) may result from exposure to acoustic stressors.

The categories of potential effects that apply to the Proposed Action alternatives are as follows:

- **hearing loss/auditory injury** – a noise-induced decrease in hearing sensitivity (can either be temporary or permanent and may be limited to a narrow frequency range of hearing)
- **masking** – when the perception of a biologically important sound (i.e., signal) is interfered with by a second sound (i.e., noise)
- **physiological stress** – an adaptive process that helps an animal cope with changing conditions (too much stress can result in physiological problems)
- **behavioral response** – a reaction ranging from very minor and brief changes in attentional focus, biologically important behaviors, and avoidance of a sound source or area, to aggression or prolonged flight

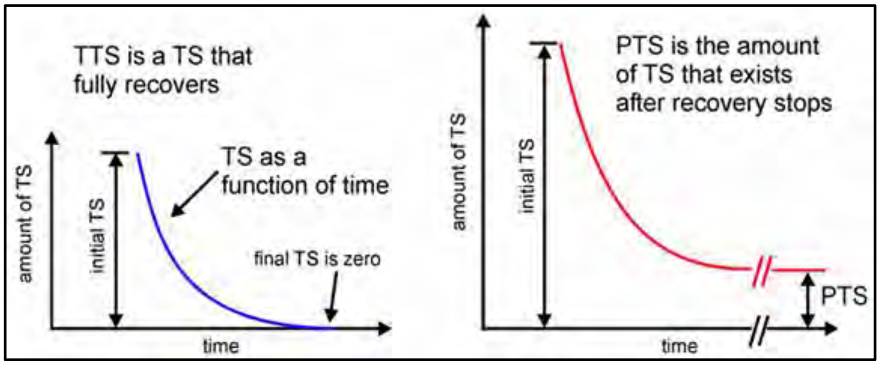
Non-auditory injuries caused by extreme impulsive pressures generated by explosives are not a part of these Proposed Action alternatives.

The magnitude of the responses is based on the characteristics of the acoustic stimuli and the characteristics of the animal (species, susceptibility, life history stage, size, and experiences). High-level, long-duration, or repetitive exposures may potentially cause some hearing loss. Even in the absence of hearing loss, perceived sounds may lead to behavioral responses, physiological stress, and/or masking. Many sounds that are detectable by an animal may also have no effect.

Hearing Loss

Hearing loss, also called a noise-induced threshold shift, is possibly the best-studied type of effect from sound exposures to animals (sub-resource specific references are provided in subsequent analysis). Hearing loss manifests itself as loss in hearing sensitivity across part of an animal’s hearing range, which is dependent upon the specifics of the noise exposure. Hearing loss may be either permanent threshold shift (PTS), or temporary threshold shift (TTS). If the threshold shift eventually returns to zero (the animal’s hearing returns to pre-exposure value), the threshold shift is a TTS. If the threshold shift does not return to zero, but leaves some finite amount of threshold shift, the remaining threshold shift is a PTS. Figure 3.4-5 shows one hypothetical threshold shift that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

The characteristics of the received sound stimuli are used and compared to the animal’s hearing sensitivity and susceptibility to noise to determine the potential for hearing loss. The amplitude, frequency, duration, and temporal pattern of the sound exposure are important parameters for predicting the potential for hearing loss over a specific portion of an animal’s hearing range. Duration is particularly important because hearing loss increases with prolonged exposure time. Longer exposures with lower sound levels can cause more threshold shift than a shorter exposure using the same amount of energy overall. The frequency of the sound also plays an important role. Experiments show that animals are most susceptible to hearing loss within their most sensitive hearing range (sub-resource specific references are provided in subsequent analysis). Sounds outside of an animal's audible frequency range do not cause hearing loss.



Key: PTS = permanent threshold shift; TS = threshold shift; TTS = temporary threshold shift.

Figure 3.4-5 Two Hypothetical Threshold Shifts

The mechanisms responsible for hearing loss may consist of a variety of mechanical and biochemical processes in the inner ear. These processes include physical damage or distortion of the tympanic membrane (not including tympanic membrane rupture, which is considered an auditory injury), physical damage or distortion of the cochlear hair cells, hair cell death, changes in cochlear blood flow, and swelling of cochlear nerve terminals (Henderson et al., 2006; Kujawa & Liberman, 2009). Although the outer hair cells are the most prominent target for fatigue effects, severe noise exposures may also result in inner hair cell death and loss of auditory nerve fibers (Henderson et al., 2006).

The relationship between TTS and PTS is complicated and poorly understood, even in humans and terrestrial mammals, where numerous studies failed to delineate a clear relationship between the two. Relatively small amounts of TTS (e.g., less than 40 to 50 decibels [dB] measured two minutes after exposure) will recover with no apparent permanent effects; however, terrestrial mammal studies revealed that larger amounts of threshold shift can result in permanent neural degeneration, despite the hearing thresholds returning to normal (Kujawa & Liberman, 2009). The amounts of threshold shift induced by Kujawa and Liberman (2009) were described as being "at the limits of reversibility." It is unknown whether smaller amounts of threshold shift can result in similar neural degeneration, or if effects would translate to other species such as marine animals.

Hearing loss can increase an animal's physiological stress, which feeds into the stress response. Hearing loss may increase the likelihood or severity of a behavioral response and increase an animal's overall physiological stress level. Hearing loss reduces the distance over which animals can communicate and detect other biologically important sounds. Hearing loss could also be inconsequential for an animal if the frequency range affected is not critical for that animal to hear within, or the hearing loss is of such short duration (e.g., a few minutes) that there are no costs to the individual.

Small to moderate amounts of hearing loss may recover over a period of minutes to days, depending on the amount of initial threshold shift. Severe noise-induced hearing loss may not fully recover, resulting in some amount of PTS. An animal whose hearing does not recover quickly and fully could suffer a reduction in lifetime reproductive success. An animal with PTS may be less successful at mating for one or more breeding seasons in addition to being more vulnerable to predators, thereby decreasing the number of offspring it can produce over its lifetime.

Masking

Masking occurs if the noise from an activity interferes with an animal's ability to detect, understand, or recognize biologically relevant sounds of interest. In this context, noise refers to unwanted or unimportant sounds that mask an animal's ability to hear sounds of interest. Sounds of interest include those among the same species such as offspring, mates, and competitors; echolocation clicks; sounds from predators; natural, abiotic sounds that may aid in navigation; and reverberation, which can give an animal information about its location and orientation within the ocean. The probability of masking increases as the noise and sound of interest increase in similarity, and the masking noise increases in level. The frequency, received level, and the percentage of time during which a sound is generated over a total operational period (i.e., duty cycle) of the noise determines the potential degree of auditory masking. Masking only occurs during the sound exposure.

The animal makes a behavioral decision (either conscious or instinctive) when the animal detects increased background noise, or possibly, when the animal recognizes that biologically relevant sounds are being masked. An animal's past experiences can be important in determining the behavioral response when dealing with masking. For example, an animal may modify its vocalizations to reduce the effects of masking noise. Other stimuli present in the environment can influence an animal's behavior decision, such as the presence of predators, prey, or potential mates.

An animal may exhibit a passive behavioral response when coping with masking. It may simply not respond and keep conducting its current natural behavior. An animal may also stop calling until the background noise decreases. These passive responses do not present a direct energetic cost to the animal; however, masking may continue to effect an animal's behavior, depending on the acoustic stimuli. An animal may actively compensate for masking. An animal can vocalize more loudly to make its signal heard over the masking noise, which could also make them more vulnerable to predators that are less sensitive to the noise. An animal may also shift the frequency of its vocalizations away from the frequency of the masking noise (Hotchkin & Parks, 2013). This shift can actually reduce the masking effect for the animal and other animals that are listening in the area.

If masking impairs an animal's ability to hear biologically important sounds, it could reduce an animal's ability to communicate other members of its species, reduce opportunities to detect or attract mates that are more distant, reduce the ability to gain information about their physical environment, or reduce navigational ability. An animal that modifies its vocalization in response to masking could also incur a cost. Modifying vocalizations may cost the animal energy, interfere with the behavioral function of a call, or reduce a signaler's apparent quality as a mating partner. For example, songbirds that shift their calls up an octave to compensate for increased background noise attract fewer or less-desirable mates, and many terrestrial species advertise body size and quality with low-frequency vocalizations (Slabbekoorn & Ripmeester, 2007). Masking may also lead to no measurable costs for an animal. Masking could be of short duration or intermittent such that biologically important sounds that are continuous or repeated are received by the animal between masking noise.

Masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity. Masking could have long-term consequences for individuals if the activity was continuous or sufficiently frequent.

Physiological Stress

Animals naturally experience physiological stress as part of their normal life histories. The physiological response to a stressor, often termed the stress response, is an adaptive process that helps an animal cope with changing external and internal environmental conditions. Sound-producing activities have the potential to cause additional stress. The stress response to sound may also be related to other, more harmful, stressors associated with a sound (e.g., physical disturbance or strike). In either case, too much of a stress response can be harmful to an animal, resulting in physiological dysfunction.

If a sound is detected (i.e., heard or sensed) by an animal, a stress response can occur. The severity of the stress response depends on the received sound level at the animal, the details of the sound-producing activity, the animal's life-history stage (e.g., juvenile or adult, breeding or feeding season), and the animal's past experience with the stimuli. An animal's life-history stage is an important factor to consider when predicting whether a stress response is likely (Ketten, 1998). An animal's life-history stage includes its level of physical maturity (i.e., larva, infant, juvenile, sexually mature adult) and the primary activity in which it is engaged, such as mating, feeding, or rearing/caring for young. Prior experience with a stressor may be of particular importance because repeated experience with a stressor may dull the stress response via acclimation (St. Aubin & Dierauf, 2001) or increase the response via sensitization. Additionally, if an animal suffers injury or hearing loss, a physiological stress response will occur.

The generalized stress response is characterized by a release of hormones (Reeder & Kramer, 2005) and other chemicals (e.g., stress markers) such as reactive oxidative compounds associated with noise-induced hearing loss (Henderson et al., 2006). Stress hormones include norepinephrine and epinephrine (i.e., catecholamines), which produce elevations in the heart and respiration rate, increase awareness, and increase the availability of glucose and lipid for energy. Other stress hormones are the glucocorticoid steroid hormones, cortisol and aldosterone, which are classically used as an indicator of a stress response and to characterize the magnitude of the stress response (Hennessy et al., 1979).

An acute stress response is traditionally considered part of the startle response and is hormonally characterized by the release of catecholamines. Annoyance-type reactions may be characterized by the release of either or both catecholamines and glucocorticoid hormones. Regardless of the physiological changes that make up the stress response, the stress response may contribute to an animal's decision to alter its behavior.

Elevated stress levels may occur whether or not an animal exhibits a behavioral response. Even while undergoing a stress response, competing stimuli (e.g., food or mating opportunities) may overcome any behavioral response. Regardless of whether the animal displays a behavioral response, this tolerated stress could incur a cost to the animal. Reactive oxygen compounds produced during normal physiological processes are generally counterbalanced by enzymes and antioxidants; however, excess stress can lead to damage of lipids, proteins, and nucleic acids at the cellular level (Berlett & Stadtman, 1997; Sies, 1997; Touyz, 2004).

Frequent physiological stress responses may accumulate over time, increasing an animal's chronic stress level. Each component of the stress response is variable in time, and stress hormones return to baseline levels at different rates. Elevated chronic stress levels are usually a result of a prolonged or repeated disturbance. Chronic elevations in the stress levels (e.g., cortisol levels) may produce long-term health consequences that can reduce lifetime reproductive success.

Behavioral Reactions

Behavioral responses fall into two major categories: alterations in natural behavior patterns and avoidance. These types of reactions are not mutually exclusive, and many overall reactions may be combinations of behaviors or a sequence of behaviors. Severity of behavioral reactions can vary drastically between minor and brief reorientations of the animal to investigate the sound, to severe reactions such as aggression or prolonged flight. The type and severity of the behavioral response will determine the cost to the animal. The type of activities, the size of the activity area, the distance between the animal and activity, and the duration of the activity are important considerations when predicting the initial behavioral responses to a proposed action.

A physiological stress response such as an annoyance or startle reaction, or cueing or alerting, may cause an animal to make a behavior decision. Any exposure that produces an injury or hearing loss is also assumed to produce a stress response and increase the severity or likelihood of a behavioral reaction. Both an animal's experience and competing and reinforcing stimuli can affect an animal's behavioral decision. The decision can result in three general types of behavioral reactions: no response, area avoidance, or alteration of a natural behavior.

An animal's past experiences can be important in determining what behavioral decision it may make when dealing with a stress response. Habituation is the process by which an animal learns to ignore or tolerate stimuli over some period and return to a normal behavior pattern, perhaps after being exposed to the stimuli with no negative consequences. Sensitization is the state in which an animal becomes more sensitive to a set of stimuli over time, perhaps because of a past negative experience that could result in a stronger behavioral response.

Other stimuli present in the environment can influence an animal's behavioral response. These stimuli may be from other members of their species or predators in the area, or the drive to engage in a natural behavior. Other stimuli can also reinforce the behavioral response caused by acoustic stimuli. For example, the awareness of a predator in the area, coupled with the sound-producing activity, may elicit a stronger reaction than the activity alone.

An animal may reorient, become more vigilant, or investigate if it detects a sound-producing activity. These behaviors all require the animal to divert attention and resources, therefore slowing or stopping their presumably beneficial natural behavior. This can be a very brief diversion, or an animal may not resume its natural behaviors until after the activity has concluded. An animal may choose to leave or avoid an area where a sound-producing activity is taking place. A more severe form of this behavior comes in the form of flight or evasion. For example, marine mammals may beach themselves while experiencing decompression sickness in response to some intense sounds (refer to Section 3.4.5, Marine Mammal Protection Act – Biological Assessment). Avoidance of an area can help the animal avoid further effects by avoiding or reducing further exposure. An animal may also choose not to respond to a sound-producing activity.

An animal that alters its natural behavior in response to stress or an auditory cue may slow or cease its natural behavior, and alternatively expend energy reacting to the sound-producing activity. Natural behaviors include feeding, breeding, sheltering, and migrating. The cost of feeding disruptions depends on the energetic requirements of individuals and the potential amount of food missed during the disruption. Alteration in breeding behavior can result in delaying reproduction or loss of fitness due to lost opportunities to breed, or failed reproductive attempts. The costs of a brief interruption to migrating or sheltering are less clear.

An animal that avoids a sound-producing activity may expend additional energy moving around the area, be displaced to poorer resources, miss potential mates, have social interactions affected, or become more vulnerable to predation. The amount of energy expended depends on the severity of the behavioral response. Missing potential mates can result in delaying reproduction or lost opportunities to breed. Groups could be separated during a severe behavioral response such as flight, and offspring that depend on their parents may die if they are permanently separated. Splitting up an animal group can result in a reduced group size, which can have secondary effects on individual foraging success and susceptibility to predators.

Some severe behavioral reactions can lead to stranding or secondary injury. Animals that take prolonged flight (a severe avoidance reaction) may injure themselves or strand in an environment for which they are not adapted. Some injury is likely to occur to an animal that strands. Trauma can reduce the animal's ability to secure food and mates, and increase the animal's susceptibility to predation and disease. An animal that strands and does not return to a hospitable environment may die.

Specific Background for Analysis

Most invertebrate, fish, and reptile/amphibian species are relatively insensitive to distant sounds, whereas birds and mammals are more sensitive to them, depending on frequency ranges and other factors (as described for biological sub-resources below).

Invertebrates

For invertebrates, comprehensive investigations regarding the range to effects of different sound sources and levels are not available. Most invertebrates can only detect sound generated very close to high-intensity sources; few species are known to hear sound frequencies from distant sources or have specializations for detecting sounds (Kunc et al., 2016; Hawkins et al., 2015; Nakano et al., 2015; Gopfert & Hennig, 2016). Insects with antennas and estuarine invertebrate species generally have their greatest sensitivity to sound below 1 to 3 kilohertz (kHz) within close proximity to the sound source (Kunc et al., 2016; Gopfert & Hennig, 2016). Terrestrial/aerial insects with pressure sensitive membranes (e.g., moths) are sensitive to higher frequencies (up to 300 kHz range, but most sensitive from 20 to 60 kHz) at greater distances due to evolutionary pressure from bats (Nakano et al., 2015; Gopfert & Hennig, 2016).

Aquatic invertebrates probably do not detect different frequencies from distant sounds because many are generally the same density as water and few, if any, have air cavities that would respond to pressure changes (Budelmann, 1992a; 1992b; Popper et al., 2001). However, many aquatic invertebrates have ciliated "hair" cells that may be sensitive to water movements, such as those caused by currents or water-particle motion very close to a sound source (Budelmann, 1992a; 1992b; Mackie & Singla, 2003). Whereas a there is little research to support a behavioral response threshold among sensitive aquatic invertebrates, there is more research for fish, and fish are most similar to aquatic invertebrates in terms of sound detection. Popper et al. (2019) supports a threshold of 163 dB peak-to-peak referenced to 1 microPascals (dB re 1 μPa) using the latest synthesis of information regarding behavioral response thresholds for fish and impulsive sound. Converting a peak-to-peak measurement of sound to peak measurement is approximated by subtracting 6 dB from the peak-to-peak measurement. The behavioral response threshold for fish is, therefore, also used for aquatic invertebrates.

Fishes

Most fish species do not have hearing specializations that allow detection of distant sounds at frequencies higher than about 2 kHz (Kunc et al., 2016; Popper et al., 2014). However, most fish species can detect the particle motion generated very close to a sound source. The range of acoustic sensitivity in fish species depends on various anatomical features, or lack thereof (modified from Popper et al. (2014)):

- Fishes without a swim bladder (e.g., sedentary bottom feeders)—hearing capabilities are limited to particle-motion detection at frequencies well below 1 kHz.
- Fishes with a swim bladder not involved in hearing (e.g., active predatory species such as striped bass)—species lack notable anatomical specializations and primarily detect particle motion at frequencies below 1 kHz.
- Fishes with a swim bladder involved in hearing (e.g., pelagic schooling species such as Atlantic menhaden, some drum species)—species can detect frequencies below 1 kHz, and possess anatomical specializations to enhance hearing and are capable of sound pressure detection up to a few kHz. Weakfish and silver perch, both common in the PRC Study Area (Table 3.4-4), can detect underwater sounds within the mid-frequency range but their hearing sensitivity is at much lower frequencies (Horodysky et al., 2008).
- Fishes with a swim bladder and high-frequency hearing (e.g., diadromous shads/herrings)—species can detect frequencies below 1 kHz and possess anatomical specializations for sound pressure detection at frequencies from 10 kHz to over 100 kHz.

After reviewing the available information on fish hearing and vocalization, Ladich and Schulz-Mirbach (2016) concluded that the ambient sound environment of a species-preferred habitat likely influences hearing sensitivity, with quieter habitats (e.g., sheltered open waters) and echo-locating predators resulting in greater hearing sensitivities. Information on the hearing sensitivities of species and life stages for which EFH has been designated in the PRC Study Area and is summarized below:

- Black sea bass: Although there is no known research characterizing the hearing sensitivity of this specific species, the black sea bass is a member of the Serranidae family, and fishes in the Serranidae family are not known to have anatomical hearing specializations that would make them sensitive to mid-frequency sounds (Ladich, 2002). However, Wright et al. (2011) reports that four species in the Serranidae family, orange-spotted grouper (*Epinephelus coioides*), brown-marbled grouper (*Epinephelus fuscoguttatus*), Malabar grouper (*Epinephelus malabaricus*), and leopard coral-grouper (*Plectropomus leopardus*) are sensitive to frequencies from approximately 100 hertz (Hz) to 2 kHz, with larger fish responding to the higher end of the range. All species and sizes showed greatest sensitivity to sounds below 700 Hz, and the orange-spotted grouper and Malabar grouper were most sensitive to sounds below 200 Hz. As a result, it is possible that black sea bass may potentially be able to detect and respond to certain lower spectrum mid-frequency sounds, although their greatest hearing sensitivity level is likely in the low-frequency range.
- Bluefish: There is no known research characterizing the hearing sensitivity of this specific species (Ladich & Schulz-Mirbach, 2016); however, bluefish—the only member of the Pomatomidae family—are not known to have anatomical hearing specializations that would enable them to hear mid-frequency sounds. Species in the Lutjanidae family (e.g., snappers) are in the same suborder (Percoidei) as bluefish. The hearing sensitivity of snappers has been studied and shown to range from 100 Hz to 1 kHz, with greatest sensitivity to sounds at 300 Hz (Ladich, 2002; Popper, 2008).

- Butterfish: Although there is no known research characterizing the hearing sensitivity of this specific species, butterfish are a member of the Stromateidae family, and fishes in the Stromateidae family are not known to have anatomical hearing specializations that would enable them to hear mid- frequency sounds (Ladich & Schulz-Mirbach, 2016).
- Cobia: Although there is no known research characterizing the hearing sensitivity of this specific species, cobia are a member of the Rachycentridae family. Fishes in the Rachycentridae family are not known to have anatomical hearing specializations that would enable them to hear mid-frequency sounds (Ladich & Schulz-Mirbach, 2016). Species in the Lutjanidae family (e.g., snappers) are in the same order (Perciformes) as the Rachycnetrids. The hearing sensitivity of snappers has been studied and shown to range from 100 Hz to 1 kHz, with greatest sensitivity to sounds at 300 Hz (Ladich, 2002; Popper, 2008).
- Scup: Although there is no known research characterizing the hearing sensitivity of this specific species, scup are a member of the Sparidae family, and fishes in the Sparidae family are not known to have anatomical hearing specializations that would enable them to hear mid-frequency sounds (Ladich & Schulz-Mirbach, 2016). The closest surrogate species to scup for which hearing sensitivity has been studied is the pinfish (*Lagodon rhomboides*), which is also a member of the Sparidae family. Although pinfish lack anatomical specializations that would enable the species to hear a wider range of frequencies, they have been shown to be capable of detecting sounds ranging from 100 Hz up to 1 kHz, with best sensitivity at 300 Hz (Tavolga, 1974). The hearing sensitivity of juvenile red seabream (*Pagrus major*), also a member of the Sparidae family, was measured by Iwashita et al. (1999). Red seabream showed greatest hearing sensitivity between 200 and 300 Hz. The range of greatest sensitivity decreased to between 100 and 200 Hz, as individuals matured into adults.
- Summer flounder and windowpane flounder: Flounders do not have air-filled chambers (e.g., swim bladders), suggesting sensitivity to only particle motion generated very close to low-frequency sound sources.
- Prey species: Refer to analysis details in "Impacts from Water-Based Assets" section below for details.

Popper et al. (2019) supports a minimum of 163 dB peak-to-peak re 1 µPa using the latest synthesis of information regarding interim behavioral response criteria for fish and repetitive impulsive sound (e.g., pile driving). Non-impulsive sounds (e.g., vessel noise) that slowly rise and fall as the source moves are generally less impactful than impulsive sound of the same peak intensity. The only underwater sounds generated by the No Action Alternative that may reach this level of underwater noise (outside the close range of physical disturbance) are larger vessel propulsion systems, active sonar systems, weapons firing noise, and low altitude sonic booms focused on targets in the Chesapeake Bay Water Range.

<u>*Reptiles and Amphibians*</u>

Sensitivity of terrestrial/freshwater reptiles and amphibians to sound is important when determining the potential impacts of noise on these species. However, studies addressing reptile responses to noise, especially aircraft noise, are extremely limited. In general, reptiles have narrower hearing ranges than mammals and birds but are highly sensitive to vibrations (Bowles, 1995). Desert tortoises (*Gopherus agassizii*) are one of only a few reptiles for which aircraft disturbance effects have been studied (Bowles et al., 1999; Efroymson et al., 2001). Desert tortoises became motionless in response to being startled but habituated to aircraft noises quickly. No significant physiological changes in response to noise were documented. Studies on the effects of land-based vehicle noise on desert reptiles found that sound pressure levels (SPLs) of 95 A-weighted decibels (dBA) and 115 dBA could affect hearing (Brattstrom & Bondello, 1983; Efroymson et al., 2001).

Diamondback terrapins likely use hearing to locate food or mates, avoid predators, navigate, or communicate (Lester, 2013). Lester et al. (2012) determined that diamondback terrapins can hear a limited range of low-frequency tones less than 1,000 Hz. Terrapins responded to in-air sounds from 100 to 1,000 Hz, and the range of best hearing from 400 to 600 Hz with mean hearing threshold of 64 dB re 20 µPa. In water, terrapins responded to sounds from 50 to 800 Hz with mean hearing threshold of 86 dB re 1 µPa (Lester, 2013). Though there is no behavioral response threshold for diamondback terrapins available, sea turtles with similar hearing capabilities may exhibit a behavioral response to a sound source within their hearing range at received levels of 175 dB re 1 µPa or greater. This is the level at which sea turtles are expected to begin to exhibit avoidance behavior based on experimental observations of sea turtles exposed to multiple firings of nearby or approaching air guns (McCauley et al., 2000).

Numerous studies have evaluated the impacts of anthropogenic noise on amphibians. Most research has examined the effects of traffic noise on frogs; however, two studies evaluated the effect of aircraft noise on frogs. Sun and Narins (2005) found that three frog species in a Thailand pond decreased their calling rate in response to aircraft overflights, while a fourth species increased its calling rate, seemingly in response to the other species' decreased rate. Kruger and Du Preez (2016) found that a frog species in South Africa significantly increased its call rates and called at higher frequencies during flyovers to overcome masking of auditory signals. Several studies have shown that traffic noise also affects frog vocalization behavior (Bee & Swanson, 2007; Lengagne, 2008; Lukanov et al., 2014). Conversely, Nelson et al. (2017) reported that the Pacific chorus frog (*Pseudacris regilla*) did not change vocalizations in the presence of traffic noise, which strongly impacted its communication at noisier sites.

Birds

Sound and hearing is very important for birds, as their ears are funnel-shaped to focus sound. The ears are located slightly behind and below the eyes, and are covered with soft feathers for protection. A review of 32 terrestrial and marine species indicates that birds generally have greatest hearing sensitivity between 1 and 4 kHz (Beason, 2013; Dooling & Therrien, 2012). Very few can hear below 20 hertz (Hz), most have an upper frequency hearing limit of 10 kHz, and none exhibit hearing at frequencies higher than 15 kHz (Dooling R. , 2002; Dooling & Popper, 2000). There is some evidence indicating the birds associated with quieter environments (e.g., freshwater ponds) are less sensitive to sound than species living together in crowded or noisier environments (e.g., colonial nesters near open estuarine waters) (Crowell et al., 2015). The body size of a bird seems to also have an effect on hearing sensitivity with larger birds hearing lower frequencies (Johansen et al., 2016). However, most knowledge regarding bird hearing reflects their abilities in an airborne environment (Dooling & Therrien, 2012). The hearing ability of diving birds underwater is relatively diminished based on adaptions necessary to protect airborne hearing from pressure changes (Dooling & Therrien, 2012; Hetherington, 2008). Available studies indicate a narrower range of frequencies for best hearing underwater relative to in-air, with greatest sensitivity around 1 to 2.86 kHz and 71 to 127 dB re 1 µPa for great cormorants and long-tailed ducks (*Phalacrocorax carbo sinensis* and *Clangula hyemalis*, respectively) (Johansen et al., 2016; Therrien, 2014; Hansen et al., 2017; Thiessen, 1958).

Numerous studies have documented that birds and other wild animals respond to human-made noise (Bowles et al., 1994; Larkin et al., 1996; National Park Service, 1994). The manner in which birds respond to noise depends on species physiology, life stage, characteristics of the noise source, intensity (i.e., decibels), onset rate, distance from the noise source, presence/absence of associated visual stimuli, and previous exposure. Birds are especially sensitive to frequency and rhythm changes and use those variations to recognize other individual birds, even in otherwise noisy environments. Birds also produce different sounds in different situations such that recognizing the difference is essential in determining their behavioral response (e.g., aversion, attraction) (Mayntz, 2020). Possible acoustic stressor effects from the No Action Alternative include auditory trauma/hearing loss resulting in temporary or permanent hearing threshold shift, auditory masking, physiological stress, or changes in behavior, including changing habitat use and activity patterns, increasing stress response, decreasing immune response, reducing reproductive success, increasing predation risk, and degrading communication (Larkin et al., 1996). However, cues appearing just before loud sounds (e.g., physical/visual disturbance) might also cause birds to temporarily vacate an area to reduce potential exposure (Larkin et al., 1996).

Hair cell damage has been observed in birds exposed to long-duration sounds that resulted in initial threshold shifts greater than 40 dB (Niemiec et al., 1994; Ryals et al., 1999). Unlike mammals, birds have the ability to regenerate hair cells in the ear, usually resulting in considerable anatomical, physiological, and behavioral recovery within several weeks (Rubel et al., 2013; Ryals et al., 1999). Still, intense exposures are not always fully recoverable, even over periods up to a year after exposure, and damage and subsequent recovery vary significantly by species (Ryals et al., 1999). Birds may be able to protect themselves against damage from sustained sound exposures by reducing middle ear pressure, an ability that may protect ears while in flight (Ryals et al., 1999) and from injury due to pressure changes during diving (Dooling & Therrien, 2012).

Studies investigating threshold shift in caged birds using long-duration (30 minutes to 72 hours) non-impulsive sounds within their frequencies of best hearing (between 2 and 4 kHz) have shown that susceptibility to hearing loss varies substantially by species, even in species with similar auditory sensitivities, hearing ranges, and body size (Niemiec et al., 1994; Ryals et al., 1999; Saunders & Dooling, 1974). For example, Ryals et al. (1999) conducted the same exposure experiment on quail and budgerigars, which have very similar audiograms. A 12-hour exposure to a 2.86-kHz tone at 112 dB re 20 µPa (cumulative sound exposure level [SEL] of 158 dB re 20 µPa squared seconds [dB re 20 μPa^2-s]) resulted in a 70-dB threshold shift measured after 24 hours of recovery in quail, but a substantially lower 40-dB threshold shift measured after just 12 hours of recovery in budgerigars which recovered to within 10 dB of baseline after three days and fully recovered by one month (Ryals et al., 1999). Although not directly comparable, this SPL would be perceived as extremely loud but just under the threshold of pain for humans per the American Speech-Language-Hearing Association. Whereas the 158 dB SEL re 20 μPa^2-s tonal exposure to quail discussed above caused 20 dB of PTS (Ryals et al., 1999), a shorter (four-hour) tonal exposure to quail with similar cumulative SEL (157 dB re 20 μPa^2-s) in a different study caused 65 dB of threshold shift that fully recovered within two weeks (Niemiec et al., 1994). However, the test subjects were confined to behavioral testing chambers and could not move far from the sound source.

Saunders and Dooling (1974) provide the only threshold shift growth data measured for birds. They exposed young budgerigars to four levels of continuous 1/3-octave band noise (76, 86, 96, and 106 dB re 20 µPa) centered at 2.0 kHz and measured the threshold shift at various time intervals during the 72-hour exposure. The earliest measurement found 7 dB of threshold shift after approximately 20 minutes of exposure to the 96 dB re 20 µPa noise (127 dB cumulative SEL re 20 μPa^2-s). The Saunders and Dooling (1974) budgerigar data are the only bird data showing low levels of threshold shift. Because of the observed variability of threshold shift susceptibility among bird species and the relatively long duration of sound exposure in Saunders and Dooling (1974), the observed onset level cannot be assumed to represent the SEL that would cause onset of TTS for other bird species or for shorter-duration exposures (i.e., a higher SEL may be required to induce TTS for shorter-duration exposures).

Since the goal of most bird-hearing studies has been to induce hair cell damage to study regeneration and recovery, exposure durations were purposely long. The SELs that induced TTS and PTS in these studies likely overestimate the potential for hearing loss due to any short-duration sound of comparable SEL that a bird could encounter outside of a controlled laboratory setting. In addition, these studies were not designed to determine the exposure levels associated with the onset of any threshold shift or to determine the lowest SEL that may result in PTS.

Critical ratios for masking potential have been determined for a variety of bird species (Dooling R. J., 1980; Noirot et al., 2011; Crowell, 2016; Dooling & Popper, 2000) and interspecies variability is evident. Some birds exhibit low critical ratios at certain vocal frequencies, perhaps indicating that hearing evolved to detect signals in noisy environments or over long distances (Dooling & Popper, 2000). Birds have also been shown to shift song frequencies in the presence of a tone at a similar frequency (Goodwin & Podos, 2013), and in continuously noisy urban habitats, populations have been shown to have altered song duration and shift to higher frequencies (Slabbekoorn & den Boer-Visser, 2006). Changes in vocalization may incur energetic costs and hinder communication with conspecifics, which, for example, could result in reduced mating opportunities in a consistently noisy environment, such as urban areas (Patricelli & Blickley, 2006) or airfield environments. Birds living in these environments also have habituated to some degree to the ambient noise characteristics. In less consistently noisy environments, the masking effect may be more pronounced but less frequent.

Numerous studies have documented that birds and other wild animals respond behaviorally to human-made noise, including aircraft overflights, weapons firing, and explosions (Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006). The manner in which an animal responds to noise could depend on several factors, including life history characteristics of the species, characteristics of the noise source, sound source intensity, onset rate, distance from the noise source, presence or absence of associated visual stimuli, food and habitat availability, and previous exposure. Researchers have documented a range of bird behavioral responses to noise, including no response, head turn, alert behavior, startle response, flying or swimming away, diving into the water, and increased vocalizations (Brown et al., 1999; Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006; Pytte et al., 2003; Stalmaster & Kaiser, 1997). Some behavioral responses may be accompanied by physiological responses, such as increased activation of the neural and endocrine systems, causing changes such as increased blood pressure, available glucose, and blood levels of hormones (Manci et al., 1988; Partecke et al., 2006). It is possible that individuals would return to normal almost immediately after short-term or transient exposure, and the individual's metabolism and energy budget would not be affected in the long term.

Studies have also shown that birds can habituate to noise following frequent exposure and cease to respond behaviorally to the noise (Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006). However, the likelihood of habituation is dependent upon a number of factors, including the bird species (Bowles et al., 1991) and the frequency of and proximity to exposure. For example, European starlings (*Sturnus vulgaris*) took significantly longer to habituate to repeated bird distress calls than white noise or pure tones (Johnson et al., 1985). Starlings may have been more likely to continue to respond to the distress because it is a more biologically meaningful sound. Starlings were also more likely to habituate in winter than summer, possibly meaning that food scarcity or seasonal physiological conditions may affect intensity of behavioral response (Johnson et al., 1985). Andersen et al. (1990) found evidence that anthropogenic disturbance (and associated noise) is related to changes in home ranges; for example, raptors have been shown to shift their terrestrial home range when concentrated military training activity was introduced to the area. In a different study, cardinals nesting in areas with high levels of military training activity (including gunfire, artillery, and explosives) were observed to have similar reproductive success and stress hormone levels as cardinals in areas of low activity (Barron et al., 2012).

Whereas chronic exposure to acoustic disturbance may compromise the general health and reproductive success of some birds (Kight et al., 2012), a physiological stress response is not necessarily indicative of negative consequences to individual birds or to populations due to aforementioned factors (Larkin et al., 1996; National Park Service, 1994; Butler et al., 2009). For analysis of the acoustic stressor, the Navy conservatively assumes that any physiological or significant behavioral response is also associated with a stress response. Minor behavioral responses such as occasional head turning are not considered significant.

<u>*Mammals*</u>

For most marine mammals, sound sensing/production and response to sounds is covered in Section 3.4.5 (Marine Mammal Protection Act – Biological Assessment). For West Indian manatees, sound sensing/production and response to sounds is covered in Section 3.4.4.2 (Federal Threatened and Endangered Species – U.S. Fish and Wildlife Service Jurisdiction). This section focuses on the sound sensing/production and response to sound for bats and terrestrial/freshwater mammals.

Bats extract information about their surrounding environment and prey using the system of echolocation. This active and adaptive system depends upon successful integration of both the animal's action (high-frequency sonar calls) and the processing of the information carried by echoes by the bat's auditory system (Moss et al., 2011). Data suggests that insectivorous bats, those present in the PRC Study Area, have good high-frequency hearing ability but poor low-frequency hearing ability (Koay et al., 1996). Koay et al. (1996) found that the average audiogram of a big brown bat ranges from 0.850 kHz at 106 dB to 120 kHz at 83 dB SPL, with a best threshold of 7 dB at 20 kHz and a distinct decrease in sensitivity at 45 kHz. Further explanation of how bats use sound and potential impacts from the No Action Alternative are included below.

The exposure to in-air sounds by bats depends on the bat's activity (in flight or roosting) and the proximity to the sound source. Overall, bats seem to avoid areas with high levels of noise, especially when the noise frequency spectrum overlaps with frequencies important for hunting (20 to 90 kHz). In a controlled laboratory experiment, Schaub et al. (2008) found that, when given a choice, bats spent 10 percent less time foraging in a compartment with noise (traffic, wind, and broadband white noise) as compared to a silent control chamber. Additionally, hunting in the noisy compartment yielded 10 percent fewer successful prey interceptions. Bats also spent significantly less time and were significantly less successful as noise conditions increased in bandwidth and overall exposure levels. The greater the noise overlap with frequencies being attended to by the bat, the greater the disturbance to the bats' foraging behavior. However, this experiment was conducted on a small spatial scale and with the absence of other sensory cues (light). Although laboratory research has shown that noise can decrease hunting success (Siemers & Schaub, 2011) and field and laboratory studies show that foraging bats avoid noise (Berthinussen & Altringham, 2012; Schaub et al., 2008), no studies provide direct evidence from playback experiments in the field that commuting, roosting, or migrating bats are disturbed by sound.

Bats can experience masking during echolocation and communication from a variety of sources such as other bats and jamming of their echolocation signal by prey species (Bates et al., 2011; Chiu et al., 2008; Conner & Corcoran, 2012; Corcoran et al., 2009). They have many strategies to compensate for masking, such as dynamically changing the duration, spectrum, aim, and pattern of their echolocation (Bates et al., 2011; Moss et al., 2011; Petrites et al., 2009; Simmons et al., 2001; Wheeler et al., 2016). Like other animals, bats increase the amplitude of their vocalizations in response to an increase in background noise level, which is known as the Lombard effect (Hage & Metzner, 2013). It is estimated that a broadband signal of 65 dB re 20 µPa would begin masking most bats' echolocation from targets beyond 5 feet (1.5 meters) away (Arnett et al., 2013). Bats have been shown to shift the frequency of their calls when a stimulus was within 2 to 3 kHz of their preferred frequency (Bates et al., 2008). Behavioral and psychophysical experiments show that the flexibility of bat vocalizations allows for perceptual rejection of masking due to clutter in the surroundings (Bates et al., 2011; Hiryu et al., 2010) or other sources of noise (Bates et al., 2008; Miller et al., 2004; Ulanovsky et al., 2004).

Bats exposed to loud noise have not been shown to exhibit TTS in hearing (Hom et al., 2016; Simmons et al., 2015; Simmons et al., 2016). Hom et al. (2016) exposed four big brown bats (*Eptesicus fuscus*) to intense broadband noise (10 to 100 kHz with 152 dB re 20 μPa^2-s SEL over one hour) and found no effect on the bats' vocalizations (which could indicate a change in hearing) or psychophysical thresholds (which indicate the bat is still detecting the noise) at 20 minutes, 24 hours, or 48 hours after exposure (Hom et al., 2016; Simmons et al., 2016). Another study on the Japanese house bat (*Pipistrellus abramus*) measured physiological (auditory brainstem response) thresholds immediately after a noise exposure (10 to 80 kHz, 90 dB re 20 µPa, 30-minute duration) and did not find evidence of TTS (Simmons et al., 2015). This may be because bats are adapted to hear in an acoustic environment where they are likely to experience loud sounds (110 to 140 dB re 20 µPa) continuously for several hours while hunting near other bats that are also echolocating (Jakobsen et al., 2013; Simmons et al., 2001). It is also possible that the stimuli used in these experiments were not loud enough to induce TTS or that measurements of hearing sensitivity took place outside the time window where TTS might be observed.

Limited data exist on instances of auditory trauma (barotrauma) to bats. The data that do exist are associated with the hypothesis of rapid pressure changes due to rotating wind turbine blades (Baerwald et al., 2008; Rollins et al., 2012). Bats in these situations have been shown to have ruptured eardrums. Although it is undetermined if these ruptures were due to pressure changes or to direct strike, the potential exists for auditory injury because of high-amplitude sound exposure. In air, the risk of barotrauma would be associated with high-amplitude impulses, such as those from explosives. It is important to note that all munitions used in the PRC are non-explosive. In addition, bats would be exposed to high-amplitude sound in-air, where unlike in-water, most acoustic energy will reflect off the surface of an animal's body. Additionally, air is compressible whereas water is not, allowing energy to dissipate more rapidly. Lastly, all non-explosive munition expenditures occur over open waters of the Chesapeake Bay Water Range and during daylight hours where and when bats and bat roosting would not occur and where foraging activity would be limited due to sparse prey availability relative to the typical open water conditions (e.g., relatively high winds, proximity to terrestrial habitats). For these reasons, in-air non-explosive sound sources in this analysis are considered to pose little risk of nonauditory injury.

There are a wide variety of terrestrial and freshwater mammals in the PRC Study Area, ranging from small rodents to large game animals such as white-tailed deer. The hearing capabilities of these species vary, but are generally within the range of 200 Hz to 25 kHz. Larger animals tend to have better hearing at lower frequencies, while smaller animals often have better hearing at high frequencies (D'Angelo, 2007; Heffner et al., 2001). A review by Shannon et al. (2016) of the research documenting the effects of noise on wildlife indicates that terrestrial wildlife responses begin at noise levels of approximately 40 dBA, and 20 percent of papers documented impacts below 50 dBA. In general, terrestrial mammals exhibited increased stress levels and decreased reproductive efficiency at noise levels between 52 and 68 dBA SPL (re 20 µPa). However, a notable proportion of studies (38 percent) lacked a record of the spectral analysis, such as duration of the measurement, frequency range, and weighting function; and only 11 percent of the studies were related to military noise. The level of response depends on a number of factors, including the life history characteristics of the species, characteristics of the noise-generating activities, habitat type, and the species' previous exposure to the noise source. Several other studies indicate a strong tendency for many species to acclimate or habituate to noise disturbances (Grubb & King, 1991; Black et al., 1984; Conomy et al., 1998; Ellis et al., 1991).

As discussed in the generic background for analysis, an animal's response to unusual sounds (above ambient levels) may include displacement or avoidance of affected areas, increased vigilance, changes in foraging behavior, habitat selection, mate attraction, and parental investment (Frid & Dill, 2002; Shannon et al., 2016), in addition to changes in the animal's sound sensing and response behavior. While difficult to measure in the field, all behavioral responses are assumed to be accompanied by some form of physiological response (Frid & Dill, 2002). Noise and other disturbances can also distract wildlife, taking their attention away from other key functions and behaviors, such as predator awareness (Chan & Blumstein, 2011; Francis & Barber, 2013).

Habituation is a reduction in response to repetitious or continuous stimuli over time as individuals learn there are neither adverse nor beneficial effects associated with the stimulus (Bejder et al., 2009). Habituation keeps animals from expending energy and attention on harmless stimuli, but the physiological component might not habituate completely (Bowles, 1995). Responses (e.g., fleeing) depend a variety of factors, such as individual tolerance, experience, species, age, sex, reproductive condition, resource availability, and habitat conditions (Gill et al., 2001; Beale & Monaghan, 2004; Bejder et al., 2009; Francis & Barber, 2013).

Impacts Analysis (Acoustics)

This section analyzes the potential impacts on all biological sub-resources except vegetation from the various types of acoustic stressors associated with the No Action Alternative (Table 3.4-1). The analysis includes potential impacts from the following: (1) air-based assets, (2) water-based assets, (3) land-based assets, and (4) non-explosive munitions and other MEM. Refer to Section 3.0.2.3.1 (Identifying Stressors for Analysis, Acoustic Stressors) for details supporting characterizations of acoustic stressor sources in this section (e.g., sound source levels).

Impacts from Air-Based Assets

Most aircraft-generated sounds, in terms of highest recurring sound levels on air-breathing animals (e.g., aerial/terrestrial invertebrates, reptiles and amphibians, birds, mammals), would be concentrated around PRC airfields where aircraft are closer to the ground and the habitat is mostly developed and regularly disturbed (e.g., regular mowing or cleared). Most of the terrestrial, estuarine and freshwater habitat in the PRC Study Area outside of the airfield environment would experience lower intensities of aircraft noise. The most affected animals would be species that are sensitive to the low-frequency component of aircraft noise relative to the other characteristics of the sound (e.g., intensity/dB within their environment), which includes most invertebrates, fish, and reptiles/amphibians (as described under previous section on "Sound Sensing/Production and Response to Sound"). Most birds and mammals are generally more sensitive to higher frequencies described by dBA weighting introduced in Section 3.0.2.3.1 (Identifying Stressors for Analysis, Acoustic Stressors).

For estuarine animals, the maximum level of low-frequency aircraft noise encountered would be from low-altitude sonic booms focused on fixed targets in the Chesapeake Bay Water Range, though this activity peaks at only a few times a year. For terrestrial/freshwater animals, the maximum level of aircraft noise would be experienced in and around the airfield environment. Outside of these locations, acoustic stressors would be low and distant (frequently) or elevated and close range (infrequently).

Invertebrates

Aerial invertebrates that are not migrating at higher altitudes generally avoid expanses of open water during the day where they are more exposed to aerial predators and high winds (refer to the Affected Environment for Invertebrates section for supporting details). During focused sonic booms, estuarine invertebrates in surface waters and on the bottom may be exposed to levels in excess of 163 dB peak-ti-peak re 1 µPa (behavioral response criteria for fish, and surrogate for aquatic invertebrates) within a relatively small area of the Bay under the aircraft's flight path. The sound levels encountered may cause a brief behavioral reaction for reactive invertebrates (e.g., shell closure in bivalves), but no injuries or hearing threshold shifts would be expected. The most intense underwater noise from subsonic aircraft (152 dB re 1 µPa root mean squard [rms]) is less than the behavioral response threshold for aquatic invertebrates and the corresponding aircraft altitudes would be mostly limited to around the airfield environment. Masking with regard to both mobile and stationary estuarine invertebrates is also not expected due to the very brief, localized, and episodic nature of moving aircraft noise. If masking occurred from aircraft, it would only be during periods where estuarine invertebrates were directly under a hovering helicopter or unmanned aerial system (UAS) where the sound exposure would be dwarfed by the physical disturbance aspect (e.g., wind buffeting). The sound generated underwater by a low-flying helicopter is also too low for even behavioral effects.

For aerial invertebrates, the level and duration of sound that may be encountered (F-35A flying up to 500 feet AGL for approximately 133 dB re 20 µPa near the surface) may cause a brief behavioral response. Terrestrial invertebrates with antennas (e.g., beetles) would be less exposed under vegetation canopies and likely less sensitive to the same noise. Distant aircraft noises would also have no effect on insects with higher-frequency hearing sensitivity (e.g., moths) because the noise is lower intensity at higher frequencies. The closer-range effects of aircraft noise occurring mostly in the airfield environment would be difficult to distinguish from the physical disturbance and strike potential. Whereas some habituation to chronic airfield noise is expected, masking outside of the airfield environment is not expected due to the very brief, localized, and episodic nature of moving aircraft noise and proximity to more attractive habitats within PRC land areas. If masking occurred from aircraft, it could only be during periods where aerial/terrestrial invertebrates were directly under a hovering helicopter or UAS where the sound exposure would be dwarfed by the physical disturbance aspect.

Freshwater invertebrate species or life stages (e.g., dragonfly nymphs) would be subjected to less than 163 dB peak-to-peak re 1 µPa from aircraft noise and would thus be unlikely to exhibit any behavioral response. Most freshwater streams and ponds on PRC land areas are also not located directly below the low-altitude flight path of fixed-wing jets producing the most noise (Figure 3.4-3). Note that Pine Hill Run, Harper's, Pearson, and Goose Creeks are all estuarine waters. The impact of distant overflight noise on freshwater invertebrates should therefore be considered negligible due to the diminished sound intensities reaching the water surface that are further reduced across the air-water interface.

Fishes

During these focused sonic booms, estuarine fishes in surface waters and on the bottom may be exposed to levels in excess of 163 dB peak-to-peak re 1 µPa (behavioral response criteria for fish). The sound levels encountered may cause a brief behavioral reaction (e.g., startle). The most intense underwater noise from subsonic aircraft (152 dB re 1 µPa rms) is less than the behavioral response threshold for fishes suggested by Popper et al. (2019). Masking with regard to both mobile and stationary estuarine fishes is also not expected due to the very brief, localized, and episodic nature of moving aircraft noise. If masking occurred from aircraft, it would only be during periods where estuarine fishes were directly under a hovering helicopter or UAS where the sound exposure would be dwarfed by the physical disturbance aspect (e.g., wind buffeting). The sound generated underwater by a low-flying helicopter is also too low for even behavioral effects.

Freshwater fishes would be subjected to less than 163 dB peak-to-peak re 1 µPa from aircraft noise and would thus be unlikely to exhibit any meaningful behavioral response. Most freshwater streams and ponds on PRC land areas are also not located directly below the low-altitude flight path of fixed-wing jets producing the most noise (Figure 3.4-3). Note that Pine Hill Run, Harper's, Pearson, and Goose Creeks are all estuarine waters. The impact of distant overflight noise on freshwater fishes should therefore be considered negligible due to the diminished sound intensities reaching the water surface that are further reduced across the air-water interface.

Reptiles and Amphibians

During focused sonic booms, diamondback terrapins present in the fixed target areas may be exposed to levels in excess of 175 dB re 1 µPa (behavioral response criteria for sea turtles, surrogate for diamondback terrapins) within a relatively small area of the Bay under the aircrafts flight path. The sound levels encountered may cause a brief behavioral reaction, but no injuries or hearing threshold shifts would be expected. The most intense underwater noise from subsonic aircraft (152 dB re 1 µPa rms) is less than the behavioral response threshold for aquatic turtles and the corresponding aircraft altitudes would be mostly limited to around the airfield environment. Whereas habituation to chronic airfield noise may be expected, masking outside of the airfield environment is not expected due to the very brief, localized, and episodic nature of moving aircraft noise. If masking occurred from aircraft, it would only be during periods where a terrapin were directly under a hovering helicopter or UAS where the sound exposure would be dwarfed by the physical disturbance aspect (e.g., wind buffeting). The sound generated underwater by a low-flying helicopter is also too low for even behavioral effects.

For terrapins and other reptiles and amphibians that are not submerged, the highest level of airborne sound that may be encountered (F-35A flying up to 500 feet AGL for approximately 133 dB re 20 µPa near the surface) is probably below their behavioral response threshold. The closer-range effects of aircraft noise occurring mostly in the airfield environment would be difficult to distinguish from the physical disturbance and strike potential. Masking with regard to terrestrial/freshwater reptiles and amphibians outside of the airfield environment is also not expected due to the very brief, localized, and episodic nature of moving aircraft noise and proximity to more attractive habitats within PRC land areas. If masking occurred from aircraft, it could only be during periods where aerial/terrestrial invertebrates were directly under a hovering helicopter or UAS where the sound exposure would be dwarfed by the physical disturbance aspect.

For context, the breeding calls of spring peepers (*Pseudacris crucifer*) have been shown to be influenced by traffic noise, which is much less than aircraft noise (Parris et al., 2009). Another study found that experimental noise treatments significantly affected the structure, volume, and duration of spring peeper advertisement calls (Hanna et al., 2014). It is likely that salamander species would not be impacted by sound produced by fixed- and rotary-wing aircraft as they spend the majority of their lives underground or under cover objects where exposure to sound would be negligible. In regards to reptiles such as snakes, lizards, and terrestrial and freshwater turtles, typical responses to aircraft noise could include no response, or a change in behavior such as moving away from the sound source and temporarily seeking shelter. These impacts are expected to be minor and long-term consequences for populations would not be expected. In support of this conclusion, the species diversity of amphibians and reptiles have remained stable at both NAS Patuxent River and OLF Webster despite frequently being exposed to aircraft noise.

Birds

Very few birds can hear below 20 Hz and most hear more in the range of humans that is reflected by A-weighted intensity/dB of sound sources. Considering aircraft noise is most intense at lower frequencies, birds will be unlikely to experience the full intensity and corresponding range to effects of aircraft noise and may response more often to the physical disturbance aspect of aircraft flight. For example, the sound intensity of a high-altitude sonic boom in surface waters of 156 dB re 1 µPa at 10 Hz would be less than 100 dB re 1 µPa at 1 to 4 kHz (Eller & Cavanagh, 2000). From the perspective of diving bird hearing underwater, this level of sound and frequency would be detectable but not particularly loud and not associated with a physical disturbance (e.g., visual stimuli).

For birds in the estuarine environment, the maximum level of aircraft noise encountered would likely be from low-altitude sonic booms focused on fixed targets in the Chesapeake Bay Water Range, though this activity peaks at only a few times a year. The area is inhabited by numerous species of water birds, including diving birds. The surface areas most impacted by focused sonic booms would be a few hundred feet in diameter (Eller & Cavanagh, 2000) and would not overlap with terrestrial habitat where most bird nesting (known and unknown) would be occurring. Increasingly lower intensities of sound would be experienced within a width of over 10 miles under the aircraft’s flight path. Within the more impact areas, nesting has been documented on the Point No Point Lighthouse and Hannibal Target within the Chesapeake Bay Water Range (Figure 3.4-1). Of the two locations, only Hannibal Target overlaps the elevated noise contours for sonic booms where the structure of the target has provided nesting habitat for peregrine falcons. The entire Chesapeake Bay nesting population of peregrine falcons is still quite small, so that serious impacts on just one or two nesting pairs could have significant population-level effects (Rambo, 2020a). However, long-term monitoring of the northeastern population of peregrine falcons suggests a stable population with surplus available for the practice of falconry (Watts et al., 2015; Franke, 2016). The surplus currently permitted for taking, as codified in 82 Federal Register 42700 (Take of Peregrine Falcons), is far less than what Franke (2016) estimated could be taken, suggesting the loss of one or two nesting pairs may not significantly affect the population of peregrine falcons. The monitoring reported in Watts et al. (2015) suggests that lost adults will soon be replaced with "floaters" (i.e., young birds looking for their own territory). The potential for harming peregrine falcons on Hannibal is also minimized by mitigation measures that prevent firing within a half mile of Hannibal Target from February 15 to August 15 when peregrine may be nesting (Rambo, 2020b).

During focused sonic booms, birds in the most affected area may be exposed to sound levels higher than the 170 dB re 1 µPa and 113 dBA re 20 µPa underwater and in-air levels, respectively, estimated for level supersonic flight (Mach 2) at 10,000 feet AGL. For diving birds underwater, the higher frequencies generated by a focused sonic boom at lower altitude could be more intense than 150 dB re 1 µPa and may cause a brief behavioral response within a very limited area. The available studies on auditory injury in birds are limited to much longer exposures in the airborne environment. The level of impulsive airborne sound generated from a focused sonic boom would be unlikely to surpass the 168 dB peak (approximately 143 dBA) that is known to have significant impacts on colonial water birds under conditions of frequent recurrence (Austin et al., 1970). The sound from a supersonic jet would also follow after the physical disturbance aspect, unlike subsonic aircraft noise that would rise and fall as the aircraft passes a location. The noise from a supersonic jet could therefore come as more of a surprise to birds that do not respond first to the physical presence of the aircraft. Though representative of only level supersonic flight, Ellis et al. (1991) found that raptors typically exhibit only minor short-term startle responses to real and simulated sonic booms at altitudes as low as 1,640 feet AGL. In either case, hearing loss among birds exposed to focused sonic booms would be unlikely due to the combination of sound level and very short duration of exposure. The rarity and very short duration of exposure suggest no long-term effect on any birds from the occasional lower altitude sonic booms associated with the No Action Alternative. Sonic booms from level supersonic flight at greater than 30,000 feet AGL are not expected to have any effect on birds.

In and around the airfield environment, sound source levels intense enough to cause an auditory injury on birds are also associated with the major physical disturbance of an aircraft taking off covered under the "Physical Disturbance and Strike" stressor. The average sound source levels in and around the airfield environment (and away from potential disturbance and strike hazards) may result in masking, though it is also possible that birds could habituate to repeated aircraft noise and no longer exhibit behavioral responses (Conomy et al., 1998; Larkin et al., 1996; National Park Service, 1994; Plumpton, 2006).

Outside the vicinity of airfield environments or the fixed water-range targets, exposure to less intense/persistent aircraft noise and physical disturbance from lower altitude subsonic or high-altitude supersonic flight may only cause less than injurious effects from birds (e.g., masking, physiological stress, behavioral reactions) as described in the introduction to acoustics stressors on birds. The majority of studies regarding low-altitude (500 feet AGL or less) subsonic military flights and bird behavior have found minimal to no meaningful response (Conomy et al., 1998; Hillman et al., 2015; Ellis et al., 1991; Black et al., 1984) or a response more related to visual stimuli (Brown A. L., 1990). Level supersonic jet flights at greater than 1,640 feet (500 meters) distances from raptors were observed to elicit no response (Ellis et al., 1991). Ellis (1981) also reported anecdotal evidence of a response that was mostly evident with associated physical disturbance (e.g., visual stimuli). However, herring gulls significantly increased their aggressive interactions within the colony and their flights over the colony during overflights with received SPLs of 101 to 116 dBA re 20 µPa (Burger, 1981). Harlequin ducks (*Histrionicus histrionicus*) were observed to show increased agonistic behavior and reduced courtship behavior up to one to two hours after low-altitude military jet overflights (Goudie & Jones, 2004). Neither effect was prolonged; it was related to flights below 500 feet AGL that occur mostly in and around the airfield environment. Fixed-wing aircraft flights outside of the airfield environment are mostly limited to altitudes greater than 600 feet AGL, with the exception of smaller UAS that are quieter and less commonly used.

Whereas most fixed-wing aircraft flights away from the airfield environment are at higher altitudes (greater than 600 feet), helicopters associated with the No Action Alternative operate both above and below 600-foot altitudes and often occur as low as 75- to 100-foot altitudes throughout the helicopter operating areas (Helo OPAREAs) and restricted airspace. Within this area, helicopter flights are more likely to impact a greater numbers of birds that forage and nest over land areas than those that only forage in and over open waters. This low altitude and location increases the likelihood that land and nearshore birds will respond to noise and physical disturbance from helicopter overflights with reactions such as flushing (Stalmaster & Kaiser, 1997), although a large portion of birds may exhibit no reaction to nearby helicopters (Grubb et al., 2010). Helicopters also travel at slower speeds (less than 100 knots) and hover for extended periods which increases the duration of noise exposure and physical disturbance compared to fixed-wing aircraft. Longer activity durations and periods where helicopters hover may increase the potential for behavioral reactions, startle reactions, and physiological stress, for birds that remain in the area (which is unlikely for most birds).

Whereas the likelihood that adult birds would remain in the immediate vicinity while an helicopter hovers or transits directly nearby would be low, the risk to flightless juvenile birds can be elevated; helicopters (or UAS) operating at low altitudes over colonial wading bird nests can cause flightless young to jump from their nesting platforms to areas where parents will not feed them (Rambo, 2020a). The risk to young flightless birds is somewhat mitigated by active avoidance of large aggregations of birds and eagle nests by Navy helicopter pilots, for both the safety of the aircraft and the birds (refer to Section 2.5, Standard Operating Procedures Included in the Proposed Action, for supporting details). Specifically over Bloodsworth Island Range, there is restriction on overflights to above 3,000 feet for fixed-wing aircraft and 1,000 feet for rotary-wing aircraft during migratory waterfowl season (typically November 15 to March 31) (Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization).

Small UAS flights (both military and nonmilitary) are becoming very common in the skies worldwide and there is some evidence of associated disturbance among mostly birds and terrestrial mammals using aerial or terrestrial habitats (Rebolo-Ifran et al., 2019). The disturbance is related to the typically low altitudes that small UAS fly (3 to 201 feet AGL) and their novelty to exposed wildlife occurring mostly on the ground or a few hundred feet off the ground (refer to Section 3.4.2, Affected Environment, for supporting details). For birds, the most frequent behavioral response to small UAS flight was escape (55.6 percent), though a small number of responses involved attacking the aircraft (11.1 percent). The percentage of birds that did not respond to small UAS flight was approximately 10 percent, though the synthesis of internet data source used in Rebolo-Ifran et al. (2019) is admittedly biased toward an interesting response. The concern over small UAS operation and wildlife is mostly intentional disturbance in relatively undisturbed areas serving as a refuge for wildlife. Small UAS operations associated with the No Action Alternative do not intentionally target wildlife and their use is generally confined to previously disturbed land areas (e.g., airfields, mowed areas) subject to other aircraft noise.

Mammals

Bats are typically nocturnal and thus foraging bats may only be exposed during flights occurring from dusk to dawn. While dusk certainly occurs before 10:00 p.m., as further explained in Appendix C (Noise Study), an average of 94 to 100 percent of all aircraft operations occurs between 7:00 a.m. and 10:00 p.m., thereby substantially reducing the likelihood that acoustic stressors from aircraft operations would impact foraging bats in flight. Flights that occur between dawn and dusk could affect bat roosting behavior; however, impacts would likely be negligible, as roosting sites provide additional shelter to bats during the daytime hours. Additionally, all of the bats present in the PRC Study Area are inactive (hibernate) in the winter when prey is scarce and, with the potential exception of eastern red bats, migrate out of the area to overwinter in the south or in hibernating sites outside of the study area.

The greatest potential for acoustic impacts to bats from air-based stressors would occur in and around the airfield environment where aircraft noise is most frequent and intense. However, this airfield is also subject to BASH program initiatives that discourage wildlife use of these areas. The relative low frequency of aircraft noise (less than or equal to 10 kHz for low-altitude flights) is not expected to mask the much higher echolocation frequencies of bats (40 kHz) (Le Roux & Waas, 2012). Although aircraft noise is within the hearing range of bats, habituation has been shown to occur with bats exposed to high levels of aircraft activity (Le Roux & Waas, 2012) (Schaub et al., 2008). Concurrently, bats that are not typically exposed to high levels of broadband background noise are more likely to avoid such areas altogether (Le Roux & Waas, 2012). Away from the airfield environment, where aircraft activity is infrequent, localized, and generally higher in altitude, occasional startle or alert reactions from bats could occur, but these reactions are not likely to disrupt major behavior patterns (such as migrating, breeding, feeding, and sheltering) or to result in serious injury to any bats.

The low altitudes of helicopter flights associated with mine countermeasure (e.g., OASIS) and anti-submarine warfare (e.g., dipping sonar) events increases the likelihood that bats would respond to noise from helicopter overflights with reactions such as flushing (Stalmaster & Kaiser, 1997). However, mine countermeasure system events occur very rarely and typically vessels provide the towing service rather than helicopters. Additionally, these events occur over open waters where bats would not roost and are not in close proximity to typical bat foraging areas. The activities also occur during the day. Terrain-following activities by helicopters around the shorelines of Harper’s and Pearson Creeks may present the most elevated risk of acoustic disturbance for bats. While there are few studies about the behavioral responses of bats to aircraft, unlike other terrestrial mammals, bats are believed to be less susceptible to noise-induced hearing loss (both temporary and permanent threshold shifts) than other mammals. This could be attributed to their use of echolocation, which requires them to forage and navigate through intensely noisy environments (Simmons et al., 2016).

Events involving sonic booms most commonly occur in the restricted airspace at altitudes greater than 30,000 feet AGL. These high-altitude events over terrestrial and riparian areas where bats would most commonly roost and forage, would produce low intensity and brief sound exposure from a bats perspective (approximately 100 dBA for milliseconds of exposure), causing no more than an occasional startle response. Rarely, sonic boom events can occur at altitudes as low as 10,000 feet AGL, but these events would only occur over the Chesapeake Bay Water Range, and while increased sound profiles would extend outside of the Chesapeake Bay Water Range boundary, their intensity over terrestrial and riparian areas where bats are likely to occur would not cause more than an occasional startle response. Additionally, all events involving sonic booms would take place during the day, when bats are not active and are sheltered in their roosting sites.

For terrestrial/freshwater mammals out of water, the highest level of airborne sound that may be encountered (F-35A flying up to 1,000 feet AGL for approximately 119 dBA re 20 μPa near the surface) peaks at frequencies lower than their typical hearing sensitivity and occurs relatively close to the airfield environment. An animal exposed to this noise level could exhibit a temporary behavioral or stress response to an unusual noise that is not associated with harm to the animal. The closer-range effects of aircraft noise occurring in the airfield environment would be difficult to distinguish from the physical disturbance and strike potential. Animal reactions to high-altitude sonic booms are similar to their reactions to low-altitude subsonic airplane flights, helicopters, and sudden noises (Manci et al., 1988).

For freshwater mammals (e.g., river otter) moving underwater in the Chesapeake Bay, the maximum level of low-frequency noise encountered would be from low-altitude sonic booms focused on fixed targets in the Chesapeake Bay Water Range, though this activity peaks at only a few times a year. During focused sonic booms, a freshwater mammals present in the fixed target areas may be exposed to levels in excess of 170 dB re 1 μPa within a relatively small area of the Bay under the aircrafts flight path. The sound levels encountered may cause a brief behavioral reaction, but no injuries or hearing threshold shifts would be expected due to the very brief exposure. For mammals swimming underwater in freshwater habitats, the sound intensity generated by a high-altitude sonic boom could be up to 159 dB re 1 μPa peak underwater at 10 Hz (approximately 139 dB re 1 μPa at higher frequencies). Whereas the maximum underwater sound is louder than the airborne sound, it is also very temporary and limited to the ideal angle for sound penetration into water. The most intense underwater noise from subsonic aircraft (152 dB re 1 μPa rms) is less than a high-altitude sonic boom and the corresponding aircraft altitudes would be mostly limited to around the airfield environment.

Whereas terrestrial/freshwater mammals may become habituated to chronic noise in the airfield environment, masking outside of the airfield environment is not expected due to the very brief, localized, and episodic nature of moving aircraft noise in those areas. Based on the localized and infrequent nature of air-based asset movement causing high levels of airborne sound, impacts are not expected to rise to the level of measurable effects on terrestrial or freshwater mammal populations.

Impacts from Water-Based Assets

Acoustic stressors from water-based assets associated with the No Action Alternative include: sonar and other transducers and propulsion system noise. This section covers only potential impacts from water-based assets on estuarine invertebrates, estuarine fishes, and water birds. The acoustic stressor effects from water-based assets on aerial invertebrates, bats, and terrestrial animals are discountable because of either lack of coincidence (terrestrial/freshwater animals) or typical avoidance of open-water habitats at low altitudes when most water-based activity is occurring (aerial invertebrates and bats). Aerial invertebrates and bats are relatively rare over these areas during the day (refer to the Affected Environment for Invertebrates section for supporting details). Bats are typically nocturnal and would likely only be exposed to water-based activities that typically occur between dawn and dusk. The mostly day time hours of activity substantially reduce the likelihood that bats would be impacted by water-based assets.

Whereas most estuarine animals (e.g., invertebrates, fishes) live entirely underwater, water birds live mostly above the water but use a variety of foraging behaviors that could expose them to underwater sound. Some water birds plunge-dive from the air into the water (e.g., brown pelicans, terns, gannets, and others) or perform aerial dipping (the act of taking food from the water surface in flight); others surface-dip (swimming and then dipping to pick up items below the surface) or jump-plunge (swimming, then jumping upward and diving underwater). Birds that feed at the surface, by surface or aerial dipping, would experience limited to no underwater exposure. Birds that plunge-dive are typically submerged for short durations, and any exposure to underwater sound would be very brief. Some fish-eating birds, such as cormorants and loons, pursue prey under the surface (i.e., pursuit diving), swimming deeper and staying underwater longer than other plunge-divers. Birds that forage near the surface would be exposed to underwater sound for shorter periods than those that forage below the surface. Exposures of birds that forage below the surface may be reduced by scattering of sound waves at the water surface. Sounds generated underwater during the proposed activities would be more likely to impact birds that pursue prey under the surface, although as previously stated, little is known about bird hearing ability underwater (refer to introductory paragraphs under the acoustic stressor).

Sonars and Other Transducers

The No Action Alternatives includes use of active dipping sonar and *de minimis* sonar (refer to 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors, for definition) associated with various water-based assets. The proposed use of low intensity *de minimis* sonars and other transducers is more common than active dipping sonar, but the effects range would be substantially more confined. Estuarine animals and diving birds may detect *de minimis*, non-impulsive sounds up to 1,531 feet (464 meters) from their source underwater (refer to Section 3.0.2.3.1 for supporting details). Many estuarine invertebrates, fishes, and turtles are sensitive to nearby low-frequency sounds that include some low-frequency *de minimis* sonars. However, *de minimis* sonar intensities fall below the threshold for a behavioral response in estuarine invertebrates, fishes, and turtles very close to their sources. Most activities involving *de minimis* sonar would also be conducted in deeper, open water of the PRC Study Area and are not likely to expose most estuarine invertebrates, fishes, and diamondback terrapins concentrated in nearshore habitats to elevated noise; although, some estuarine animals inhabiting the deeper waters away from shore could be exposed more frequently to this occasional occurrence. The brief exposure to *de minimis* underwater sound would also rise and fall as the water-based asset moves relative to a stationary animal or animal swimming away from the sound source, giving the animal an opportunity to move away. The longer-range exposure to *de minimis* sonars would also be un-associated with any physical disturbance, which may diminish a potential response.

The close-range effects of higher intensity sound from active dipping sonar would likely be indistinguishable from the physical disturbance aspect (e.g., low-hovering helicopter over dipping sonar); birds and other highly mobile surface animals would likely move away from the helicopter disturbance and avoid the most intense underwater sound generated by active dipping sonar. Potential direct injuries from dipping sonars at close range are also unlikely, because of the relatively lower peak pressures and slower rise times than stressors with a strong shock wave (e.g., pile driving, explosives). The close range impact of these sonars and other transducers is limited to drifting or slow-moving pelagic organisms such as oyster larvae (covered in Section 3.4.7, Magnuson Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). Subsequent analysis of dipping sonar will therefore focus on long-range effects of underwater animals that may be sensitive to mid-frequency sonar. Estuarine invertebrates and diamondback terrapins are unlikely to hear mid-frequency sound and are thus not carried forward for analysis.

Whereas most navigational sonars are considered *de minimis* disturbances and below the recommended behavioral response criteria level for fish by Popper et al. (2019), dipping sonars can have much higher source levels and potential impacts on some fishes with hearing specializations. The potential impact of distant dipping sonar on fish is therefore limited to behavioral effects and masking from actually hearing the sound. The proximity of sound sources detectable by selected predatory fish (e.g., striped bass, bluefish, butterfish, cobia, summer flounder, weakfish, windowpane) in the PRC Study Area (e.g., less than 1 kHz, as documented earlier in the acoustic stressor discussion) overlaps marginally with that of the dipping sonar transmissions. However, predatory fish prey upon species that can detect the full range of mid-frequency sound (e.g., Clupeidae family—includes menhaden, anchovies, shads, herrings). Other prey fish species of the study area are not known to detect any distant sounds (refer to the introduction paragraph of the Acoustic discussion for fishes).

There are few studies that assess the potential effects of sonar transmissions on clupeid anchovies and silversides—a favored food of bluefish in the Bay (Section 3.4.7, Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). The other species with EFH in the PRC Study Area eat primarily invertebrates. Atlantic silversides are not known to be capable of detecting mid-frequency sounds. Anchovies are known to have anatomical hearing specializations that allow them to detect mid-frequency sounds up to approximately 4 kHz, and with best hearing sensitivity, below 1 kHz (Popper, 2008). However, a dipping sonar operates as a mid-frequency active sonar (MFAS) (between 1 and 10 kHz) and may not be detectable by anchovies at long range. Insight into the potential physiological and behavioral effects of MFAS on clupeids (including anchovies) has been gained from studies conducted on herrings (Doksæter et al., 2009; Jørgensen et al., 2005; Kvadshein & Sevladsen, 2005).

In the first study, Jørgensen et al. (2005) investigated the effects of hull-mounted and towed sonar systems on groups of four larval and juvenile fish species, including larval and juvenile herring (the only clupeid evaluated). During the experiment, the fish were placed in a large tank and contained in plastic bags approximately 10 feet (3 meters) from the sound source, and were exposed to sounds at frequencies of 1.5 kHz, 4 kHz, and 6.5 kHz and SPLs ranging from 160 to 190 dB re 1 µPa. No effect on species without anatomical hearing specializations was observed. Of species evaluated, only herrings showed an effect. Between 20- and 30-percent mortality resulted in 2 out of 42 groups of herring, following sound exposure at 180 to 190 dB re 1 µPa. Jørgensen et al. (2005) also observed and recorded the behavioral reactions of the surviving herring. The fish showed strong behavioral reactions to the sonar, including startle and flight reactions and a dramatic increase in swimming speed. Some individual fish even appeared to be briefly stunned. After the experiment concluded, the organs and tissues of some surviving herring were compared to a control group that was not exposed to sonar. No acute damage to organs or tissues was found, and the authors concluded that the long-term behavior, survival, and growth of fish exposed to the sonar would not be significantly different from fish that were not exposed to the sonar.

In the second study, Kvadsheim and Sevaldsen (2005) describe the results from mathematically analyzing a hypothetical "worst-case" scenario involving two frigates equipped with sonar systems performing an anti-submarine warfare exercise in the middle of an ecologically and economically important spawning area during the most intensive spawning period. In the scenario, both vessels use hull-mounted sonar and towed sonar systems transmitting alternately at maximum power and duty cycle. The hull-mounted sonar transmitted at 5 to 8 kHz at a depth of 16 feet (5 meters) and the towed sonar system transmitted at 1 to 2 kHz at a depth of 164 feet (50 meters). Source levels for both systems were between 200 and 225 dB re 1 µPa at 3.3 feet (1 meter). Based on the results of Jørgensen et al. (2005), Kvadsheim and Sevaldsen (2005) established thresholds of 180 dB re 1 µPa or 190 dB re 1 µPa, depending on the type of sonar, for predicting 100 percent mortality in juvenile herring within 10 feet (3 meters) of the sound source. Both thresholds represented conservatively low estimates of the SPL that would cause 100 percent mortality, considering that Jørgensen et al. (2005) noted only 20 to

30 percent mortality in 2 groups of herring (out of 42) exposed to hull-mounted sonar, and no physiological impacts were observed from exposure to towed sonar transmissions in the Jørgensen et al. (2005) study.

Using the thresholds, the analysis by Kvadsheim and Sevaldsen (2005) predicted that a maximum of 1 percent of the stock of juvenile herring would incur mortality when hull-mounted sonar transmitted near the fish's swim-bladder resonance frequency and at the highest source level (225 dB re 1 μPa at 1 meter). Lower source levels resulted in even lower predicted mortality (e.g., at 220 dB re 1 μPa at 1 meter, mortality was 0.5 percent). The maximum predicted impact for towed sonar systems was 0.3 percent mortality. The daily natural mortality of juvenile herring is estimated at 10 percent, leading the researchers to conclude that the impact of sonar on juvenile herring is insignificant. Physiological effects on adult herring are less likely because adult fish are more robust than juveniles are, their swim-bladder resonance frequency is outside of the mid-frequency range, and they would be expected to move away from an "unpleasant stimulus" before incurring injury or mortality (Kvadshein & Sevladsen, 2005). Species without hearing specializations exposed to hull-mounted and towed sonar systems showed no effects.

Kvadsheim and Sevaldsen (2005) concluded that, in comparison to hull-mounted sonar and towed sonar systems, the impact of dipping sonar (3.5 to 4.5 kHz) and sonobuoys (6.5 to 9.5 kHz) could be ignored with regard to sound effects on fish, for the following reasons:

- They are generally less powerful than hull-mounted and towed sonar systems.
- They operate below 164 feet (50 meters), reducing the number of fish likely to be in the impact zone. However, the dipping sonar use in the PRC does not necessarily occur in deeper water below a thermocline (i.e., transition from warm, oxygenated water to cold/hypoxic water) during the growing season when organisms are most diverse and abundant.
- They are generally stationary in the water column, which also reduces the size of the impact zone and the number of fish that would be impacted.

The results of this study, which analyzes the physiological effects of mid-frequency hull-mounted or towed sonar on stocks of a clupeid fish, are more relevant to the No Action Alternative than the study by Jørgensen et al. (2005), which held fish captive approximately 10 feet (3 meters) from the source. Fish in the Bay, including anchovies, exposed to MFAS will have the ability to move away from the source. In addition, the analysis showed that the hull-mounted sonar, which transmitted in the 5- to 8-kHz range, had the greatest impact on the herring. Anchovies are most sensitive to sound less than 1 kHz, and the No Action Alternative would only transmit MFAS from a helicopter dipping sonar system. Therefore, the likelihood of impacts to anchovies in the Bay would be less than the impacts predicted for herring by Kvadsheim and Sevaldsen (2005). The study's conclusion that mid-frequency helicopter dipping sonar would have a discountable impact on herring stocks is also relevant and noteworthy. Kvadsheim and Sevaldsen (2005) acknowledged that herring may exhibit behavioral responses to sonar and that further investigation was needed to assess potential behavioral impacts. However, a reaction would likely benefit predatory species that cannot detect the sound while taking advantage of the distracted prey.

In the third Norwegian study, Doksæter et al. (2009) investigated the potential behavioral effects of sonar on herring. The reactions of free-swimming herring to sonar transmissions at 1 to 2 kHz and 6 to 7 kHz were compared with the playback of recorded killer whale (*Orcinus orca*) feeding sounds. Received SPLs for the lower frequency range were 127 to 197 dB re 1 μPa and for the higher range was 139 to 209 dB re 1 μPa. The killer whale feeding sounds ranged from approximately 800 Hz to 20 kHz and source levels of 150 to 160 dB re 1 µPa at 1 meter. The reactions of the herring, which were generally located between 33 and 164 feet (10 and 50 meters) in the water column, were monitored by two upward-looking echo sounders. No vertical or horizontal fleeing reactions to the sonar transmissions were observed as the vessels passed multiple times over the stock of herring. By contrast, the killer whale feeding sounds induced both vertical and horizontal fleeing reactions in the herring. The authors concluded that the operation of sonar resulted in no effect on the behavior of the herring stock; therefore, there would be no large-scale adverse effects to the herring stock.

The Doksæter et al. (2009) study is perhaps the most relevant to the No Action Alternative because it assesses potential behavioral reactions to sonar by a clupeid fish. Given that it is highly unlikely that a large portion of anchovies, the most abundant fish in the Bay, would be close enough to the sonar transducer during a functional check to incur injury or mortality, the most likely type of exposure may result in a brief behavioral response. As stated above, lower intensity sonar transmissions resulted in no behavioral effects to a population of clupeid fish. In addition, the hearing of anchovies is most sensitive to frequencies below 1 kHz; therefore, anchovy behavior would not likely be affected by higher frequency transmissions from the dipping sonar. Whereas particle motion very close to the sonar could affect anchovies (based on aforementioned research on herrings), the probability of coincidence (for a surface schooling fish and a highly localized and infrequent stressor) should be considered discountable due to the physical disturbance associated with a helicopter dangling a dipping sonar. Anchovies also experience a naturally high mortality rate despite the fact they are highly abundant in the estuarine environment.

There are no studies of bird responses underwater to sonars, but the effect of sonar-like pingers on fishing nets has been examined. Fewer common murres (*Uria aalge*) were entangled in gill nets when the gill nets were outfitted with 1.5-kHz pingers with a source level of 120 dB re 1 µPa; however, there was no significant reduction in rhinoceros auklet (*Cerorhinca monocerata*) bycatch in the same nets (Melvin et al., 1999; Melvin et al., 2011). It was unknown whether the pingers elicited a behavioral response by the birds or decreased prey availability. Limited information (Johansen et al., 2016) and data from other species suggest the range of best hearing may shift to lower frequencies in water (Dooling & Therrien, 2012; Therrien, 2014). Because few birds can hear above 10 kHz in air, and best hearing is between 1 and 4 kHz, it is likely that the only sonar sources they may be able to detect are mid-frequency (1 to 10 kHz) sources.

Other than pursuit diving species, the exposure to birds by these sounds is likely to be discountable because they spend only a very short time underwater (plunge diving or surface dipping) or forage only at the water surface. Pursuit divers may remain underwater for minutes, increasing the chance of underwater sound exposure. In addition to diving behavior, the likelihood of a bird being exposed to underwater sound depends on factors such as duty cycle, whether the source is moving or stationary, and other activities occurring in the area. The potential for birds to be exposed to intense sound associated with stationary sonar sources would be somewhat limited due to other activities occurring in conjunction may cause them to leave the immediate area (e.g., hovering helicopter). However, lower levels of sound generated at greater distances from the dipping sonar could cause a behavioral response (e.g., startle).

A physiological impact, such as hearing loss, would likely only occur if a water bird were close to the intense sound produced by a dipping sonar but not close enough to have moved away from the hovering helicopter. Whereas the very high source level generated by dipping sonar (greater than 200 dB re 1 µ Pa at 1 meter) from 1 to 10 kHz could result in hearing loss, there are no available studies of such short duration exposure on diving birds. In general, birds are less susceptible to both temporary and permanent threshold shifts than mammals (Saunders & Dooling, 1974). Diving birds also have adaptations to protect the middle ear and tympanum from pressure changes during diving that could negatively affect in-air hearing (refer to the Specific Background for Analysis section). The intense underwater sound exposure would also have to be of sufficient duration to cause hearing loss. In the case of dipping sonar, the duration would be only one to four minutes, per dip. The total annual duration of active dipping sonar in the Chesapeake Bay s also very brief (approximately one hour). Avoiding the sound by returning to the surface would also limit extended or multiple sound exposures underwater. For these reasons, the likelihood of a diving bird experiencing dipping sonar noise that could result in an impact to hearing is considered low. Whereas diving birds may detect intense mid-frequency sources far from their sources (e.g., dipping sonar), the potential for any meaningful behavioral interruption would be unlikely due to the lack of an associated physical disturbance.

Given the unlikely event of an exposure to any sonars or other transducers associated with the No Action Alternative, there is a similarly unlikely potential for masking because there is no evidence that diving birds rely on underwater acoustic communication for foraging.

Propulsion System Noise

Whereas most estuarine invertebrates and fish can detect the particle motion and sound pressure from the low-frequency component of broadband propulsion system noise, the higher frequencies are not generally detectable. The pressure component of propulsion system noise also diminishes substantially with distance, though not as much as particle motion. In the unlikely event of a coincidence, the relative contribution of particle motion to disturbance would be difficult to distinguish from the physical disturbance aspect.

The impact of most propulsion system noise associated with the No Action Alternative on estuarine invertebrates, fishes, diamondback terrapins, and diving birds would be very similar to that of *de minimis* sonars covered in the previous section; the maximum source level for most PRC vessel propulsion systems moving at slow to high speed is 164 to 173 dB re 1 µPa at 1 meter at a frequency range of 2.5 to 0.8 kHz (small to medium-size vessels, respectively). These levels decline to *de minimis* characteristics beyond 6.6 to 23 feet (2 to 7 meters). Therefore, the potential for any meaningful behavioral disruption among estuarine invertebrates, fishes, diamondback terrapins, and diving birds apart from the associated physical disturbance from localized and infrequent stressors is likely negligible. Smaller in-water device propulsion systems are not only quieter and higher frequency than small to medium vessels, they also represent a very low percentage of total operating hours. Larger vessel propulsion systems associated with the No Action Alternative are more intense and lower frequency (178 dB re 1 µPa at 1 meter, and 0.1 kHz). However, the elevated noise from large vessels is likely below the behavioral response thresholds of 163 dB re 1 µPa peak-to-peak (behavioral response criteria for fish and surrogate for aquatic invertebrates) and 175 dB re 1 µPa (behavioral response criteria for sea turtles and surrogate for terrapins) at a distance of 33 feet (10 meters) from the slow-moving source and represents only 5.5 percent of operating hours for mobile, water-based assets. The low frequencies of large vessel propulsion systems are also mostly outside the hearing range of diving birds. The slow speed of large vessels also suggests more of a disconnect between the noise and the associated physical disturbance that would otherwise condition an alarm response in estuarine invertebrates (e.g., blue crabs), fishes, diamondback terrapins, and diving birds capable of response.

Impacts from Land-Based Assets

This section only covers potential impacts from land-based assets (e.g., grounded aircraft, ground support vehicles, unmanned ground systems) on aerial and terrestrial animals. Estuarine animals (e.g., invertebrates, fishes, turtles) and water birds would be mostly unaffected by land-based asset noise, due to relatively low sound levels produced by those assets, distant proximity to estuarine habitats, and reduced transmission of sound from air to water. While underwater in freshwater habitats, animals would be unaffected by land-based asset noise for essentially the same reasons. The location of land-based assets is mostly associated with louder aircraft and limited to the airfield environments where there are relatively few named pond/creeks (Figure 3.4-3) or previously disturbed locations verified by installation natural resource staff to be devoid of sensitive biological resources. Considering the analysis of aircraft noise supports no population-level effect on aerial or terrestrial animal species, so too would there be no population-level effect of land-based asset noise.

Implementation of management measures set forth in INRMPs also has the effect of minimizing noise impacts on wildlife within installation boundaries. These measures are tailored to the specific conditions of the installation but generally include fenced or posted wildlife protection areas and spatial separation of established testing and training areas from installation boundaries using interior forested or noise buffer zones. Uncommon/specialist species occurring more in these wildlife protection areas could be affected by land-based asset noise associated with the No Action Alternative but to a lesser degree than associated aircraft noise.

Impacts from Non-Explosive Munitions and Other Military Expended Materials

This section covers mostly potential impacts on estuarine animals (e.g., invertebrates, fishes, turtles) and water birds because the vast majority of MEM noise (i.e., weapons firing/impact noise) is limited to open estuarine waters of the PRC Study Area (e.g., Chesapeake Bay Water Range). The impact of weapons firing/impact noise on bats and terrestrial/freshwater animals is likely minimal due to lack of proximity of these animals to deeper estuarine waters where the stressor is occurring. In addition, since most weapons separation events occur during the day, nocturnal bats and terrestrial mammals species would not experience impacts (refer to affected environment section for supporting details). Numerous terrestrial mammal species are also considered nocturnal. Considering the distribution of bats and terrestrial/freshwater mammals and the aforementioned factors minimizing coincidence with weapons firing/impact noise, there are no population-level effects on these animals anticipated from this activity associated with the No Action Alternative.

Within the estuarine environment, weapons firing noise is mostly limited to approximately 1.86 miles (3 km) around the fixed targets where peak airborne and underwater sounds levels are greater than 130 dB re 20 µPa and 162 dB re 1 µPa, respectively. The highest intensity, low-frequency weapons firing noise of 137 dB peak re 20 µPa (airborne) and 169 dB peak re 1 µPa (underwater) from rocket firing would be similar in impulsive intensity to the occasional sonic booms associated with weapons separation testing, but weapons firing would be more frequent, and associated with the physical disturbance of air- or water-based asset. Impact noise is also associated with weapons firing and release of other MEM and may be louder than weapons firing, depending on the size, shape, and speed of the falling object, and surface conditions. Weapons firing/impact noise is therefore the most intense and frequent acoustic stressor from the No Action Alternative apart from aircraft noise in and around the airfield environment. However, weapons firing/impact noise is relatively brief and associated with physical disturbance of the associated asset. The sound intensities would be significantly diminished from the perspective of terrestrial/freshwater animals landward of the shoreline and mostly inactive during the day.

Estuarine fishes, terrapins, and water birds may be present during weapons firing/impact noise over the Chesapeake Bay Water Range. Aerial invertebrates would tend to be scarce over these open water areas during the day, and terrestrial invertebrates would be unaffected by weapons firing/impact noise due to lack of close proximity (refer to affected environment section for supporting details). Over open estuarine waters, the sound intensities generated from weapons firing/impact noise are greater than most associated aircraft noise occurring at the same time and general location. The single exception would be for supersonic weapons separation testing that creates sound levels similar to weapons firing. However, both weapons firing and supersonic weapons separation testing are localized and infrequent but may result in a startle reaction among animals nearest the weapons firing or impact location. Bird responses to weapons-firing/impact noise may include short-term behavioral or physiological responses such as alert responses, startle responses, or temporary increases in heart rate. Studies of impacts of weapons noise on raptors show that these birds show little reaction (e.g., head turn) and do not alter behavior in the presence of noise from weapons testing (Brown et al., 1999; Schueck et al., 2001; Stalmaster & Kaiser, 1997). Once surface weapons firing activities begin, birds would likely disperse away from the area around the target area and the path of projectiles if disturbed. Other activities in the general area that precede aircraft movement or target setting could also disperse birds away from the area in which weapons-firing noise would occur. Masking of important biological sounds may occur during the brief duration, even when multiple shots are fired in series.

Considering the mostly nearshore distribution of estuarine animals (refer to affected environment section for supporting details) and the aforementioned factors minimizing coincidence with weapons firing/impact noise, there are no population-level effects anticipated from weapons firing/impact noise associated with the No Action Alternative. This conclusions is also supported by the analysis of localized and more frequent aircraft noise supporting no population-level effect on estuarine animals and most water birds. The single exception to this overall conclusion could be for peregrine falcons nesting on Hannibal Target and other locations under low-altitude airspace. However, the potential for air-based assets and associated MEM harming peregrine falcons is minimized by factors introduced in the air-based asset discussion (e.g., floater population, seasonal flight restrictions).

Impact of Acoustic Stressor (Summary)

Vegetation would not be affected by acoustic stressors. Most invertebrate, fish, and reptile/amphibian species are relatively insensitive to distant sounds and unlikely to encounter more intense short-range sounds from primarily mobile/high-altitude sources. Birds and mammals are more sensitive to distant sounds, but they are similarly unlikely to encounter more intense short-range sounds from primarily mobile/high-altitude sources. Intense short-range exposure to sound sources would also be accompanied by physical disturbances (e.g., aircraft approaching). The exceptions are for generally higher intensities of sound occurring more often in the airfield environment and highest intensities of sound occurring occasionally in or near the Chesapeake Bay Water Range where terrestrial and estuarine animals may be impacted, respectively. Whereas masking is possible in the airfield environment for terrestrial animals, there is likely some degree of habituation to the consistently elevated noise. The occasional low-altitude sonic booms, weapons firing, and active sonar (dipping sonar) in or near the Chesapeake Bay Water Range may have more of an effect on estuarine animals (e.g., sturgeon, sea turtles, water birds, marine mammals), but the effect would be limited to temporary behavioral or stress responses to the noises. There are also avoidance and mitigation measures in place with these activities that should prevent any harmful disturbance to surface-visible marine animals (e.g., sea turtles, marine mammals).

Summary conclusions for species and habitats with special regulatory designations are provided below, based on analysis details for Alternative 2 in Sections 3.4.4 through 3.4.7 (Federal Endangered Species Act – Biological Assessments through Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). The qualitative conclusions presented in these sections are not meaningfully different when applied to the No Action Alternative and analysis endpoints for NEPA, as described in Sections 3.4.3.2 and 3.4.3.3 (Alternative 1 Potential Impacts and Alternative 2 (Preferred Alternative) Potential Impacts, respectively). Furthermore, any reduction in proposed sound-producing activity would not change the regulatory determinations from the Preferred Alternative due to the similarity of alternatives and qualitative nature of the regulatory analysis.

Sea Turtles and Sturgeons

The four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) and two sturgeon species (shortnose and Atlantic sturgeon) present in the PRC Study Area may be exposed to a variety of acoustic stressors from sonars, vessels, aircraft, and non-explosive munitions and other MEM. Exposure to these acoustic stressors, with the exception of the sonars and other transducers, are within the hearing range of sea turtles and sturgeon. Sea turtle and sturgeon hearing is limited in range and sensitivity and they may only sense sounds substantially less than 2 kHz or 1 kHz, respectively. Therefore, sea turtles and sturgeon are unlikely able to detect sonar and other transducers that operate in the mid-frequency range, which are covered by the No Action Alternative, and hearing loss, physiological stress, and behavioral responses to those sources are not expected. Additionally, in order for masking to occur, sea turtles and sturgeon would need to hear the sonar transmissions. Because sea turtles and sturgeon hear only low-frequency sound, acoustic masking effects from the sonar and other transducers would not affect them.

Behavioral reactions, startle reactions, and physiological stress due to noise produced by aircraft (including hovering helicopters), vessels, and non-explosive munitions and other MEM are likely to be brief and minor, if they occur at all. Impacts to even individual sea turtles or sturgeon would be discountable as they are highly unlikely to occur or rise to the level of measurable impacts as suggested by the analyses presented in Section 3.4.4.1 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction) for a greater quantity of proposed activity. Because impacts, if any, are expected to be minor and limited, no long-term consequences for the population of sea turtle and sturgeon species present in the PRC Study Area are expected.

Eastern Black Rails, Red Knots, and Tiger Beetles

The analysis and conclusions for uncommon/specialist animals living mostly away from both the airfield environment and Chesapeake Bay Water Range also applies to eastern black rails (a wading bird), red knots (a shore bird), and tiger beetles (nearshore terrestrial insect). The localized and infrequent acoustic stressor on these species from the No Action Alternative would be limited to aircraft overflights and distant water-based assets and weapons firing/impact noise that are even less frequent. The insect's antennas are also not sensitive to distant noises. No long-term consequences for the population of eastern black rails, red knots, or tiger beetles are expected from these acoustic stressors under even a maximum of proposed activity (refer to Section 3.4.4.2, Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction, for analysis details).

Marine Mammals

The five species of marine mammals (bottlenose dolphin, harbor porpoise, harbor seal, humpback whale, and West Indian manatee) present in the PRC Study Area may be exposed to a variety of acoustic stressors from sonars, vessels, aircraft, and non-explosive munitions and other MEM. Exposure to these acoustic stressors, including sonars and other transducers, are within the hearing range of these marine mammals. The hearing of marine mammals present in the PRC Study Area is sensitive to mid-frequency underwater sounds that may be detected at great distances from the source. Therefore, these marine mammals are likely to detect sonar and other transducers that operate in the mid-frequency range, which is covered by the No Action Alternative. However, hearing loss, physiological stress, and behavioral responses to those sources are not expected due to the effectiveness of mitigation measures that are in place (e.g., surface visibility of animals combined with large mitigation zones watched by trained observers from helicopter platforms) as well as other factors (e.g., seasonal occurrence of dolphins, rarity of other marine mammals, rarity of dipping sonar events). The potential for masking at greater distances is possible, but negligible considering the very temporary duration of high intensity mid-frequency sonar sounds.

Behavioral reactions, startle reactions, and physiological stress due to noise produced from aircraft (including hovering helicopters), vessels, and non-explosive munitions and other MEM (i.e., weapons firing/impact noise) are likely to be brief and minor, if they occur at all. Impacts to relatively rare marine mammals would be discountable as they are highly unlikely to occur or rise to the level of measurable impacts as suggested by the analysis in Section 3.4.5 (Marine Mammal Protection Act – Biological Assessment) for a greater quantity of proposed activity. Because impacts, if any, are expected to be minor and limited, no long-term consequences for the population of marine mammals species present in the PRC Study Area are expected.

Estuarine Vegetation and Shellfish Beds

Sounds generated by the No Action Alternative would not affect estuarine vegetation EFH because plants do not possess the structures necessary for hearing. However, estuarine invertebrates including shellfish bed species (e.g., oysters, mussels) may detect low-frequency sounds generated by the No Action Alternative (e.g., weapons firing noise, sonic booms). Whereas responses of shellfish bed species to noise are not well documented, the highest intensity underwater noises they may experience could result in temporary shell closure, particular around Hannibal Target with weapons firing and supersonic weapons separation testing. Shellfish bed larvae looking for substrate may also prematurely settle in response to mid-frequency sonar sounds, but there are many factors weighing against any meaningful response. In either case, the exposure to potential stressors would be highly infrequent and localized. Other sources of underwater sounds, such as subsonic aircraft and vessel noise, are even less impactful on shellfish beds because they rise and fall slowly at lower intensities.

Impacts to shellfish bed EFH would therefore be insignificant as they are highly unlikely to rise to the level of measurable impacts as suggested by the analysis in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment) for a greater quantity of proposed activity. Because impacts, if any, are expected to be minor and limited, no long-term consequences for the population of shellfish bed species present in the PRC Study Area are expected.

Physical Disturbance and Strike

A potential impact on plants and animals from disturbance or strike associated with Proposed Action alternatives depends on the interplay of the following aspects: (1) stressor characteristics (e.g., distribution, size, speed) (Section 3.0.2.3.2, Identifying Stressors for Analysis, Physical Disturbance and Strike Stressors) and (2) response of the individual organism and populations (e.g., distribution/density, displacement, physiological stress, injury). Other than damage to tissues or disturbance to habitat, plants do not response behaviorally to physical disturbance or strike. The remainder of this section will therefore be focused on animals

Prior to being struck, some animals sense a pressure wave through the water and respond by remaining in place, moving away from the object, or moving toward it. A physical pressure wave differs from sound pressure in that it is measured in terms of distance and direction. As such, a disturbance could be measured in terms of both sound pressure and displacement (i.e., particle motion). An animal that is displaced a small distance, because of movements generated by an object falling into nearby waters, would likely continue with no response. However, other animals could be disturbed and may exhibit a generalized stress response. An animal can also detect an approaching object by the sight of it, given the medium is transparent (e.g., clear water). If the object actually hits the animal, direct injury in addition to stress may result. The function of the stress response in vertebrates is to raise the blood sugar level rapidly, to prepare the organism to flee or fight. This generally adaptive physiological response can become a liability if the stressor persists and the organism cannot return to its baseline physiological state.

Most animals would respond to sudden physical approach or contact by darting quickly away from the stimulus. Other species may respond by freezing in place or seeking refuge. In any case, the individual must stop whatever it was doing and divert its physiological and cognitive attention to responding to the stressor. The energy costs of reacting to a stressor depend on the specific situation, but in all cases, the caloric requirements of stress reactions reduce the amount of energy available to the individual for other functions such as predator avoidance, reproduction, growth, and metabolism. For example, a disturbance stressor can result in abnormal behavioral, growth, or reproductive impacts in nesting birds and can cause foraging and nesting birds to flush from or abandon their habitats or nests (Andersen et al., 1989; Komenda-Zehnder et al., 2003).

The ability of an animal to return to what it was doing following a physical strike (or near miss resulting in a stress response) is a function of fitness, genetic, and environmental factors. Some organisms are more tolerant of environmental- or human-caused stressors than others are and become acclimated more easily. Within a species, the rate at which an individual recovers from a physical disturbance or strike may be influenced by its age, sex, reproductive state, and general condition. An animal that has reacted to a sudden disturbance by swimming at burst speed would tire after some time; its blood hormone and blood sugar levels may not return to normal for 24 hours. During the recovery period, the animal may not be able to attain burst speeds and could be more vulnerable to predators. If the individual were not able to regain a steady state following exposure to a physical stressor, it may suffer depressed immune function and even death.

Alertness, mobility, resilience (in terms of body and substrate hardness), and association with protective structures are relevant to physical disturbance and strike. Most of the estuarine invertebrates in Table 3.4-2 are sedentary or slow-moving, with hard shells, and sensory systems that respond to only short-range threats detected by touch and/or primitive visual stimuli. Even the relatively fast invertebrates (e.g., blue crabs, mantis shrimp) are slow, compared to fishes. With the exception of burrowing invertebrates (e.g., worms, clams) and heavily armored horseshoe crabs (*Limulus Polyphemus*), most benthic invertebrates gravitate to structural or tidal refuges found mostly in shallower water in estuarine environments. The pelagic invertebrates are typically either microscopic (e.g., zooplankton) or spherical masses of gelatinous material (e.g., jellyfish), though a small squid species may also be found during period of high salinity in the upper Bay. All the flying and ground insects in Table 3.4-3, as well as most other terrestrial invertebrates (e.g., slugs, spiders, snails), are generally smaller and less resilient than hard-shelled benthic invertebrates. Butterflies, moths, and beetles are active/mobile but mostly slow compared to predatory reptiles, birds and mammals. Dragonflies and bees are somewhat faster and more evasive than butterflies, moths, and beetles.

In general, fish are more alert and mobile than aquatic invertebrates. The majority of fishes in Table 3.4-4 forage in and around structures or in the open water throughout the Bay portion of the PRC Study Area. However, there are some species that gravitate to structural refuge (e.g., oyster toadfish, gobies, blennies, skilletfish) that occur mostly in shallower waters of the Bay (wetland margins, seagrass beds, oyster beds/reefs, artificial structures) with the exception of Hooper Target complex. Many predatory species are also attracted to structures, but more as foraging/ambush habitat (e.g., striped bass, bluefish, flounder, sea trout, cobia). In general, most amphibians and reptiles are not fast moving species and may be subject to strike by even slow-moving assets or MEM. Birds are generally highly alert to perceived threats and mobile, though association with physical structure depends on the species (e.g., forest versus open field dwellers). Bats and terrestrial/freshwater mammals are generally highly alert to perceived threats and mobile, though association with physical structure depends on the species (e.g., forest versus open field dwellers).

The intense noise often associated with close-range physical disturbances from mobile air-, water-, and land-based assets has a combined effect on other air-breathing animals (e.g., aerial and terrestrial animals, estuarine turtles, birds) that was covered sufficiently under the acoustic stressor section. This approach is supported by numerous studies reported in the acoustic stressor section where acoustic effects on wildlife were confounded by associated physical disturbance effects. The analysis for air-breathing animals therefore focuses on the potential for actually striking an animal. Both potential for disturbance and strike is covered for estuarine invertebrates and fishes under for the water-based asset and MEM sub-stressors because the acoustic and physical disturbance stressors are somewhat disconnected due to low water clarity in the Chesapeake Bay.

Impacts Analysis (Physical Disturbance and Strike)

This section analyzes the potential impacts on biological sub-resources from physical disturbance and strike stressors associated with the No Action Alternative (Table 3.4-1). The analysis includes potential impacts from the following: (1) air-based assets, (2) water-based assets, (3) land-based assets, and (4) non-explosive munitions and other MEM. Refer to Section 3.0.2.3.2 (Identifying Stressors for Analysis, Physical Disturbance and Strike Stressors) for details supporting characterizations of the physical disturbance and strike stressor in this section.

Impacts from Air-Based Assets

This section covers only the physical strike aspect of air-based assets on aerial animals (invertebrates, bats, and birds) with the exception of aerial target crashes; the crash of aerial targets in the water is analyzed under the potential impacts of non-explosive munitions and other MEM. Estuarine and terrestrial animals are unaffected by the physical disturbance or strike potential of air-based based assets (while in the air), and will not be discussed further. The impact of ground-based aircraft on plants and animals is covered under the land-based assets section.

The BASH program described in Section 2.5 (Standard Operating Procedures Included in the Proposed Action) focuses on preventing aircraft striking birds and other large wildlife species that are far less abundant and prolific than common terrestrial/aerial invertebrates. However, the BASH program endeavors to discourage features of the airfield landscape that may attract birds and other wildlife, such as habitats that concentrate invertebrate food resources. Aerial invertebrates that are not migrating at higher altitudes generally avoid expanses of open water during the day where they are more exposed to aerial predators and high winds (refer to the Affected Environment for Invertebrates section for supporting details). Considering typical flight altitudes for manned and unmanned aircraft described for the No Action Alternative, the potential for striking aerial invertebrates is mostly limited to just above runways, where the frequently disturbed habitat is mostly unattractive to them. Even for common insects struck above runways, their overall populations would be unaffected by relatively minor and localized losses from aircraft strikes. The population of uncommon/specialized insects would likely be unaffected by aircraft, due to lack of coincidence with their preferred habitats combined with their relatively low abundance.

Approximately 97 percent of the reported civilian aircraft-wildlife damaging strikes from 1990 to 1999 involved common, large-bodied birds or large flocks of small birds. The Federal Aviation Administration reported that almost 70 percent of these events involved gulls, waterfowl, and raptors (Federal Aviation Administration, 2003). Bird-aircraft strikes are a serious concern for the Navy because these incidents can result in injury to aircrews as well as damage equipment and injure or kill birds (Bies et al., 2006). From 2008 to 2018, the BASH program for the PRC reported between 9 and 28 bird strikes per year (averaging 10 strikes/year) by aircraft taking off or landing at NAS Patuxent River and OLF Webster (Naval Safety Center, 2019). A wide range of birds were struck, including representatives of all bird types described in the Affected Environment for Birds section, though the identity of numerous impacted birds was unknown. The vast majority of strikes were on NAS Patuxent River. While bird strikes can occur anywhere aircraft are operated, Navy data indicate that they occur most often within the airfield environment (i.e., over land or close to shore) (U.S. Department of the Navy, 2019d). Dolbeer (2006) reports that about 90 percent of aircraft-bird strikes occur on or near airports, when aircraft are below altitudes of 3,500 feet. Bird strike potential is greatest in foraging or resting areas, in migration corridors at night, and at low altitudes during the periods around dawn and dusk. For example, birds can be attracted to airports where foraging and nesting resources are present. There is no evidence of any local or population-level impacts to any bird species, including raptors, due to bird/aircraft collisions or disturbance from flight activities (Rambo, 2021b). All available survey data from bald eagle aerial surveys to recent Breeding Bird Atlas works indicate stable or even increasing numbers of most, if not all, raptor species.

Considering approximately 95 percent of bird flight during migration occurs below 10,000 feet, with the majority below 3,000 feet (U.S. Geological Survey, 2006), less than half of aircraft flights associated with the No Action Alternative present disturbance and strike hazards for most birds because most flights take place at greater than 3,000 feet. Fixed-wing aircraft encounters with birds are also more likely to occur during aircraft takeoffs and landings than when the aircraft is engaged in low-level flight (greater than 600 feet AGL). In a study that examined 38,961 bird and aircraft collisions, Dolbeer (2006) found that the majority (74 percent) of collisions occurred below 500 feet. However, collisions have been recorded at elevations as high as 12,139 feet (Dove & Goodroe, 2008). The potential for bird strikes in the airspace outside of the airfield environment is relatively low because Navy activities are widely dispersed and mostly above 3,000 feet (for fixed-wing aircraft) where bird densities are low.

For military rotary-wing aircraft, wildlife strikes happened most frequently when the aircraft were traveling en route (flying [moving forward] at an altitude greater than 1,000 feet AGL) or were engaged in terrain flight (flying at an altitude less than 1,000 feet AGL), as opposed to (1) hovering (off the ground at less than 1,000 feet AGL and stationary), (2) on approach (in the early stages of the landing process at greater than 100 feet AGL and moving forward), (3) landing (the final stages of landing at less than 100 feet AGL), (4) taxiing (moving along the ground or at less than 10 feet AGL, in transition from one part of the airport to another), (5) taking off (leaving the ground and ascending upward at less than 100 feet AGL), or (6) climbing out (for rotary-wing aircraft in the later stages of taking off at greater than 100 feet AGL) (Washburn et al., 2014). Helicopter flights also occur closer to the shoreline where sheltering, roosting, and foraging birds occur. Helicopters can hover and fly low, and would sometimes be used to suspend or tow in-water devices (e.g., Airborne Mine Neutralization System [AMNS]–suspended, Organic Airborne and Surface Influence Sweep [OASIS]–towed) at relatively slow speeds. This combination would make helicopter bird strikes somewhat more likely than for fixed-wing aircraft.

In addition to manned aircraft and large UAS, smaller UAS (including aerial targets) could also incur a bird strike; however, evidence from returned aerial targets indicate the probability is relatively low. In a bird strike study for the Navy and U.S. Air Force, geese were the most hazardous group to aircraft, followed by other large-bodied birds, based on the number of bird strikes reported (Pfeiffer et al., 2018). These species groups occur within the PRC Study Area, but are generally found in nearshore areas (Mowbray et al., 2002; Shields et al., 2002). Considering the very low percentage of smaller UAS flight hours relative to that of manned aircraft, and their generally slower speed, there is likely a negligible effect of smaller UAS strikes on bird populations.

According to BASH reports from the last 50 years, there has only been one confirmed bat strike at NAS Patuxent River, which occurred in 2012 during a helicopter approach to landing. Two additional unconfirmed but suspected bat strikes have occurred; one occurred in 1986 during an aircraft platform-testing event (Naval Safety Center, 2019), and another in 2016 when a bat was found dead during a morning runway walk to identify foreign objects or debris (Smith J. , 2020c). There have been no accounts of bat strikes at OLF Webster (Naval Safety Center, 2019). According to a study of the wildlife strike records from all military branches of DoD (from 1990 to 2011), bats are far less likely to be struck by aircraft than birds. Bats accounted for only 9 percent of the wildlife group struck, while birds accounted for the remaining 91 percent (Washburn et al., 2014). Among wildlife groups most commonly struck on the airfield, bats accounted for 6 percent of strikes, and off the airfield they accounted for 10 percent of strikes (Washburn et al., 2014). Data compiled by the Federal Aviation Administration, reporting damage or adverse effects on civilian U.S. aircraft or flights due to wildlife, identified only four strikes to bats over a nine-year span (from 1990 to 1999) (Federal Aviation Administration, 2003).

As fixed-wing aircraft flying en route to a destination would typically be at a much higher altitude than rotary-wing aircraft and consequently above the airspace (and altitudes) typically used by bats during their normal foraging flight patterns (as explained above in the Affected Environment section), rotary-wing aircraft are more likely to strike bats than fixed-wing (Washburn et al., 2014). For military rotary-wing aircraft in the DoD study (1990 to 2011), wildlife strikes happened most frequently when the aircraft were traveling en route (flying [moving forward]) at an altitude above 1,000 feet AGL); or were engaged in terrain flight (flying at an altitude below 1,000 feet AGL), as opposed to: (1) hovering (off the ground at less than 1,000 feet AGL and stationary); (2) on approach (in the early stages of the landing process at above 100 feet AGL and moving forward); (3) landing (the final stages of landing below 100 feet AGL); (4) taxiing (moving along the ground or below 10 feet AGL, in transition from one part of the airport to another); (5) taking off (leaving the ground and ascending upward below 100 feet AGL); or (6) climbing out (for rotary-wing aircraft in the later stages of taking off above 100 feet AGL) (Washburn et al., 2014).

Bats are typically nocturnal and would likely only be struck by aircraft during flight activities occurring between dusk and dawn. While strikes to birds are more likely to occur in the morning and during the aircraft takeoff phase, strikes to bats are more likely to occur during early evening and while an aircraft is landing (Parsons et al., 2008). PRC restricted airspace is normally activated between 7:00 am and 11:00 pm, although about 97 percent of sorties are flown between 7:00 am and 10:00 pm. The highest level of activity occurs at midmorning with a lull at midday and slight increase in mid-afternoon. While night operations can occur after 10:00 pm, almost no operations begin after midnight. The timing of aircraft operations during daytime hours substantially reduces the likelihood that bats will be in the area when aircraft are operating at their highest frequency. Additionally, as explained further in the acoustic stressor analysis, the likelihood of bats foraging in areas close to aircraft is low because as researched by Schaub et al. (2008), bats will avoid foraging areas with particularly loud background noise. Lastly, all of the bats that could be present in the PRC Study Area are inactive (hibernate) in the winter when prey is scarce and, with the exception of eastern red bats, migrate out of the area to overwinter in the south or in hibernacula in locations outside of the PRC Study Area.

Impacts from Land-based Assets

This section covers only impacts of land-based assets on aerial and terrestrial animals (Table 3.4-1). The impact of land-based assets on most aquatic animals and water birds is discountable because of the lack of close proximity to associated stressors. The vast majority of vehicle use is associated with aircraft operations on the airfield, which is managed to reduce wildlife habitat. BASH program initiatives to discourage wildlife in the airfield environment may also discourage invertebrate food sources (details in Section 2.5, Standard Operating Procedures Included in the Proposed Action). Each installation also implements best management practices in accordance with the INRMP, which further reduce the potential for strike. These measures include managing species and habitats within the constraints of the military mission and balancing population levels with habitat carrying capacity (U.S. Department of the Navy, 2017c). In accordance with established avoidance/mitigation measures, all land-based assets would be limited to previously disturbed sites, such as airfields, roadways, or developed open space (e.g., mowed areas) where installation natural resources staff have determine there are no sensitive species (e.g., threatened or endangered species). In general, these frequently disturbed locations do not have high plant or animal biodiversity due to a lack of preferred natural habitats such as forested areas and freshwater wetlands. Ground-support vehicles and grounded aircraft moving in the airfield environment are also mostly slow and less likely to strike significant numbers of common/generalist species likely present in the airfield environment.

Whereas uncommon/specialist species could be present in the airfield environment and moving between relatively small and undisturbed habitats in the airfield environment could be struck by proposed vehicle use, the probability is low given the rarity of undisturbed habitat and the associated species. Road mortality would depend in part on the relative size and speed of the vehicle and the behavioral reaction of each species. Animal behavior, time of year, time of day, and weather conditions could play a role the species and number of individuals potentially struck. Certain species have periods of increased mobility because of breeding or feeding. It is possible that some animals could be struck by moving vehicles transiting a roadway; however, ground support vehicles are mostly limited to the airfield environment where crossing roads between suitable habitats is mostly not required (Figure 3.4-1), which makes a strike at high speed improbable.

Invertebrates likely detect the approach of a vehicle or grounded aircraft at very close ranges that would preclude avoidance if the vehicle is moving fast. Amphibians and reptiles likely detect approaching vehicles, but most are unable to respond quickly enough to avoid being struck. Most mammal species are expected to be able to detect approaching aircraft or vehicles and move into a protected location, such as a burrow or vegetative cover, but occasionally are unable to respond quickly enough to avoid being struck. BASH reports from November 2008 to November 2018 indicate mammals are rarely struck by aircraft, with a total of five reports in 10 years (three deer, one coyote, and one woodchuck) (Naval Safety Center, 2019). Strike of birds by aircraft are included in the air-based asset discussion.

There is also some occasional clearing of vegetation on previously established helicopter landing zones around Harper's and Pearson Creeks (Figure 3.4-3). Common and resilient species of terrestrial vegetation (e.g., warm-season grasses) and animals may be temporarily disturbed, but the disturbance would be infrequent and localized, such that no significant population-level effects are likely. The clearing is actually conducted by installation natural resources staff to ensure there are no sensitive species impacted. To address potential impacts (e.g., sediment compaction) on diamondback terrapin nesting in these locations, established avoidance and mitigation measures (Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) require the closing and use of only one of two beach landing zones during diamondback terrapin nesting and hatching season (May to September). Fencing is placed around the active landing zone to prevent terrapins from nesting in the area. Furthermore, terrapin nest surveys are conducted within landing zones each season.

Vessel beaching on installation shorelines is also possible, but it would be mostly limited to vessel basins/ramp areas. The vast majority of water-based activity would be confined to navigation channels and the deeper waters of the Chesapeake Bay Water Range. The potential locations for vessel beaching, apart from established ramps, are either not available (OLF Webster) or permitted after verification that location is devoid of sensitive species (Bloodsworth Island Range, NAS Patuxent River).

Impacts from Water-Based Assets

This section only covers physical disturbance and strike stressors associated with water-based assets on estuarine animals (e.g., invertebrates, fishes, turtles) and water birds. Both disturbance and strike are included in this analysis because there are stationary or slow-moving assets that are not associated with elevated noise levels (e.g., bottom devices). The physical disturbance and strike impact of water-based assets on estuarine plants (e.g., seaweed, seagrass) is covered in Section 3.4.7 (Magnuson Stevens Fishery Conversation and Management Act – Essential Fish Habitat Assessment). The impact of vessels and in-water devices on aerial invertebrates, bats, and terrestrial animals is discountable because of either lack of coincidence (terrestrial animals/freshwater) or typical avoidance of open-water habitats at low altitudes when most water-based activity is occurring (aerial invertebrates and bats). Aerial invertebrates and bats are relatively rare over these areas during the day (refer to the Affected Environment for Invertebrates section for supporting details). Bats are typically nocturnal and would likely only be exposed to water-based activities that typically occur between dawn and dusk. The mostly day time hours of activity substantially reduce the likelihood that bats would be impacted by water-based assets, as described in detail in the air-based asset analysis.

Vessels and mobile in-water devices could impact adults and other life stages of estuarine animals by directly striking organisms, or by disturbing the water column or sediments. Macroscopic species or life stages that occur at or near the surface (e.g., jellyfish, swimming crab, brief squid, pelagic fishes, turtles, water birds, marine mammals) would potentially be exposed to direct strikes, and especially so, for species that are relatively abundant. However, higher abundances of some species such as common jellyfish species (e.g., sea nettles) in the Bay are an indicator of human-altered food webs (Richardson et al., 2009) and impacts to them could be considered beneficial. Exposure to propeller-generated turbulence was found to result in mortality in a microscopic invertebrate species (the copepod [*Acartia tonsa*]) located near the surface (Bickel et al., 2011). Many zooplankton (including larger invertebrate larvae) also move away from the surface during the day, reducing potential exposures during mostly daytime vessel and in-water device operations. Zooplankton and fish larvae are also very small and highly abundant in the pelagic or demersal water column and typically experience naturally high growth and mortality rates (Nybakken, 1993). Vessels and in-water devices operating at high speeds also have a hydrodynamic interface with the water that allows tiny pelagic invertebrates, larger gelatinous invertebrates, and fish larvae to flow around them. However, a vessel's propeller movement or propeller wash could entrain early life stages of some fish species.

Vessels and mobile surface targets do not normally collide with adult fishes, most of which can detect and avoid collisions. One study on Barents sea capelin (*Mallotus villosus*) behavioral responses to vessels showed that most adults exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jørgensen et al., 2004), reducing the potential for vessel strikes. Misund (1997) found that fishes, such as Polar cod (*Boreogadus saida*), haddock (*Melanogrammus aeglefinus*), jack mackerel (*Trachurus symmetricus*), sardine (*Sardina pilchardus*), herring, anchovy (*Engraulis ringens*), and capelin, that were ahead of a ship showed avoidance reactions, and did so at ranges of 14 to 1,148 feet (50 to 350 meters). When the vessel passed over them, some fishes had sudden avoidance responses that included lateral avoidance or downward compression of the school. Conversely, Rostad et al. (2006) observed that some fishes are attracted to different types of vessels (e.g., research vessels, commercial vessels) of varying sizes, noise levels, and habitat locations. However, the attraction was related to disposal of bycatch and other aspects that would not be associated with PRC assets. Diamondback terrapins in the water likely detect approaching vessels (including unmanned surface targets), but do not typically exhibit avoidance behaviors (Lester, 2013; Lester et al., 2012). However, it is not known at what point or through what combination of stimuli (visual or acoustic) a diamondback terrapin becomes aware of a vessel or other potential physical disturbances prior to reacting or being struck. Strikes of diamondback terrapin could cause permanent injury or death from bleeding or other trauma, paralysis and subsequent drowning, infection, or inability to feed or reproduce.

Based on the general alertness/reactions of birds described under the stressor introduction, direct collisions with most surface vessels (targets and non-targets) are unlikely but may occur, especially at night. Lighting on boats and vessels has also contributed to bird fatalities in open-water environments when birds are attracted to these lights, usually in inclement weather conditions (Merkel & Johansen, 2011). Birds can become disoriented at night in the presence of artificial light (Favero et al., 2011; Hamilton III, 1958; Hyrenbach, 2001; 2006), and lighting on vessels may attract some birds, increasing the potential for harmful encounters. Some Navy vessels are minimally lighted for tactical purposes. For vessels of this type, there are two white lights that shine forward and one that shines aft; these lights must be visible for at least 6 nautical miles (nm). A single red and a single green light are located on the port and starboard sides of vessels, respectively. These lights are visible for a minimum of 3 nm. Solid white lighting appears more problematic for birds, especially nocturnal migrants (Gehring et al., 2009;

Poot et al., 2008). Navy vessel lights are mostly solid but sometimes may not appear solid because of the constant movement of the vessel (wave action), making vessel lighting potentially less problematic for birds in some situations. Other than direct strike potential, birds respond to moving vessels in various ways. Some birds, including certain species of gulls and sea birds commonly follow vessels; while other groups such as shorebirds seem to avoid vessels (Borberg et al., 2005; Hyrenbach, 2006). There could be a slightly increased risk of impacts during the winter or fall/spring migrations when migratory birds use celestial clues during nighttime-flight navigation and are concentrated in coastal areas. However, despite this concentration, most birds would still be able to avoid collision with a vessel.

The potential for vessels and in-water devices to disturb estuarine animals on or near the bottom would be limited to shallow areas around the margins of the Chesapeake Bay Water Range (85 to 90 percent) and elsewhere in the PRC Study Area (10 to 15 percent). Most high-speed operations are also localized in the Chesapeake Bay Water Range and they typically avoid contact with the bottom, in order to prevent potential damage to the asset. There are also minimum safe operating depths and standard operating procedures that should keep vessels and in-water devices away from many shallow-water habitats where most estuarine animals are concentrated. Whereas vessel beaching on installation shorelines is possible, it would be mostly limited to vessel basins/ramp areas. The vast majority of water-based activity would be confined to navigation channels and the deeper waters of the Chesapeake Bay Water Range. The potential locations for vessel beaching, apart from established ramps, are either not available (OLF Webster) or permitted after verification that location is devoid of sensitive species (Bloodsworth Island Range, NAS Patuxent River). There is a very low potential that freshwaters mammals visiting the nearshore estuarine environment (e.g., river otter, raccoon) may encounter a slow-moving vessels approaching a vessel basin/ramp area. Freshwater mammals could easily avoid such slow-speed vessel movement and would be unlikely to encounter high-speed vessel movement mostly limited to deeper waters of the Bay.

Small vessels and underwater devices operating in shallow-water environments, including navigation channels, can also create localized plumes of suspended sediment, where the force of propulsion systems disturb areas of soft bottom. Water-based propulsion system effects on the bottom depend on the asset size and speed, depth of water, and substrate type. Beachler and Hill (2003) showed that disturbance of the substrate was greatest at speeds around 10 miles per hour, with diminishing disturbance at both slower and faster speeds. According to the equations in Beachler and Hill (2003), a 25-foot vessel (representative) proposed with the No Action Alternative, moving at a slow speed (10 knots), would disturb the bottom substrate the most at a depth less than 13 feet (4 meters). Considering the vast majority of the Chesapeake Bay Water Range is greater than 13 feet (4 meters) deep (and mostly greater than 8 meters [26 feet] deep, Figure 3.4-4), it is reasonable to predict there would be very little disturbance of the bottom where the majority of vessel operations are conducted. Episodic turbidity in shallow water is naturally occurring with storms and high-wind events, whereas chronic turbidity is a regulated pollutant (Section 3.3, Water Resources and Sediments). Along low-energy shorelines in sheltered inshore waters, the force of vessel wakes can also result in elevated erosion and resuspension of fine sediment (Zabawa & Ostrom, 1980). In both cases, the disturbed sediment would settle back on or near the location of disturbance, depending on the strength and direction of the winds and currents.

Only vessel basins may be subject to chronic disturbance from vessel wakes from the No Action Alternative. Few sources of information are available on the impact of even chronic vessel disturbance to benthic animals. One study of seagrass-associated marine invertebrates, such as amphipods and polychaete worms, found that chronic disturbance from vessel wakes resulted in the long-term displacement of some marine invertebrates from the impacted shallow-water area (Bishop, 2008). Studies of shallow freshwater areas found that waves generated from small boats caused about 10 percent of benthic invertebrates (e.g., amphipods) to become suspended in the water column, where they presumably would be more vulnerable to predation (Bilkovic et al., 2017). Resuspension of sediment can also smother sedentary invertebrates, while turbidity may affect respiratory organs or impair the ability of filter-feeding invertebrates and fishes to obtain food (e.g., by clogging their feeding structures or diluting the amount of food in the surrounding volume of water).

The physical disturbance and strike potential for in-water devices is relatively low compared to surface vessels and mobile surface targets; even torpedo-shaped in-water devices are typically slower and quieter than surface vessels, and they have propeller guards. And although in-water devices may be used closer to the bottom in deeper water, they are generally smaller than surface vessels and not likely to disturb benthic animal populations that are concentrated in shallower water during the growing season, as described in the Affected Environment section. An exception is possible with remote-operated vehicle demonstrations in the various basins on NAS Patuxent River; some of these devices (e.g., remote operated vehicles) may operate in the water column or land on the bottom in shallow-water environments that are already altered and frequently disturbed (e.g., pier-side in basins). Most of these devices do not have a realistic potential to strike highly mobile estuarine animal or diving birds because they either move slower than surface vessels (e.g., most in-water devices) or are closely monitored by observers manning the towing platform (e.g., most towed devices) who ensure the towed in-water device does not run into objects in the water that could damage the equipment.

Placement or deployment of bottom devices could also cause disturbance, injury, or mortality to sedentary or slow-moving estuarine invertebrates within the footprint of the device (e.g., worms, clams). Impacts to populations of sedentary or slow-moving invertebrates would be inconsequential because the area exposed to the stressor is extremely small relative to the area of both suitable and occupied habitats. Stationary bottom devices pose little threat to highly mobile organisms (e.g., crabs, fishes, turtles, water birds, marine mammals) with the exception of unsuspecting individuals that might be struck as a device settles on the bottom. The deployment is also associated with greater disturbance from the associated vessel. Moreover, none of the bottom devices presents a trapping threat to estuarine animals, as would a crab pot, which is the primary cause of terrapin death in the water. As a result, it is unlikely that there will be impacts (physical strike or accidental capture) to the estuarine animal in the unlikely event of a coincidence.

The very limited testing of bottom crawlers (small and slow-moving) represents the only water-based propulsion system that does not involve propellers or surface towing. However, the typical bottom crawler is too small/light and slow-moving (e.g., C-TALON) to pose a meaningful threat to highly mobile or common animal populations and less common animal species would likely never encounter a bottom crawler. In addition, the activity of bottom devices is generally localized and infrequent such that few individuals would likely be exposed to more than one event occurring primarily in the Chesapeake Bay Water Range. The organisms most frequently impacted would be burrowing soft-bottom invertebrates that are relatively resilient to localized sediment disturbance.

Bottom devices may also disturb benthic animals outside the footprint of the device, and would cause temporary and localized increases in turbidity and sedimentation near the bottom, along with some changes in scouring/deposition patterns in higher current areas with a soft bottom. Objects placed temporarily on the bottom may also attract benthic animals or provide temporary attachment points for sedentary invertebrate larvae (e.g., oyster spat) in soft bottom areas generally devoid of suitable structures (e.g., artificial reefs, shipwrecks, oyster beds). Sedentary invertebrates attached to the devices would be removed from the water when the devices are recovered. However, the number of individuals affected would likely be very small compared to overall population size. Some structure-oriented fishes are also attracted to virtually any tethered object in the water column for food or refuge (Dempster & Taquet, 2004), and could be attracted to a mine shape and associated anchoring system.

Impacts from Non-Explosive Munitions and Other Military Expended Materials

This section only covers impacts of MEM on estuarine animals (e.g., invertebrates, fishes, turtles) and water birds (Table 3.4-1). The impact of MEM on estuarine plants (e.g., seaweed, seagrass) is covered in Section 3.4.7 (Magnuson Stevens Fishery Conversation and Management Act – Essential Fish Habitat Assessment). The impact of MEM on aerial invertebrates, bats, and terrestrial animals is discountable because of either lack of coincidence (terrestrial animals) or typical avoidance of open-water habitats during the day (aerial invertebrates and bats). Aerial invertebrates and bats are relatively rare over these areas during the day (refer to the Affected Environment for Invertebrates section for supporting details). Bats are typically nocturnal and would likely only be exposed to water-based activities that typically occur between dusk and dawn. The mostly day time hours of activity substantially reduce the likelihood that bats would be impacted by water-based assets, as described in detail in the air-based asset analysis.

The areas of higher MEM deposition are generally located away from the shallow margins of the Chesapeake Bay, where benthic invertebrates, fishes, diamondback terrapins, and water birds are most abundant (refer to the Affected Environment section for supporting details). Physical disturbance or strikes by MEM on estuarine animals and water birds are possible at and above the water's surface, through the water column, and on bottom features in depths mostly greater than 26 feet (8 meters) where most munition concentration areas are located. Therefore, the discussion of MEM disturbance and strikes will focus on items impacting the surface waters and bottom features in a very limited area of the PRC Study Area. The potential impacts from MEM are mostly limited to regions of Chesapeake Bay Water Range, where the bottom is seasonally hypoxic and relatively low in terms of benthic habitat quality, as described in the Affected Environment section. The total annual footprint of MEM deposited and remaining exposed in the Chesapeake Bay Water Range is miniscule compared to the size of the range.

The maximum annual percent coverage of MEM in the water range is 0.0002 percent under the No Action Alternative (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis). The annual footprint of MEM in the munition concentration areas is also no greater than 0.0075 percent; the Hannibal Target munition concentration area also represents the location where higher quality habitat for estuarine animals and water birds (e.g., shell bottom in shallow area above seasonal hypoxia) coincides with the highest percent coverage of MEM, which is mostly gunfire rounds. The miniscule area of the MEM footprint on the bottom is further reduced to the extent munitions strike/embed in their target during testing and training scenarios. However, no permanent structures are actually fired upon in the Chesapeake Bay Water Range, though Hannibal Target may be used as a backstop for firing on temporary targets. Even when a mobile estuarine animal is present in the impact areas, they would likely flee the area after the initial strike of munitions, fired in rapid succession. Additionally, it is assumed that mobile estuarine animals would soon return to the area after such infrequent and localized disturbance. Most of this MEM will sink in the shifting sands around the target within about 90 days (Inman & Jenkins, 2002). These considerations are noteworthy when considering the potential impacts of disturbance and strike stressors on estuarine animals and water birds described in the following paragraphs.

Live-fired gun ammunition strikes the water surface with greater force, and sinks after penetrating for deadly force at most a few meters (Noonan & Steves, 1970). The depth of penetration was estimated for a bullet designed to penetrate in water. With the exception of bombs, other munitions (e.g., rockets, missiles) and MEM (e.g., marine markers, practice sonobuoys) that are dropped from high altitude are generally larger and less dense than bullets, suggesting somewhat slower speeds and less penetration in water before sinking. In addition to striking the surface, torpedoes and AMNS munitions, and other in-water devices may move through the water column at relatively slow speeds that are expected to do little more than displace planktonic invertebrate (e.g., zooplankton, jellyfish) and fish larvae or adjust the movement of larger, mobile animals. Therefore, the potential for disturbance and strike by MEM applies mostly to the surface and upper water column, where localized concentrations of pelagic and structure-oriented animals on artificial substrate (e.g., fixed targets) may be present. However, large fish seldom swim close enough to the surface for very long during daylight hours, to avoid avian predators (Safina & Burger, 1988; Clark et al. , 2003) and less than optimum combinations of temperature and dissolved oxygen (Kraus et al., 2015). Many zooplankton species also move away from the surface during the day (Nybakken, 1993). Only very localized concentrations of small phytoplanktivores (e.g., Atlantic menhaden, anchovies) would be commonly encountered at the water's surface during the day and mostly nearshore (Lankowicz et al., 2020). Upon striking the water surface, some pelagic and structure-oriented invertebrates and fishes could be injured or killed by munitions striking target areas, but would affect a relatively low number of individuals of likely common and prolific species. The miniscule footprint of MEM expended in the deeper waters of the Chesapeake Bay Water Range, coupled with the often patchy and nearshore distribution of water birds (Fauchald et al., 2002; Haney, 1986; Schneider & Duffy, 1985), suggest that the probability of these materials striking a water bird is also low.

Furthermore, human activity such as vessel or boat movement, aircraft overflights, and target placement could cause birds and mobile estuarine animals to flee a target area before the onset of firing, thus avoiding harm. Even when a water bird remains within an impact area, they would likely flee after the initial strike of munitions fired in rapid succession. The force of MEM also dissipates quickly once it hits the water, so direct strikes on birds foraging below the surface (and unaware of associated human activity) would not be likely. The bird would soon return to the area after such infrequent and localized disturbances. In the PRC Study Area where projectiles may be fired, only Hannibal Target has documented nesting habitat for peregrine falcons that could be disturbed by MEM striking the target. However, the potential for harming peregrine falcons on Hannibal is minimized by mitigation measures prohibiting firing within a half mile of Hannibal Target during the nesting season for peregrine falcons (Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization, for supporting details).

Once on the bottom, expended items could also cause increased turbidity that could affect filter-feeding benthic and pelagic species, although such impacts would be localized and temporary. Some MEM could also cause abrasion of a supporting structure or hard body part (e.g., shell, exoskeleton) through repeated impact to the same individual or structure. Abrasion would generally be associated with MEM such as flexible materials (e.g., wires/cables) that become fixed in a location for some time, but are moved repeatedly over sessile invertebrates by water currents. However, these impacts would generally cease when the MEM are incorporated into the bottom by natural encrustation or burial processes, or become otherwise immobilized.

Impact of Physical Disturbance and Strike Stressor (Summary)

The primary physical disturbance and strike potential comes from aircraft at low altitudes, with other assets and MEM being secondary. However, most exposure of flying animals to strike potential would be relatively brief as an aircraft transits low-altitude airspace in and around the airfield environment where animal activity is discouraged by BASH program initiatives. The potential for disturbance or strikes from water-based assets and MEM on mobile biological resources outside the airfield environment (e.g., estuarine animals) is relatively low compared to aircraft-related risks, due to either relatively slow speeds (e.g., in-water devices), localized and infrequent occurrence of the activities (e.g., vessels, MEM), and/or rarity of some affected species (e.g., sturgeon, sea turtles, marine mammals). Estuarine plants (e.g., marsh vegetation, seagrass beds) could be adversely affected by a relatively small number of mobile water-based assets operating outside the Chesapeake Bay Water Range, though such shallow-water hazards would typically be avoided. Disturbance of other estuarine habitat by MEM represents a miniscule portion of munition concentration areas in mostly the deeper waters of the Chesapeake Bay Water Range where the bottom is subject to seasonal hypoxia (low dissolved oxygen) that temporarily reduces life on the bottom. Proposed land-based activities that could disturb terrestrial plants and animals are localized and infrequent but limited to in and around the airfield environment or in other previously disturbed areas.

Summary conclusions for species and habitats with special regulatory designations are provided below, based on analysis details for Alternative 2 in Sections 3.4.4 through 3.4.7 (Federal Endangered Species Act – Biological Assessment through Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). The qualitative conclusions presented in these sections are not meaningfully different when applied to the No Action Alternative and analysis endpoints for NEPA, as described in Sections 3.4.3.2 and 3.4.3.3 (Environmental Consequences, Alternative 1 and Alternative 2, respectively). Furthermore, any reduction in proposed physical disturbance or strike-producing activity would not change the regulatory determinations from the Preferred Alternative due to the similarity of alternatives and qualitative nature of the regulatory analysis.

Sea Turtles and Sturgeons

The four species of sea turtles (green, Kemp’s ridley, leatherback, and loggerhead sea turtles) and two sturgeon species (shortnose and Atlantic sturgeon) that are present in the PRC Study Area may be exposed to a variety of physical disturbance and strike stressors from water-based assets such as vessels and in-water or bottom devices as well as non-explosive munitions and other MEM. No impacts are expected from stationary or slow-moving bottom devices. The way a physical strike and/or disturbance may affect a sea turtle or sturgeon would depend in part on the relative size and speed of the water-based asset or MEM, the location of the animal in the water column, and their behavioral reactions. The potential responses to a physical disturbance and strike stressor are varied, but include behavioral changes such as avoidance, altered swimming speed and direction, physiological stress, and physical injury or mortality.

Only a minority of proposed activities under the No Action Alternative involve vessels, unmanned underwater or surface vehicles, and MEM. As a result, potential impacts from water-based assets as well as non-explosive munitions and other MEM to individual sea turtles or sturgeon would be unlikely but not discountable as detailed in Section 3.4.4.1 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction). Potential impacts from water-based assets and MEM to individual shortnose sturgeon, due to their absence from the main stem of the Bay in the warmer months and preference for deep waters of the Bay during cooler months, and Atlantic sturgeon belonging to the New York Bight Distinct Population Segment (DPS) and Carolinas DPS, due to their rarity within the Bay, are not anticipated. However, Atlantic sturgeon belonging to the Chesapeake Bay DPS may be subject to vessel strikes. Because impacts, if any, are expected to be minor and limited, no long-term consequences for the population of sea turtle and sturgeon species present in the PRC Study Area are expected.

Eastern Black Rails, Red Knots, and Tiger Beetles

The analysis and conclusions for uncommon/specialist animals living mostly away from both the airfield environment and Chesapeake Bay Water Range also applies to eastern black rails (a wading bird), red knots (a shore bird), and tiger beetles (terrestrial shoreline insect). The localized and infrequent physical disturbance and strike stressors on the bird species from the No Action Alternative would be mostly limited to aircraft overflights. However, low-altitude flights over the Bloodsworth Island Range (containing large areas of relatively undisturbed habitat for both species) are limited to during winter or spring, which represents half the seasons in which eastern black rails and red knots may occur in the PRC Study Area. Coincidence of water-based assets with the shoreline where these rare species may occur is not expected because such activity is limited to vessel basins and ramps. No long-term consequences for the population of eastern black rails, red knots, or tiger beetles are expected from these physical disturbance and strike stressors under even a maximum of proposed activity (refer to Section 3.4.4.2, Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction, for analysis details).

Marine Mammals

The five species of marine mammals (bottlenose dolphin, harbor porpoise, harbor seal, humpback whale, and West Indian manatee) present in the PRC Study Area may be exposed to a variety of Physical Disturbance and Strike stressors from water-based assets such as vessels and in-water or bottom devices as well as non-explosive munitions and other MEM. No impacts are expected from bottom devices. The way a physical strike and/or disturbance may affect a marine mammal would depend in part on the relative size and speed of the water-based asset or MEM, the location of the animal in the water column, and their behavioral reactions. The potential responses to a Physical Disturbance and Strike stressor are varied, but include behavioral changes such as avoidance, altered swimming speed and direction, physiological stress, and physical injury or mortality.

Only a minority of proposed activities under the No Action Alternative involve vessels, unmanned underwater or surface vehicles, and MEM. As a result, potential impacts from water-based assets as well as non-explosive munitions and other MEM to individual marine mammals would be unlikely but not discountable, as detailed in Section 3.4.5 (Marine Mammal Protection Act – Biological Assessment). The bottlenose dolphin would be the most exposed to physical disturbance and strike stressors from water-based assets due to their relative abundance. However, bottlenose dolphins would likely be able to avoid potential interactions due to their speed and maneuverability. Harbor seals, harbor porpoise, humpback whales, and West Indian manatees may only be present seasonally and in such low numbers that the likelihood of encountering testing and training activities where physical disturbance and strike may occur is so low as to be discountable. Because impacts, if any, are expected to be minor and limited, no long-term consequences for the population of marine mammal species present in the PRC Study Area are expected.

Estuarine Vegetation and Shellfish Beds

Physical disturbance and strike potential from shallow-water activities associated with the No Action Alternative may affect both estuarine vegetation and shellfish bed EFH. The primary factors minimizing impacts from proposed activities include the shallow-water hazard coincident with the habitat and relatively low quantity of activities. Water-based assets and MEM that may present a disturbance or strike risk to estuarine vegetation and shellfish beds also operate in deeper waters of Chesapeake Bay Water Range where the habitat is absent or relatively scarce. Whereas some water-based assets may operate in shallow habitats/hazards outside of the Chesapeake Bay Water Range, the disturbance would be minor and typically avoided. With regard to disturbance from MEM, estuarine vegetation is located far from the deep-water locations where it is expended. However, shellfish beds located in the Hannibal Target area could be disturbed by MEM. Even in this case, the exposure to potential stressors would be highly infrequent and localized.

Impacts to estuarine vegetation and shellfish bed EFH would therefore be insignificant as they are highly unlikely to rise to the level of measurable impacts, as suggested by the analysis in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). Because impacts, if any, are expected to be minor and limited, no long-term consequences for the population of estuarine vegetation or shellfish bed species present in the PRC Study Area are expected.

Pollutants

The effects of pollutants on organisms depend on the concentration and nature of the pollutant. Whereas excesses of oxygen-consuming wastes, nutrients, and suspended sediment affect organisms indirectly via their habitats, toxins (e.g., chlorine, ammonia, heavy metals) can have a direct lethal effect or sublethal effect(s) on reproduction and/or resilience to other stressors. Pollutants associated with the Proposed Action alternatives include criteria air pollutants from fuel-burning assets and some material constituents of MEM (e.g., lead, copper, phosphorus). Most of these pollutants have regulatory standards set to levels considered safe for humans and the environment (e.g., terrestrial and aquatic life), as discussed in Sections 3.2 (Air Quality) and 3.3 (Water Resources and Sediments), respectively. The analysis of air and water quality, discussed in Sections 3.2 and 3.3, also serve as the conditions for stressor-based analysis in this section. Regulated pollutants associated with the Proposed Action alternatives (e.g., some metals, chemical propellants) are also discussed if an organism is particularly sensitive to them.

For substances that do not have regulatory standards, additional analysis is conducted if the available scientific literature suggests a meaningful impact. The direct and indirect effects of bioaccumulation of pollutants from ingesting microplastics are analyzed as ingestion and indirect/secondary stressors, respectively.

Impact Analysis (Pollutants)

The pollutant stressors associated with the No Action Alternative could affect all biological sub-resources (Table 3.4-1). Whereas air pollutants may affect primarily aerial/terrestrial invertebrates, reptiles and amphibians, birds, and mammals, water pollutants may affect primarily estuarine plants and animals. The regulated pollutants for both air and water pollutants associated with the proposed activities are primarily from fuel-burning activities (e.g., jet fuel, rocket fuel) and MEM metal/chemical constituents (e.g., lead, copper, phosphorus). Substances associated with the No Action Alternative that do not have regulatory standards include iron and chaff fibers. Note that the Proposed Action does not include any use of chemicals containing per- and polyfluoroalkyl substances that have been associated with other PRC activities (Wheeler, 2020).

In accordance with the generic background for analysis, the baseline air and water pollutants from air-, water-, and land-based assets and some MEM analyzed in Sections 3.2 (Air Quality) and 3.3. (Water Resources and Sediment) for the No Action Alternative is not expected to exceed any regulatory thresholds and would continue to represent a very small portion of the overall PRC Study Area annual emissions that contribute to regional air quality or water quality of the Chesapeake Bay. Considering the regulatory thresholds are based on levels considered safe for the environment (including terrestrial and aquatic life), the conclusions for air and water quality suggest an insignificant impact of the No Action Alternative on affected plants and animals.

Iron accumulation from MEM has the potential to encourage growth a cyanobacteria (i.e., blue-green algae). Proliferation of these organisms can negatively affect adjacent habitats by releasing toxins, potentially creating hypoxic conditions. Introducing iron into the estuarine environment from munitions or bridge infrastructure is not known to cause toxic red tide events; rather, these harmful events are more associated with natural causes (e.g., upwelling) and the effects of large-scale human activities (e.g., agricultural/industrial runoff) (Hayes et al., 2007). Considering the miniscule annual footprint (and degradation/weathering) of MEM in the Chesapeake Bay Water Range (refer to physical disturbance stressor for supporting details), it is reasonable to conclude that iron from MEM should not be considered a large-scale human activity similar to agricultural/industrial runoff.

With regard to chaff fibers, several literature reviews and controlled experiments indicate little risk to organisms, except at concentrations substantially higher than could reasonably occur from military activities (Arfsten et al., 2002; U.S. Department of the Air Force, 1997; U.S. Department of the Navy, 1999). Nonetheless, some organisms within the PRC Study Area could be exposed to chaff through direct body contact, inhalation, and ingestion (refer to ingestion stressor for analysis). Chemical alteration of water and sediment from decomposing chaff fibers is not expected to occur. Based on the dispersion characteristics of chaff, it is likely that organisms in and over the Chesapeake Bay Water Range or Armament Test Area (ATA) would occasionally come in direct contact with chaff fibers. This contact could potentially occur while in the air (e.g., bats, birds, flying insects), on the land (e.g., land mammals, birds, reptiles/amphibians, ground insects, terrestrial plants), or at the water's surface or while submerged (e.g., marine mammals, sea turtles, estuarine fish/invertebrates/plants); however, such contact would be inconsequential. Because of the flexibility and softness of chaff, external contact would not be expected to impact most wildlife (U.S. Department of the Air Force, 1997), and the fibers would quickly wash off shortly after contact. Given the properties of chaff, skin irritation is not expected to be a problem (U.S. Department of the Air Force, 1997). The potential exists for air-breathing animals to inhale chaff fibers, if at the surface while chaff is airborne. Arfsten et al. (2002), Navy (1999), and Air Force (1997) reviewed the potential impacts of chaff inhalation on humans, livestock, and other animals and concluded that the fibers were too large to be inhaled into the lungs of air-breathing animals. Chaff expended as part of the No Action Alternative at the ATA is also collected after testing events.

Impact of Pollutant Stressor (Summary)

The analysis in Section 3.2 (Air Quality) and Section 3.3 (Water Resources and Sediments) determined that no air, water, or sediment quality standards would be exceeded by the No Action Alternative. Considering the regulatory thresholds considered safe for the environment (including terrestrial and aquatic life), the conclusions for air and water quality suggest an insignificant impact of the No Action

Alternative on affected plants and animals, including species with special regulatory designations. Furthermore, any reduction in proposed activity that generates pollutants would not change the regulatory determinations from the Preferred Alternative due to the similarity of alternatives and qualitative nature of the regulatory analysis. For substances without regulatory standards (e.g., iron, chaff), the effect on biological resources is limited to only discountable effects, as detailed in this section.

Energy

A potential impact on plants and animals from energy stressors generated by the Proposed Action alternatives depends on the interplay of the following aspects: (1) stressor characteristics (e.g., source intensity and exposure rate) (Section 3.0.2.3.5, Identifying Stressors for Analysis, Energy Stressors) and (2) response of organisms and populations (e.g., distribution/density, sensitivity to energy).

Although plants are known to respond to magnetic field variations, effects on plant growth and development are not well understood (Maffei, 2014). The area of potential effects from electromagnetic devices or low-energy lasers is so small (limited to a few meters from source) and temporary, as to be discountable in terms of any effect on vegetation. Radar, which is high-frequency electromagnetic radiation, is not known to affect plants. High-energy lasers could burn plant tissue, but would have no other effects. High-powered microwave weapons are designed to damage sensitive electronics and are, thus, not expected to damage plant tissues during the brief exposures that may occur during weapon system testing.

Evaluation of potential energy exposure risks considers the behavior of the organism, especially where the organism lives and feeds (e.g., in-air, surface, water column, bottom), and how it perceives and detects electromagnetic fields. Many different types of animals (e.g., some invertebrates, fishes, sea turtles, birds, mammals) are sensitive to electromagnetic fields (Normandeau Associates et al., 2011). An animal is considered “exposed” to an electromagnetic stressor if the field strength at the animal’s location is above that of the Earth’s magnetic field. A variety of effects (including no effect) may result from exposure to electromagnetic stressors. An animal that encounters a disturbance in an electromagnetic field could respond by moving toward the source, moving away from the source, or not responding at all. An animal's response to lasers depends on the lasers’ power level and proximity, with high-energy laser having the potential to burn tissue directly impacted by the narrow beam. High-power microwave systems are designed to only damage sensitive electronics and are, thus, not expected to damage animal tissues during brief exposures that may occur during weapon system testing.

<u>Impacts Analysis (Energy)</u>

As described in Section 3.0.2.3.5 (Identifying Stressors for Analysis, Energy Stressors), the types of energy sources associated with the No Action Alternative include: (1) in-air electromagnetic, (2) in-water electromagnetic, and (3) non-weaponized directed energy (e.g., low-energy lasers).

<u>In-air Electromagnetic</u>

In-air electromagnetic devices may only affect air-breathing animals (e.g., aerial/terrestrial invertebrates, reptiles and amphibians, birds, mammals; Table 3.4-1). Most of the transmissions from in-air or land-based electromagnetic devices (e.g., for routine surveillance, communications, and navigation) will be at low power. Based on human standards, high-power, in-air electromagnetic devices are those that produce peak pulses of 200 kilovolts per 3.3 feet (1 meter) in a single pulse (North

Atlantic Treaty Organization, 2018); there are no federal standards for electromagnetic radiation exposure on animals (Manville, 2016; North Atlantic Treaty Organization, 2018). Based on available studies, in-air electromagnetic effects can be categorized as nearfield/thermal (i.e., capable of causing damage by heating tissue) or far-field/nonthermal (Bruderer et al., 1999; Nicholls & Racey, 2007; Manville, 2016; Wiltschko et al., 2011; Wiltschko & Wiltschko, 2005). According to a knowledge overview conducted by Malkemper et al. (2018), there is not much agreement on the effect of far-field electromagnetic radiation on ecologically relevant parameters. Studies reporting effects are approximately as frequent as studies reporting no effects. There are some studies that provide evidence that some animals might avoid strong radiation sources (i.e., radar and mobile phone towers), but these studies do not allow definite conclusions to be drawn regarding ecological implications (Malkemper et al., 2018). Due to such ambiguous study results, far-field radar exposure was determined to pose no significant risk to biological resources, with the exception of bats (Nicholls & Racey, 2007). In addition, neither mobile nor stationary sources of energy are expected to expose organisms to constant radiation, because they are operated intermittently. Therefore, an organism's exposure to radar in the far field is not considered a stressor on most biological resources in the PRC Study Area.

With regard to far-field effects of electromagnetic energy and bats, Nicholls and Racey (2009) theorize that the large surface area of bats' wing membranes may absorb electromagnetic radiation, thereby increasing the risk of hyperthermia and causing bats to avoid sources of electromagnetic radiation. However, previous studies have consistently determined that the chances that a bat will move in the same direction and at the same speed as a constant beam of electromagnetic radiation (e.g., while an in-air electromagnetic device tracks a target), and therefore be exposed to radiation that could cause thermal damage, are extremely small. Should effects from electromagnetic devices occur, they would likely cause bats to temporarily avoid the area receiving the electromagnetic radiation until the stressor ceases (Ahlén et al., 2009; Manville, 2016; Nicholls & Racey, 2007). For example, studies have found that bat activity and foraging effort is substantially reduced in the vicinity of radar (less than 200 meters [656 feet] at an intensity of 2 volts per meter [3.3 feet]) (Nicholls & Racey, 2007), despite the fact that radar does not impact the abundance of prey (insects) available to bats in these areas (Nicholls & Racey, 2007; Nicholls & Racey, 2009). As such, bats may temporarily avoid the general vicinity where proposed activities that generate electromagnetic radiation occur, thereby greatly reducing or completely diminishing the potential to for in-air electromagnetic radiation to injure bats. Additionally, the majority of events involving in-air electromagnetic devices would occur during daylight hours, when bats are not in-flight.

In-water Electromagnetic

In-water electromagnetic devices may only affect estuarine animals (e.g., invertebrates, fishes, and turtles) and water birds (Table 3.4-1). The in-water devices (e.g., OASIS, Magnetic Orange Pipe System [MOPS]) producing an electromagnetic field are towed by various assets generating substantial acoustic and physical disturbance stressors. In an actual mine-clearing operation, the intent is that the electromagnetic field would trigger an enemy mine designed to sense a vessel's magnetic field. The electromagnetic field is produced to simulate a vessel's magnetic field, and is of relatively minute strength. The maximum strength of the magnetic field is approximately 2,300 microteslas, with the strength of the field decreasing further from the device. At a distance of 13 feet (4 meters) from the source of a 2,300-microtesla magnetic field, the strength of the field is approximately 50 microteslas, which is within the range of the Earth's magnetic field (25 to 65 microteslas). At this range, the acoustic and physical disturbance of the towing platform may have cleared any highly mobile organisms from the affected area. At 78.7 feet (24 meters) away from the source, the strength of the field is approximately 10 percent of the Earth's magnetic field (U.S. Department of the Navy, 2005c). At a distance of 656 feet (200 meters), the magnetic field would be approximately 0.2 microteslas (Navy, 2005), which is likely outside the range of detection for even sensitive biological resources. Localized electromagnetic fields that are less than the Earth's magnetic field may be subject to masking and thus difficult for an animal to detect.

Directed Energy (Non-Weaponized)

An assessment on the use of low-energy lasers by the Navy determined that low-energy lasers, including those involved in testing and training activities, have an extremely low potential to impact biological resources (U.S. Department of the Navy, 2010a). The assessment determined that the maximum potential for laser exposure is at the surface, where laser intensity is greatest. As the laser penetrates a surface, 96 or more percent of a laser beam is absorbed, scattered, or otherwise lost (Ulrich, 2004). Based on the parameters of the low-energy lasers and the behavior and life history of major biological groups, it was determined that the greatest potential for impact would be to the eye of an animal. However, an animal's eye would have to be exposed to a direct laser beam for at least 10 seconds to sustain damage. Navy (2010a) assessed the potential for damage based on species-specific eye/vision parameters and the anticipated output from low-energy lasers, and determined that no animals were predicted to incur damage. Therefore, low-energy lasers are not analyzed further in this document for biological resources. With the No Action Alternative, non-weaponized high-energy lasers may only be used for communication relays and high-power microwave use is limited to inside test facilities.

Impact of Energy Stressor (Summary)

Animal species (with the possible exception of bats), including species with special regulatory designations, are relatively insensitive to distant electromagnetic energies and unlikely to encounter more intense short-range energies from primarily mobile/high-altitude sources. Short-range exposure to intense electromagnetic energy sources would also be accompanied by physical disturbances (e.g., an asset towing the electromagnetic device that is often not turned on), with the exception of some ground test facilities where only common/generalist species may be exposed to increased heat generated very close to high-energy electromagnetic antennas. A negligible long-range effect of electromagnetic energy stressors on most animals is therefore supported by the analysis, as detailed in this section and Sections 3.4.4 through 3.4.7 (Federal Endangered Species Act – Biological Assessments through Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). Furthermore, any reduction in proposed activity that presents an energy stressor would not change the regulatory determinations from the Preferred Alternative due to the similarity of alternatives and qualitative nature of the regulatory analysis. With regard to non-weaponized directed energy involved in Navy testing and training with the No Action Alternative, there is an extremely low potential to impact biological resources. Plants would not be affected by electromagnetic energy or non-weaponized directed energy sub-stressors.

Entanglement

A potential impact on organisms from entanglement stressors generated by the Proposed Action alternatives depends on the interplay of the following aspects: (1) stressor characteristics (e.g., distribution of entangling objects, physical properties of the object) (Section 3.0.2.3.6, Identifying Stressors for Analysis, Entanglement Stressors) and (2) response of organisms and populations (e.g., distribution/density, vulnerability to entanglement).

The physical makeup of the organism itself is also considered when evaluating the risk of entanglement. Some species, by their size or physical features, are more susceptible than others are to entanglement. For example, more rigid bodies with protruding snouts or with large, rigid fins, would have an increased risk of entanglement when compared to species with smoother, streamlined bodies, such as lamprey or eels. Evaluation of potential entanglement risk also considers the general behavior of an animal, including where the organism typically occurs (e.g., surface, water column, bottom). The analysis particularly considers those species known to become entangled in non-military expended materials (e.g., "marine debris") such as fishing lines, nets, rope, and other derelict fishing gear that often entangle Bay organisms.

Materials similar to fishing gear, which is designed to entangle an organism, would be expected to have a greater entanglement potential than other materials. An entangled organism would likely try to free itself of the entangling object; in the process, the organism may become more entangled, possibly leading to an injury and/or stress response (e.g., physical exhaustion). Stress responses or infection from injuries could also lead to delayed mortality.

Impacts Analysis (Entanglement)

Impacts on Estuarine Invertebrates

Estuarine invertebrates are likely less susceptible than vertebrates to entanglement, as suggested by the fact that fishing nets designed to take pelagic invertebrates operate by enclosing or entrapping rather than entangling (Chuenpagdee et al., 2003). A summary of the effects of litter on various marine species identified potential impacts to some invertebrate groups, particularly mobile benthic species such as crabs and sea stars, that may become entangled in debris (e.g., nets) after attempting to move through the items (National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). A survey of marine debris entanglements found that marine invertebrates accounted for 16 percent of all animal entanglements (Ocean Conservancy, 2010). The same survey cites potential entanglement in military items only in the context of waste handling aboard ships, and not for MEM. However, entanglement may be possible with some invertebrates and some MEM (e.g., fiber-optic cables, sonobuoy wires, small decelerator/parachutes, flare O-rings) under some unlikely conditions described in the stressor introduction.

Impacts on Estuarine Fishes and Terrapins

The impacts of entanglement on individual fish and terrapins are highly variable, ranging from temporary disorientation to mortality due to predation or physical injury. Most entanglement of fish involve abandoned or discarded nets, lines, traps, and other materials that form loops or incorporate rings at or just below the surface, where commercial fishing activity is concentrated (Helfman et al., 2009; Derraik, 2002; Laist, 1997; 1987; Macfadyen et al., 2009; Keller et al., 2010). A 25-year dataset assembled by the Ocean Conservancy reported that fishing line, rope, and fishing nets accounted for 68 percent of fish entanglements, with the remainder entanglements occurring due to encounters with various items such as bottles, cans, and plastic bags (Ocean Conservancy, 2010). The species affected the most depends on many factors, including orientation to the surface and the presence of rigid or protruding features that increase the risk of entanglement compared to fishes with smoother, more streamlined bodies (Macfadyen et al., 2009). With the exception of eels and similar species, most fishes are susceptible to entanglement in gear specifically designed for that purpose (e.g., gill nets). Terrapin drowning events are most often associated with bycatch in crab pots (Seigel & Gibbons, 1995; Hoyle & Gibbons, 2000). Estimates of the effects of crab trapping on a Chesapeake Bay population suggest that 15 to 78 percent of a local population dies annually in shallow water crab trapping localities and that a population can be extirpated in three to four years (Roosenburg et al., 1997). New crab traps with terrapin exclusions have greatly reduced terrapin bycatch (Lester, 2013; Pfau & Roosenburg, 2010; University of Georgia, 2019). Although Ocean Conservancy (2010) and Roosenburg (1997) do not specifically reference MEM as an entanglement hazard, entanglement may be possible with some fishes or terrapins and some MEM (e.g., fiber-optic cables, sonobuoy wires, small decelerator/parachutes, flare O-rings) under some unlikely conditions described in the stressor introduction.

Impacts on Water Birds

Birds have an aerodynamic shape and general alertness to visible objects that could impede their movement (e.g., tree branches, stumps) that were not designed for entanglement (e.g., netting). While the vast majority of bird entanglements involved fishing gear (e.g., monofilament line and hooks), approximately 8.3 percent of the entanglements were from non-fishery-related items (e.g., plastics and other synthetic materials that they may gather for making nests) (National Oceanic and Atmospheric Administration, 2016). Cormorants in Maine have been observed making nests from such plastic marine debris, including net fragments and fishing line. It is thought that the biggest threat of entanglement from using debris as nesting material is to chicks, but no such entanglements have been observed (National Oceanic and Atmospheric Administration, 2016). Although National Oceanic and Atmospheric Administration (2016) does not specifically reference MEM as an entanglement hazard, entanglement may be possible with some water birds and some MEM (e.g., fiber-optic cables, sonobuoy wires, small decelerator/parachutes, flare O-rings) under some unlikely conditions described in the stressor introduction.

Impact of Entanglement Stressor (Summary)

The relatively few MEM that could entangle an animal also lack the characteristics necessary for effective entanglement (e.g., anchored netting). Additionally, the materials presenting an entanglement risk represent a small portion of overall MEM that cover a miniscule area of munition concentration areas in mostly the deeper waters of the Chesapeake Bay Water Range where the bottom is subject to seasonal hypoxia (low dissolved oxygen) that temporarily reduces life on the bottom. Plants and terrestrial/freshwater animals would not be affected by entanglement stressors.

Summary conclusions for species and habitats with special regulatory designations are provided below, based on analysis details for Alternative 2 in Sections 3.4.4 through 3.4.7 (Federal Endangered Species Act – Biological Assessments through Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). The qualitative conclusions presented in these sections are not meaningfully different when applied to the No Action Alternative and analysis endpoints for NEPA, as described in Sections 3.4.3.2 and 3.4.3.3 (Alternative 1 Potential Impacts and Alternative 2 (Preferred Alternative) Potential Impacts, respectively). Furthermore, any reduction in proposed activity/MEM presenting an entanglement risk would not change the regulatory determinations from the Preferred Alternative due to the similarity of alternatives and qualitative nature of the regulatory analysis.

Sea Turtles and Sturgeons

The four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) and two sturgeon species (shortnose and Atlantic sturgeon) present in the PRC Study Area may be exposed to a variety of entanglement stressors from wires and cables, flare O-rings, and decelerators/parachutes and their associated cords proposed with the No Action Alternative. Potential impacts from these types of MEM to individual sea turtles or sturgeon would be discountable as they are unlikely to occur or rise to the level of measurable impacts due to low density of the material in the species' habitat and lack of material features necessary for effective entanglement, respectively, as detailed in Section 3.4.4.1

(Federal Threatened and Endangered Species – National Marine Fisheries Service). No long-term consequences for the population of sea turtles and sturgeon are therefore expected from these entanglement stressors under even a maximum of proposed activity.

Eastern Black Rails, Red Knots, and Tiger Beetles

The analysis and conclusions for uncommon/specialist animals living mostly away from both the airfield environment and Chesapeake Bay Water Range also applies to eastern black rails (a wading bird), red knots (a shore bird), and tiger beetles (terrestrial shoreline insect). The localized and infrequent physical entanglement stressors on bird species from the No Action Alternative would be mostly limited to open water or diving birds and not wading or shore birds. The entanglement stressors are not only far removed from habitats where the subject species may be encountered, they also lack the material properties necessary for effective entanglement. No long-term consequences for the population of eastern black rails, red knots, or tiger beetles are therefore expected from these entanglement stressors under even a maximum of proposed activity (refer to Section 3.4.4.2, Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction, for analysis details).

Marine Mammals

The five species of marine mammals (bottlenose dolphin, harbor porpoise, harbor seal, humpback whale, and West Indian manatee) present in the PRC Study Area may be exposed to a variety of entanglement stressors from wires and cables, flare O-rings, and decelerators/parachutes and their associated cords proposed with the No Action Alternative. Potential impacts from these types of MEM to individual marine mammals would be discountable as they are unlikely to occur or rise to the level of measurable impacts due to low density of the material in the species' habitat and lack of material features necessary for effective entanglement, respectively, as detailed in Section 3.4.5 (Marine Mammal Protection Act – Biological Assessments). No long-term consequences for the population of marine mammal are therefore expected from these entanglement stressors under even a maximum of proposed activity.

Estuarine Vegetation and Shellfish Beds

Entanglement stressors associated with the No Action Alternative would not affect either estuarine vegetation or shellfish bed EFH. Neither biological resource has the moving parts necessary to be entangled, in addition to being physically disturbed (refer to the summary in the Physical Disturbance and Strike section).

Ingestion

A potential impact on individual organisms and populations from ingestion stressors generated by the Proposed Action alternatives depends on the interplay of the following aspects: (1) stressor characteristics (e.g., distribution of the ingestible items, size/buoyancy of item) (Section 3.0.2.3.7, Identifying Stressors for Analysis, Ingestion Stressors) and (2) response of organisms and populations (e.g., distribution/density, vulnerability to ingestion stressors).

Ingestion stressors will not impact vegetation because plants use photosynthesis to obtain nutrients and energy versus ingesting food matter. Plants that acquire nutrients from animals to supplement photosynthesis (e.g., Venus flytraps, bladderworts) do not occur in the affected environment of the PRC Study Area (refer to Section 3.4.2.2, Affected Environment, Vegetation). Ingestion stressors, therefore, are not applicable to vegetation and are not analyzed in this section. Evaluation of potential ingestion risk considers the feeding behavior of an animal, including where (e.g., surface, water column, bottom) and how (e.g., filter feeding) the organism feeds, and what it feeds on. The analysis particularly considers those species known to ingest nonfood items (e.g., plastic or metal items).

Potential impacts of ingesting foreign objects on a given organism depend on the species and size of the organism. Species that normally eat spiny hard-bodied invertebrates would be expected to have tougher mouths and guts than those that normally feed on softer prey. Materials similar in size and shape to the normal diet of an organism may be more likely to be ingested without causing harm to the animal; however, some general assumptions are made. Relatively small objects with smooth edges, such as shells or small-caliber projectiles, might pass through the digestive tract without causing harm. A small sharp-edged item may cause the individual immediate physical distress by tearing or cutting the mouth, throat, or stomach. If the object is rigid and large (relative to the individual's mouth and throat), it may block the throat or obstruct digestive processes. A cyst in the gut lining may even enclose an object. The net result of ingesting large foreign objects is disruption of the normal feeding behavior, which could be sublethal or lethal. In addition to serious injuries, the longer term impact of ingesting nonfood items can include nutrient deficiency, bioaccumulation (indirect/secondary stressors), uptake of toxic chemicals (pollutant stressors), compaction, and mortality.

Impacts Analysis (Ingestion)

This section analyzes the potential impacts on estuarine animals (e.g., invertebrates, fishes, turtles), and water birds from the various types of ingestion stressors associated with non-explosive munitions and other MEM planned with the No Action Alternative. Refer to Section 3.0.2.3.7 (Identifying Stressors for Analysis, Ingestion Stressors) for details supporting characterizations of ingestion stressors in this section. Ingestion stressors are not applicable to terrestrial animals because ingestible MEM is only associated with estuarine waters in the PRC Study Area (e.g., Chesapeake Bay Water Range). Ingestion stressors are also unlikely to coincide with aerial invertebrates (e.g., butterflies, dragonflies) and bats, due to their relative scarcity over open water during the day where MEM occurs (refer to discussion in physical disturbance and strike analysis for supporting details).

Considering the composition of most MEM associated with the No Action Alternative (e.g., metal, cement/sand) and its very limited coverage in the Chesapeake Bay Water Range (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis), the contribution of the No Action Alternative to overall floating debris and microplastic concentrations in the environment should be considered miniscule. The deployment of potentially ingestible materials is also not expected over shallow, nearshore areas, where benthic invertebrates, fishes, terrapins, and feeding water birds are concentrated. The materials would have to drift into these habitats to pose any greater risk of entanglement, which is unlikely given the typically slow current speed and downstream direction of currents flowing through the deeper waters where the MEM impact the surface (refer to Section 3.0.2.3.6, Identifying Stressors for Analysis, Entanglement Stressors, for supporting details).

Several literature reviews and controlled experiments indicate that chaff poses little risk to organisms, except at concentrations substantially higher than could reasonably occur from military activities (Arfsten et al., 2002; U.S. Department of the Air Force, 1997; U.S. Department of the Navy, 1999). Nonetheless, some organisms within the PRC Study Area could be exposed to chaff through direct ingestion. Based on the dispersion characteristics of chaff, it is likely that organisms in and over the Chesapeake Bay Water Range or ATA would occasionally come in direct contact with chaff fibers. This contact could potentially occur while in the air (e.g., bats, birds, flying insects), on the land (e.g., land mammals, birds, reptiles/amphibians, ground insects, terrestrial plants), or at the water's surface or while submerged (e.g., marine mammals, sea turtles, estuarine fish/invertebrates/plants); however, such contact would be inconsequential. Navy (1999) reviewed the potential impact of chaff ingestion on animals and concluded the fibers were essentially harmless at concentrations likely to be encountered in the environment. Even higher concentrations and force-feeding to a crab and fish species resulted in no evidence of an ingestion stressor. Furthermore, many animals that actively select their food are capable of distinguishing nonfood and food items, based on scent. Chaff expended as part of the No Action Alternative at the ATA is also collected after testing events.

The only area where both MEM and estuarine animals and water birds are concentrated would be around Hannibal Target where only 0.0075 percent of the bottom is covered annually by MEM. The heaviest and largest area of MEM including mostly small and medium caliber gun ammunition will sink in the shifting sands around the target within about 90 days (Inman & Jenkins, 2002). However remote, there is also the potential for exposure of buried MEM when the pattern of sedimentation and erosion changes with major storms and hydrologic modifications. Another factor reducing the contribution of MEM to ingestion stressors in other target location is related to the episodic hypoxia impacting deeper waters of the Chesapeake Bay Water Range; dissolved oxygen levels on the bottom of range is seasonally very low and breakdown of MEM is correspondingly slow. The seasonally low dissolved oxygen levels on the bottom (i.e., hypoxia) also correspond to relatively poor habitat for benthic organisms.

Impacts on Estuarine Invertebrates

Feeding mechanism, mouth size, and habitat use are important factors for ingestion. Even the large predatory invertebrates (e.g., blue crabs, mantis shrimp) have very small mouthparts, and the collection mechanism of filter or deposit feeders (e.g., clams versus worms, respectively) could only collect material pieces that are even smaller or microscopic. Of the intact MEM that may pose an ingestion risk to biological resources in general, all are too large to pose an ingestion risk to invertebrates; the smallest MEM is 1.4 inches in longest dimension (flare O-ring). The potential ingestion risk to estuarine invertebrates comes from a very small amount of fragments created as some MEM degrades through time. There will also be some unrecovered target fragments small enough for ingestion by invertebrates.

As MEM breaks down, tiny metal or plastic particles in the water column may be taken up by suspension feeders (e.g., jellyfish, zooplankton) (Chiarelli & Roccheri, 2014; Griscom & Fisher, 2004), although metal concentrations in the water are typically much lower than concentrations in sediments (Bazzi, 2014; Brix et al., 2012). Most MEM components (e.g., steel, cement, sand) are relatively inert in the saltwater environment, and are not likely to cause injury or mortality via chemical effects. Filter or deposit-feeding invertebrates (e.g., bivalve shellfish, worms) have the greatest potential to ingest small plastic fragments, and any associated pollutants could harm the individual (National Oceanic and Atmospheric Administration Marine Debris Program, 2014b; Wright et al., 2013). Ingestion of microplastics may result in physical effects such as internal abrasion and gut blockage, toxicity due to leaching of chemicals, and exposure to attached pollutants. Potentially harmful bacteria may also grow on microplastic particles (Kirstein et al., 2016). In addition, consumption of microplastics may result in decreased consumption of natural foods such as algae (Cole et al., 2013). Microplastic ingestion by marine worms was shown in one study to result in lower energy reserves (Wright et al., 2013). Microplastic ingestion has been documented in numerous marine invertebrates (Cole et al., 2013; Hall et al., 2015; Wright et al., 2013; Setala et al., 2016). In an experiment involving pelagic and benthic marine invertebrates with different feeding methods, all species exposed to microplastic particles ingested some of the items (Setala et al., 2016). Deposit-feeding worms and an amphipod species ingested the fewest particles, while bivalves and free-swimming crustaceans ingested higher amounts. Overall population-level effects from all sources of microplastics across a broad range of species are currently uncertain (Kaposi et al., 2014; Wright et al., 2013).

Impacts on Estuarine Fishes

Ingesting nonfood items is common among a variety of adult fishes, particularly those that feed on the bottom (Boerger et al., 2010; Hoss & Settle, 1990; Jackson et al., 2000). Metal items that may be eaten by fish in the PRC Study Area are generally small (such as fishhooks, bottle caps, and metal springs), suggesting that only small- and medium-caliber munitions may be confused for food. Large predatory fishes in the water ranges of the PRC Study Area (e.g., striped bass, bluefish, summer flounder, seatrout) could ingest relatively small expended materials; MEM ranging in size from 1.4 inches to 5.8 inches in longest dimension (flare O-ring and chaff cartridge, respectively). Small decelerator/parachutes (18-inch diameter) are too large for the vast majority of fish likely present in the PRC Study Area. Smaller predators or filter feeders (e.g., croaker, Atlantic menhaden, respectively) and larvae or juveniles of larger species could only collect material pieces that are very small or microscopic (e.g., target fragments, fragments created as MEM degrades through time).

The items of most concern for fishes are relatively low-density materials of ingestible size (e.g., target fragments, plastic endcaps, compression pads) that either drift at or just below the surface (or in the water column) for a time, before sinking to the bottom, where they remain on the substrate surface. Some of these items could also become entangled in dense masses of dying seagrass or marsh plants floating in the water column. On or near the water surface, the lighter items of concern may be investigated by surface-feeding predators (e.g., striped bass, bluefish, cobia) or inadvertently collected during feeding activity (e.g., filter feeders). Higher-density items (e.g., shell casings) fall rapidly to the bottom where they may become buried in lighter sediment (e.g., mud, sand). During their fall, flashy shell casings may be mistaken for prey species by large, open-water predators that mouth them for a time before expelling the nonfood item (Felix et al., 1995). This represents the most likely scenario in the rare event of a predatory fish encountering MEM in the upper water column. Some open-water species may consume nonfood items at times (Rochman et al., 2015; Choy & Drazen, 2013), though none of the species studied occur in the Chesapeake Bay Water Range. On or near the bottom, large scavengers and predatory fishes (e.g., clearnose skate, black sea bass) feed opportunistically on or near the bottom, where they may inadvertently ingest marine debris with associated food resources (e.g., clams, worms). In the United Kingdom, plastic cups thrown from ferries have been discovered in cod stomachs (Hoss & Settle, 1990). The varied diet of the cod and the low visibility in its deep shelf habitat may promote the ingestion of foreign objects. However, most fish in turbid environments have an acute sense of smell that allows them to discern food from nonfood items.

It is also possible that expended shell casings on the bottom could be colonized by bottom organisms and mistaken for prey, or that expended small-caliber projectiles be accidentally or intentionally eaten during indiscriminate foraging. However, the vast majority of the Chesapeake Bay Water Range experiences some degree of seasonal hypoxia that may greatly reduce benthic food resources during a substantial portion of the growing season. Within the limited areas where the bottom is not seasonally hypoxic (e.g., Hannibal Target munition concentration area), metallic MEM may oxidize/corrode or become buried in sediment, reducing the likelihood of a fish encountering them.

In the unlikely event of encountering and ingesting MEM associated with the No Action Alternative, a fish could experience various digestive problems (Danner et al., 2009). Relatively small or smooth objects, such as small-caliber projectiles or their casings, might pass through the digestive tract without causing harm. A small sharp-edged item could cause a fish immediate physical distress by tearing or cutting the mouth, throat, or stomach. If the object is rigid and large (relative to the fish's mouth and throat), it may block the throat or obstruct the flow of waste through the digestive system. A cyst in the gut lining could also enclose particularly large objects (Danner et al., 2009; Hoss & Settle, 1990). In either case, ingestion of large foreign objects could lead to disruption of a fish's normal feeding behavior, which could be sublethal or lethal. Both physical and toxicological impacts on adult fish could also occur because of consuming metal or plastic materials (Dantas et al., 2012; Davison & Asch, 2011; Possatto et al., 2011). Most MEM components (e.g., steel, cement, sand) are relatively inert in the saltwater environment, and are not likely to cause injury or mortality via chemical effects. However, ingestion of microplastic particles has been shown to increase hazardous chemicals in fish leading to liver toxicity of fishes (Rochman et al., 2015).

Impacts on Diamondback Terrapins

Diamondback terrapins appear to be dietary generalists and opportunistic in foraging habits with a wide array of prey and forage items, which may increase the risk of ingestion for non-prey items. As visual predators, however, diamondback terrapins appear to use visual cues while foraging, showing selectivity in the prey that they eat (Outerbridge et al., 2017). In the unlikely event of a terrapin encountering a small piece of MEM in this area (ranging in size from 1.4 to 5.8 inches in size), the turtle is very unlikely to consider it a food item.

Impacts on Water Birds

Birds can mistake various plastics and other floating materials for food, and the incidence of ingestion appear to be related to a bird's feeding mode and diet (Henry et al., 2011; Provencher et al., 2014). Species that forage by picking drifting/planktonic prey from the surface have a greater potential to ingest floating plastic debris than fish-eating species (Azzarello & Van Vleet, 1987; Provencher et al., 2014). Seabirds in the order Procellariiformes (e.g., gannets, petrels) are particularly vulnerable because they cannot regurgitate ingested plastic. However, representatives of the Procellariiformes family and planktivorous water birds (e.g., phalaropes) are uncommon to rare in the PRC Study Area (U.S. Department of the Navy, 2017c). Other water birds, including gulls and terns, commonly regurgitate indigestible parts of their food items such as shell and fish bones. The impact of relatively small quantities of floating MEM (e.g., unrecovered target fragments, plastic endcaps, compression pads) on these birds in the PRC Study Area is likely negligible.

Rapidly sinking munitions and small material accessories are unlikely to be accessible or attractive as potential food items to predatory diving birds that feed in the upper water column. However, some waterfowl species that are common in the PRC Study Area may ingest foreign particles (e.g., bird shot from waterfowl hunting, fishing weights) that are mixed up in their shallow-water foraging habitat (Scheuhammer, 2009). However, the maximum size of ingestible particles (0.8-inch diameter) is smaller than all the intact MEM associated with the No Action Alternative, with the exception of chaff (discounted as a threat to wildlife earlier in section). The potential ingestion risk to waterfowl and planktivorous birds comes from a very small amount of tiny metal or plastic fragments created as some MEM degrades through time. Ingestion of microplastics may also result toxicity due to leaching of chemicals and exposure to attached pollutants.

In the unlikely event that a bird consumed a fragment of MEM, the physiological impacts to birds from ingestion may include blocked digestive tracts and subsequent food passage, blockage of digestive enzymes, lowered steroid hormone levels, delayed ovulation (egg maturation), reproductive failure, nutrient dilution (nonnutritive debris displaces nutritious food in the gut), exposure to indirect effects from harmful chemicals found in and on the plastic material, and altered appetite satiation (the sensation of feeling full), which can lead to starvation. While ingestion of marine debris has been linked to bird mortalities, sublethal impacts are more common (Moser & Lee, 1992).

Impact of Ingestion Stressor (Summary)

The relatively few MEM that could present an ingestion risk also do not resemble most food items. Additionally, the materials presenting an ingestion risk represent a small portion of overall MEM that cover a miniscule area of munition concentration areas in mostly the deeper waters of the Chesapeake Bay Water Range where the bottom is subject to seasonal hypoxia (low dissolved oxygen) that temporarily reduces life on the bottom. Plants and terrestrial/freshwater animals would not be affected by ingestion stressors.

Summary conclusions for species and habitats with special regulatory designations are provided below, based on analysis details for Alternative 2 in Sections 3.4.4 through 3.4.7 (Federal Endangered Species Act – Biological Assessments through Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). The qualitative conclusions presented in these sections are not meaningfully different when applied to the No Action Alternative and analysis endpoints for NEPA, as described in Sections 3.4.3.2 and 3.4.3.3 (Alternative 1 Potential Impacts and Alternative 2 (Preferred Alternative) Potential Impacts, respectively). Furthermore, any reduction in proposed activity/MEM presenting an ingestion risk would not change the regulatory determinations from the Preferred Alternative due to the similarity of alternatives and qualitative nature of the regulatory analysis.

Sea Turtles and Sturgeons

The four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) and two sturgeons (shortnose and Atlantic sturgeon) present in the PRC Study Area may be exposed to a variety of ingestion stressors from live gun ammunition, flechettes, chaff, flare casings, and small decelerators/parachutes. Not only are these potentially ingestible items rare in the species' habitat, they are also generally unappealing to sea turtles and sturgeons. Ingestion of these types of MEM by sea turtles or sturgeon, while rare, could occur but is unlikely to result in blockage or exert other deleterious health effects. Potential impacts from these types of MEM to individual sea turtles or sturgeon would be discountable as they are unlikely to occur or rise to the level of measurable impacts as suggested by the analyses presented in Section 3.4.4.1 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction).

Eastern Black Rails, Red Knots, and Tiger Beetles

The analysis and conclusions for uncommon/specialist animals living mostly away from both the airfield environment and Chesapeake Bay Water Range also applies to eastern black rails (a wading bird), red knots (a shore bird), and tiger beetles (terrestrial shoreline insect). The localized and infrequent physical ingestion stressors on bird species from the No Action Alternative would be mostly limited to open water or diving birds and not wading or shore birds. The ingestion stressors are not only rare and far removed from habitats where the subject species may be encountered, they are also generally unappealing for consumption. No long-term consequences for the population of eastern black rails, red knots, or tiger beetles are therefore expected from these ingestion stressors under even a maximum of proposed activity (refer to Section 3.4.4.2, Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction, for analysis details).

Marine Mammals

The five species of marine mammals (bottlenose dolphin, harbor porpoise, harbor seal, humpback whale, and West Indian manatee) present in the PRC Study Area may be exposed to a variety of ingestion stressors from live gun ammunition, flechettes, chaff, flare casings, and small decelerators/parachutes. Not only are these potentially ingestible items rare in the species' habitat, they are also generally unappealing to marine mammals. Ingestion of these types of MEM by marine mammals, while rare, could occur but is unlikely to result in blockage or exert other deleterious health effects. Potential impacts from these types of MEM to individual marine mammals would be discountable as they are unlikely to occur or rise to the level of measurable impacts as suggested by the analyses presented in Section 3.4.5 (Marine Mammal Protection Act – Biological Assessment).

Estuarine Vegetation and Shellfish Beds

Ingestion stressors associated with the No Action Alternative would not affect estuarine vegetation EFH because it does not consume food items. However, ingestion stressors associated with the No Action Alternative may impact shellfish bed EFH, though the potential impact is limited to microplastic fragments and chaff fibers that are a rare contribution to overall microscopic particles in the Chesapeake Bay. Even if encountered, the effects on a shellfish ingesting a particle from the proposed activities would be minor. Impacts to shellfish bed EFH would, therefore, be insignificant as they are highly unlikely to rise to the level of measurable impacts as suggested by the analysis in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). Because impacts, if any, are expected to be minor and limited, no long-term consequences for the population of estuarine vegetation or shellfish bed species present in the PRC Study Area are expected.

Indirect/Secondary

Indirect or secondary stressors do not interact directly with an organism. The indirect/secondary impact occurs because of effects on an organism's overall habitat (e.g., water resources, sediment, vegetation), nutrition sources, or major predators. The indirect impact on prey resources also considers bioaccumulation of pollutants from lower trophic levels.

Considering "habitat" for an organism is any quality of the environment necessary for that organism's successful reproduction, feeding, and growth to maturity, the concept creates the potential for duplication of analysis at the species and habitat level, which should be avoided to prevent differing levels of analysis in an environmental assessment. The potential for duplication of analysis applies to:

- Acoustic stressor effects on fishery species covered in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Acoustic) that are referenced in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment) for effect on water column EFH; and
- Physical disturbance and pollutant effects on water column and sediment covered in Section 3.3 (Water Resources an Sediments) that are referenced in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment) for effects on water column and substrate EFH.

Impacts Analysis (Indirect/Secondary)

This section analyzes the potential impacts on biological resources from indirect/secondary effects associated with the No Action Alternative. Impacts from the No Action Alternative on prey/forage are covered in their respective subsections (Invertebrates, Fishes, Reptiles and Amphibians, Birds, and Mammals) in Section 3.4.3.1 (Environmental Consequences, No Action Alternative).

With regard to habitat impacts as an indirect/secondary stressor on vegetation, there is very limited ground/soil disturbance associated with the No Action Alternative, and it may only occur on previously disturbed land where installation natural resources staff have surveyed for sensitive terrestrial species (including plant and animal species) (refer to Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization, for supporting details). The potential impact of Alternative 2 on estuarine habitats (including barren substrate) was considered minimal and not more than short term in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment).

Another indirect/secondary effect is bioaccumulation of pollutants. Whereas some metals and contaminants associated with microplastics bioaccumulate, the physiological impacts on biological resources begin to occur only after several trophic transfers concentrate the pollutants. Bioaccumulation is, therefore, most pronounced at higher trophic levels (e.g., large predatory fish, birds, marine mammals). Filter- or deposit-feeding invertebrates (e.g., sponges, clams, worms) have the greatest potential to ingest small plastic fragments, and any associated pollutants could be incorporated into the food chain (National Oceanic and Atmospheric Administration Marine Debris Program, 2014b; Wright et al., 2013). Ingestion by these types of organisms is the most likely pathway for degraded MEM to enter the Bay food web and impact estuarine animals and water birds. Transfer of microplastic particles to higher trophic levels was demonstrated in one experiment (Setala et al., 2016). However, the contribution to overall microplastic pollution from the No Action Alternative is likely miniscule (refer to Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis, for supporting details).

<u>Impact of Indirect/Secondary Stressor (Summary)</u>

The lack of any significant direct impacts on plant or animal habitats, predators or prey resources, or measureable contribution to overall microplastic pollution suggests a corresponding lack of significant indirect/secondary impacts on plant or animal populations, including species with special regulatory designations. The effects on predator and prey resources as well as habitat from direct stressors (e.g., physical disturbance from MEM) are included in the previous individual stressor analysis.

Stressors Combined

Military assets often generate a combination of different stressors with various ranges to effects on biological resources. Those effects may combine individually and cumulatively to have a greater effect on an organism than instances of a single stressor (e.g., noise from all water-based assets), if an exposed organism is not repelled by the most far-reaching stressor (e.g., sight, sound pressure) first. The range order of stressor effects on an organism can also result in avoidance of additive effects (i.e., “subtractive” effects). For example, an animal could move away from a disturbing sound before any physical disturbance or strike potential is possible. In this case, the stressors are not necessarily additive (note that subtractive effects are considered in the analysis of individual stressors). In other cases, an acoustic stressor could combine with an associated physical disturbance to increase the overall stress response in an exposed organism.

An analysis of combined effects incorporates factors such as the co-occurrence of stressor effects in space and time, the impacts of individual stressors (e.g., habitat alteration, changes in animal behavior or physiology, injury, mortality), and the duration and intensity of the impacts of individual stressors. For example, an indirect/secondary stressor from a munitions strike could be habitat alteration added to the primary impact of the actual strike on organisms occupying the habitat. For stressors that do not have quantifiable impacts, potential additive impacts are qualitatively evaluated using available scientific knowledge and best professional judgment.

Impacts Analysis (Stressors Combined)

This section analyzes the potential impacts on all biological sub-resources from a combination of the various types of stressors associated with the No Action Alternative (Table 3.4-1). The analysis includes potential combined impacts from the following: (1) air-based assets, (2) water-based assets, (3) land-based assets, and (4) non-explosive munitions and other MEM.

Most of the proposed activities generally involve the use of moving platforms (e.g., aircraft, vessels) or MEM that may produce one or more stressors on animals (e.g., acoustic, physical disturbance and strike, energy); therefore, if animals were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously or sequentially (e.g., physical disturbance, energy, and acoustic stressors precede strike potential). Individual stressor that would otherwise have minimal to no impact may combine to have a greater than minimal impact on individuals, if they occur simultaneously. However, the combined effect of short-range physical disturbance, electromagnetic energy, and acoustic stressors from mobile assets has not been studied and it would be difficult to parse out the effects. Longer-range effects that would expose more animals to individual stressors are covered in subsequent sub-resource sections.

Due to the wide dispersion of stressors, speed of the platforms, and general dynamic movement of many testing and training activities, it is unlikely that highly mobile animals (e.g., blue crabs, dragonflies, fish, reptiles and amphibians, birds, mammals) would occur in the potential impact range of multiple stressors that combine to create additive effects (e.g., short-range, asset-based stressors adding to physical disturbance from MEM or directed energy). In the very unlikely event of a coincidence, relatively few individuals would be impacted compared to their overall population size within the PRC Study Area, and the affected animals would likely be common/generalist species that are less vulnerable to population-level effects. The likelihood of an uncommon/specialist species encountering one of the rare instances of additive effects potential should be considered low.

Additionally, bats and numerous land mammals are mostly nocturnal and would likely only be exposed to stressors that occur between dusk and dawn. Furthermore, all of the bats that could be present in the PRC Study Area are inactive (hibernate) in the winter when prey is scarce and, with the exception of eastern red bats, migrate out of the area to overwinter in the south or in hibernacula in locations outside of the PRC Study Area. Terrestrial/freshwater mammals may be active all year long but do not coincide with locations where MEM is deployed. A combination of assets and stressors in an area could also expose animals to less harmful effects (e.g., acoustic or physical disturbance stressors) before the more damaging ones (e.g., physical strike), which may give some animals an opportunity to minimize impacts on themselves—as evidenced by recent increases in BASH incidents during reduced airfield activity resulting from the COVID-19 pandemic (Block, 2020).

Standard Operating Procedures and avoidance and mitigation measures described in Sections 2.5 (Standard Operating Procedures Included in the Proposed Action) and 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization), respectively, for PRC activities further minimize potential impacts on biological resources. Those measures protect plants and animals inhabiting seagrass beds and terrestrial animals inhabiting relatively undisturbed, natural areas within installation boundaries. Protective measures restricting low-altitude flight to a summer–fall time frame for birds also minimize potential impacts on birds and other animals. Installation BASH initiatives also discourage airfield features that could attract animals posing a danger to aircraft. There is also no beaching of vessels allowed in the Bloodsworth Island Range where diamondback terrapins and many native birds are concentrated in the study area.

Impact of Stressors Combined (Summary)

Due to the wide dispersion of stressors, speed of the platforms, and general dynamic movement of many testing and training activities, it is unlikely that highly mobile aquatic animals (e.g., blue crabs, striped bass, diamondback terrapins, sea turtles, birds, marine mammals) would occur in the potential impact range of multiple stressors that combine to create additive effects (e.g., aircraft noise and physical disturbance adding to physical disturbance from MEM or directed energy weapons). A combination of assets and stressors in mostly the airfield environment could also expose animals to less harmful effects (e.g., acoustic or physical disturbance stressors) before the more damaging ones (e.g., physical strike or directed energy weapon) which may give them an opportunity to avoid the greater impacts. Terrestrial/freshwater plants and animals should experience fewer additive or synergistic effects because they do not inhabit water ranges where MEM are expended. Accordingly, there are no long-long/population-level impacts on any biological resources expected from either individual stressors or stressors combined with the No Action Alternative.

3.4.3.2 Biological Resources, Alternative 1 Potential Impacts

Relative to the No Action Alternative and stressor/sub-stressors that affect biological resources, Alternative 1 includes an increase in air-, water-, and land-based asset activity characteristics (e.g., operating hours, events, numbers) and expenditure of munitions and other MEM, and the addition of some new activities and a new sub-stressor (weaponized high-energy lasers and high-power microwaves).

The NEPA analysis and conclusions for biological resources under Alternative 1 for individual stressors and stressors combined are provided in the following stressor sections. The analysis for each stressor and sub-resource relies upon and incorporates the qualitative analysis details provided in the No Action Alternative that would be the same among alternatives. This section provides the analysis details for the differences between Alternative 1 and the No Action Alternative. This was done to reduce unnecessary repetition of text in an already voluminous document. This is also consistent with the qualitative analysis endpoints defined in Sections 3.0.2.4 and 3.0.2.5 (Resource-Specific Impact Analysis for Individual Stressors, and Resource-Specific Impacts Analysis from Multiple Stressors, respectively); qualitative analysis endpoints are described in terms of intensity (lesser or greater), localization (localized or widespread) and frequency/duration (infrequent or frequent/temporary to long-term).

Acoustic

The qualitative analysis detailed and summarized in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Acoustic) also apply to Alternative 1. Whereas the quantitative increases in sound-producing activities (e.g., aircraft hours) and expended materials (e.g., number of non-explosive expended materials) and some new activities suggest a greater impact from Alternative 1 compared to the No Action Alternative, they are not expected to alter the qualitative analysis conclusions from the No Action Alternative in a meaningful way because:

- The acoustic stressor intensities (per individual asset or MEM) and their locations in the PRC Study Area are mostly the same at the level of description used in the affected environment section (e.g., restricted airspace, estuarine waters of the middle Chesapeake Bay). For example, the intensity and location of sound produced by an individual fixed-wing jet operating below 3,000 feet AGL is approximately the same regardless of alternative. Exceptions are described in subsequent bullets.
    - The new activity in the Patuxent Seaplane Area (Section 2.3.2, Action Alternative 1) represents the relocation of a portion of search and rescue training (and associated helicopter activity and marine markers) that currently occurs in the Chesapeake Bay Water Range to the adjacent Patuxent River Seaplane Area (both estuarine waters in the same general vicinity). The biological community of the middle Chesapeake Bay analyzed for the No Action is similar to that of the lower Patuxent River, and the additional impacts would be mostly to estuarine animals and water birds that are relatively more sensitive to aircraft sound. The long-range effects would be mostly temporary displacement before any potential for auditory injuries, as described for the No Action Alternative;
    - The addition of active sonobuoys to existing dipping sonar tests emit underwater sound at the same frequency range as the dipping sonar but at a much lower SPL though longer duration (Section 3.0.2.3.1.2, Acoustic Stressors, Vessels (and Other Water-Based Assets), Sonars and Other Transducers). Impacts from the quieter sonobuoys are, therefore, not expected to alter any acoustic stressor conclusions for only the dipping sonar. The elevated impacts would be mostly to estuarine animals that are relatively sensitive to mid-frequency sonar (e.g., clupeid fishes, diving birds, marine mammals). The long-range effects on these animals is insignificant or discountable based on the analysis in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Acoustic) and the avoidance and mitigation measures described in Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization); and
    - The addition of a new stressor (weaponized high-energy lasers and high-power microwaves) with directed energy weapon system testing targeting small UAS or vessels within PRC surface danger zones (SDZ) and previously disturbed installation areas (Section 3.0.2.3.5.4, Energy Stressors, Directed Energy) may affected some biological resources. The analysis for biological resources and directed energy weapon system testing is therefore fully included under the energy stressor section. The acoustic stressor potential from the high-energy weapons is negligible (weapon is relatively quiet) and the various targets that do present an acoustic stressor occur in the same location as other target activity included with the No Action Alternative.
- The changes do not alter an overall characterization of the acoustic stressors as either localized and infrequent (outside the airfield environment) or localized and frequent (in airfield environment), with supporting details in the following bullets.
    - Air-based assets and affected sub-resources (all environments and animal groups; Table 3.4-1): The greatest increases in air-based activity relative to the No Action Alternative are for activities that started out very low in terms of hours (e.g., UAS, aerial targets; Table 3.0-3, Estimated Flight Altitude and Percent of Flight Hours by Aircraft Category of

the Proposed Action Alternatives) and they are generally quieter than other air-based assets. Most air-based activities that started out relatively high in terms of hours or events increase very little (e.g., subsonic flights above 3,000 feet AGL) or decline (supersonic flights and subsonic flights above 3,000 feet AGL). The only air-based activity that started out fairly high (8,260) and increases substantially (45 percent) is subsonic flights below 3,000 feet AGL. However, the increased number of hours over the PRC Study Area with Alternative 1 (11,990) likely do not elevate associated stressor effects to frequent over any particular area outside of the airfield environment due to the immense size of the study area and dispersion of aircraft. The acoustic stressor from air-based assets in the airfield environment was localized and frequent for the No Action Alternative and remains so with Alternative 1;

- Water-based assets and affected sub-resources (aerial/estuarine invertebrates, estuarine fish, estuarine reptiles, water birds, bats, and freshwater/marine mammals; Table 3.4-1): The greatest increases in mobile water-based hours relative to the No Action Alternative are for activities that started out very low in terms of hours or numbers (e.g., dipping sonar – active sonar, underwater unmanned maritime system (UMS); Table 3.0-7, Annual Dipping Sonar and Sonobuoy Testing and Training Events), and the hours remain very low for any given year with Alternative 1. Activities that started out relatively high in terms of hours (e.g., surface vessels, including surface UMS) increase very little with Alternative 1, and no water-based activity that started out fairly high also increases substantially with this alternative. Other water-based activities started out very low in terms of events or hours and also increase very little (e.g., in-water electromagnetic devices that also simulate vessel noise; Table 3.0-16, Operating Hours by Energy-producing Asset for the Proposed Action Alternatives);
- Land-based assets and affected sub-resources (aerial/terrestrial insects, terrestrial reptiles and amphibians, terrestrial mammals; Table 3.4-1): For UGS operating hours on previously disturbed lands, the maximum number increases from 4 to 80 (Table 3.0-10, Types of Land-Based Asset Activities (Hours per Year)). Even 80 hours per year would not change the characterization of this relatively quiet activity from infrequent to frequent in previous disturbed areas. Other sound-producing land-based activities started out relatively high (e.g., grounded aircraft, ground support equipment) or very low (e.g., ground test facility events) in terms of events or hours and also increase very little (Table 3.0-10 and Table 3.0-11, Type and Number of Ground Test Facility Events); and
- Non-explosive munitions and other MEM and affected sub-resources (estuarine invertebrates, estuarine fish, estuarine reptiles, water birds, and freshwater/marine mammals; Table 3.4-1): The greatest increases in MEM-based activity relative to the No Action Alternative (baseline) started out very low in terms of weapons firing or MEM impact numbers Table 2.3-2, Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed energy Weapon Systems), and they remain low for any given year with Alternative 1. The numbers for weapons firing or MEM impact noise with the No Action Alternative (67,904 and 69,413, respectively) increase 39 percent with Alternative 1.

In summary, the most significant increases in acoustic disturbances with Alternative 1 are with the aircraft flights below 3,000 feet AGL, followed by non-explosive munitions and other MEM, affecting mostly the Chesapeake Bay Water Range. The increases in aircraft flights would affect birds in and around the runways and low-altitude flights paths most directly, due to the primarily daytime activity of both aircraft and birds and typically lower altitudes of bird activity. Terrestrial animals and bats are generally more active at night when aircraft flights are less frequent. Animals on the ground and on the estuarine surface in and around the airfield environment (but not on the runways) would likely habituate to the more frequent noise, based on analysis provided under the No Action Alternative. The increasing instances of weapons firing and impact noise would continue to represent an infrequent and miniscule duration of disturbance that would likely have a negligible impact on estuarine animal populations (e.g., marine mammals, water birds, fish). The very minor increases in other noise-producing assets (e.g., vessel noise, dipping sonar, land vehicles) do not elevate the conclusions from the No Action Alternative to any long-term/population-level effects.

Physical Disturbance and Strike

The qualitative analysis detailed and summarized in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Physical Disturbance and Strike) also apply to Alternative 1. Whereas the quantitative increases in activities (e.g., vessel hours) and expended materials (e.g., number of materials) and addition of some new activities suggest a greater physical disturbance and strike potential from Alternative 1 compared to the No Action Alternative, they are not expected to alter the qualitative conclusions from the No Action Alternative in a meaningful way because:

- The physical disturbance and strike stressor intensities (per individual asset or MEM) and their locations in the PRC Study Area are mostly the same at the level of description used in the affected environment section (e.g., restricted airspace, estuarine waters of the middle Chesapeake Bay). For example, the intensity and location of physical disturbance and strike potential produced by an individual fixed-wing jet operating below 3,000 feet AGL is approximately the same regardless of alternative. Exceptions include the new activity in the Patuxent River Seaplane Area described under the acoustic stressor. Other exceptions include:
    - The physical disturbance and strike potential added from the relatively few active sonobuoys expended with additional dipping sonar tests (Section 3.0.2.3.1.2, Acoustic Stressors, Vessels (and Other Water-Based Assets), Sonars and Other Transducers) that represent a negligible contribution to the overall MEM footprint; and
    - The physical disturbance and strike from unrecovered UAS target fragments associated with directed energy weapon system testing proposed in PRC land areas, Bloodsworth Island SDZ where there is currently no MEM expended, and Chesapeake Bay Water Range where MEM is already included with the No Action Alternative (Section 3.0.2.3.5.4, Energy Stressors, Directed Energy). The new activity in the Bloodsworth Island SDZ could affect seagrass beds, shellfish beds, and estuarine animals in the area, though impacts are unlikely due to: (1) SOP directing water-based assets to avoid shallow water hazards/habitats, and (2) recovery of most downed UAS targets. In deeper water where UAS target use is more likely, the chance encounter of a rare UAS target striking a rare estuarine animal (e.g., sea turtle, marine mammal) and doing any significant damage should be considered remote. The UAS targets expended on PRC land areas would be on previously disturbed areas (i.e., regularly mowed) or other installation land areas where no sensitive species would be impacted (refer to Section

3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization, for supporting details). Other air-, water- or land-based assets (weapon platforms or targets) for directed energy weapon testing are included in the numbers for other activities analyzed for the No Action Alternative and not meaningfully different for Alternative 1 (e.g., surface vessel activities).

- The changes do not alter an overall characterization of physical disturbance and strike stressors as either localized and infrequent (outside the airfield environment) or localized and frequent (in airfield environment), with supporting details in the following bulleted list.
  - Air-based assets and affected sub-resources (aerial invertebrates, birds, and bats; Table 3.4-1): The characterization under the acoustic stressor also applies to physical disturbance and strike, but at much closer ranges;
  - Water-based assets and affected sub-resources (estuarine plants, aerial/estuarine invertebrates, estuarine fish, estuarine reptiles, water birds, bats, and freshwater/marine mammals; Table 3.4-1): The characterization under the acoustic stressor for animals also applies to physical disturbance and strike, but at much closer ranges. An addition with regard to physical disturbance and strike is the stationary targets/bottom devices (Table 3.0-13, Type and Annual Number of Stationary Targets or Bottom Devices) that also start low in terms of numbers and increase substantially. However, the relative impact of these devices remains low compared to mobile assets that are far more numerous but still considered a localized and infrequent occurrence in mostly the deeper estuarine waters;
  - Land-based assets and affected sub-resources (terrestrial vegetation, aerial/terrestrial insects, terrestrial reptiles and amphibians, terrestrial mammals; Table 3.4-1): The characterization under the acoustic stressor for animals also applies to physical disturbance and strike on plants and animals, but at much closer ranges. An exception would be for stationary ground test facilities that do not present a disturbance or strike stressor; and
  - Non-explosive munitions and other MEM and affected sub-resources (estuarine plants, estuarine invertebrates, estuarine fish, estuarine reptiles, water birds, and freshwater/marine mammals; Table 3.4-1): The greatest increases in MEM-based activity relative to the No Action Alternative started out very low in terms of area footprint as a percentage of munition concentration areas (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis), and they remain low with Alternative 1. The physical disturbance and strike footprint for MEM with the No Action Alternative (10,486 ft^2) increases 84 percent with Alternative 1 (including UAS target fragments). But this increase for temporary or short-term impacts (on animals and habitats, respectively) represents only 0.0013 percent of the area of munition concentration areas per year.

In summary, the most significant increases in physical disturbances and strike potential with Alternative 1 are with the aircraft flights below 3,000 feet AGL (a 45 percent increase), followed by non-explosive munitions and other MEM, affecting mostly the Chesapeake Bay Water Range. The increases in aircraft flights would affect birds in and around the runways and low-altitude flights paths most directly, due to the primarily daytime activity of both aircraft and birds and typically lower altitudes of bird activity. Terrestrial animals and bats are generally more active at night when aircraft flights are less frequent. Animals on the ground and on the estuarine surface in and around the airfield environment (but not on the runways) would likely habituate to the more frequent physical disturbance, based on analysis provided under the No Action Alternative. Assuming a potential 45 percent increase in BASH incidents involving birds could mean approximately 4 to 5 additional birds struck and reported, on average, per year. Such a low number of birds per year would not present a long-term/population-level effect to the bird species likely to occur in and around the airfield environment.

The increasing instances of weapons firing and expenditure of MEM would continue to represent an infrequent and miniscule duration of disturbance and strike potential that would likely have a negligible impact on estuarine animal populations (e.g., marine mammals, water birds, fish). The very minor increases in other moving assets (e.g., high-speed vessel activity, land vehicles) do not elevate the conclusions from the No Action Alternative to any long-term/population-level effects.

Pollutants

The increase in air and water pollutants from air-, water-, and land-based assets and some MEM analyzed in Sections 3.2 (Air Quality) and 3.3 (Water Resources and Sediment) for Alternative 1 is not expected to exceed any regulatory thresholds for environmental or aquatic life protection and would continue to represent a very small portion of the overall PRC Study Area annual emissions/material additions that affect regional air quality or water quality of the Chesapeake Bay. For substances without regulatory standards for environmental or aquatic life protection (e.g., iron, chaff), the effect on biological resources is limited to only discountable effects even at slightly higher concentrations (refer to analysis in Section 3.4.3.1, Environmental Consequences, No Action Alternative, Pollutants). For both potential pollutants, the environmental concentrations needed to produce a measurable effect on biological resources are far in excess of what any of the Proposed Action alternatives would generate. For these reasons, pollutant stressors associated with Alternative 1 would be unlikely to result in significant adverse impacts on plant and animal populations in the PRC Study Area.

Energy

As described in Section 3.0.2.3.5 (Identifying Stressors for Analysis, Energy Stressors), the types of energy sources associated with the Alternative 1 include: (1) in-air electromagnetic, (2) in-water electromagnetic, (3) non-weaponized directed energy, and (4) weaponized high-energy lasers and high-power microwaves associated with directed energy weapon system testing that are new to the Proposed Action under this alternative.

Electromagnetic Energy and Non-weaponized Directed Energy

The qualitative analysis details provided in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Energy) also apply to Alternative 1. Whereas the quantitative increases in activities and addition of some new activities that generate electromagnetic energy or non-weaponized directed energy suggest a greater impact from Alternative 1 compared to the No Action Alternative, they are not expected to alter the qualitative conclusions from the No Action Alternative in a meaningful way because:

- The electromagnetic energy and low-energy laser sub-stressor intensities (per asset or MEM) and their locations in the PRC Study Area are the same at the level of description used in the affected environment section (e.g., restricted airspace, estuarine waters of the middle Chesapeake Bay);

- The changes do not alter an overall characterization of electromagnetic energy or low-energy sub-stressor effects as either infrequent (outside the airfield environment) or frequent (in airfield environment), with supporting details in the following bullets.
  - Air-based assets and affected sub-resources (aerial invertebrates, birds, and bats; Table 3.4-1): The characterization under the acoustic stressor also applies to in-air electromagnetic energy and low-energy laser sub-stressors, but at much closer ranges;
  - Water-based assets and affected sub-resources (aerial/estuarine invertebrates, estuarine fish, estuarine reptiles, water birds, bats, and freshwater/marine mammals; Table 3.4-1): The characterization under the acoustic stressor also applies to in-air electromagnetic energy and low-energy laser sub-stressors, but at much closer ranges; and
  - Land-based assets and affected sub-resources (aerial/terrestrial insects, terrestrial reptiles and amphibians, terrestrial mammals; Table 3.4-1): Stationary land-based activities generating in-air electromagnetic energy started out very low in terms of events and also increase very little (Table 3.0-11, Type and Number of Ground Test Facility Events).

In summary, the most significant increases in electromagnetic energy and non-weaponized directed energy with Alternative 1 are between aircraft flights below 3,000 feet AGL and the various targets for sensor activity (e.g., radar, laser targeting). The very close ranges needed for a potential impact on biological resources would be overshadowed by the acoustic and physical disturbance associated with mobile assets. The very minor increases in other electromagnetic energy–producing assets (e.g., mine countermeasure systems, some land facilities) do not elevate the conclusions from the No Action Alternative to any long-term/population-level effects.

Directed Energy Weapon Systems Testing

The addition of directed energy weapon testing with Alternative 1 adds 150 UAS targets, 53 of which would be expended over the Chesapeake Bay Water Range or Bloodsworth Island SDZ. The expenditure of MEM in Bloodsworth Island Range SDZ represents an expansion of locations where MEM may be expended from the No Action Alternative and Alternative 1. Weaponized high-energy laser use on Bloodsworth Island Range will be approved on a case-by-case basis. Targeting from surface to air (at UAS targets) may affect aerial insects, birds, and bats, whereas targeting from air (or surface) to surface (at land- or water-based targets) may affect terrestrial plants and animals or estuarine plants and animals at or near the surface. The effects of the UAS targets on biological resources are covered under the acoustic and physical disturbance and strike stressor sections.

All weaponized high-energy laser and high-power microwave use will follow the laser safety standard operating procedures and guidance documents indicated in Table 2.5-1 (Standard Operating Procedures), including a requirement that the intended target be positively identified and confirmed before activating a directed energy weapon. Whereas the path of a directed energy weapon from origin platform to the target could briefly intersect a plant or animal in the air or on a surface, the thermal effects would be momentary as the weapon tracks its moving target. Whereas a plant could easily regenerate small areas of damage, an organism could sustain a more serious injury in the event of an prolonged intersection. Very small organisms could be damaged with even an instant of intersection. Aquatic plants or animals at or near the water surface could also be injured to a lesser degree. However, the prolonged intersection of a moving directed energy beam and a larger organism should be considered very unlikely. The high-energy weapons are also characterized as short-range, which limits their effects range on incidental targets. In the unlikely event of a intersection with directed energy, the affected species would likely be small and a common/generalist whose population would be unaffected by impacting a small number of individuals. In other words, the potential for both intersecting and affecting protected species that are relatively large and resilient (e.g., sea turtles, marine mammals) is remote. A combination of assets and stressors in an area could also expose animals to less harmful effects (e.g., acoustic or physical disturbance stressors) before the more damaging ones (e.g., directed energy effects, physical strike).

Entanglement and Ingestion

The qualitative analysis details provided in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Entanglement and Ingestion) also apply to Alternative 1. Whereas the quantitative increases in expended materials and addition of some new activities that include entanglement and/or ingestion stressors suggest a greater impact from Alternative 1 compared to the No Action Alternative, they are not expected to alter the qualitative conclusions from the No Action Alternative in a meaningful way because:

- The entanglement and ingestion stressor intensities (per asset or MEM) and their locations in the PRC Study Area are mostly the same at the level of description used in the affected environment section (e.g., estuarine waters of the middle Chesapeake Bay). Exceptions are described in subsequent bullets.
    - The addition of active sonobuoys that fully deploy around the dip points just north of the Chesapeake Water Range (Section 3.0.2.3.1.2, Acoustic Stressors, Vessels (and Other Water-Based Assets), Sonars and Other Transducers). The entanglement and ingestion potential added from the active sonobuoys represents a negligible contribution to the overall MEM footprint that may affect estuarine animals mostly away from shore (e.g., pelagic fishes, sea turtles, marine mammals); and
    - The ingestion potential from unrecovered UAS target fragments associated with directed energy weapon system testing occurs in the Bloodsworth Island Range SDZ where there is currently no MEM expended, as well as the Chesapeake Bay Water Range where MEM is also included with the No Action Alternative (Section 3.0.2.3.5.4, Energy Stressors, Directed Energy). The increase in target fragments in the Bloodsworth Island Range SDZ represents a miniscule portion of an already small footprint of MEM in the deeper estuarine waters of the PRC study area (refer to physical disturbance and strike stressor for details), and therefore no change in the analysis conclusions from the No Action Alternative.

The changes do not alter an overall characterization of entanglement or ingestion stressor effects as either infrequent (outside the airfield environment) or frequent (in airfield environment). Entanglement stressors decrease by 24 percent from a relatively low number (568 items; Table 3.0-17, Potential Entangling Materials Released in the Chesapeake Bay Water Range) and small portion of the overall MEM footprint. Ingestion stressors, including UAS target fragments, increase by 55 percent from a relatively larger number (46,541 items; Table 3.0-18, Potential Ingestible Materials Released in the Chesapeake Bay Water Range). But the overall footprint of MEM (including many ingestion stressors) represents only 0.0013 percent of the area of munition concentration areas per year.

In summary, the entanglement and ingestion stressors associated with Alternative 1 would be decreasing and increasing, respectively. For entanglement, the impact on estuarine animals would be less than the No Action Alternative and, therefore, no long-term/population-level impacts would be expected. For ingestion stressors, the footprint on the bottom continues to represent a miniscule portion of estuarine habitat in mostly the deeper waters of the Chesapeake Bay that are seasonally hypoxic and less appealing as a foraging habitat. Sturgeon and sea turtles may consume an ingestible item, but adverse effect would be unlikely, based on the analysis in Section 3.4.4.1 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction) for a greater quantity of ingestion stressors.

Indirect/Secondary

The qualitative analysis details provided in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Indirect/Secondary) also apply to Alternative 1. The quantitative changes in direct stressors described under the individual stressors above are not expected to change the aforementioned conclusions for indirect/secondary stressors that are limited to qualitative analysis and professional judgement.

Stressors Combined

The qualitative analysis details provided in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Stressors Combined) also apply to Alternative 1. The quantitative changes in direct and indirect/secondary stressors described under the individual stressors are not expected to change the aforementioned conclusions for stressors combined that are limited to qualitative analysis and professional judgement.

3.4.3.3 Biological Resources, Alternative 2 (Preferred Alternative) Potential Impacts

Relative to the No Action Alternative and stressor/sub-stressors that affect biological sub-resources, Alternative 2 includes a maximum increase in air-, water-, and land-based asset (e.g., operating hours, events, numbers) and expenditure of munitions and other MEM, and the addition of some new activities and a new sub-stressor. However, the activities measures either do not change (directed energy weapon system testing), decline (supersonic flights, entangling MEM), or increase only slightly (everything else), from that of Alternative 1. For the same reasons outlined for Alternative 1, the changes would not alter the overall conclusions from the No Action Alternative in a meaningful way. Repetition of the analysis under the No Action Alternative and Alternate 1 is therefore unnecessary.

The greatest and most significant increase in proposed activity with Alternative 2 over the No Action Alternative is with aircraft activity below 3,000 feet AGL (a 61 percent increase) that will primarily affect birds in and around the airfield environment due to the typically daytime activity of both birds and aircraft and low altitudes of most bird activity. Terrestrial animals and bats are generally more active at night when aircraft flights are less frequent. The effects would be a combination of longer range acoustic disturbances, closer range physical disturbance, and very close range strike potential that will likely increase the number of birds struck annually by aircraft. Federally protected species that may occur in the PRC Study Area (e.g., sturgeon, sea turtles, some nearshore birds, marine mammals) would not typically be found in this frequently disturbed environment and would be minimally affected by the increase. The impacts would be mostly to birds commonly found in and around the airfield environment that tend to habituate to increasing disturbance from airfield activities. Assuming a potential 61 percent increase in BASH incidents involving birds could mean approximately 6 additional birds struck and reported, on average, per year. Such a low number of birds per year would not present a long-term/population-level effect to the bird species likely to occur in and around the airfield environment.

The substantial increases in other assets and associated stressors over the No Action Alternative do not elevate the conclusions to any long-term/population-level effects because the baseline number and duration of events was either very low (e.g., dipping sonar, unmanned asset activity) and/or relatively sparse and infrequent compared to aircraft activity in and around the airfield environment (e.g., high-speed vessel activity, non-explosive MEM).

3.4.3.4 Alternative Impact Summary

Summary of Impacts, Biological Resources

The Navy considered all potential stressors on biological resources (acoustic, physical disturbance and strike, pollutants, energy, entanglement, ingestion, indirect/secondary, and stressors combined) from the Proposed Action alternatives. For all Proposed Action alternatives, the potential impact of the proposed activities is minimized by established standard operating procedures (Section 2.5) and avoidance and mitigation measures (Section 3.10).

Alternative 2 (Preferred Alternative)

- The type of events would be mostly the same as under the No Action Alternative, but the number of events would be greater due to a maximum level of current and additional activities. The additional events feature the same stressors, representative assets, and locations as under the No Action Alternative. Alternative 2 would add active sonobuoys in the same location as dipping sonar and directed energy weapon systems testing. The additional events and activities would not result in long-term/population-level impacts for any biological resource, in accordance with the analysis summarized below.

  Estuarine Environment

- Estuarine vegetation (e.g., marsh plants, seagrass beds) may be affected by physical disturbance and strike, pollutants, indirect or secondary stressors, and combined stressors from mostly water-based assets. However, the damaging effect of these localized and infrequent or temporary stressor sources is not expected to result in any long-term/population-level impacts on estuarine plant species. Estuarine animals, including sturgeon, sea turtles, water birds, and marine mammals, may be affected by acoustic, physical disturbance and strike, pollutants, energy, entanglement, ingestion, indirect/secondary, and combined stressors from mostly air- and water-based assets and associated weapons firing/MEM. However, the mostly behavioral response to these localized and infrequent or temporary sub-stressors is not expected to result in any long-term/population-level impacts on estuarine animal species.
- Impact of additional activities: Estuarine vegetation may be impacted by directed energy weapon systems testing and associated UAS targets expended in the Bloodsworth Island Range SDZ, though minimally, due to the nature of the disturbances. Directed energy weapon systems testing over estuarine waters may damage plant tissue at or above the surface, but the effect would be unlikely to occur and/or insignificant in terms of population-level effects on estuarine plant species. Invertebrates, fishes, and reptiles, including shellfish beds, sturgeon, and sea turtles, are not sensitive to mid-frequency sounds from dipping sonar and

active sonobuoys. Marine mammals are sensitive to mid-frequency sonar but impacts from this rare activity would be avoided with application of established avoidance and mitigation measures and other factors. Directed energy weapon systems testing and associated UAS targets expended in the Chesapeake Bay Water Range and Bloodsworth Island Range SDZ are very unlikely to coincide with the occurrence of rare species (e.g., sturgeon, sea turtles, marine mammals) at the surface and it would be unlikely to harm large and resilient animals in the event of a brief exposure. Impacts on smaller estuarine animals could be more damaging but would be unlikely and insignificant in terms of population-level effects.

Aerial, Terrestrial, and Freshwater Environments

- Terrestrial vegetation in mostly previously disturbed land areas may be affected by physical disturbance and strike, pollutants, indirect or secondary stressors, and stressors combined from land-based assets. However, the damaging effect of these localized and infrequent or temporary sub-stressors is not expected to result in long-term/population-level impacts on terrestrial plant species. Freshwater vegetation would not be affected by any of the action alternatives. Aerial and terrestrial animals, including rare tiger beetles, shore birds, and wading birds, may be affected by acoustic, physical disturbance and strike, pollutants, energy, indirect/secondary, and combined stressors from mostly air- and land-based assets. Freshwater animals may be affected by acoustic stressors when their head is above water. However, the mostly behavioral response to these mostly localized and infrequent or temporary stressor sources is not expected to result in long-term/population-level impacts on aerial, terrestrial, or freshwater animal species.
- Impact of additional activities: Terrestrial vegetation may be damaged by directed energy weapon systems testing and associated UAS targets recovered over previously disturbed areas, but the effect would either be very unlikely to occur for rare plants or insignificant in terms of a population-level effects in the event of an effect on more-common plants. No effect on freshwater plants is expected from directed energy weapon systems testing. Rare species (e.g., tiger beetles, some wading/shore birds) are very unlikely to coincide with directed energy weapon systems testing over terrestrial areas and effects would be insignificant in terms of population-level effects on more-common animals. No effect on freshwater animals is expected from directed energy weapon systems testing.

Alternative 1

- The type of events would be mostly the same as under the No Action Alternative, but the number of events would be greater due to the increased level of current and additional activities. The additional events feature the same stressors, representative assets, and locations as under the No Action Alternative. Alternative 1 would add active sonobuoys in the same location as dipping sonar and directed energy weapon systems testing. The additional events and activities would not result in long-term/population-level impacts for any biological resource.

No Action Alternative

- The type of events would be mostly the same as under Alternatives 1 and 2, but the number of events would be lower due to the decreased level of only current activities. The current level of activity characterizing the No Action Alternative has not resulted in long-term/population-level impacts for any biological resource.

3.4.4 Federal Endangered Species Act – Biological Assessments

This section serves as the assessment for species covered under the federal ESA. The purpose of this section is to describe the status of affected species, distinct population segments (DPSs), and critical habitats and review the Proposed Action alternatives in sufficient detail to determine to what extent the Proposed Action (Preferred Alternative) may affect those biological sub-resources that may occur in the PRC Study Area for ESA section 7 consultation.

The regulatory determinations for ESA section 7 consultation are based on an assessment of:

- Direct and indirect effects (including individual and combined stressors) of the action(s)[5] under consultation, including avoidance and mitigation measures (Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization); and
- The effects of the action when added to the environmental baseline and the predicted cumulative effects to determine the overall effects to the species for purposes of preparing a biological opinion on the Proposed Action, that is the responsibility of the regulatory agencies being consulted. For the purpose of this biological assessment, a description of future non-federal projects adding to relevant cumulative effects is provided.

The possible regulatory determinations required for ESA section 7 consultation include:

- No Effect – the appropriate determination when the action agency determines its proposed action may have discountable, insignificant, or completely beneficial effects on a listed species or critical habitat.
- May Affect, Not Likely to Adversely Affect – the appropriate determination when the action agency determines its proposed action may have discountable, significant, or completely beneficial effects on a listed species or critical habitat.
    - Beneficial effects – contemporaneous positive effects without any adverse effects;
    - Insignificant effects – adverse effects that cannot be meaningfully measured, detected, or evaluated and are not expected to ever reach the level where “take” occurs; and/or
    - Discountable effects – adverse effects that are extremely unlikely to occur; based on best judgment, a person would not expect discountable effects to occur.
- May Affect, Likely to Adversely Affect – the appropriate determination when an action agency determines its proposed action will have effects on a listed species or critical habitat that are not discountable, insignificant, or beneficial.

The following information is referenced in Sections 3.4.4.1 and 3.4.4.2 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction and U.S. Fish and Wildlife Service Jurisdiction, respectively) to comply with statutory requirements to use the best scientific information available when assessing the risks posed to listed and/or proposed species and designated and/or proposed critical habitat by proposed federal actions. This section is prepared in accordance with legal requirements set forth under regulations implementing section 7 of the ESA (50 CFR part 402; 16 U.S.C.

[5] Including interrelated and interdependent action.

section 1536 (c)). The parts of a biological assessment are provided in this section or referenced to another section of this document:

- The description of the Proposed Action and associated stressors is provided in Chapter 2 (Proposed Action and Alternatives) and Section 3.0.2.3 (Identifying Stressors for Analysis), respectively.
- The "Environmental Baseline" for all habitats in the PRC Study Area is provided in Section 3.4.2.1 (Affected Environment, Environmental Baseline) and linked to ESA-listed species by "Species-Specific Threats" described under Sections 3.4.4.1 and 3.4.4.2 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction and U.S. Fish and Wildlife Service Jurisdiction, respectively).
- The "References" section of this EIS provides the full citations for referenced information.

The action proponent has not consulted with NMFS or USFWS on this Proposed Action in any way prior to this version of the Draft EIS.

3.4.4.1 Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction

This section serves as the biological assessment for species covered under the ESA (NMFS jurisdiction).

Status of Affected Species and Critical Habitats

The following listed and proposed candidate species and critical habitats may be present in the Proposed Action area described in Chapter 2 (Proposed Action and Alternatives) and Section 3.0 (Introduction) for the Preferred Alternative (Alternative 2):

- Sea turtles (4 Species):
  - Green sea turtle (*Chelonia mydas*)/North Atlantic Ocean DPS – Listed Threatened
  - Kemp's ridley sea turtle (*Lepidochelys kempii*) – Listed Endangered
  - Leatherback sea turtle (*Dermochelys coriacea*) – Listed Endangered
  - Loggerhead sea turtle (*Caretta caretta*)/Northwest Atlantic Ocean DPS – Listed Threatened
- Sturgeons:
  - Atlantic sturgeon (*Acipenser oxyrinchus oxyrhynchus*)/Carolina, Chesapeake Bay, and New York Bight DPSs – Listed Endangered, with Critical Habitat described in the subsequent affected environment section
  - Shortnose sturgeon (*Acipenser brevirostrum*) – Listed Endangered

This section describes the affected environment for both proposed and currently listed species, organized into the following categories of information:

- Status and Management
- Habitat and Geographic Range
- Population Trends
- Predator and Prey Interaction
- Species-specific Threats

Sea Turtle Species

Green Sea Turtle

Status and Management

The green sea turtle was first listed under the ESA in 1978. In 2016, NMFS and the USFWS reclassified the species into 11 distinct population segments, which maintains federal protections while providing a more tailored approach for managers to address specific threats facing different populations (see the NMFS and USFWS Final Rule published on April 6, 2016). The geographic areas that include these distinct population segments are as follows: (1) North Atlantic Ocean, (2) Mediterranean Sea, (3) South Atlantic Ocean, (4) Southwest Indian Ocean, (5) North Indian Ocean, (6) East Indian Ocean – West Pacific Ocean, (7) Central West Pacific Ocean, (8) Southwest Pacific Ocean, (9) Central South Pacific Ocean, (10) Central North Pacific Ocean, and (11) East Pacific Ocean. Only the North Atlantic Ocean DPS (listed as threatened) is within the PRC Study Area and is discussed further in this document (Seminoff et al., 2015).

In 1998, critical habitat was designated for green sea turtles in coastal waters around Culebra Island, Puerto Rico (63 Federal Register 46693). There is no critical habitat designated for the green sea turtle within the PRC Study Area.

Habitat and Geographic Range

The green sea turtle is distributed worldwide across tropical and subtropical coastal waters generally between 45 degrees north and 40 degrees south. After emerging from the nest, green sea turtle hatchlings swim to offshore areas, where they forage and develop in floating *Sargassum* habitats of the open ocean. For the North Atlantic DPS, green sea turtle post-hatchlings are known to live in the open-ocean waters of the Gulf Stream and North Atlantic Gyre (Christiansen et al., 2016a; Putman & Mansfield, 2015; Witherington et al., 2012). At the juvenile stage (estimated at five to six years), they leave the open-ocean habitat and retreat to protected lagoons and open coastal areas that are rich in seagrass or marine algae (Bresette et al., 1998; Bresette et al., 2006; Plotkin & Amos, 1998), where they will spend most of their lives (Bjorndal & Bolten, 1988). The optimal developmental habitats for late juveniles, and foraging habitats for adults, are warm shallow waters (3 to 5 meters [10 to 16 feet]) with abundant SAV and close to nearshore reefs or rocky areas (Holloway-Adkins, 2006; Seminoff et al., 2002; Seminoff et al., 2015). In the western North Atlantic, juvenile green sea turtles forage as far north as Cape Cod Bay, Massachusetts; as far east as Bermuda; and throughout the Caribbean.

There are four main regions within the North Atlantic Ocean DPS that support nesting concentrations—Costa Rica (Tortuguero), Mexico (Campeche, Yucatan, and Quintana Roo), United States (Florida), and Cuba. For the United States, most green sea turtle nesting occurs along the Atlantic Coast of eastern central Florida, with smaller concentrations along the Gulf Coast and Florida Keys. Occasional nesting also occurs in Texas, Georgia, South Carolina, North Carolina, and Virginia. Green sea turtles have been documented nesting on Virginia beaches located north and south of Dam Neck Annex, but not in estuarine and coastal areas near the PRC Study Area (Maryland Department of Natural Resources, 2019b; Virginia Department of Game and Inland Fisheries, 2016).

As ocean temperatures increase in the spring, green sea turtles migrate from southeastern U.S. waters to the estuarine habitats of Long Island Sound, Peconic Bay, Chesapeake Bay, and possibly Nantucket Sound, where an abundance of algae and eelgrass occurs. Peak occurrence along the Northeast U.S. Continental Shelf and adjoining estuaries is likely in September (Berry et al., 2000). During nonbreeding periods, adult and juvenile distributions may overlap in coastal feeding areas (Hirth, 1997; Weishampel et al., 2006). Adult green sea turtles conduct breeding migrations between foraging and nesting grounds every few years (Plotkin, 2003; National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2007). The main source of information on green sea turtle distribution in the PRC Study Area comes from stranding records.

Green sea turtles are not common inhabitants of the Chesapeake Bay and are only present in the warmer months, primarily from May to October (Mansfield et al., 2009). Green sea turtles prefer seagrass flats; therefore, they would be more likely to occur in the shallow areas of the Bay, such as the waters around Bloodsworth Island Range and Smith Island (see Figure 3.4-1 in Section 3.4.2.2, Affected Environment, Vegetation). Green turtles have been sighted (in low numbers) in the lower and middle Chesapeake Bay (Virginia waters) during spring, summer, and fall aerial line transect surveys from 2011–2012 (Barco et al., 2018a). Surveys were conducted in the coastal ocean waters of Virginia and Maryland, including most of the Chesapeake Bay. Green turtle sightings comprised about 5.5 percent (n=195) of the total sightings that were recorded during the surveys, with most of the sightings occurring in the coastal ocean waters (Barco et al., 2018a)

Sea turtle strandings (dead and live for all species) in Virginia have increased since the 1990s, with an average of 247 strandings per year from 2009 to 2018 (Costidis et al., 2019). This increase in stranding numbers could be due to an increase in sea turtle monitoring effort or due to more green turtles occurring in the region. More green turtle strandings have been recorded in Virginia compared to Maryland, and these are almost exclusively juvenile turtles (Barco & Lockhart, 2015; Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019). Strandings were mainly recorded in the lower Chesapeake Bay from 2000 to 2019, with less than five strandings, overall, recoded in the middle and upper portions of the Bay, as well as the Potomac River. No green turtles have been recorded stranded on and around NAS Patuxent River, Bloodsworth Island Range, and OLF Webster (Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019).

Population Trends

Green turtle nesting has shown an exponential increase over the past 29 years, with nests reported along the Florida Panhandle, Florida Gulf Coast, Florida Atlantic Coast, Georgia, Alabama, South Carolina, North Carolina, and Virginia (Florida Fish and Wildlife Conservation Commission, 2019a; Seminoff et al., 2015). A green sea turtle nested at Cape Henlopen State Park in Delaware in August 2011, which was the first green sea turtle nesting ever observed north of Virginia (Murray, 2011). While nesting abundance has been monitored at these sites for decades, in-water abundance for green sea turtles in the Gulf of Mexico or along the Atlantic Coast remains unavailable (Seminoff et al., 2015).

Generally, nesting trends in the Western Atlantic Ocean are stable to increasing, and are increasing in Florida, as shown by annual total nest counts for green sea turtles on Florida's index beaches. Green sea turtle nest counts in Florida have increased by a factor of 80 since counts began in 1989. Green sea turtles set record highs in 2011, 2013, 2015, and 2017. In 2018, green sea turtle nest counts on the index beaches were substantially lower than in 2017. This decline in nest counts does not represent a downward trend, as green sea turtles tend to follow a two-year reproductive cycle; therefore, it is normal to have wide year-to-year fluctuations in the number of nests recorded (Florida Fish and Wildlife Conservation Commission, 2019a).

Predator and Prey Interactions

The green sea turtle is the only species of sea turtle that, as an adult, primarily consumes plants and other types of vegetation (Burgett et al., 2018; Mortimer, 1995; Nagaoka et al., 2012). While primarily herbivorous, a green sea turtle's diet changes substantially throughout its life. Very young green sea turtles are omnivorous (Bjorndal, 1997; Burgett et al., 2018). Salmon et al. (2004) reported that post-hatchling green sea turtles were found to feed near the surface on seagrasses or at shallow depths on comb jellies and unidentified gelatinous eggs off the coast of southeastern Florida. Juvenile green sea turtles are more of generalist feeders and may forage on several different prey types including algae, invertebrates, tunicates, tubeworms, and seagrass (Bjorndal, 1997; Holloway-Adkins & Hanisak, 2017; Nagaoka et al., 2012; Sampson & Giraldo, 2014). Research indicates that green sea turtles in the open-ocean environment, and even in coastal waters, also consume jellyfish, sponges, and sea pens (Hatase et al., 2006; Seminoff et al., 2015).

Sharks are the primary nonhuman predators of juvenile and adult green sea turtles at sea (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1991; Seminoff et al., 2015).

Species-Specific Threats

Sea turtles that utilize coastal foraging habitats are at risk of being impacted by anthropogenic effects such as fisheries bycatch, vessel strike, and entanglement and ingestion of marine debris. Scientists reported that 54 percent of stranded green turtles from a foraging area in New Zealand showed signs of anthropogenic impacts (Godoy & Stockin, 2018).

In offshore waters of the United States, bycatch from commercial fisheries is a primary threat to sea turtles. In U.S. fisheries, Finkbeiner et al. (2011) estimate that bycatch resulted in 71,000 sea turtle deaths per year prior to effective regulations that protect sea turtles (e.g., regulations adopted since the mid-1990s in different U.S. fisheries for turtle exclusion devices).

Vessel strike has been identified as one of the important mortality factors in several nearshore sea turtle habitats worldwide. Precise data are lacking for sea turtle mortalities directly caused by ship strikes; however, live and dead turtles are often found with deep cuts and fractures indicative of collision with a boat hull or propeller (Hazel et al., 2007; Lutcavage et al., 1997). For example, scientists in Hawaii reported that 2.5 percent of green sea turtles found dead on the beaches between 1982 and 2003 had been killed by boat strike (Chaloupka et al., 2008).

Debris in offshore and inshore waters present ingestion and entanglement risks for sea turtles. Ingestion of marine debris can cause mortality or injury (e.g., intestinal blockage) to sea turtles. Plastic is the primary type of debris found in marine and coastal environments, and plastics are the most common type of marine debris ingested by sea turtles (Nelms et al., 2016; Rizzi et al., 2019; Schuyler et al., 2014). Sea turtles can mistake debris for prey; one study found that juvenile green sea turtles were at higher risk to marine debris ingestion, likely due to the resemblance of small pieces of debris to omnivorous dietary items (Fukuoka et al., 2016). In 2014, Schuyler et al. (2014) reviewed 37 studies of debris ingestion by sea turtles, showing that young oceanic sea turtles are more likely to ingest debris (particularly plastic), and that green and loggerhead turtles were significantly more likely to ingest debris than other sea turtle species.

Climate change and ocean-warming trends may negatively impact the habitat and range of this species over time (Fuentes et al., 2013). These impacts include the potential loss of nesting beaches due to sea level rise and increasingly intense storm surge (Patino-Martinez et al., 2008), feminization of populations from elevated nest temperatures (and skewing populations to more females than males unless nesting shifts to northward cooler beaches) (Laloë et al., 2017; Reneker & Kamel, 2016), decreased reproductive success (Hawkes et al., 2006; Laloë et al., 2016; Pike, 2014), shifts in reproductive periodicity and latitudinal ranges (Pike, 2014), disruption of hatchling dispersal and migration, and indirect effects to food availability (Witt et al., 2010). For example, Jensen et al. (2018), discovered that the warmer, northern Great Barrier Reef green sea turtle rookeries have produced primarily females for at least 20 years.

In addition to the threats described above, which may also affect the other species of sea turtles, damage to seagrass beds and declines in seagrass distribution can reduce foraging habitat for green sea turtles (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1991; Seminoff et al., 2015). Green sea turtles are susceptible to the disease fibropapillomatosis, which causes tumor-like growths (fibropapillomas) resulting in reduced vision, disorientation, blindness, physical obstruction to swimming and feeding, increased susceptibility to parasites, and increased susceptibility to entanglement (Balazs, 1986; National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1991; Patrício et al., 2016; Work & Balazs, 2013).

Kemp's Ridley Sea Turtle

Status and Management

The Kemp's ridley sea turtle is listed as a single population and is classified as endangered under the ESA (35 Federal Register 18319). The most recent status review was released in 2015 by the USFWS and NMFS (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2015). There is no critical habitat currently designated for this species. In 2010, the USFWS and NMFS received a petition to designate critical habitat on nesting beaches in Texas and along Gulf Coast states. The petition is still under consideration, and no proposed rule on the establishment of critical habitat has been released by either agency.

Habitat and Geographic Range

Kemp's ridley sea turtle nesting is essentially limited to the beaches of the western Gulf of Mexico, primarily in Tamaulipas, Mexico, as well as Texas (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2011). Occasional nesting has been reported from Florida, Alabama, Georgia, South Carolina, North Carolina, Virginia, with the furthest north nesting occurring in New York (in 2018) (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2015; Uda, 2018). Kemp's ridley sea turtles have been documented nesting on Virginia beaches located on Dam Neck Annex, but not in coastal areas near the PRC Study Area (Maryland Department of Natural Resources, 2019b; Virginia Department of Game and Inland Fisheries, 2016). Shaver et al. (2016) has noted that the known nesting range for the Kemp's ridley sea turtle has expanded since the late 1980s, possibly due to the captive rearing and release of sea turtles in Florida, as well as increased nesting numbers (Shaver et al., 2016).

Habitats frequently used by Kemp's ridley sea turtles in U.S. waters are warm-temperate to subtropical sounds, bays, estuaries, tidal passes, shipping channels, and beachfront waters, where their preferred food, the blue crab, is abundant (Lutcavage & Musick, 1985). The general migration pattern of females begins with travel through relatively shallow migratory corridors toward the nesting beaches in the late winter, in order to arrive at the nesting beaches by early spring. Males and females can loop along the northeast U.S. Continental Shelf in the spring, and back down the Southeast U.S. Continental Shelf in the fall. From nesting beaches in the Gulf of Mexico, the migratory corridor traverses nearshore areas of the

Mexico and U.S. Gulf Coasts in late May through August (Shaver et al., 2016). As adults, many turtles remain in the Gulf of Mexico, with only occasional occurrence in the Atlantic Ocean (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2011).

Evidence suggests that post-hatchling and small juvenile Kemp's ridley sea turtles, similar to loggerhead and green sea turtles of the same region, forage and develop in floating *Sargassum* habitats of the North Atlantic Ocean. Juveniles migrate to habitats along the U.S. Atlantic Continental Shelf from Florida to New England (Morreale & Standora, 1998; Peña, 2006) at around two years of age. Migrating juvenile Kemp's ridley sea turtles travel along coastal corridors in bottom depths generally shallower than 164 feet (50 meters) (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2011). Suitable developmental habitats are seagrass beds and mud bottoms in waters with a bottom depth of less than 33 feet (10 meters) and with sea surface temperatures between 72°F and 90°F (Coyne et al., 2000). Studies show that Virginia's coastal and estuarine waters are important seasonal developmental (foraging) habitats for juvenile Kemp's ridley sea turtles (Lutcavage & Musick, 1985; Mansfield, 2006; Seney & Musick, 2005). Individual juvenile Kemp's ridley sea turtles have been known to return to the same seasonal foraging areas, such as the Chesapeake Bay, for many years (Lutcavage & Musick, 1985; Mansfield, 2006). The main source of information on distribution in the PRC Study Area comes from telemetry studies and stranding records.

A tag study funded by the U.S. Navy and completed by Barco et al. (2017; 2018b) indicates that juvenile Kemp's ridley sea turtles utilize the lower to middle Chesapeake Bay in the spring and summer, similar to tagged loggerheads. Preliminary results indicate Kemp's ridley sea turtles prefer to spend more time and forage in shallower waters closer to shore, such as small inlets, embayments, and flats close to shore in the main stem of the Chesapeake Bay (Barco et al., 2018b). Tagged turtles displayed area-restricted search behavior (consistent with foraging) in rivers, shallow inlets, and estuarine waters off of Virginia (e.g., James and York Rivers) and Maryland (waters around Bloodsworth Island Range and Tangier Island), where their preferred prey, the blue crab, occurs. These waters may be foraging grounds while juveniles are in transit along the Atlantic Coast.

Sea turtle strandings (dead and live for all species) in Virginia have increased since the 1990s, with an average of 247 strandings per year from 2009 to 2018 (Costidis et al., 2019). Kemp's ridley sea turtles are the second most common species to strand in Virginia. From 1997 to 2019, strandings were recorded from the lower to upper Chesapeake Bay and several waterways off the Bay (e.g., York, Piankatank, and Patuxent Rivers). Kemp's ridley sea turtles have been recorded (less than 10 turtles) stranded on and around NAS Patuxent River and Bloodsworth Island Range (Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019). Injured and dead Kemp's ridley sea turtles have been recovered at OLF Webster (U.S. Department of the Navy, 2017c).

Population Trends

The earliest estimate of population size was derived from analyzing archival film footage of a large arribada (mass nesting) event in 1947 and other life history information on the Kemp's ridley sea turtle. From these data sources and the analysis of the raw footage, (Bevan et al., 2016) suggests that the Kemp's ridley sea turtle population during and prior to the 1947 nesting season was relatively robust, with the estimated number of nests exceeding 121,000. The lowest point in the decline of Kemp's ridley sea turtles occurred in 1985 (approximately 700 nests), representing a 99 percent decline in the number of nests compared to the 1947 estimate. Although the Kemp's ridley sea turtle population has shown increases since 1985, the rate of recovery has declined in recent years. In 2010, Kemp's ridley sea turtle nesting showed a steep decline (35 percent) followed by some recovery to 2009 levels, with other declines in 2013 and 2014 (Caillouet et al., 2016; National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2015; Shaver et al., 2016). The numbers of Kemp's ridley sea turtle nests counted along Texas beaches have increased from 2015 (159 nests) to 2017 (353 nests); however, nest counts fell to 250 in 2018 (Hampton, 2018; Shaver D. , 2018).

Predator and Prey Interactions

Kemp's ridley sea turtles feed primarily on crabs, but are also known to prey on molluscs, shrimp, fish, jellyfish, and plant material (Frick et al., 1999; Marquez, 1994; Seney, 2016). Plant material, primarily macroalgae, is likely consumed incidentally with invertebrate prey items (Seney, 2016). Blue crabs and spider crabs are important prey species for the Kemp's ridley sea turtle (Keinath et al., 1987; Lutcavage & Musick, 1985; Seney, 2016). They may also feed on shrimp fishery bycatch (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2011), and Servis et al. (2015) noted instances of fish and horseshoe crab predation, indicating that Kemp's ridley turtles may opportunistically feed to supplement their diet.

Sharks are the primary predator of juvenile and adult Kemp's ridley sea turtles (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2011).

Species-Specific Threats

Because the Kemp's ridley sea turtle is very range-limited, anthropogenic effects (such as fisheries bycatch, vessel strike, and entanglement and ingestion of marine debris) that sea turtles face may increase impacts on this species. For example, energy extraction and development in the Gulf of Mexico are a particular threat to Kemp's ridley sea turtles because most of the nesting activity occurs there (Shaver & Caillouet, 1998). Kemp's ridley sea turtles periodically strand on beaches in Mexico that are covered in crude oil; most of the turtles found injured and dead following the Deepwater Horizon oil spill were Kemp's ridley sea turtles (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2011; Wilkin et al., 2017).

In offshore waters of the United States, bycatch from commercial fisheries is a primary threat to sea turtles. Shrimp trawling in the southeastern U.S. Atlantic and Gulf of Mexico was once a significant threat to Kemp's ridley sea turtles; however, the use of turtle excluder devices and the general decline of shrimp fishing in recent years have greatly reduced mortality levels (Caillouet et al., 2008; Nance et al., 2012).

Vessel strike has been identified as one of the important mortality factors in several nearshore sea turtle habitats worldwide. Post-pelagic turtles that recruit to shallow coastal waters, estuaries, and bays, such as the Kemp's ridley sea turtle, are at risk of vessel strike (Godoy & Stockin, 2018). Live and dead turtles are often found with deep cuts and fractures indicative of collision with a boat hull or propeller (Hazel et al., 2007; Lutcavage et al., 1997). Several stranded Kemp's ridley sea turtles in Maryland waters were suspected of being struck by a vessel, based on the recorded damage to the carapace (Maryland Department of Natural Resources, 2019c).

Debris in offshore and inshore waters present ingestion and entanglement risks for sea turtles. Turtles living in oceanic or coastal environments and feeding in the open ocean or on the bottom may encounter different types and densities of debris, and may therefore have different probabilities of ingesting debris) (Schuyler et al., 2014).

Sea turtles are particularly susceptible to climate change effects because their life history, physiology, and behavior are extremely sensitive to environmental temperatures (Fuentes et al., 2013), feminization of populations from elevated nest temperatures (Laloë et al., 2017; Reneker & Kamel, 2016), decreased reproductive success (Hawkes et al., 2006; Laloë et al., 2016; Pike, 2014), shifts in latitudinal ranges (Pike, 2014), and indirect effects to food availability (Witt et al., 2010). Griffin et al. (2019) used a Bayesian count model to predict that this warming trend could produce higher numbers of cold-stun Kemp's ridley sea turtles within the waters of the northwest Atlantic; although cold-stunning may currently affect a small proportion of the overall population.

In addition to the threats described above, which might also affect the other species of sea turtles, vehicles on beaches can also pose a threat to the Kemp's ridley sea turtle. Vehicle activity can disrupt the nesting process, crush nests, and create ruts and ridges in the sand, which pose obstacles to turtles (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2011). Beach vehicular driving is permitted on most beaches in Texas, where adult turtles and hatchlings have been crushed by passing vehicles, as well as on some beaches in Mexico.

Leatherback Sea Turtle

Status and Management

The leatherback sea turtle is listed as a single population and is classified as endangered under the ESA (35 Federal Register 8491). Recent information on population structure (through genetic studies) and distribution (through telemetry, tagging, and genetic studies) have led to an increased understanding and refinement of the global population structure. The USFWS and NMFS completed a status review of the leatherback sea turtle in 2020 and identified seven distinct population segments based on genetic discontinuity among the populations and marked separation at nesting locations and foraging areas. The USFWS and NMFS identified the following seven leatherback populations as potential distinct population segments: Northwest Atlantic, Southwest Atlantic, Southeast Atlantic, Southwest Indian, Northeast Indian, West Pacific, and East Pacific (National Marine Fisheries Service & U.S. Fish and Wildlife Service, 2020). The seven populations have not been established as distinct population segments under the ESA because the populations are required to be identified and listed as threatened or endangered by the USWFS and NMFS through official rulemaking and publication in the Federal Register (16 U.S.C. 1533(a)(1)). Leatherback sea turtles from nesting stocks originating throughout the Atlantic have the potential to be within the PRC Study Area, but only two of these—the Florida genetic stock and the Northern Caribbean genetic stock—nest on beaches in the jurisdiction of the United States.

In 1978, critical habitat was designated for the leatherback sea turtle's terrestrial environment on St. Croix Island at Sandy Point because of its importance as a nesting habitat (43 Federal Register 43688). In 1979, critical habitat was designated for the waters next to Sandy Point, St. Croix (44 Federal Register 17710). There is no critical habitat designated for the leatherback sea turtle within the PRC Study Area.

Habitat and Geographic Range

The leatherback sea turtle is distributed worldwide in tropical and temperate waters of the Atlantic, Pacific, and Indian Oceans (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013).

Important nesting areas in the Western Atlantic Ocean occur in Florida, St. Croix, Puerto Rico, Costa Rica, Panama, Colombia, Trinidad and Tobago, Guyana, Suriname, French Guiana, and southern Brazil (Brautigam & Eckert, 2006; Márquez, 1990; National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013; Spotila et al., 1996). Occasional nesting also occurs in the Gulf of Mexico on the Florida

Panhandle, Georgia, South Carolina, and as far north as North Carolina, but not in coastal areas near the PRC Study Area (Maryland Department of Natural Resources, 2019b; National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1992; Rabon et al., 2003; Virginia Department of Game and Inland Fisheries, 2016). Female leatherbacks conduct migrations between nesting seasons, typically to the north towards more temperate latitudes, which support high densities of jellyfish prey in the summer. Leatherback sea turtles mate in waters adjacent to nesting beaches and along migratory corridors (Cummings et al., 2016; Figgener et al., 2016).

In the Northwestern Atlantic Ocean, post-nesting female migrations appear to be restricted to north of the equator; however, the migration routes vary (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013). Leatherback sea turtles have made round-trip migrations from where they started through the North Atlantic Ocean heading northwest to foraging areas off the Gulf of Maine, Canada, and Gulf of Mexico. These data support earlier studies that found that adults and subadults captured in waters off Nova Scotia stayed in waters north of the equator (James et al., 2005a; James et al., 2005b; James et al., 2006).

Limited information is available on the habitats used by post-hatchling and early juvenile leatherback sea turtles, especially in the Atlantic Ocean, because these age classes are entirely oceanic (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 1992). These life stages are not considered to associate with *Sargassum* or other flotsam and are restricted to waters warmer than 79°F; consequently, much time is spent in the tropics (Eckert, 2002; Horrocks, 1987).

Late juvenile and adult leatherback sea turtles are known to range from mid-ocean to the continental shelf and nearshore waters (Barco & Lockhart, 2015; Grant & Ferrell, 1993; Schroeder & Thompson, 1987; Shoop & Kenney, 1992). Juvenile and adult foraging habitats include both coastal and offshore feeding areas in temperate waters and offshore feeding areas in tropical waters (Dodge et al., 2014). Dodge et al. (2014) tagged adult and subadult leatherback sea turtles off the coast of Massachusetts and found that the turtles showed a strong preference for the Northeast U.S. Continental Shelf waters during the summer, with concentrated movements off Virginia and North Carolina. Additionally, turtles were recorded occurring near the mouth of the Chesapeake Bay for multiple days during the summer, ranging from 5 to 15 days. Leatherback sea turtles may prefer a temperate neritic habitat during the summer, due to the availability of their gelatinous prey source (e.g., jellyfish) in the summer (Dodge et al., 2014). The main source of information on distribution in the PRC Study Area comes from stranding and sighting records.

Leatherback sea turtles are pelagic and have been observed most commonly from the mouth of the Chesapeake Bay to offshore waters. Although leatherback sea turtles have been observed annually in the Chesapeake Bay, they are not common and are unevenly distributed. Limited sightings data indicate that leatherback sea turtles may occur in the PRC Study Area from May through August, especially in Maryland waters (Maryland Department of Natural Resources, 2019c; National Aquarium in Baltimore, 2019).

Several leatherback sea turtle strandings have been recorded from 1992 to 2017, for both Virginia and Maryland, mainly from late spring to summer (Maryland Department of Natural Resources, 2019c; Swingle et al., 2018; Virginia Aquarium & Marine Science Center, 2019). Less than 40 strandings have been recorded from the lower to upper Chesapeake Bay, with some strandings near NAS Patuxent River and Bloodsworth Island Range.

Population Trends

Leatherback sea turtle subpopulations in the Atlantic Ocean show either an increasing or stable trend, with the exception of the Western Caribbean and West Africa regions (Turtle Expert Working Group, 2007). Nesting populations in southern Florida, Culebra, Puerto Rico, and the U.S. Virgin Islands are believed to be increasing due to heightened protection and monitoring of the nesting habitat over the past 30 years (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013; Turtle Expert Working Group, 2007). The Florida nesting stock comes ashore primarily along the East Coast of Florida. In the 1980s, fewer than 100 nests per year were reported. Based on data extrapolated from the index nesting beach surveys, nesting activity has shown an annual growth rate of 1 percent between 1989 and 2005 (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013). However, larger growth rates (10.2 percent increases per year) in nesting activity in this area have been shown from 68 Florida beaches from 1979 to 2008 (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013; Stewart et al., 2011; Stewart et al., 2014). Leatherback sea turtle nest numbers have been increasing exponentially over the period of the Florida index nesting beach surveys; however, leatherback sea turtle nest counts showed a decline from 2014 to 2017. In 2018, leatherback sea turtle nest counts rebounded with 316 recorded nests compared to the 205 nests (the lowest number of nests reported since 2006) that were recorded in 2017 (Florida Fish and Wildlife Conservation Commission, 2019a).

Predator and Prey Interactions

Leatherback sea turtles lack the crushing chewing plates characteristic of hard-shelled sea turtles that feed on hard-bodied prey. Instead, they have pointed tooth-like cusps and sharp-edged jaws that are adapted for a diet of soft-bodied prey such as jellyfish and salps. Leatherback sea turtles feed at the surface and throughout the water column (Davenport, 1988; Eckert et al., 1989; Eisenberg & Frazier, 1983; Grant & Ferrell, 1993; James et al., 2005b; James et al., 2005c; Salmon et al., 2004). Leatherback sea turtle prey is predominantly jellyfish (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013; Wallace et al., 2015). In North Carolina and Georgia, turtles feed on cannonball jellies (*Stomolophus meleagris*) (Frick et al., 1999; Grant & Ferrell, 1993), which also occur in Virginia waters. Patterns in feeding behavior off St. Croix, U.S. Virgin Islands, over a 24-hour period suggest an interaction between leatherback sea turtle diving and vertical movements of the deep scattering layer (a horizontal zone of planktonic organisms), with more frequent and shallower dives at night compared with fewer and deeper day dives (Eckert et al., 1989). Research in the feeding grounds of Georgia (Frick et al., 1999) and North Carolina (Grant & Ferrell, 1993)has documented leatherback sea turtles foraging on jellyfish at the surface.

Sharks are the primary predator of juvenile and adult leatherback sea turtles (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013).

Species-Specific Threats

Sea turtles that utilize coastal foraging habitats are at risk of being impacted by anthropogenic effects, such as fisheries bycatch, vessel strike, and entanglement and ingestion of marine debris. Bycatch in commercial fisheries is a particular threat to leatherback sea turtles. Incidental capture in longline and coastal gill-net fisheries has caused a substantial number of leatherback sea turtle deaths, likely because leatherback sea turtles dive to depths targeted by longline fishermen and are less maneuverable than other sea turtle species (Finkbeiner et al., 2011; Wallace et al., 2010). The shrimp fishery in the U.S. has been estimated to capture about 1,628 leatherback sea turtles each year, with 144 of those turtles dying as a result (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013). Along the Atlantic Coast of the United States, NMFS estimated that about 800 leatherback sea turtles are captured each year in pelagic longline fisheries, bottom longline, and drift gill net fisheries combined. Although most of these turtles are released alive, these fisheries kill about 300 leatherback sea turtles each year (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013; Stewart et al., 2016). Several stranded and sighted leatherback sea turtles in Maryland waters were found entangled in crab pot lines (Maryland Department of Natural Resources, 2019c; National Aquarium in Baltimore, 2019).

Vessel strike has been identified as one of the important mortality factors in several nearshore sea turtle habitats worldwide. Live and dead turtles are often found with deep cuts and fractures indicative of collision with a boat hull or propeller (Hazel et al., 2007; Lutcavage et al., 1997). The leatherback sea turtle may be impacted from vessels, given its preference for open-ocean and coastal habitats, as well as its feeding behavior (feed at the surface) and prey (e.g., jellyfish).

Debris in offshore and inshore waters present ingestion and entanglement risks for sea turtles. Turtles living in oceanic or coastal environments and feeding in the open ocean or on the sea floor may encounter different types and densities of debris, and may therefore have different probabilities of ingesting debris and becoming entangled in debris (Schuyler et al., 2014). Sea turtles can mistake debris for prey; one study found 34 percent of dead leatherback sea turtles to have ingested various types of plastic (Mrosovsky et al., 2009). Leatherback sea turtles feed primarily on jellyfish; therefore, the ingestion of marine litter may be related to the availability of some types of plastic litter (e.g., bags) in their foraging habitat.

Lastly, climate change may impact leatherback sea turtles in ways different from other sea turtle species because their distribution is so closely associated with jellyfish aggregations, which are affected by changing ocean temperatures and dynamics (Pike, 2014). Robinson et al. (2013) suggest that climate change impacts are contributing to the Pacific leatherback sea turtle population declines through a shifting of nesting dates (i.e., time of year that nesting occurs) to increase stressor exposure. The observed mean nesting date shifts in the Atlantic leatherback sea turtle genetic stocks, in contrast to Pacific populations, may increase resiliency of Atlantic leatherback sea turtles to climate-related impacts.

Loggerhead Sea Turtle

Status and Management

In 2009, a status review conducted for the loggerhead sea turtle (*Caretta caretta*) identified nine distinct population segments within the global population (Conant et al.). In a September 2011 rulemaking, NMFS and the USFWS listed five of these distinct population segments as endangered and kept four as threatened under the ESA (76 Federal Register 58868). The North Pacific Ocean, South Pacific Ocean, North Indian Ocean, Northeast Atlantic Ocean, and Mediterranean Sea DPSs of the loggerhead sea turtle are classified as endangered under the ESA, and the Southeast Indo-Pacific Ocean, Southwest Indian Ocean, Northwest Atlantic Ocean, and South Atlantic Ocean DPSs are classified as threatened. The Northwest Atlantic Ocean DPS is the only one that occurs entirely within the PRC Study Area.

In 2014, marine and terrestrial critical habitats were designated for the loggerhead sea turtle. Specific areas designated as critical habitat include 38 occupied marine areas within the range of the Northwest Atlantic Ocean DPS of loggerhead sea turtles (79 Federal Register 39856). NMFS named five different habitat types that comprise the critical habitat designation: (1) nearshore reproductive habitat, (2) winter habitat, (3) breeding habitat, (4) constricted migratory habitat, and (5) Sargassum habitat (National Marine Fisheries Service, 2014). The USFWS designated 88 nesting beaches (consisting of approximately 685 miles of nesting beaches) in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi in a separate rulemaking (79 Federal Register 51264). There is no critical habitat designated for the loggerhead sea turtle within the PRC Study Area.

Habitat and Geographic Range

Loggerhead sea turtles occur in U.S. waters in habitats ranging from coastal estuaries to waters far beyond the continental shelf (Chapman & Seminoff, 2016; Dodd, 1988). Loggerheads typically nest on beaches close to reef formations and in close proximity to warm currents (Dodd, 1988), preferring beaches facing the ocean or along narrow bays (National Marine Fisheries Service, 2014; Reece et al., 2013). Within the United States, large nesting colonies exist in Florida, with more limited nesting occurring along the Gulf Coast and north through Maryland. Nesting in Virginia and Maryland occurs on the ocean beaches from May through September, with a peak in June and July. No nests have been recorded in the coastal areas near the PRC Study Area (Maryland Department of Natural Resources, 2019b; Virginia Department of Game and Inland Fisheries, 2016). At emergence, hatchlings swim to offshore currents and remain in the open ocean, often associating with floating mats of *Sargassum* (Carr, 1986; Carr, 1987; Witherington & Hirama, 2006).

Migration between oceanic and nearshore habitats occurs during the juvenile stage (at about eight years of age) as turtles move seasonally from open-ocean current systems to nearshore foraging areas (Bjorndal et al., 2000; Bolten, 2003; Mansfield, 2006). After reaching a length of 40 centimeters (cm) (16 inches) (Carr, 1987), early juvenile loggerhead sea turtles make a transoceanic crossing, swimming back to nearshore feeding grounds near their beach of origin in the western Atlantic Ocean (Bowen et al., 2004; Musick & Limpus, 1997). Juveniles are frequently observed in developmental habitats, including coastal inlets, sounds, bays, estuaries, and lagoons, with depths less than 328 feet (100 meters) (Hopkins-Murphy et al., 2003). Immature loggerhead sea turtles may occupy coastal feeding grounds for 20 years before their first reproductive migration (Bjorndal et al., 2001; Putman et al., 2015).

Small bottom-feeding juveniles are the predominant loggerhead sea turtle size class found along the Northeast and Mid-Atlantic U.S. Coast, while adults inhabit the entire continental shelf area (Hopkins-Murphy et al., 2003; Mansfield et al., 2001). As late juveniles and adults, loggerhead sea turtles most often occur on the continental shelf and along the shelf break of the U.S. Atlantic and Gulf Coasts, as well as in coastal estuaries and bays where they spend time foraging or resting on the bottom (Bjorndal, 1997; Hawkes et al., 2006; Hopkins-Murphy et al., 2003; Patel et al., 2018; Putman et al., 2015; Roberts et al., 2005). Long Island Sound, Cape Cod Bay, and Chesapeake Bay are the most frequently used juvenile developmental habitats along the Northeast U.S. Continental Shelf (Mansfield, 2006). Loggerhead sea turtles (juveniles and subadults) equipped with satellite tags were found to arrive within the Mid-Atlantic Bight, which includes the Chesapeake Bay, in late May and to depart in early October (Patel et al., 2018). An adult female loggerhead sea turtle was tagged and tracked over three nesting seasons in Virginia, and its satellite tracks showed that it utilized the lower and middle portions of the Chesapeake Bay as well as the Delaware Bay as internesting, and possibly foraging, habitat (Mansfield et al., 2001).

Aerial surveys and tagging studies, as well as stranding data, suggest that the loggerhead sea turtle species, particularly juveniles, is the most abundant sea turtle species using the Virginia and Maryland waters of the Chesapeake Bay (Barco et al., 2018a; Burt et al., 2014; Mansfield, 2006; Richlen et al., 2018; Swingle et al., 2018). The Chesapeake Bay, particularly within the mouths of the estuarine tributaries, are high-use areas and important seasonal development (foraging) habitats for juvenile loggerhead sea turtles, especially during their residency period, which is spring through early fall (May through November) (Barco et al., 2018a; Lutcavage & Musick, 1985; Mansfield, 2006; Mansfield et al., 2009). Based on aerial survey data, abundances for the Virginia and Maryland coastal ocean waters, including most of the Chesapeake Bay, were highest in the spring relative to summer and fall, with no presence in winter (e.g., loggerhead abundance for 2012 was estimated to be 34,162 turtles for spring compared to 17,962 turtles in summer) (Barco et al., 2018a; Burt et al., 2014). Individual juvenile loggerhead sea turtles have been known to return to the same seasonal foraging areas, such as the Chesapeake Bay, for many years (Lutcavage & Musick, 1985; Mansfield, 2006). As water temperatures drop from October to December, most loggerhead sea turtles emigrate from their summer developmental habitats and eventually return to warmer waters south of Cape Hatteras (e.g., Florida Keys and islands in the Caribbean), where they spend the winter (Morreale & Standora, 1998; Tucker et al., 2014).

A tag study funded by the U.S. Navy and completed by Barco et al. (2017; 2018b) indicates that juvenile and sub-adult loggerhead sea turtles utilize more of the lower to middle Chesapeake Bay in the spring and summer, similar to tagged Kemp's ridley sea turtles. Telemetry data from 34 tagged loggerhead turtles were used for a home range and foraging behavior analysis (Barco et al., 2017). Tagged turtles displayed foraging behavior in May for both Virginia and Maryland waters, but this was mostly concentrated around the mouth of the Chesapeake Bay. Medium- to high-relative foraging levels shifted to the entire Bay, including Maryland waters, during summer. By fall, tagged loggerhead sea turtles started to move south of the Virginia/North Carolina border, and all of the turtles were south of this border by December (Barco & Lockhart, 2016; Barco et al., 2017).

Loggerhead sea turtles are the most common species to strand in Virginia and Maryland, with records showing a high number of strandings from summer to fall (Costidis et al., 2019; Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019). Loggerhead strandings have been recorded from the lower to upper Chesapeake Bay and several waterways off the Bay (e.g., York, Potomac, and Patuxent Rivers). Loggerhead strandings have been recorded from the lower to upper Chesapeake Bay and several waterways off the Bay (e.g., York, Potomac, and Patuxent Rivers). Loggerhead sea turtles have been recorded stranded on and around NAS Patuxent River, Bloodsworth Island Range, and OLF Webster (Maryland Department of Natural Resources, 2019c). Only one loggerhead sea turtle has been observed alive at NAS Patuxent River, but numerous carcasses have washed up on the beaches (U.S. Department of the Navy, 2017c). Some loggerhead sightings have been recorded around Bloodsworth Island Range during Chesapeake Bay aerial surveys (Barco et al., 2018a; Richlen et al., 2018).

Population Trends

There are at least five demographically independent loggerhead sea turtle nesting groups within the Northwest Atlantic Ocean subpopulation: (1) the Northern Recovery Unit, from the Florida-Georgia border to southern Virginia, (2) the Peninsular Florida Recovery Unit, along Florida's Atlantic Coast to Key West; (3) the Dry Tortugas Recovery Unit, encompassing all islands west of Key West; (4) the Northern Gulf of Mexico Recovery Unit, from the Florida Panhandle through Texas; and (5) the Greater Caribbean Recovery Unit, from Mexico through French Guiana, the Bahamas, and the Lesser and Greater Antilles (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2008).

The Northern Recovery and Peninsular Florida Units comprise about 10 percent and 87 percent, respectively, of all of the loggerhead sea turtle nesting in the Northwest Atlantic Ocean subpopulation

(Ehrhart et al., 2003; National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2008). The number of recorded loggerhead sea turtle nests showed a decline at a rate of 1.3 percent annually from 1989 to 2008 (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2008). Annual total nest counts for loggerhead sea turtles on Florida's index beaches (27 beaches identified as a subset for measuring long-term nesting trends) fluctuate widely, and scientists do not yet understand fully what drives these changes. A detailed analysis of Florida's long-term loggerhead sea turtle nesting data from 1989 to 2017 shows three distinct phases. Following a 52 percent increase between 1989 and 1998, nest counts declined by 53 percent over nearly a decade (1998 to 2007). However, annual nest counts showed a strong increase (66 percent) from 2007 to 2018. Overall, nest counts in Florida over the monitoring period (1989 to 2018) increased by approximately 19 percent (Florida Fish and Wildlife Conservation Commission, 2019b).

Abundance and density estimates based on aerial surveys conducted in the lower and middle Chesapeake Bay appear to show an increase in the population of sea turtles, mainly loggerhead sea turtles (as they were the most commonly sighted species during surveys); however, differences between survey methodologies could influence this trend (Barco et al., 2018a). For the lower Chesapeake Bay, Barco et al. (2018a) estimated density to be about 0.376 and 0.146 turtles per square km for spring and summer of 2011 and 2012, respectively, which were 1.5 and 4.0 times higher than Mansfield's (2006) density estimates for spring and summer (surveys conducted from 2001 to 2004). A potential increase in turtle abundances in the Chesapeake Bay may be occurring due to the rebounding of the blue crab population within the Bay, a preferred prey resource for loggerhead and Kemp's ridley sea turtles. The 2014 Chesapeake Bay Stock Assessment Committee reported an increase in the number of mature female blue crabs from 2014 to 2017, as well as an increase in juvenile blue crab abundance, due to strong recruitment (Corrick, 2018).

Predator and Prey Interactions

Loggerhead sea turtles are primarily carnivorous in both open-ocean and nearshore habitats, although they also consume some algae (Bjorndal, 1997). Diet varies by age class (Godley et al., 1998) and by specializing in specific prey groups dependent on location (Donaton et al., 2019). Both juveniles and adults forage in coastal habitats, where they feed primarily on the bottom; although, they also capture prey (e.g., jellyfish and squid) throughout the water column. Loggerhead sea turtles feed on a variety of bottom-dwelling animals, such as crabs, shrimp, sea urchins, sponges, and fish. They have powerful jaws that enable them to feed on hard-shelled prey, such as whelks and conch (Bjorndal, 2003; Donaton et al., 2019; Fukuoka et al., 2016; Pajuelo et al., 2016; Rizzi et al., 2019).

Sharks are the primary predator of juvenile and adult loggerhead sea turtles (Fergusson et al., 2000).

Species-Specific Threats

Sea turtles that utilize coastal foraging habitats are at risk of being impacted by anthropogenic effects such as fisheries bycatch, vessel strike, and entanglement and ingestion of marine debris.

Bycatch from commercial fisheries is a primary threat to sea turtles in the offshore and coastal waters of the United States. Mortality associated with shrimp trawls has been a substantial threat to large juvenile and subadult loggerhead sea turtles because these trawls operate in the nearshore habitats commonly used by this species; however, shrimping nets have been modified with turtle excluder devices to allow sea turtles to escape and reduce mortality levels (Bugoni et al., 2008; Nance et al., 2012). Loggerhead sea turtles are also captured and killed by other fisheries (e.g., summer flounder, herring, and monkfish) that utilize trawls, gill nets, pound nets, traps and pots, and longlines, as well as dredges. Finkbeiner et al. (2011) estimated that interactions and mortality of sea turtles by U.S. Atlantic fisheries have decreased since regulations have been put into place, with about 26,500 loggerhead sea turtles captured annually and 1,400 of those sea turtles dying, because of being captured.

Vessel strike has been identified as one of the important mortality factors in several nearshore sea turtle habitats worldwide. Post-pelagic turtles that recruit to shallow, coastal waters, estuaries, and bays, such as the loggerhead sea turtle, are at risk of vessel strike (Godoy & Stockin, 2018). For example, a study by Barco et al. (2016) found that of the 60 fresh, dead loggerhead sea turtle strandings that were examined between 2004 and 2013 in Virginia, 25 percent were the result of vessel interactions. Several stranded loggerhead sea turtles in Maryland waters were suspected of being struck by a vessel based on the recorded damage to the carapace (Maryland Department of Natural Resources, 2019c).

Sea turtles living in oceanic or coastal environments and feeding in the open ocean or on the sea floor may encounter different types and densities of debris, and may therefore have different probabilities of ingesting debris and becoming entangled in debris (Schuyler et al., 2014). In 2014, Schuyler et al. (2014) reviewed 37 studies of debris ingestion by sea turtles, showing that young oceanic sea turtles are more likely to ingest debris (particularly plastic), and that green and loggerhead sea turtles were significantly more likely to ingest debris than other sea turtle species.

Sea turtles are particularly susceptible to climate change effects because their life history, physiology, and behavior are extremely sensitive to environmental temperatures (Fuentes et al., 2013) (Patino-Martinez et al., 2008), feminization of populations from elevated nest temperatures (Laloë et al., 2017; Reneker & Kamel, 2016), and decreased reproductive success (Hawkes et al., 2006; Laloë et al., 2016; Pike, 2014). Laloë et al. modeled the temperature impacts on embryonic sex and survival at a loggerhead sea turtle rookery in the Cape Verde Islands. Results from the study indicated that the number of female hatchlings are predicted to increase based on warming temperatures, but so are the number of nests given this increase. However, as incubation temperatures reach lethal levels due to rising temperatures, the natural growth rate of the population may decrease (based on an increase in hatchling mortality).

In addition to the threats described above, which may also affect the other species of sea turtles, vehicle use on sea turtle nesting beaches is also an issue for loggerhead sea turtles. Vehicles are allowed on some beaches in Florida, Georgia, North Carolina, and Texas. Vehicles can run over and kill hatchlings or nesting adult turtles on the beach, disrupt the nesting process, create ruts in the sand that impede turtle movement, and crush nests (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2008).

Sturgeon Species

Atlantic Sturgeon

Status and Management

The Atlantic sturgeon fishery is managed by Atlantic States Marine Fisheries Commission in state waters and by NMFS in waters under federal jurisdiction. Sharp declines in the abundance of Atlantic sturgeon resulting from historic overfishing, pollution, and habitat loss and degradation led the Atlantic States Marine Fisheries Commission to issue a coast-wide moratorium on the commercial harvest of the species in state waters in 1998 (63 Federal Register 9967). This was followed closely by a similar moratorium in federal waters issued by NMFS in early 1999 (64 Federal Register 9449). When the population continued to decline, NMFS listed the species as endangered or threatened, depending on the distinct population segment, under the ESA throughout its range in 2012 (77 Federal Register 5880;

77 Federal Register 5914). Under the ESA, a distinct population segment is defined as a vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species (61 Federal Register 4722). Distinct population segments maintain federal protections while providing a more tailored approach for managers to address specific threats facing different populations. The New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs are listed as endangered, and the Gulf of Maine DPS is listed as threatened. Only Atlantic sturgeon belonging to the New York Bight, Chesapeake Bay, and Carolina DPSs have been documented to occur within the PRC Study Area.

Habitat and Geographic Range

Subadult and adult Atlantic sturgeon inhabit the waters of the Atlantic Ocean from Canada to Florida. Juveniles, subadults, and adults also inhabit many of the estuarine and riverine systems along the Atlantic Coast. Atlantic sturgeon are fairly well studied during their juvenile and spawning life phases in riverine environments, but their subadult and adult estuarine and marine phases are less understood.

Female Atlantic sturgeon spawn highly adhesive eggs on cobble substrate located on river bottoms, which are fertilized by males. Larvae hatch out in four to seven days, and newly hatched young are active swimmers, frequently leaving the bottom and swimming throughout the water column. After 9 to 10 days, the yolk sac is absorbed and the larvae begin to show more strictly benthic behavior. Juveniles remain riverine and estuarine residents for two to six years before migrating to the Atlantic Ocean. After reaching 76 to 92 cm (30 to 36 inches) in length, subadults move from natal estuaries into the marine environment, and may undertake long-range migrations (Atlantic Sturgeon Status Review Team, 2007). Subadults disperse widely both north and south along the Atlantic Coast and beyond the continental shelf (Bain, 1997).

Age of sexual maturity varies from 5 to 34 years depending on latitude (Atlantic Sturgeon Status Review Team, 2007). Within the Chesapeake Bay, maturity generally occurs around 15 years of age. Sturgeon in the southern parts of the range tend to mature faster, but experience shorter lifespans than sturgeon in the northern portions of the range.

Despite extensive mixing in coastal waters, adults return to their natal river to spawn, as indicated from tagging records. Spawning was originally thought to occur only in the spring along the Atlantic Coast (Atlantic Sturgeon Status Review Team, 2007); however, recent research indicates that spawning primarily occurs in the fall in the South Atlantic, including the Chesapeake Bay, rather than spring (Balazik & Musick, 2015; Hager et al., 2014; Kahn et al., 2014; Smith et al., 2015; Balazik et al., 2012a). Adult males and females return to the ocean shortly after spawning.

During non-spawning years, adults remain in marine waters year-round or seasonally venture into either natal or non-natal estuarine environments (Bain, 1997; Hager, 2016). As part of a Navy-funded research effort, Hager (2016) found that sturgeon implanted with acoustic transmitters in the York River system in Virginia spent the summer and fall seasons of non-spawning years in either the main stem of the Chesapeake Bay, the Delaware Bay and the Delaware River, or along the coast of New York and in the Hudson River.

Multiple agencies and organizations have established a series of telemetry receiver arrays in the Maryland and Virginia waters of the Chesapeake Bay and its tributaries, to detect animals implanted with acoustic transmitters (Figure 3.4-6). These agencies include the Maryland Department of Natural Resources, the University of Maryland Chesapeake Biological Laboratory, the Smithsonian Environmental Research Center, the U.S. Navy, Virginia Commonwealth University, and the Virginia

Institute of Marine Science. Based on detection data acquired from these arrays, Atlantic sturgeon have been detected throughout nearly all of the PRC Study Area, including the main stem of the Chesapeake Bay, Tangier Sound, Pocomoke River, Nanticoke River, Choptank River, Potomac River, Patuxent River, Rappahannock River, and York River (Hager, 2016; Ogburn & Anguilar, 2020; Secor & O'Brien, 2020; Stence, 2020). In the immediate PRC Study Area, the areas of most common occurrence are the main stem of the Chesapeake Bay, Tangier Sound, and the Potomac, Nanticoke, and York Rivers.

Population Trends

Atlantic sturgeon is a long-lived (life span of up to 60 years), late maturing, estuarine-dependent, iteroparous (reproducing more than once in a lifetime), and anadromous (migrating up rivers from the sea to spawn) species.

Historically, Atlantic sturgeon were recorded in 38 rivers from St. Croix, Maine to the St. Johns River, Florida. As of 2007, they were only known to occupy 35 rivers (Atlantic Sturgeon Status Review Team, 2007). In addition, as of 2004, only 12 genetically distinct populations along the U.S. Atlantic Coast had been differentiated (Stein, Friedland, & Sutherland, 2004). However, previously undiscovered genetically distinct spawning populations have been identified in several new river systems since this estimate (Fox et al., 2016; Hager et al., 2014; Fox & Peterson, 2018; Balazik et al., 2012a) and preliminary research indicates there are likely spawning populations in several more river systems that have yet to be fully investigated.

In the early 1600s, the Atlantic sturgeon fishery was considered an important fishery (Jerome et al., 1965). In the mid-1800s, incidental catch of Atlantic sturgeon in the shad and river herring seine fisheries indicated that the species was very abundant (Armstrong & Hightower, 2002). By 1870, females were collected for their eggs, which were sold as caviar. By 1890, over 3,350 metric tons were landed from rivers along the Atlantic Coast (Smith & Clugston, 1997). Landings of the species peaked around the turn of the 20th century, followed by drastic declines and an eventual collapse, thereafter (Smith & Clugston, 1997). Despite a moratorium on commercial fishing for this species since 1998, there has been no indication of recovery. The lack of recovery is largely attributed to coastal development, pollution, poor water quality, and habitat degradation and loss (Atlantic Sturgeon Status Review Team, 2007).

Predator and Prey Interactions

Atlantic sturgeon prey upon benthic invertebrates such as isopods, crustaceans, worms, and molluscs (National Marine Fisheries Service, 2013). It has also been documented to feed on fish (Bain, 1997). Evidence of predation on Atlantic sturgeon is scant, but it is speculated that juveniles may be eaten by the American alligator (*Alligator mississippiensis*), alligator gar (*Atractosteus spatula*), striped bass (*Morone saxatilis*), and sharks (National Marine Fisheries Service, 1998; Dadswell, 2006). However, only striped bass and an occasional shark may occur in the PRC Study Area.

Species-Specific Threats

Overfishing of Atlantic sturgeon females for caviar, prior to the 1900s, resulted in large population declines. Current threats include bycatch in fisheries targeting other species; habitat degradation from dredging, dams, and water withdrawals; passage impediments including locks and dams; and ship strikes (Atlantic Sturgeon Status Review Team, 2007; Balazik et al., 2012b; Brown & Murphy, 2010; Foderaro, 2015). *Dichelesthium oblongum*, a species of copepod, parasitizes 93 percent of the Atlantic sturgeon sampled in the New York Bight. High parasite load, stress, and reduced immune suppression have been associated with Atlantic sturgeon inhabiting areas of poor water quality (e.g., sewage contamination) (Fast, Sokolowski, Dunton, & Bowser, 2009).

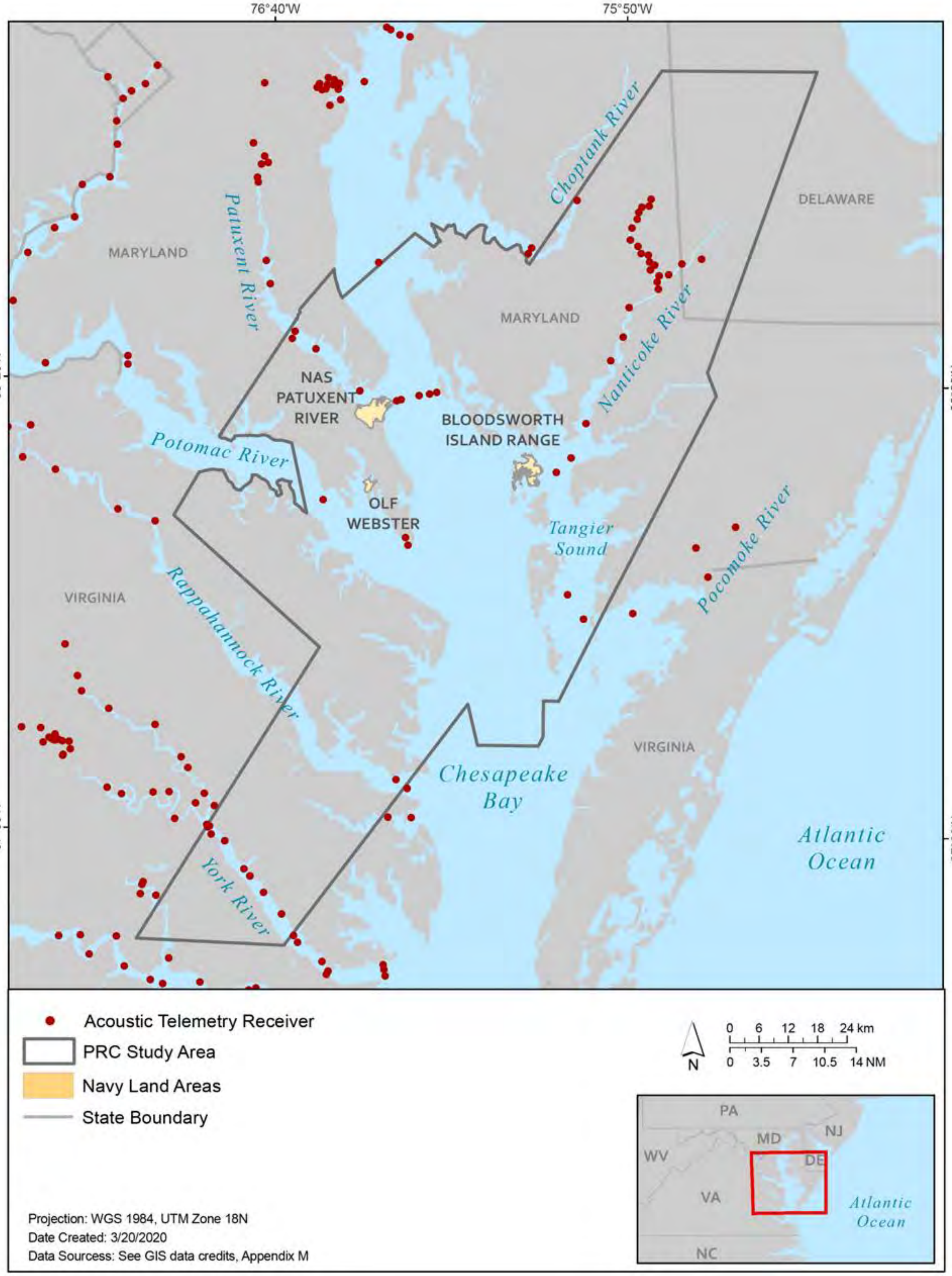


Figure 3.4-6 Acoustic Telemetry Receivers in the Chesapeake Bay and Tributaries

Critical Habitat

In August 2017, NMFS designated critical habitat for each of the five Atlantic sturgeon distinct population segments: Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic (82 Federal Register 39160). All critical habitat designations are related to riverine waters between Maine and Georgia related to spawning or potential spawning habitat.

The physical features essential for the conservation of Atlantic sturgeon belonging to the Chesapeake Bay DPS are those habitat components that support successful reproduction and recruitment. These components include the following:

- Hard bottom substrate (e.g., rock, cobble, gravel, limestone, boulder, etc.) in low-salinity waters (i.e., 0.0 to 0.5 ppt range) for settlement of fertilized eggs, refuge, growth, and development of early life stages
- Aquatic habitat with a gradual downstream salinity gradient of 0.5 up to as high as 30 ppt and soft substrate (e.g., sand, mud) between the river mouth and spawning sites for juvenile foraging and physiological development
- Water of appropriate depth and absent physical barriers to passage (e.g., locks, dams, thermal plumes, turbidity, sound, reservoirs, gear, etc.) between the river mouth and spawning sites necessary to support the following:
  - unimpeded movement of adults to and from spawning sites
  - seasonal and physiologically dependent movement of juvenile Atlantic sturgeon to appropriate salinity zones within the river estuary
  - staging, resting, or holding of subadults or spawning-condition adults
- Water depths in main river channels deep enough (e.g., at least 3.9 feet [1.2 meters]) to ensure continuous flow in the main channel at all times when any sturgeon life stage would be in the river
- Water, between the river mouth and spawning sites, especially in the bottom 3.3 feet (1 meter) of the water column, with the temperature, salinity, and oxygen values that, combined, support the following:
  - Spawning
  - Annual and interannual adult, subadult, larval, and juvenile survival
  - Larval, juvenile, and subadult growth, development, and recruitment (e.g., 13 to 26°C [55 to 79°F] for spawning habitat, no more than 30°C [86°F]for juvenile-rearing habitat, and 6 milligrams per liter or greater dissolved oxygen for juvenile-rearing habitat)

Critical habitat has been designated within the following rivers for the Chesapeake Bay DPS (Figure 3.4-6):

- Nanticoke River, Maryland
- Marshyhope Creek, Maryland
- Potomac River, Maryland
- Rappahannock River, Virginia
- York, Mattaponi, and Pamunkey Rivers, Virginia
- James River, Virginia

Shortnose sturgeon

Status and Management

In 1967, the U.S. Department of Interior listed the shortnose sturgeon as endangered throughout its range (32 Federal Register 4001). The species remained listed following enactment of the ESA in 1973 (Wippelhauser & Squiers Jr., 2015). NMFS has recognized 19 distinct population segments, although they have not been officially incorporated into the ESA designation for the species. These distinct population segments include New Brunswick, Canada (1); Maine (2); Massachusetts (1); Connecticut (1); New York (1); New Jersey/Delaware (1); Maryland/Virginia (1); North Carolina (1); South Carolina (4); Georgia (4); and Florida (2) (National Marine Fisheries Service, 1998).

Habitat and Geographic Range

The geographic range of shortnose sturgeon runs along eastern North America from the St. John River, New Brunswick, Canada to the St. Johns River, Florida (Kynard, 1997; National Marine Fisheries Service, 1998). However, the distribution of shortnose sturgeon across this range is disjunct, with a separation between the northern populations and the southern populations of approximately 400 km occurring in southern Virginia and northern North Carolina near the geographic center of their coast-wide distribution (Kynard, 1997; Shortnose Sturgeon Status Review Team, 2010). The Potomac River is the southern-most river that supports shortnose sturgeon belonging to the northern and mid-Atlantic metapopulations (National Marine Fisheries Service, 2020a).

After hatching in rivers, larvae orient into the current and away from light, generally staying near the bottom and seeking cover. Within two weeks, the larvae emerge from cover and swim in the water column, moving downstream from the spawning site. Within two months, juvenile behavior mimics adults, with active swimming (Deslauriers & Kieffer, 2012) and foraging at night along the bottom (Richmond & Kynard, 1995). The shortnose sturgeon species primarily occurs in rivers and estuaries of the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems, occasionally moving into the nearshore coastal waters (Dadswell, 2006; National Marine Fisheries Service, 1998; Richmond & Kynard, 1995). In estuaries, juveniles and adults occupy areas with little or no current over a bottom composed primarily of mud and sand (Secor et al., 2000). Adults are found in deep water (10 to 30 meters [33 to 98 feet]) in winter and in shallower habitat (2 to 10 meters [7 to 33 feet]) during summer (Welsh et al., 2002). Within the PRC Study Area, shortnose sturgeon would primarily be found in shallow riverine areas during the warmer summer months and in the deeper waters of the main stem of the Chesapeake Bay during the cooler, winter months (Shortnose Sturgeon Status Review Team, 2010).

Population Trends

Shortnose sturgeon is a long-lived (life span of up to 30 years), riverine and estuarine habitat dependent, iteroparous, and anadromous species. Populations were stable or possibly increasing in the 1990s (Wippelhauser & Squiers Jr., 2015). Certain subpopulations have increased in recent decades, particularly the Hudson River stock (Bain, 1997; Stein, Friedland, & Sutherland, 2004). Several strong cohorts (i.e., groups of fish born in the same year within a population or stock) had higher-than-expected survival during the 1980s and early 1990s, then recovery slowed during the late 1990s (Woodland and Secor, 2007). Abundances in the Hudson River population exceed recovery criteria (Bain, 1997; Woodland & Secor, 2007). The Delaware River supports an estimated 8,445 individuals (Welsh et al., 2002). According to NMFS (2020a), the Potomac River supports a shortnose sturgeon population, although the current status of the population is unknown.

Predator and Prey Interactions

Prey varies with season between northern and southern river systems. In northern rivers, some sturgeon feed in freshwater during summer and over sand-mud bottoms in the lower estuary during fall, winter, and spring (National Marine Fisheries Service, 1998). In southern rivers, feeding has been observed during winter at or just downstream the saltwater and freshwater interface (Kynard, 1997). In the Southeast U.S. Continental Shelf Large Marine Ecosystem, shortnose sturgeon reduces feeding activity during summer months (Sulak & Randall, 2002).

The shortnose sturgeon feeds by suctioning worms, crustaceans, molluscs, and small fish from the bottom (National Marine Fisheries Service, 1998; Stein, Friedland, & Sutherland, 2004). Juveniles have been found in the stomachs of yellow perch (*Perca flavescens*). Predation on subadults and adults is not well documented; however, sharks are likely predators in the marine environment (National Marine Fisheries Service, 1998).

Species-Specific Threats

The population decline of the shortnose sturgeon has been attributed to pollution, overharvest in commercial fisheries (including bycatch), and its resemblance to the formerly commercially valuable Atlantic sturgeon (Bain, 1997; National Marine Fisheries Service, 1998). Other risk factors include poaching, non-native species, poor water quality in spawning and nursery habitats, contaminants (e.g., heavy metals, pesticides, and organochlorine compounds), siltation from dredging, bridge construction and demolition, impingement on power plant cooling water intake screens, impoundment operations, and hydraulic dredging operations (Collins, Rogers, Smith, & Moser, 2000; National Marine Fisheries Service, 1998).

Critical Habitat

No critical habitat has been designated for shortnose sturgeon at this time.

Effects of the Proposed Action on Federal Threatened or Endangered Species (NMFS Jurisdiction)

The purpose of this section is to document analysis of the potential impacts of the Proposed Action (Preferred Alternative, Alternative 2) on listed species and/or critical habitats. The criteria for analysis conclusions is described in introduction of Section 3.4.4 (Federal Endangered Species Act – Biological Assessments). The analysis approach for direct, indirect/secondary, and combined stressors was provided in Section 3.4.3.1 (Environmental Consequences, No Action Alternative).

The summary and tabular conclusions for this section are provided in Section 3.4.4.1 (Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Regulatory Conclusions).

Sea Turtle Species

Acoustic

This section analyzes the potential impacts on four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead) from the various types of acoustic stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors, for supporting details). This section includes analysis of the potential impacts from air-based assets, water-based assets, and weapons firing/non-explosive munitions and other MEM. Acoustic stressors from land-based assets are not applicable to sea turtles due to the following: (1) sea turtles do not nest on beaches located within the PRC Study Area and (2) the transmission of sound is greatly reduced across the air/water interface and lack of close proximity to vehicle use.

A working group organized under the American National Standards Institute (ANSI) Accredited Standards Committee S3, Subcommittee 1, Animal Bioacoustics, developed sound exposure guidelines for fish and sea turtles (Popper et al., 2014), which is hereafter referred to as the *ANSI Sound Exposure Guidelines*. Lacking any data on nonauditory sea turtle injuries due to sonars, the working group estimated the risk for nonauditory injury to sea turtles from low-frequency sonar to be low, and from mid-frequency sonar to be nonexistent (Garcia-Parraga et al., 2014).

Exposure to intense sound may result in auditory injury such as hearing loss, typically quantified as threshold shift, which persists after cessation of the noise exposure. Being that studies on inducing threshold shift in sea turtles are very limited, are not sufficient to estimate PTS and TTS onset thresholds, and have not been conducted on any of the sea turtles present in the PRC Study Area, auditory threshold shift in sea turtles is considered to be consistent with general knowledge about noise-induced hearing loss described in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Acoustic) and (U.S. Department of the Navy, 2017c). Sea turtle susceptibility to hearing loss due to an acoustic exposure is evaluated using knowledge about sea turtle hearing abilities in combination with non-impulsive auditory effect data from other species (marine mammals and fish). The criteria and thresholds that were used to qualitatively assess the potential effects from the Proposed Action on sea turtles were developed in accordance with NMFS and are consistent with those used in Phase III of the Navy's at-sea environmental planning program (U.S. Department of the Navy, 2017c). The SELs for onset of TTS and PTS to the frequency of non-impulsive sounds (e.g., sonar) are 200 dB re 1 µPa and 220 dB re 1 µPa, respectively. The SELs for onset of TTS and PTS to the frequency of impulsive sounds (e.g., air guns and weapon firing) are 189 dB re 1 µPa and 2014 dB re 1 µPa, respectively. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) qualitatively estimate that sea turtles are less likely to incur TTS or PTS, with increasing distance from various sound sources. Sea turtle hearing ability is limited above 1 kHz, and hearing is most sensitive around 300 to 400 Hz in air and 100 to 400 Hz in water (Bartol & Ketten, 2006; Piniak et al., 2016), and is much less sensitive than that of any marine mammal. Therefore, sound exposures from most mid-frequency and all high-frequency sound sources are not anticipated to affect sea turtle hearing, and sea turtles are likely only susceptible to auditory impacts when exposed to very high levels of sound within their limited hearing range.

The stress caused by acoustic exposure has not been studied for sea turtles. Therefore, the stress response in sea turtles in the PRC Study Area due to acoustic exposures is considered consistent with general knowledge about physiological stress responses described in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Acoustic).

Based on the description of auditory masking in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Generic Background for Analysis, Masking) and because sea turtles likely use their hearing to detect broadband low-frequency sounds in their environment, the potential for masking would be limited to certain sound exposures. Only continuous human-generated sounds that have a significant low-frequency component, are not of brief duration, and are of sufficient received level could create a meaningful masking situation (e.g., proximate vessel noise). Other intermittent, short-duration sound sources with low-frequency components (e.g., low-frequency sonars) would have more limited potential for masking, depending on how frequently the sound occurs. There is evidence that sea turtles may rely primarily on senses other than hearing for interacting with their environment, such as vision

(Narazaki et al., 2013) and magnetic orientation (Avens, 2003; Putman et al., 2015). Any effect of masking may be mediated by reliance on other environmental inputs.

As described in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Acoustic), the behavioral response of a sea turtle to an anthropogenic sound would likely depend on the frequency, duration, temporal pattern, and amplitude of the sound, as well as the animal's prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). Distance from the sound source, and the perception of whether it is approaching or moving away, may also affect the way a sea turtle responds to a sound. Sea turtles may exhibit a behavioral response to a sound source within their hearing range at received levels of 175 dB re 1 µPa or greater. This is the level at which sea turtles are expected to begin to exhibit avoidance behavior based on experimental observations of sea turtles exposed to multiple firings of nearby or approaching air guns (McCauley et al., 2000). Sea turtles may detect sources below 2 kHz, but likely have limited hearing ability above 1 kHz. They may detect most broadband sources (e.g., vessel noise) and low-frequency sonars, so they may respond to these sources. Because auditory abilities are poor above 1 kHz, detection and consequent reaction to any mid-frequency source is unlikely. The *ANSI Sound Exposure Guidelines* (Popper et al., 2014) state that there is a low likelihood that sea turtles would respond within tens of meters of low-frequency sonars, and that it is highly unlikely that sea turtles would respond to mid-frequency sources.

Studies have been conducted on sea turtle responses to underwater non-impulsive sounds (e.g., sonar). Lenhardt (1994) used very-low-frequency vibrations (less than 100 Hz) coupled to a shallow tank to elicit swimming behavior responses by two loggerhead sea turtles. Watwood et al. (2016) tagged green sea turtles with acoustic transponders and monitored them using acoustic telemetry arrays in Port Canaveral, FL. Sea turtles were monitored before, during, and after a routine pier-side submarine sonar test that utilized typical source levels, signals, and duty cycle. The sea turtles in this study demonstrated no significant long-term displacement. The authors note that Port Canaveral is an urban marine habitat and that resident sea turtles may be less likely to respond than naïve individuals.

For the sea turtles present in the PRC Study Area, long-term consequences to individuals and populations due to acoustic exposures have not been studied.

Impacts from Air-based Assets

Fixed- and rotary-wing aircraft are used during a variety of testing and training activities throughout the PRC Study Area. A description of aircraft noise produced during Navy activities is provided in Section 3.0.2.3.1 (Identifying Stressors for Analysis, Acoustic Stressors), including estimates of underwater sound levels produced by certain flight activities. The four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area may be exposed to aircraft-generated overflight noise associated with testing and training activities throughout the PRC Study Area. However, most of the aircraft noise would be concentrated around PRC airfields, where aircraft are closer to the ground and away from sea turtles. Green, Kemp's ridley, and loggerhead sea turtles may be exposed to aircraft noise from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may be exposed in the spring and summer when this species may occur in the waters in/around the Bay. Exposures to aircraft noise are more likely to occur in portions of the PRC Study Area that are more heavily used by Navy aircraft (Section 3.0.2.3.1.1, Aircraft and Aerial Targets (Air-Based Assets)), such as the middle and upper Chesapeake Bay and areas adjacent to airfields.

Depending on atmospheric conditions, in-air sound can refract upwards, limiting the sound energy that reaches the water surface. In the Bay, most in-air sound would be reflected at the air-water interface. Any sound that does enter the water from the aircraft would be strongest just below the surface and directly under the aircraft. The reduction of sound transmitted to the underwater environment from the air is described in Appendix B (A Noise Primer: Noise and Its Effect on the Environment).

Rotary-wing aircraft (helicopters) produce low-frequency sound and vibration (Pepper et al., 2003). Most aircraft overflights are transient in nature and would pass quickly overhead, although rotary-wing aircraft (e.g., helicopters) may hover for extended periods (15 minutes or less) at lower altitudes over the Bay for a longer duration. About 52 percent of testing and training flights (this includes fixed- and rotary-wing aircraft and UAS) would occur at higher altitudes (3,000 feet and higher). Helicopters that hover in a fixed location could increase the potential for exposure to sea turtles, especially when surfacing to breathe or while basking at the surface. However, impacts from testing and training activities would be highly localized and concentrated in space and duration as described in Section 3.0.2.3.1 (Identifying Stressors for Analysis, Acoustic Stressors).

An infrequent type of aircraft noise is the sonic boom, produced when a fixed-wing aircraft exceeds the speed of sound. Supersonic flights could generate an airborne sonic boom that may be sensed by sea turtles while at the surface or as a much quieter sound (up to 32 dB re 1 µPa higher) underwater at the ideal angle of incidence (13 degrees). Supersonic flights mostly occur in the PRC Study Area (specifically R4008 restricted airspace and on rare occasion, Chessie Air Traffic Control Assigned Airspace (ATCAA), see Figure 1.3-2, PRC Airspace) at altitudes of 30,000 feet or greater.

The maximum level of low-frequency noise potentially encountered by sea turtles would be from low-altitude sonic booms focused on fixed targets in the Chesapeake Bay Water Range, which occurs during a supersonic weapons separation test. However, this activity occurs at the most, a few times a year. During these focused sonic booms, sea turtles in surface waters may be exposed to levels in excess of 175 dB re 1 µPa (behavioral response criteria for sea turtles). The sound levels encountered may cause a brief behavioral reaction (e.g., startle). The most intense underwater noise from subsonic aircraft (159 dB peak re 1 µPa at the water surface) is less than the behavioral response threshold for sea turtles. Additionally, the sound frequencies associated with these pressures would possibly be below the in-air and in-water hearing sensitivity ranges for sea turtles (Bartol & Ketten, 2006; Piniak et al., 2016; Laney & Cavanagh, Supersonic aircraft noise at and beneth the ocean surface: Estimation of risk for effects on marine mammals, 2000), reducing the likelihood of a behavioral reaction.

As discussed above in the background for this section, direct injury and hearing loss in sea turtles because of exposure to aircraft overflight noise is likely discountable to occur due to the close proximity that is required to cause any injury or hearing loss and is therefore, not further considered as a potential effect. Potential impacts considered are masking of other biologically relevant sounds, physiological stress, and changes in behavior.

In most cases, exposure of a sea turtle to fixed-wing or rotary-wing (e.g., helicopter) aircraft presence and noise would be brief as the aircraft quickly passes overhead. Animals would have to be at or near the surface at the time of an overflight to be exposed to appreciable sound levels. The likelihood that the four species of sea turtles (green, Kemp’s ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area would occur or remain at the surface while an aircraft or helicopter transits directly overhead would be very low. Behavioral reactions, startle reactions, and physiological stress due to aircraft noise, including hovering helicopters, are likely to be brief and minor, if they occur at all.

Therefore, longer-range effects on sea turtles are not expected. Because most overflight exposures from fixed-wing aircraft or transiting helicopters would be brief and aircraft noise would be at low received levels, only startle reactions, if any, involving an individual momentarily swimming or diving to a range where they cannot detect the noise of the aircraft, are expected in response to low-altitude flights. In addition, the noise of the aircraft is not likely to be detectable at long ranges for sea turtles due to the low received levels of most aircraft noise. Similarly, the brief duration of most overflight exposures would limit any potential for masking of relevant sounds.

The likelihood of green and leatherback sea turtles being exposed to aircraft noise would be lower compared to Kemp's ridley and loggerhead sea turtles, which are more common in the PRC Study Area since the Chesapeake Bay serves an important seasonal development (foraging) habitat for juvenile and possibly adult loggerhead turtles as well as juvenile Kemp's ridley turtles (Barco et al., 2018b; Lutcavage & Musick, 1985; Mansfield, 2006). Lower number of sightings and strandings in the Bay have been recorded for the green and leatherback sea turtles compared to the Kemp's ridley and loggerhead sea turtles (Maryland Department of Natural Resources, 2019c; National Aquarium in Baltimore, 2019; Virginia Aquarium & Marine Science Center, 2019).

- Juvenile and adult green sea turtle prefer nearshore habitats such as sea grass flats (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for this species) and would, therefore, be more likely to occur in shallow areas of the Bay such as the waters around Bloodsworth Island Range, where less testing and training activities involving aircraft are conducted.
- Given leatherback sea turtles' preference for open-ocean habitats, impacts from aircraft noise, if any, could be to juveniles and adults that occasionally occur in the Bay to forage (Dodge et al., 2014), but this is not common (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for this species).
- Telemetry data and stranding records indicate that Kemp's ridley sea turtles regularly utilize the lower to upper Bay, as well as the waterways off the Bay (e.g., Patuxent River) (Barco et al., 2017; Barco et al., 2018b; Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019). However, satellite-tagged Kemp's ridley sea turtles were shown to prefer spending more time and foraging in shallower waters closer to shore, such as small inlets and flats (e.g., Bloodsworth Island Range and Tangier Island) (Barco et al., 2017; Barco et al., 2018b), where less testing and training activities involving aircraft are conducted.
- The loggerhead sea turtle is the most abundant sea turtle species using the Virginia and Maryland waters of the Bay (Barco et al., 2018a; Burt et al., 2014; Mansfield, 2006; Richlen et al., 2018; Swingle et al., 2018). Tagged loggerheads have displayed high levels of foraging in the middle and upper Bay, particularly during the summer (Barco et al., 2017; Barco et al., 2018b), but they start to leave the Bay in the fall as they migrate south to warmer waters (Barco & Lockhart, 2016; Barco et al., 2017).

<u>Impacts from Water-based Assets</u>

Noise generated by various sonars and vessel/underwater device propulsion systems is associated with the Preferred Alternative.

Sonars and Other Transducers

Sonar sources covered by the Proposed Action include navigational sonars, dipping sonars, and active sonobuoys (e.g., DICASS). Whereas most navigational sonars are considered *de minimis* (see Section 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors, for definition) disturbances, dipping sonars and sonobuoys can have higher source levels and potential impacts. The four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area may be exposed to sonar and other transducers throughout the PRC Study Area. However, potential impacts from sonar and other transducers would be highly localized and concentrated in space and duration, as described in Section 3.0.2.3.1 (Identifying Stressors for Analysis, Acoustic Stressors). Green, Kemp's ridley, and loggerhead sea turtles may be exposed to sonar and other transducers from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may be exposed in the spring and summer when this species may occur in the waters in/around the Bay.

As discussed in the background for this section, there is no data available for hearing loss and specific behavioral response threshold for sea turtles exposed to sonar and other transducers. The behavioral response threshold of 175 dB re 1 µPa referenced previously was based on an impulsive sound source (air guns), which is different than a non-impulsive sonar source (McCauley et al., 2000). Therefore, sea turtle susceptibility to hearing loss and behavioral responses due to an acoustic exposure is evaluated using knowledge about sea turtle hearing abilities, in combination with the *ANSI Sound Exposure Guidelines* (Popper et al., 2014). Popper et al. (2014) estimate that the risk of a sea turtle responding to a low-frequency sonar (less than 1 kHz) is low regardless of proximity to the source, and that there is no risk of a sea turtle responding to mid-frequency sonars (1 to 10 kHz). This is consistent with what is known about sea turtles' limited hearing abilities and absence of underwater sound production. The dipping sonar and DICASS sonobuoys associated with the Proposed Action, operate in the mid-frequency range (1 to 10 kHz) and each water-based asset is deployed in the estuarine environment for only a few hours a year. Therefore, the species of sea turtles that are present in the PRC Study Area are unlikely to be exposed to received levels from sonars in their hearing range.

In summary, implementation of protective measures may further reduce the already unlikely risk of auditory impacts on sea turtles. Depending on the sonar source, protective measures include not activating the transducer and ceasing active sonar transmission if a protected species is observed in the mitigation zone, as discussed in Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization).

Activities involving sonar and other transducers occur at highly localized areas within the PRC Study Area (i.e., Chesapeake Bay Water Range, dip points; refer to Figure 3.4-4), where Kemp's ridley, leatherback, and loggerhead sea turtles may occur, but in an area where green sea turtles probably do not occur (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species).

- Few green sea turtles (live and dead) have been sighted in the upper Chesapeake Bay (Maryland Department of Natural Resources, 2019c; National Aquarium in Baltimore, 2019).
- Kemp's ridley sea turtles may utilize the upper Bay. However, tagged Kemp's ridleys have been found to prefer spending more time and forage in shallower waters closer to shore, such as small inlets and flats (Barco et al., 2017; Barco et al., 2018b), where close-range detection of sonar and other transducers are unlikely.

- Leatherback sea turtles may utilize the upper Bay and waters north of the Chesapeake Bay Water Range. However, based on sighting and stranding records, leatherback turtles are not common in the Bay (Maryland Department of Natural Resources, 2019c; National Aquarium in Baltimore, 2019).
- Tagged loggerhead sea turtles have been found to utilize the middle and upper part of the Bay during summer, mainly for foraging, but start to leave the Bay in the fall as they migrate south to warmer waters (Barco & Lockhart, 2016; Barco et al., 2017).

Based on the species' seasonal occurrence, distribution, and habitat preferences, as well as the analysis presented above and the sound sources being outside of sea turtles' hearing range, the potential for sonar transmissions to affect green, Kemp's ridley, leatherback, and loggerhead sea turtles is considered discountable.

Propulsion System Noise

Most activities using vessels/in-water devices would be conducted in deeper, open waters of the PRC Study Area, primarily within the Chesapeake Bay Water Range, where the four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area could occur. Green, Kemp's ridley, and loggerhead sea turtles may be exposed to vessels and in-water devices from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may be exposed in the spring and summer when this species may occur in the waters in/around the Bay.

Vessels engaged in testing and training activities may consist of a single or multiple vessels for a period of a few hours up to eight hours per vessel per activity, within the PRC Study Area. Most activities involving vessel movements and in-water devices occur intermittently and are variable in duration, ranging from a few hours up to 12 hours per day. Based on the hours of operation proposed with the Preferred Alternative, vessel activity within mostly the Chesapeake Bay Water Range would be localized and infrequent. Proposed activities involving vessel movements in the PRC Study Area occur intermittently, compared to commercial/recreational vessels. Vessels and in-water devices associated with the Proposed Action also occur less frequently than aircraft testing in the PRC Study Area.

The four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area are likely able to detect low-frequency components of broadband continuous water-based propulsion system noise. The source levels of some Navy vessels, which emit noise within a sea turtle's hearing range, are below the level of sound that would cause hearing loss for sea turtles (Erbe, 2002; Hildebrand J. A., 2009; Mintz & Filadelfo, 2011 ; U.S. Department of the Navy, 2017e). There is little information on assessing behavioral responses of sea turtles to vessels/in-water devices. The *ANSI Sound Exposure Guidelines* suggest that the relative risk of a sea turtle behaviorally responding to a continuous noise, such as vessel noise that is within the animal's hearing rage, is high when near a source (tens of meters), moderate when at an intermediate distance (hundreds of meters), and low at farther distances (Popper et al., 2014) due to the level of sound intensity decreasing as the distance between the animal and vessel increases. Naval vessels and in-water devices of medium to large sizes (50 feet to greater than 100 feet) would produce low-frequency, broadband underwater sound, though the exact level of noise produced varies by vessel type.

Larger vessel propulsion systems produce sound that is dominant in the lower frequencies (peak frequency of about 0.1 kHz at 173 to 178 dB re 1 μPa at a max speed of 10 knots), where sea turtle hearing is most sensitive. Medium vessel propulsion systems may produce sound that is in the upper range for sea turtle hearing (peak frequency of about 0.8 kHz at 165.5 to 173 dB re 1 µPa at a max speed of 10 knots), where sea turtle hearing is less sensitive. However, the expected sound level for slow- to fast-moving small to medium vessels is estimated to diminish to 160 dB re 1 µPa at 2 to 7 meters (7 to 23 feet), respectively. Smaller vessel propulsion systems emit more energy in higher frequencies (2.5 to 10 kHz) (Erbe, 2002; Hildebrand J. A., 2009; Kipple & Gabriele, 2004), much of which would not be detectable by sea turtles since this would be outside of the animal's hearing range. For self-propelled in-water devices, there is generally some cavitation noise from propellers; however, noise from these platforms is generally minimal, and the source characteristics are expected to be similar to those from small vessels, but at lower amplitudes due to the reduced size and speed of the platform. Testing and training activities using water-based assets would primarily consist of small and medium-sized surface vessels, and the use of in-water devices and large surface vessels would be infrequent, thus reducing the likelihood of potential impacts of propulsion system noise on sea turtles. In addition, the majority of vessel operating hours would be spent at idle speed (about 75 percent for small to medium vessels and 60 percent for large vessels), which further reduces the likelihood of potential impacts of propulsion system noise on sea turtles.

Surface combatant vessels are designed to be quiet to evade enemy detection. Sea turtles exposed to these Navy vessels may not respond at all or exhibit brief startle dive reactions, if, for example, basking on the surface near a passing vessel. Even for louder vessels, it is not clear that sea turtles would typically exhibit any reaction other than a brief startle and avoidance reaction, if they react at all. Any of these short-term reactions to vessels are not likely to disrupt important behavioral patterns more than a brief moment.

Acoustic masking, especially from larger, noncombatant vessels (e.g., range support boats), is possible. Sea turtles most likely use sound to detect nearby broadband, continuous low-frequency environmental sounds, such as the sounds of waves crashing on the beach; therefore, vessel noise in those nearshore habitats may cause more meaningful masking. However, most activities involving vessels and in-water devices would occur in deeper, open waters of the PRC Study Area, limiting masking impacts on sea turtles that occur in many nearshore areas (e.g., juvenile adult green, Kemp's ridley, and loggerhead sea turtles). Existing high-ambient noise levels in harbors with non-Navy vessel traffic, and in shipping lanes with large commercial vessel traffic, would limit the potential for masking by Navy vessels in those areas. Because sea turtles appear to rely on senses other than hearing for foraging and navigation, any impact of temporary masking is likely minor or inconsequential.

The likelihood of green and leatherback sea turtles being exposed to water-based propulsion system noise would be lower compared to Kemp's ridley and loggerhead sea turtles, which are more common in the PRC Study Area since the Chesapeake Bay serves an important seasonal development (foraging) habitat for juvenile and possibly adult loggerhead turtles as well as juvenile Kemp's ridley turtles (Barco et al., 2018b; Lutcavage & Musick, 1985; Mansfield, 2006). Lower number of sightings and strandings in the Bay have been recorded for the green and leatherback sea turtles compared to the Kemp's ridley and loggerhead sea turtles (Maryland Department of Natural Resources, 2019c; National Aquarium in Baltimore, 2019; Virginia Aquarium & Marine Science Center, 2019).

- Juvenile and adult green sea turtle prefer nearshore habitats such as sea grass flats (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for this species), and would therefore, be more likely to occur in shallow areas of the Bay where less testing and training activities involving vessels and in-water devices are conducted.

- Kemp's ridley sea turtles (dead and live) have been recorded in the deeper, open waters of the Chesapeake Bay Water Range, especially during spring and summer. However, Kemp's ridley turtles have been found to prefer spending more time and foraging in shallower waters closer to shore, such as small inlets and flats (Barco et al., 2017; Barco et al., 2018b), where there would be less activity involving vessels and in-water devices.
- Leatherback sea turtles would be more likely to occur in the deeper, open waters of the Chesapeake Bay Water Range, given they are a pelagic species and prefer open-ocean habitats. Although leatherback sea turtles have been observed annually in the Bay, they are not common and are unevenly distributed (Maryland Department of Natural Resources, 2019c; National Aquarium in Baltimore, 2019).
- Juvenile loggerhead sea turtles regularly occur in the Chesapeake Bay, even in Maryland waters, on an an44nual basis and have been found to display high levels of foraging in the deeper, open waters of the middle and upper Chesapeake Bay, particularly during the summer (Barco et al., 2017; Barco et al., 2018b). However, the probability of co-occurrence between activities involving water-based assets and loggerhead sea turtle individuals is low because loggerheads seem to prefer to forage/travel throughout the Bay with the changing water temperatures (e.g., forage in the lower part of the Bay during spring/fall and middle/upper part of the Bay during summer; (Barco & Lockhart, 2016; Barco et al., 2017). Loggerhead turtles start to leave the Chesapeake Bay in the fall as they migrate south to warmer waters (Barco & Lockhart, 2016; Barco et al., 2017).

Given the seasonal occurrence, distribution, and habitat preferences of the four species (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area, the probability of co-occurrence between vessel and in-water device activity and these species is low. Behavioral reactions, startle reactions, and physiological stress, due to vessel and in-water device noise are likely to be brief and minor, if they occur at all.

Impacts from Non-explosive Munitions and Other Military Expended Materials

All use of non-explosive munitions and other MEM is confined to established SDZs, and mostly within the Chesapeake Bay Water Range. Munitions (e.g., bombs and small- and medium-caliber guns) are released with the highest concentrations near the fixed targets, recovery areas, and/or aim points within the Chesapeake Bay Water Range.

Sea turtles may be exposed to sounds caused by the firing of weapons, objects in flight, and inert impact of non-explosive munitions on the water's surface (e.g., weapons separation tests). In general, these are impulsive sounds generated near or at the water surface. In the Bay, most in-air sound would be reflected at the air-water interface. Underwater sounds would be strongest just below the surface and directly under the firing point. The reduction of sound transmitted to the underwater environment from the air is described in Appendix B (A Noise Primer: Noise and Its Effect on the Environment). The amount of sound entering the water from weapons firing, projectile travel, and inert objects hitting the water would be very limited in duration and affected area. Within the estuarine environment, weapons firing noise is mostly limited to approximately 3 km around the fixed targets where peak sounds levels are 130 dB re 20 µPa or greater (refer to Section 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors, and Appendix C, Noise Study). Sound levels could be relatively high directly beneath a gun blast; however, even in the worst-case scenario of a rocket fired at the ideal angle of 13 degrees, sound levels in the water directly below the blast are substantially lower than necessary to cause hearing loss in a sea turtle (about 169 dB peak re 1 µPa; see Section 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors). Similarly, situations in which inert objects hitting the water, even at high speeds, could hypothetically generate sound sufficient to cause hearing loss within a short distance would be very rare. Therefore, hearing loss is not further considered as a potential effect.

All weapons-firing and impact noise would be brief, lasting from less than a second for a blast or inert impact, to a few seconds for other launch and object travel sounds. Most incidents of impulsive sounds produced by weapons-firing, launch, or inert object impacts would be single events include multiple rocket launches, with the exception of gunfire activities. Most of the weapons firing is also from aircraft high above the water. It is expected that these sounds may elicit brief startle reactions or diving, with avoidance being more likely with the repeated exposure to sounds during gunfire events. It is assumed that, similar to air gun exposures, sea turtle behavioral responses would cease following the exposure event and the risk of a corresponding, sustained stress response would be low. Similarly, exposures to impulsive noise caused by these activities would be so brief that risks of masking relevant sounds would be low.

Green, Kemp's ridley, and loggerhead sea turtles may be exposed to noise generated by non-explosive munitions and other MEM from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may be exposed in the spring and summer when this species may occur in the waters in/around the Bay. The majority of weapons-firing and impact noise is limited to open estuarine waters of the PRC Study Area (e.g., Chesapeake Bay Water Range), where Kemp's ridley, leatherback, and loggerhead sea turtles may occur, but in an area where green sea turtles are unlikely to occur (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species).

- Low numbers of live green sea turtles have been sighted in the middle Chesapeake Bay (Barco et al., 2018a), and a few stranded green sea turtles have been recorded in the middle and upper portions of the Bay (Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019). Given juvenile and adult green sea turtle habitat preference for seagrass flats, green turtles would be more likely to occur in shallow areas of the Bay, such as the waters around Bloodsworth Island Range, where no ordnance has been dropped or fired since 1996 and activities are not proposed to resume.
- Most activities are limited to the deeper waters of the Chesapeake Bay Water Range, where Kemp's ridley sea turtles (dead and live) have been recorded, especially during spring and summer. However, Kemp's ridley turtles, primarily juveniles, utilize the Bay for foraging habitat, and tagged turtles have been found to spend more time and to forage in shallower waters closer to shore, such as small inlets and flats (Barco et al., 2017; Barco et al., 2018b), where exposures to MEM are less likely.
- The leatherback sea turtle would be more likely to co-occur with these activities given it is a pelagic species and its feeding behavior (feeds at or near the surface). Although leatherback sea turtles have been observed annually in the Bay, they are not common and are unevenly distributed (Maryland Department of Natural Resources, 2019c; National Aquarium in Baltimore, 2019).

Tagged loggerhead sea turtles, primarily juveniles, have been found to regularly occur in the deeper waters of the Chesapeake Bay Water Range, especially during the summer while they are foraging

(Barco et al., 2017; Barco et al., 2018b). However, the probability of co-occurrence between activities involving MEM and loggerhead sea turtle individuals is low because loggerhead sea turtles seem to prefer to forage/travel throughout the Bay with the changing water temperatures (e.g., forage in the lower part of the Bay during spring/fall and middle/upper part of the Bay during summer) (Barco & Lockhart, 2016; Barco et al., 2017). Loggerhead turtles start to leave the Chesapeake Bay in the fall as they migrate south to warmer waters (Barco & Lockhart, 2016; Barco et al., 2017). Weapons-firing and impact noise are transient in nature; therefore, impacts from testing and training activities would be highly localized and concentrated in space and duration. Given the seasonal occurrence, distribution, and habitat preferences of the four species (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area, the probability of co-occurrence between activities involving non-explosive munitions and other MEM and these species is low. Behavioral reactions, startle reactions, and physiological stress, due to noise produced by non-explosive munitions and other MEM are likely to be brief and minor, if they occur at all.

Impacts from Acoustic Stressor (Determination)

Acoustic stressors associated with the Proposed Action (Alternative 2) "may affect, but are not likely to adversely affect" sea turtle species that may occur in the PRC Study Area (see Table 3.4-12 in Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Regulatory Conclusions, for species-specific determinations). The "may affect" conclusion is associated with only movement of air and water-based assets and non-explosive munitions and other MEM/weapons firing in the Chesapeake Bay Water Range.

Physical Disturbance and Strike

This section analyzes the potential impacts on sea turtles from the various types of physical disturbance and strike stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.2, Identifying Stressors for Analysis, Physical Disturbance and Strike Stressors, for supporting details). The physical disturbance and strike stressors that may impact sea turtles within the PRC Study Area include water-based assets and non-explosive munitions and other MEM. Physical disturbance and strike from air- and land-based assets are not anticipated because these assets do not coincide with sea turtle habitat (e.g., sea turtles do not nest on beaches located within the PRC Study Area), therefore, they will not be discussed further.

It is not known at what point or through what combination of stimuli (visual, acoustic, or through detection in pressure changes) a sea turtle becomes aware of a vessel or other potential physical disturbances prior to reacting or being struck. If a sea turtle reacts to physical disturbance, the individual must stop its activity and divert its attention in response to the stressor. The energetic costs of reacting to a stressor will depend on the specific situation, but one can assume that the energetic requirements of a response may reduce the amount of energy available for other biological functions (e.g., foraging). If a strike does occur, the cost to the individual could range from slight injury to death.

Impacts from Water-based Assets

Most activities using vessels, in-water or bottom devices would be conducted in deeper, open water of the PRC Study Area, primarily within the Chesapeake Bay Water Range, where the four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the study area could occur. Testing and training activities may consist of a single or multiple water-based assets (primarily small and medium-sized surface vessels). Most activities involving vessel movements and in-water devices occur intermittently and are variable in duration, ranging from a few hours up to 12 hours per day. Based on the hours of operation proposed with the Preferred Alternative, vessel activity within mostly the Chesapeake Bay Water Range would be localized and infrequent. The rest of the activities may be conducted in waters near the installations and rivers in the western portion of the PRC Study Area. A small amount of vessel movement (15 percent of water-based asset hours) may occur outside the water range, but within the PRC Study Area. Activities involving bottom or in-water devices would take place within the water range, but may also take place in waters surrounding NAS Patuxent River and OLF Webster as well as the Potomac and Saint Mary's Rivers. Under the Proposed Action, activities involving in-water devices account for about 6 to 7 percent of water-based asset hours. For activities occurring in the waterways off the Chesapeake Bay, loggerhead and Kemp's ridley sea turtles may be impacted as these species have been found to occur more around the mouths of some of the rivers (e.g., Potomac and Patuxent Rivers) within the PRC Study Area.

Bottom devices include items placed on, dropped on or moved along the bottom such as mine shapes and spar buoys. Potential impacts on sea turtles are anticipated to be insignificant because (1) a low number of activities involving bottom devices are estimated to occur in the PRC Study Area, (2) the likelihood of any sea turtle species encountering bottom devices is considered extremely low because these items are either stationary or move very slowly along the bottom, and (3) all bottom devices are recovered. Sea turtles (e.g., green, Kemp's ridley, and loggerhead sea turtles) that have recruited to benthic foraging grounds in the Chesapeake Bay would possibly encounter a bottom device, but would likely avoid it. In the unlikely event that a sea turtle is near a bottom device, the slow movement and stationary characteristics of these devices would not be expected to physically disturb or alter natural behaviors of sea turtles; therefore, potential impacts are anticipated to be insignificant. Therefore, these items do not pose a significant strike risk to sea turtles.

Under the Proposed Action, about 17 to 18 percent of the hours for water-based asset activity involve high-speed (greater than 10 knots) vessel movements and maneuvering (Table 3.0-8, Annual Operating Hours for Water-based Assets Associated with the Proposed Action). The vast majority of high-speed movement is represented by fuel-powered, small to medium, surface vessels (with exposed propellers) operating in the Chesapeake Bay Water Range where depths are mostly greater than 13 feet (4 meters). These high-speed vessel movements in inshore waters present a relatively higher risk for strike because of the higher concentrations of sea turtles in these areas and the difficulty for vessel operators to avoid collisions during high-speed activities, which is especially true for unmanned surface vessels representing approximately half of overall vessel hours.

Strikes of sea turtles can cause permanent injury or death from bleeding or other trauma, paralysis and subsequent drowning, infection, or inability to feed. Apart from the severity of the physical strike, the likelihood and rate of a turtle's recovery from a strike may be influenced by its age, reproductive state, and general condition. Vessel strikes are known to injure and kill sea turtles (Barco et al., 2016; Work et al., 2010). Much of what is written about recovery from vessel strikes is inferred from observing individuals sometime after a strike. Numerous sea turtles bear scars that appear to have been caused by propeller cuts or collisions with vessel hulls (Hazel et al., 2007; Lutcavage et al., 1997). Fresh wounds on some stranded animals may strongly suggest a vessel strike as the cause of death. The actual incidence of recovery versus death is not known, given available data. Any of the sea turtle species found in the PRC Study Area can occur at or near the surface, whether feeding, basking, or periodically surfacing to breathe.

Sea turtles spend a majority of their time submerged (Renaud & Carpenter, 1994; Sasso & Witzell, 2006), though Hazel et al. (2007) showed turtles staying within the top 10 feet (3 meters) of water despite deeper water being available. Loggerhead sea turtles are the most abundant sea turtles found in the PRC Study Area. Loggerheads are considered the most generalist of sea turtle species in terms of feeding and foraging behavior, and apparently, exhibit varied dive behavior that is linked to the quantity and quality of available prey resources. Patel et al. (2016) found that loggerheads spent 7.3 percent of time at the surface (associated with breathing), 42 percent of time under the surface, but close to the surface within one body length, and 44 percent of time within the water column (the remaining time observed at or near the bottom). Dive histogram data from satellite-tagged loggerhead turtles in Virginia suggest that loggerheads in Chesapeake Bay may spend about 22.1 percent (in fall) to 38.5 percent (in spring) of their time within 3.3 feet (1 meter) of the surface. This is the area of the water column, where these animals would be the most susceptible to vessel strike (Barco et al., 2016). Leatherback sea turtles are more likely to feed at or near the surface; however, they can forage for jellyfish at depth but bring them to the surface to ingest (Benson et al., 2007; Fossette et al., 2007; James & Herman, 2001). Green, Kemp's ridley, and loggerhead sea turtles primarily feed along the bottom; however, they surface periodically to breathe while feeding and moving between habitats.

Basking on the water's surface is common for all species within the PRC Study Area as a strategy to thermoregulate. Loggerhead and Kemp's ridley sea turtles have been found to spend more time at or near the surface during spring while inhabiting the Chesapeake Bay as opposed to summer as water temperatures increase (Mansfield, 2006). The reduced activity associated with basking may pose higher risks for sea turtle strikes, especially during the spring, because of a likely reduced capacity to avoid cues.

Some vessels and in-water devices associated with testing and training can travel at high speeds, which increase the strike risk to sea turtles (Hazel et al., 2007). Small Navy craft (less than 50 feet in length) and in-water devices, e.g., USVs, (less than 10 feet in length), have much more variable speeds (0 to 60 knots, depending on the mission and vessel type). Smaller, faster vessels and in-water devices that operate in inshore waters, where certain species such as Kemp's ridley and loggerhead sea turtles can be more densely concentrated, pose a greater risk (Chaloupka et al., 2008). For example, sea turtle occurrence (e.g., Kemp's ridley and loggerhead) increases in nearshore areas within the Chesapeake Bay from late spring to early fall, most likely due to foraging (Barco & Lockhart, 2015). Other studies have shown that the potential for vessel strike increases in areas important for foraging sea turtles (Denkinger et al., 2013). These inshore water activities may be conducted in more confined waterways, limiting maneuverability of the vessel, especially when trying to avoid a potential collision with an animal. High-speed vessel/in-water device movements further increase the potential risk of strike by reducing the available reaction time of both the sea turtle and vessel/in-water device (if not unmanned) operator to an impending strike. Hazel et al. (2007) noted in one study that green sea turtles did not have time to react to vessels moving at speeds of about 10 knots, but reacted frequently to vessels at speeds of about 2 knots. Detection, therefore, was suggested to be based on the turtle's ability to see rather than hear an oncoming vessel.

Work et al. (2010) conducted experiments on the type of injurious effects that small (3 to 6 meters [10 to 20 feet]) vessels could have on sea turtles, and found that the occurrence of catastrophic injury was found to decrease from 100 percent to 40 percent when vessel speed was decreased from high speed to idle speed. Boat strike has been identified as one of the important mortality factors in several nearshore sea turtle habitats worldwide. Precise data are lacking for sea turtle mortalities directly caused by vessel strikes; however, live and dead sea turtles are often found with injuries indicative of collision with a vessel hull or propeller (Barco et al., 2016; Hazel et al., 2007; Lutcavage et al., 1997). For example, about 33 percent of stranded leatherback sea turtles found along the shorelines and in marine or estuarine waters of Florida from 1986 to 2014 had a vessel-strike injury (Foley et al., 2019). Scientists in Hawaii reported that 2.5 percent of green sea turtles found dead on the beaches between 1982 and 2003 had been killed by vessel strike (Chaloupka et al., 2008). Stranded Kemp's ridley sea turtles found along shorelines and in estuarine waters of Florida and Maryland had injuries indicative of a vessel strike (Foley et al., 2019; Maryland Department of Natural Resources, 2019c). Barco et al. (2016) found that 15 of the 60 fresh, dead loggerhead turtles that were examined from 2004 to 2013 in Virginia, showed signs of vessel interactions. Stranded loggerheads with injuries indicative of a vessel strike have also been found along shorelines and in estuarine waters of Florida and Maryland (Foley et al., 2019; Maryland Department of Natural Resources, 2019c).

Vessels and in-water devices that operate in shallow waters travel at slower speed and pose less risk of strikes to sea turtles (Hazel et al., 2007; Lutcavage et al., 1997). Another factor in reducing effects on foraging sea turtles could be seasonal hypoxia that covers most of the Chesapeake Bay Water Range. This could push more foraging sea turtles closer to shore and shallower water where strike hazards are reduced.

Given the amount of high-speed vessel movement hours, the inshore water locations of where these activities would occur, and species' seasonal occurrence and distribution throughout the PRC Study Area, the likelihood of co-occurrence with individuals of green, Kemp's ridley, leatherback, and loggerhead sea turtles is low, but the potential for physical disturbance and strike cannot be discounted. In-water devices are generally smaller (several inches to 111 feet) than most Navy vessels, but some are similar to support crafts (typically less than 15 meters [49 feet] in length). Therefore, sea turtles could respond to the physical presence of the device similar to how they respond to the physical presence of a vessel. In-water devices that move slowly through the water, such as unmanned underwater vehicles (UUVs), are highly unlikely to strike sea turtles because the turtle could easily avoid the object. Some UUVs have propeller guards, which further reduces the risk of strike. Towed devices are unlikely to strike a sea turtle because of the observers on the towing platform and other standard safety measures employed when towing in-water devices. Physical disturbance from the use of in-water devices is not expected to result in more than a temporary behavioral response, and potential impacts are anticipated to be insignificant. These responses would likely include avoidance behaviors (swimming away or diving) and cessation of normal activities (e.g., foraging). As with an approaching vessel, not all sea turtles would exhibit avoidance behaviors and therefore would be at higher risk of a strike. Devices that could pose more of a risk for physical disturbance or strike to sea turtles are those that are operated at high speeds and those that are unmanned.

Under the Proposed Action, physical disturbance and strikes would most likely occur where there is an overlap in location with sea turtles, especially in high densities, and with high-speed vessel and in-water device testing and training activities. There is not expected to be any predictable seasonal difference in Navy vessel and in-water device use; therefore, impacts from vessels and in-water devices, including physical disturbance and potential for strike, would depend on each species' seasonal patterns of occurrence or degree of residency in the PRC Study Area. The four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead turtles) present in the PRC Study Area, generally occur from late spring to fall, therefore, potential impacts would be more likely during this part of the year. As previously indicated, any physical disturbance from vessel movements and use of in-water devices is not expected to result in more than a momentary behavioral response; however, an actual strike of a sea turtle would likely result in permanent injury, temporary injury that weakens a sea turtle's resilience to other natural and human-induced stressors, or death. In-water devices have a very limited potential to strike a sea turtle because they either move slowly through the water column (e.g., UUVs) or are closely monitored by observers manning the towing platform (e.g., most towed devices).

Potential impacts from interactions with vessels and in-water devices may result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Testing and training activities could present a physical disturbance from bottom devices, but those activities are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Potential impacts of exposure to vessels and in-water or bottom devices are not expected to result in population-level impacts for the four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) that are present in the PRC Study Area.

Green, Kemp's ridley, and loggerhead sea turtles may encounter water-based assets (e.g., vessels, in-water or bottom devices) from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may encounter them in the spring and summer when this species may occur in the waters in/around the Bay. Some activities using water-based assets may be conducted in waters near the installations and rivers in the western portion of the PRC Study Area, but the majority would be conducted in the deeper, open waters of the Chesapeake Bay Water Range, where Kemp's ridley, leatherback, and loggerhead sea turtles may occur, but in an area where green sea turtles are unlikely to occur (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species).

- Given juvenile and adult green sea turtle habitat preference for sea grass flats, they would be more likely to occur in shallow areas of the Bay such as the waters around Bloodsworth Island Range, where there would be less activity involving water-based assets. In addition, green sea turtles (primarily juveniles) are observed annually in the Bay, but are not as common as the other species that are present (e.g., Kemp's ridley sea turtles) and are unevenly distributed (Barco & Lockhart, 2015) throughout these waters.
- Kemp's ridley sea turtles (dead and live) have been recorded in the middle Bay as well as near the mouths of the rivers (e.g., Potomac River) in the western portion of the Bay, especially during spring and summer. However, Kemp's ridley turtles utilize the Bay for foraging habitat and tagged turtles have been found to spend more time and forage in shallower waters closer to shore such as small inlets and flats, where their preferred prey, the blue crab, occurs (Barco et al., 2017; Barco et al., 2018b) and where exposures to water-based assets are less likely to occur.
- Leatherback sea turtles may encounter and be impacted by vessels and in-water devices in the Chesapeake Bay Water Range, given their preference for open water and their feeding behavior (feed at or near the surface) and prey (e.g., jellyfish). Leatherbacks have been observed annually in the Chesapeake Bay during warmer months (June through August); however, they are not common and are unevenly distributed (Barco & Lockhart, 2015).
- Tagged loggerhead sea turtles have been found to regularly occur in the open water of the middle to upper Chesapeake Bay, especially during the summer, as well as near the mouths of the rivers (e.g., Potomac River) in the western portion of the Bay, while they are foraging (Barco

et al., 2017; Barco et al., 2018b). Loggerhead sea turtles are likely the most at risk of interactions with water-based assets in the PRC Study Area because this species is the most abundant in the Bay. However, the probability of co-occurrence is low, as loggerheads seem to prefer to forage/travel throughout the Bay with the changing water temperatures (e.g., forage in the lower part of the Bay during spring/fall and middle/upper part of the Bay during summer) (Barco & Lockhart, 2016; Barco et al., 2017). Loggerhead turtles start to leave the Bay in the fall as they migrate south to warmer waters (Barco & Lockhart, 2016; Barco et al., 2017).

Given the number of overall hours (including hours of high-speed movement) for water-based assets in the PRC Study Area, and the seasonal occurrence and distribution of sea turtles in the area, the possibility of physically disturbing or striking an individual of the four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead turtles) present in the PRC Study Area is low, but cannot be discounted. Impacts, if any, could be substantial as any strike from a vessel or in-water device at high speed is likely to result in significant injury.

Impacts from Non-explosive Munitions and Other Military Expended Materials

Some activities associated with the Proposed Action generate MEM in the following categories: (1) non-explosive munitions; and (2) other MEM (e.g., sonobuoys, marine markers). Potential impacts of MEM resulting from ingestion, entanglement, and pollutants are discussed in those subsections, respectively.

The expenditure of non-explosive munitions and other MEM would primarily occur in the deep waters of the Chesapeake Bay Water Range and be focused near fixed targets, recovery areas and/or aim points, as well as possibly at the dip points located north of the water range, where the four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area could occur. Marine markers will also be expended in the Patuxent River Seaplane Area, where sea turtles are less likely to occur. The annual footprint of non-explosive munitions and other MEM in the PRC Study Area is relatively low with overall percent coverage of MEM in the Chesapeake Bay Water Range being 0.0004 percent (about 19,211 out of 5,140,955,570 square feet) under the Preferred Alternative (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis). The Hannibal Target ordnance concentration area represents the location with the highest percent coverage of MEM (relative to the square footage of the ordnance concentration location) of 0.0132 percent (about 7,322 out of 55,437,000 square feet). The relatively low MEM footprint is further reduced when munitions strike their target in testing and training scenarios, and thus further reducing the likelihood of physical disturbance or strike from MEM associated with the Proposed Action.

In addition, deeper parts of the Chesapeake Bay, including the PRC Study Area (see Figure 3.3-2, Characterization of the PRC Water Column During the Warm Season in Terms of Salinity and Dissolved Oxygen (Minimums)), experience seasonal depletions of dissolved oxygen (termed "hypoxia"), which further reduces the likelihood of physical disturbance or strike from MEM, particularly in the Chesapeake Bay Water Range. Hypoxic conditions may occur in the benthic environment from May to September, when sea turtles occur in the Bay, and last approximately 120 days, though dissolved oxygen minimums are limited to the late summer months (Murphy et al., 2011). The seasonal hypoxia can reduce benthic food resources (e.g., fish, molluscs, and sea grass) by 90 percent (Sturdivant et al., 2014), which corresponds to relatively poor habitat for benthic foraging sea turtles (green, Kemp's ridley, and loggerhead sea turtles). Therefore, there is a low probability of co-occurrence between activities expending MEM and green, Kemp's ridley, and loggerhead sea turtles.

The primary concern is the potential for a sea turtle to be struck with an MEM at or near the water's surface, which could result in injury or death. While disturbance or strike from an item as it falls through the water column is possible, it is not likely, because objects generally sink through the water slowly and can be avoided by most sea turtles. Materials will slow in their velocity as they approach the bottom of the water and will likely be avoided by any sea turtles (e.g., Kemp's ridley, green, or loggerhead sea turtles) that happen to be in the vicinity, foraging in benthic habitats. Therefore, the discussion of MEM strikes focuses on the potential of a strike at or near the surface of the water.

Sea turtles are generally at the surface for short periods, and spend most of their time submerged (Renaud & Carpenter, 1994; Patel et al., 2016; Sasso & Witzell, 2006). However, they surface periodically to breathe while feeding and moving between habitats or to bask. Leatherback sea turtles are more likely to be foraging at or near the surface in the open waters of the PRC Study Area than the other species. There is a possibility that an individual sea turtle at or near the surface may be struck if they are in the target area at the point of physical impact at the time of munitions delivery. Expended munitions may strike the water surface with sufficient force to cause injury or mortality. The primary MEM used in the water range include small- and medium-caliber gun ammunition. Cartridge casings are retained within the aircraft after firing, while the projectiles are deposited into the water. Projectiles are aimed at targets, which will absorb the impact of the projectile and reduce the risk of strike.

Direct strikes from non-explosive bombs, missiles, and rockets are potential stressors to some species. Some individuals at or near the surface may be struck directly if they are at the point of impact at the time of non-explosive practice munitions delivery. However, when missiles hit their target or are disabled before hitting the water, these munitions enter the water as fragments, causing their kinetic energy to quickly dissipate within a short distance of the surface.

Given the number of aircrafts and vessels involved and the type of activities occurring in the PRC Study Area, it is likely that any sea turtle present would vacate the immediate vicinity until the activity has concluded, further reducing the potential for a sea turtle to get struck by an MEM. Under the Proposed Action, testing and training activities could present a physical disturbance from MEM, but activities are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Potential impacts of exposure to MEM are not expected to result in population-level impacts for the four species of sea turtles that are present in the PRC Study Area.

Green, Kemp's ridley, and loggerhead sea turtles may encounter MEM from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may encounter MEM in the spring and summer when this species may occur in the waters in/around the Bay. Activities involving the expenditure of MEM would primarily occur in the deeper waters of the Chesapeake Bay Water Range, where Kemp's ridley, leatherback, and loggerhead sea turtles may occur, but in an area where green sea turtles are unlikely to occur (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species).

- Seagrass is not found within the water range (see Figure 3.4-1 in Section 3.4.2.2, Affected Environment, Vegetation), and given juvenile and adult green sea turtle habitat preference for sea grass flats, they would be more likely to occur in shallow areas of the Bay such as the waters around Bloodsworth Island Range, where no munitions have been dropped or fired since 1996 and activities are not proposed to resume there. In addition, green sea turtles (primarily juveniles) are observed annually in the Bay, but are not as common as other species (e.g., Kemp's ridley sea turtles) and are unevenly distributed (Barco & Lockhart, 2015).

- Kemp's ridley sea turtles (dead and live) have been recorded in the middle and upper Bay especially during spring and summer. However, Kemp's ridley turtles utilize the Bay for foraging habitat and tagged turtles have been found to spend more time and forage along the bottom in shallower waters closer to shore such as small inlets and flats, where their preferred prey, the blue crab, occurs (Barco et al., 2017; Barco et al., 2018b) and where exposures to MEM are less likely to occur.
- Leatherback sea turtles may encounter and be impacted by MEM in the Chesapeake Bay Water Range, given it is a pelagic species that prefers open water. Because leatherback turtles are more likely to feed at or near the surface, they are more likely to encounter materials at the surface than the other species that are present (e.g., Kemp's ridley sea turtle) that primarily feed along the bottom. However, the likelihood of a leatherback turtle being struck by MEM remains very low because although this species has been observed annually in the Bay during warmer months (June through August), leatherback turtles are not common and are unevenly distributed (Barco & Lockhart, 2015).
- Tagged loggerhead sea turtles have been found to regularly occur in the deeper waters of the Chesapeake Bay Water Range, especially during the summer while they are foraging (Barco et al., 2017; Barco et al., 2018b). However, the probability of co-occurrence is low, as loggerhead turtles seem to prefer to forage/travel throughout the Bay with the changing water temperatures (e.g., forage in the lower part of the Bay during spring/fall and middle/upper part of the Bay during summer) (Barco & Lockhart, 2016; Barco et al., 2017). Loggerheads start to leave the Bay in the fall as they migrate south to warmer waters (Barco & Lockhart, 2016; Barco et al., 2017).

Given the seasonal occurrence, distribution, and habitat preferences of the four species (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area, the probability of co-occurrence between activities involving non-explosive munitions and other MEM and these species is low, and impacts, if any, would be minor. Strikes would not be a minor impact, but would be even less likely than disturbance impacts.

Impacts from Physical Disturbance and Strike Stressor (Determination)

Physical disturbance and strike stressors associated with the Proposed Action (Alternative 2) "may affect, and are likely to adversely affect" sea turtle species that may occur in the PRC Study Area (see Table 3.4-12 in Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Regulatory Conclusions, for species-specific determinations). The "may affect" conclusion is associated with only movement of water-based assets and the expenditure of non-explosive munitions and other MEM in mostly the Chesapeake Bay Water Range.

Energy

This section analyzes the potential impacts on sea turtles from the various types of energy stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.5, Identifying Stressors for Analysis, Energy Stressors, for supporting details). However, this section includes analysis of the potential impacts of in-water electromagnetic devices (e.g., mine neutralization systems) and directed energy weapons systems (e.g., high-energy laser and high-power microwave). In-air electromagnetic stressors are not applicable to sea turtles because in-air electromagnetic energy is transmitted over short distances and it does not penetrate the water.

Impacts from In-Water Electromagnetic Devices

Events involving electromagnetic mine neutralization systems occur in the Chesapeake Bay Water Range, typically between the NAS Patuxent River shoreline and Hooper Target, but may also occur in the SDZ around Bloodsworth Island. For the Preferred Alternative, no more than 21 events using in-water electromagnetic devices are planned per year within the PRC Study Area (refer to Table 3.0-16, Operating Hours by Energy-producing Asset for the Proposed Action Alternatives, in Section 3.0.2.3.5, Identifying Stressors for Analysis, Energy Stressors).

Studies have shown that magnetic fields and other cues (e.g., visual cues), are important for sea turtle orientation and navigation (Lohmann et al., 1997; Putman et al., 2015). Studies on behavioral responses to magnetic fields have been conducted on green and loggerhead sea turtles. Loggerheads were found to be sensitive to field intensities ranging from 0.005 to 4,000 microteslas, and green sea turtles were found to be sensitive to field intensities from 29.3 to 200 microteslas (Normandeau Associates et al., 2011). Because these data are the best available information, this analysis assumes that the responses would be similar for other sea turtle species. Sea turtles use geomagnetic fields to navigate at sea, and therefore changes in those fields could impact their movement patterns (Lohmann & Lohmann, 1996; Lohmann et al., 1997). Sea turtles in all life stages orient to the earth's magnetic field to position themselves in oceanic currents. Directional swimming presumably aided by magnetic orientation has been shown to occur in some sea turtles (Christiansen et al., 2016a). This helps them locate seasonal feeding and breeding grounds and return to their nesting sites (Lohmann & Lohmann, 1996; Lohmann et al., 1997). Experiments show that sea turtles can detect changes in magnetic fields, which may cause them to deviate from their original direction (Irwin & Lohmann, 2003; Lohmann & Lohmann, 1996; Lohmann et al., 1997). Liboff (2015) determined that freshly hatched sea turtles are able to detect and use the local geomagnetic field as a reference point before embarking on a post-hatchling migration.

Sea turtles also use nonmagnetic cues for navigation and migration, and these additional cues may compensate for variations in magnetic fields. Putman et al. (2015) conducted experiments on loggerhead hatchlings and determined that electromagnetic fields may be more important for sea turtle navigation in areas that may constrain a turtle's ability to navigate (cold temperatures or displacement from a migration route). The findings of this study suggest that the magnetic orientation behavior of sea turtles is closely associated with ocean ecology and geomagnetic environment (Putman et al., 2015).

As stated in Section 3.0.2.3.5 (Identifying Stressors for Analysis, Energy Stressors), the in-water devices (e.g., OASIS, MOPS) producing an electromagnetic field are towed. In an actual mine-clearing operation, the intent is that the electromagnetic field would trigger an enemy mine designed to sense a vessel's magnetic field. The electromagnetic field is produced to simulate a vessel's magnetic field. The maximum strength of the magnetic field is approximately 2,300 microteslas, with the strength of the field decreasing further from the device. At a distance of 13 feet (4 meters) from the source of a 2,300-microtesla magnetic field, the strength of the field is approximately 50 microteslas, which is within the range of the Earth's magnetic field (25 to 65 microteslas). At 78.7 feet (24 meters) away from the source, the strength of the field is approximately 10 percent of the Earth's magnetic field (U.S. Department of the Navy, 2005c). At a distance of 656 feet (200 meters) the magnetic field would be approximately 0.2 microteslas (Navy, 2005), which is likely within the range of detection for sea turtle species, but at the lower end of the sensitivity range (Normandeau Associates et al., 2011). Localized electromagnetic fields that are less than the Earth's magnetic field may not be detectable and may be subject to masking, and therefore difficult for sea turtles to detect.

If located in the immediate area (within about 4 meters [13 feet]) where in-water electromagnetic devices are being used, sea turtles could be temporarily disoriented and could deviate from their original movements, but the extent of this disturbance is likely to be inconsequential given the brief duration of the potential disorientation due to the short duration (about two hours) of the events involving energy-producing assets (refer to Table 3.0-16, Operating Hours by Energy-producing Asset for the Proposed Action Alternatives, in Section 3.0.2.3.5, Identifying Stressors for Analysis, Energy Stressors), and animals would likely recovery completely. Given the low number of events, the seasonal occurrence of sea turtles within the PRC Study Area, and the species' distribution, potential impacts on sea turtles are anticipated to be insignificant because any potential effects are likely limited to a few minor disturbances. Chances are, the turtle would be affected first by the physical presence of the fast-moving vessel (or helicopter) towing the device before any effects could be noticed from electromagnetic fields above background levels. The in-water electromagnetic devices planned with the Proposed Action are not expected to cause more than a short-term behavioral disturbance to sea turtles because of the: (1) relatively low intensity of the magnetic fields generated (0.2 microteslas at 200 meters [656 feet] from the source), (2) highly localized potential impact area, (3) limited and temporary duration of the activities (hours), and (4) low likelihood of these devices being turned on. Any sea turtles potentially impacted also have to co-occur with the stressor.

Under the Proposed Action, potential impacts of exposure to in-water electromagnetic devices are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Potential impacts of exposure to in-water electromagnetic devices are not expected to result in population-level impacts for the four species of sea turtles that are present in the PRC Study Area.

Green, Kemp's ridley, and loggerhead sea turtles may be exposed to in-water electromagnetic devices from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may encounter these devices in the spring and summer when this species may occur in the waters in/around the Bay. Activities involving in-water electromagnetic devices would primarily occur in the northern portion of the Chesapeake Bay Water Range, where Kemp's ridley, leatherback, and loggerhead sea turtles may occur, but in an area where green sea turtles are unlikely to occur (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species). Some activities may also occur around Bloodsworth Island, where Kemp's ridley (primarily juveniles) and green (juveniles and possibly adults) may occur.

- Green sea turtles prefer shallow-water habitats such as sea grass flats, so there is the possibility for co-occurrence (albeit low) in the waters around Bloodsworth Island Range. Green turtles are observed annually in the Bay, but are not as common as other species (e.g., Kemp's ridley sea turtles) and are unevenly distributed throughout these waters (Barco & Lockhart, 2015). Low numbers of live green turtles have been sighted in the middle Bay (Barco et al., 2018a), where most activities involving in-water electromagnetic devices occur, and a few stranded green sea turtles have been recorded in the middle and upper portions of the Bay (Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019).
- ridley sea turtles (dead and live) have been recorded in the middle and upper Bay especially during spring and summer, but tagged turtles have been found to spend more time and forage

in shallower waters closer to shore such as small inlets and flats, where their preferred prey, the blue crab, occurs (Barco et al., 2017; Barco et al., 2018b).

- The leatherback sea turtle would be more likely to co-occur with these activities in the northern portion of the Chesapeake Bay Water Range, particularly in deeper water, given it is a pelagic species and prefers open-ocean habitat. Leatherbacks have been observed annually in the Chesapeake Bay during warmer months (June through August); however, they are not common and are unevenly distributed (Barco & Lockhart, 2015).
- Tagged loggerhead sea turtles have been found to regularly occur in the deeper waters of the Chesapeake Bay Water Range, especially during the summer. However, loggerhead turtles seem to prefer to forage/travel throughout the Bay with the changing water temperatures (e.g., forage in the lower part of the Bay during spring/fall and middle/upper part of the Bay during summer) and start leaving the area by the fall (Barco & Lockhart, 2016; Barco et al., 2017).

Given the distribution and seasonal occurrence of the four species (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area as well as the limited location of activities using in-water electromagnetic devices, disturbances (e.g., temporary disorientation) from these devices are likely to be brief and minor, if they occur at all, due to the low probability of co-occurrence between the stressor and individual sea turtles. Therefore, the likelihood of co-occurrence and effects for each of the four species is discountable/insignificant.

Directed Energy Weapon Systems Testing

Events involving directed energy weapons systems occur in the Chesapeake Bay Water Range, typically at Hooper and Hannibal Targets, but may also occur in the SDZ around Bloodsworth Island; however, approval is on a case-by-case basis. For the Preferred Alternative, no more than 170 events/days using high-energy lasers (50 events) and high-power microwaves (120 events) are planned per year within the PRC Study Area (refer to Table 3.0-16, Operating Hours by Energy-producing Asset for the Proposed Action Alternatives, in Section 3.0.2.3.5, Identifying Stressors for Analysis, Energy Stressors). All lasers and high-power microwave events would be conducted in accordance with the laser safety and electromagnetic safety radiation standard operating procedures, respectively, indicated in Section 2.5 (Standard Operating Procedures Included in the Proposed Action).

As discussed in Section 3.0.2.3.5.4 (Directed Energy), high-energy laser weapons testing involves the use of up to one megawatt and high-power microwave systems testing mainly involves the use of narrowband (1 to 5 gigahertz) and wideband (100 to 500 megahertz) levels of directed energy against air, surface, or land targets. These weapons systems are deployed from air, land, or surface platforms. High-energy lasers create small but critical failures in potential targets and are used at short ranges from the target. High-power microwaves produce impacts on electronics systems and would be turned on an average of three seconds per firing event with up to two firings per day. The primary target focus for directed energy weapons testing is air-based targets (e.g., small UAS targets), with a smaller number of targets being water-based (e.g., vessels).

The primary concern for directed energy weapons systems training and testing is the potential for a sea turtle to be struck by a directed energy weapon (e.g., high-energy laser beam), at or near the water's surface, which could result in injury or death, resulting from burns from the weapon. Whereas the path of a directed energy weapon from origin to target could briefly intersect a sea turtle at the water surface, the thermal effects would be momentary as both the firing platform and target would be in motion since the weapon tracks its target.

Sea turtles are generally at the surface for short periods, and spend most of their time submerged (Renaud & Carpenter, 1994; Patel et al., 2016; Sasso & Witzell, 2006). However, they surface periodically to breathe while feeding and moving between habitats or to bask. Leatherback sea turtles are more likely to be foraging at or near the surface in the open waters of the PRC Study Area than the other species. Sea turtles could be exposed to a directed energy weapon if the beam missed the target. Should the beam strike the sea surface, individual sea turtles at or near the surface could be exposed. The potential for exposure to a directed energy weapon decreases as the water depth increases. Because directed energy weapon platforms are typically aircrafts and vessels, sea turtles would likely transit away or submerge in response to other stressors, such as vessel or aircraft noise and physical presence before any effects could occur from the weapon. In addition, the likelihood of an exposure due to the directed energy weapons systems planned with the Proposed Action is further reduced because of the: (1) highly localized potential impact area, (2), limited range and temporary duration of the directed energy weapons, and (3) both the firing platform and the target would be in motion, thus potential encounters with directed energy would be very brief.

Given the number of aircrafts and vessels involved and the type of activities occurring in the PRC Study Area, it is likely that any sea turtle present would vacate the immediate vicinity until the activity has concluded, further reducing the potential of a sea turtle being impacted by a directed energy weapons system. Under the Proposed Action, testing and training activities could add exposure risk to directed energy weapons systems, but activities are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Potential impacts of exposure to directed energy weapons systems are not expected to result in population-level impacts for the four species of sea turtles that are present in the PRC Study Area.

Green, Kemp's ridley, and loggerhead sea turtles may be exposed to directed energy weapons systems from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may encounter these systems in the spring and summer when this species may occur in the waters in/around the Bay. Activities involving directed energy weapons would primarily occur in the Chesapeake Bay Water Range, where Kemp's ridley, leatherback, and loggerhead sea turtles may occur, but in an area where green sea turtles are unlikely to occur (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species). Some activities may also occur around Bloodsworth Island, where Kemp's ridley (primarily juveniles) and green (juveniles and possibly adults) may occur.

- Green sea turtles prefer shallow-water habitats such as sea grass flats, so there is the possibility for co-occurrence (albeit low) in the waters around Bloodsworth Island Range. Green turtles are observed annually in the Bay, but are not as common as other species (e.g., Kemp's ridley sea turtles) and are unevenly distributed throughout these waters (Barco & Lockhart, 2015). Low numbers of live green turtles have been sighted in the middle Bay (Barco et al., 2018a), where most activities involving directed energy weapons systems occur, and a few stranded green sea turtles have been recorded in the middle and upper portions of the Bay (Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019).
- Kemp's ridley sea turtles (dead and live) have been recorded in the middle and upper Bay especially during spring and summer, but tagged turtles have been found to spend more time and forage in shallower waters closer to shore such as small inlets and flats, where their preferred prey, the blue crab, occurs (Barco et al., 2017; Barco et al., 2018b).

- The leatherback sea turtle would be more likely to co-occur with these activities in the Chesapeake Bay Water Range, particularly in deeper water, given it is a pelagic species and prefers open-ocean habitat. Leatherbacks have been observed annually in the Chesapeake Bay during warmer months (June through August); however, they are not common and are unevenly distributed (Barco & Lockhart, 2015).
- Tagged loggerhead sea turtles have been found to regularly occur in the deeper waters of the Chesapeake Bay Water Range, especially during the summer. However, loggerhead turtles seem to prefer to forage/travel throughout the Bay with the changing water temperatures (e.g., forage in the lower part of the Bay during spring/fall and middle/upper part of the Bay during summer) and start leaving the area by the fall (Barco & Lockhart, 2016; Barco et al., 2017).

Given the seasonal occurrence, distribution, and habitat preferences of the four species (green, Kemp's ridley, leatherback, and loggerhead sea turtles) present in the PRC Study Area as well as the limited location of activities using directed energy weapons systems, the probability of co-occurrence between activities involving directed energy weapons and these species is low, and impacts, if any, would be minor. Strikes would not be a minor impact, but would be even less likely than disturbance impacts.

Impacts from Energy Stressors (Determination)

Energy stressors associated with the Proposed Action (Alternative 2) "may affect, but are not likely to adversely affect" sea turtle species that may occur in the PRC Study Area (see Table 3.4-12 in Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Regulatory Conclusions, for species-specific determinations). The "may affect" conclusion is associated with only in-water electromagnetic devices used mostly in the Chesapeake Bay Water Range.

Entanglement

This section analyzes the potential impacts on ESA-listed sea turtles from the various types of entanglement stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.6, Identifying Stressors for Analysis, Entanglement Stressors, supporting details). This section includes analysis of the potential entanglement from flare O-rings, wires/cables, and decelerator/parachutes. Given the small size of the flare O-rings (about 1.4 inches in diameter) and the age classes (late juveniles to adults) of the sea turtles (green, Kemp's ridley, leatherback, and loggerhead turtles) that most likely occur in the PRC Study Area, the likelihood for entanglement is discountable.

These materials could be encountered by sea turtles and if encountered, may have the potential to entangle sea turtles in the PRC Study Area at the surface or in the water column. Risk factors for entanglement of sea turtles include animal size (and life stage), sensory capabilities, and foraging methods. Most entanglements discussed in the literature are attributable to sea turtle entrapments with fishing gear or other nonmilitary materials that float or are suspended at the surface. Entanglement events are difficult to detect from land or from a boat as they may occur at considerable distances from shore and typically take place underwater. Smaller, juvenile turtles are inherently less likely to be detected than larger adult sea turtles. The likelihood of witnessing an entanglement event is therefore typically low.

Impacts from Wires and Cables

AMNS cables are composed of tactical fiber, which is relatively brittle and readily breaks if knotted, kinked, abraded against sharp objects, or looped beyond the items' bend radius of 3.4 millimeters (mm) (Corning Incorporated, 2005; Raytheon Company, 2015). If the fiber becomes looped around an underwater object or organisms, it does not tighten unless it is under tension. If a loop did form around an appendage or the body of a sea turtle, the cable would subsequently break quickly on its own or in response to sea turtle movement. The fiber cables would be suspended within the water column during the activity, and then be expended and sink to the bottom (effective sink rate of 1.45 cm/second), where it would be susceptible to abrasion and burial by sedimentation or colonization by attaching/encrusting organisms (refer to Section 3.0.2.3.6, Identifying Stressors for Analysis, Entanglement Stressors). The sink rate and the likelihood for stabilization of the material on the bottom reduces the risk of entanglement and would rule out the possibility of these cables drifting great distances into nearshore areas where some species (e.g., green and Kemp's ridley sea turtles) are more likely to occur and feed on the bottom. Additionally, the very small number (four cables on an annual basis) that are expended under the Preferred Alternative limits encounter rates with fiber-optic cables. Therefore, fiber-optic cables present an entanglement risk to sea turtles, but it is unlikely that an entanglement event would occur and any entanglement would be temporary (seconds to a few minutes) before the sea turtle could resume normal activities.

Sonobuoys associated with the Proposed Action are described in Section 3.0.2.3.6.1 (Identifying Stressors for Analysis, Entanglement Stressors, Wires and Cables). Sonobuoys and sonobuoy wires remain suspended in the water column for no more than eight hours, after which they sink to the bottom, which would increase the likelihood that a sea turtle could encounter a sonobuoy wire either while it is suspended or as it sinks. However, up to 50 percent of practice sonobuoys used during testing activities do not fully open and do not present any entanglement risk. Several factors reduce the likelihood of sea turtle entanglement from sonobuoy components. If a wire were to wrap around an adult or juvenile sea turtle, it would likely break soon after entanglement or break while bending into potentially entangling loops due to the material's low breaking strength. These materials, however, are only temporarily buoyant and would begin sinking after use in an activity. The entanglement risk from these components would only occur when a sea turtle and these components were in close proximity, which is only in the water column.

Activities involving the expenditure of non-explosive munitions and other MEM, including sonobuoys and AMNS cables, would primarily occur in the deep waters of the Chesapeake Bay Water Range, particularly near fixed targets, recovery areas and/or aim points, as well as possibly at the dip points located north of the water range. These waters are not too deep for benthic foraging sea turtles (Hochscheid, 2014), so some bottom foraging species (e.g., Kemp's ridley and loggerhead turtles) that may forage at depths greater than 49 feet (15 meters) would possibly interact with these materials once they sink. The bottom areas where sonobuoys probably land are also mostly mud and seasonally hypoxic. In the benthic environment under normal oxygen levels, subsequent colonization by encrusting organisms, burying by sediment, and chemical breakdown of the various materials would eliminate or further reduce the potential for entanglement risk.

Under the Proposed Action, exposure to wires and cables used in testing and training activities may cause short-term or long-term disturbance to an individual sea turtle because if a sea turtle were to become entangled in a cable or wire, it could free itself, or the entanglement could lead to injury or death. The four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) that are seasonally present (from spring to fall) in the PRC Study Area could at some time encounter expended cables or wires. However, cables and wires are generally expected to cause an insignificant impact to sea turtles because of (1) the physical characteristics of the cables and wires, (2) the behavior of the species, as sea turtles are seasonally present in the PRC Study Area, and (3) the low concentrations of expended wires and cables in the PRC Study Area. Potential impacts of exposure to wires and cables are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Potential impacts of exposure to wires and cables are not expected to result in population-level impacts for the four species of sea turtles that are present in the PRC Study Area.

Green, Kemp's ridley, and loggerhead sea turtles may encounter expended wires and cables from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may encounter them in the spring and summer when this species may occur in the waters in/around the Bay. Wires and cables would primarily be expended in the deeper, open waters of the Chesapeake Bay Water Range, where Kemp's ridley, leatherback, and loggerhead sea turtles may occur, but in an area where green sea turtles are unlikely to occur (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species).

- Seagrass is not found within the water range (Figure 3.4-1 in Section 3.4.2.2, Affected Environment, Vegetation), and given juvenile and adult green sea turtle habitat preference for sea grass flats, they would be more likely to occur in shallow areas of the Bay such as the waters around Bloodsworth Island Range, wires and cables would not expended. In addition, green sea turtles (primarily juveniles) are observed annually in the Bay, but are not as common as other species (e.g., Kemp's ridley sea turtles) and are unevenly distributed (Barco & Lockhart, 2015). Low numbers of live green turtles have been sighted in the middle Bay (Barco et al., 2018a) and a few stranded green sea turtles have been recorded in the middle and upper portions of the Bay (Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019).
- Kemp's ridley sea turtles (dead and live) have been recorded in the middle and upper Bay especially during spring and summer. However, Kemp's ridley turtles utilize the Bay for foraging habitat and tagged turtles have been found to spend more time and forage in shallower waters closer to shore such as small inlets and flats, where their preferred prey, the blue crab, occurs (Barco et al., 2017; Barco et al., 2018b) and where exposures to expended wires and cables are less likely to occur.
- Leatherback sea turtles may encounter and be impacted by expended wires and cables in the Chesapeake Bay Water Range, given it is a pelagic species that prefers open water. Because leatherback turtles are more likely to feed at or near the surface and throughout the water column, they are more likely to encounter wires and cables at or near the surface than other species that primarily feed along the bottom. Leatherbacks have been observed annually in the Bay during warmer months (June through August); however, they are not common and are unevenly distributed (Barco & Lockhart, 2015).
- Tagged loggerhead sea turtles have been found to regularly occur in the deeper waters of the Chesapeake Bay Water Range, especially during the summer while they are foraging (Barco et al., 2017; Barco et al., 2018b). However, the probability of co-occurrence is low, as loggerhead turtles seem to prefer to forage/travel throughout the Bay with the changing water temperatures (e.g., forage in the lower part of the Bay during spring/fall and middle/upper part of the Bay during summer; (Barco & Lockhart, 2016; Barco et al., 2017). Loggerheads start to leave the Bay in the fall as they migrate south to warmer waters (Barco & Lockhart, 2016; Barco et al., 2017).

Based on the discussion presented above, the likelihood that a sea turtle would encounter a wire or cable associated with Navy testing and training activities in the PRC Study Area, and become entangled, is low, and impacts, if any, would likely be minor.

Impacts from Decelerators/Parachutes

While in the Chesapeake Bay Water Range, a sea turtle is less likely to become entangled because the decelerator/parachute would have to land directly on the sea turtle, or the sea turtle would have to swim into the decelerator/parachute or its cords, before it sank or was recovered. The small (up to 2 feet in diameter) decelerator/parachutes and medium parachutes (up to 18 feet in diameter) due to their size and the length of the attachment cords. The small decelerator/parachutes sink after 5 to 15 seconds and are not recovered, whereas larger decelerators/parachutes (up to 50 feet in diameter) are mostly recovered (Environmental Science Group, 2005). Recovery of most of the larger decelerators/parachutes reduces the risk of a sea turtle encountering them before they sink. The likelihood of encountering a large decelerators/parachutes is further reduced by the small number expended on an annual basis under the Preferred Alternative. Prior to reaching the bottom, an unrecovered decelerator/parachute could be carried along in a current, or snagged on a hard structure near the bottom. If bottom currents are present, the canopy may billow and pose an entanglement threat to sea turtles that feed in benthic habitats (i.e., green, Kemp's ridley, and loggerhead sea turtles).

The decelerators/parachutes would be expended within the Chesapeake Bay Water Range and at the dip points located north of the water range. Given the depth profile of the Chesapeake Bay Water Range, decelerators/parachutes would be expended in waters within the dive depth range of green, Kemp's ridley, and loggerhead sea turtles, which are benthic foragers. Leatherbacks are more likely to feed at or near the surface (Hochscheid, 2014). Conversely, the decelerator/parachute and associated cords could settle to the bottom, where they would be buried by sediment in most soft bottom areas or colonized by attaching and encrusting organisms, which would further stabilize the material and reduce the potential for reintroduction as an entanglement risk. However, the likelihood that a sea turtle would encounter decelerators/parachutes on the bottom is further reduced due to a proportion of these items being fully recovered. Decelerators/parachutes or their associated cords may be a risk for sea turtles to become entangled, particularly while at the surface. A sea turtle would have to be basking at the surface, surface to breathe, or grab prey from under the decelerator/parachute and swim into the decelerator/parachute or its cords in order to become entangled.

Under the Proposed Action, exposure to decelerators/parachutes used in testing and training activities may cause short-term or long-term disturbance to an individual sea turtle, because if a sea turtle were to become entangled in a decelerator/parachute, it could free itself, or the entanglement could lead to injury or death. The four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) that are seasonally present (from spring to fall) in the PRC Study Area could at some time encounter an expended decelerator/parachute. Potential impacts of exposure to decelerators/parachutes and the associated cords may result in changes to an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment. Given the location and size of the decelerators/parachutes and the associated cords there is the potential for disturbance to sea turtles if the decelerator/parachute were to land directly on an animal or an animal were to swim into it before it sinks or is recovered. It is possible that a benthic feeding sea turtle could become entangled when foraging in areas where decelerators/parachutes have settled on the bottom. However, decelerators/parachutes are generally expected to cause an insignificant impact to sea turtles because of (1) the number of decelerators/parachutes expended under testing and training activities for the Proposed Action; (2) the seasonal occurrence of sea turtles present in the PRC Study Area and general behavior of the species; (3) the low likelihood of a decelerator/parachute assembly landing directly on a sea turtle or a sea turtle swimming directly into it, and (4) most medium-large decelerators/parachutes are recovered by range support vessels.

Potential impacts of exposure to decelerators/parachutes are not expected to result in substantial changes in an individual’s behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for the four species of sea turtles (green, Kemp’s ridley, leatherback, and loggerhead sea turtles) that are present in the PRC Study Area.

Green, Kemp’s ridley, and loggerhead sea turtles may encounter expended decelerators/parachutes from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may encounter them in the spring and summer when this species may occur in the waters in/around the Bay. Decelerators/parachutes would primarily be expended in the deeper, open waters of the Chesapeake Bay Water Range, where Kemp’s ridley, leatherback, and loggerhead sea turtles may occur, but in an area where green sea turtles are unlikely to occur (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species).

- Given juvenile and adult green sea turtle habitat preference for sea grass flats, they would be more likely to occur in shallow areas of the Bay such as the waters around Bloodsworth Island Range, where decelerators/parachutes would not be expended. In addition, juvenile green sea turtles are observed annually in the Bay, but are not as common as other species (e.g., Kemp’s ridley sea turtles) and are unevenly distributed (Barco & Lockhart, 2015) throughout these waters. Low numbers of live green turtles have been sighted in the middle Bay (Barco et al., 2018a) and a few stranded green sea turtles have been recorded in the middle and upper portions of the Bay (Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019).
- Kemp’s ridley sea turtles (dead and live) have been recorded in the middle and upper Bay especially during spring and summer. However, Kemp’s ridley turtles utilize the Bay for foraging habitat and tagged turtles have been found to spend more time and forage in shallower waters closer to shore such as small inlets and flats, where their preferred prey, the blue crab, occurs (Barco et al., 2017; Barco et al., 2018b) and where exposures to expended decelerators/parachutes are less likely to occur.
- Leatherback sea turtles may encounter and be impacted by expended decelerators/parachutes in the Chesapeake Bay Water Range, given it is a pelagic species that prefers open water. Because leatherback turtles are more likely to feed on jellyfish at or near the surface and throughout the water column, they are more likely to encounter decelerators/parachutes at or near the surface than other species that primarily feed along the bottom. Leatherbacks have been observed annually in the Bay during warmer months (June through August); however, they are not common and are unevenly distributed (Barco & Lockhart, 2015).
- Tagged loggerhead sea turtles have been found to regularly occur in the deeper waters of the Chesapeake Bay Water Range, especially during the summer while they are foraging (Barco et al., 2017; Barco et al., 2018b). However, the probability of co-occurrence is low, as loggerhead turtles seem to prefer to forage/travel throughout the Bay with the changing water temperatures (e.g., forage in the lower part of the Bay during spring/fall and middle/upper part

of the Bay during summer; (Barco & Lockhart, 2016; Barco et al., 2017). Loggerheads start to leave the Bay in the fall as they migrate south to warmer waters (Barco & Lockhart, 2016; Barco et al., 2017).

Based on the discussion presented above, the likelihood that a sea turtle would encounter a decelerator/parachute and the associated cords, and become entangled, is low for the four species that are present in the PRC Study Area, and impacts, if any, would likely be minor.

Impacts from Entanglement Stressor (Determination)

Entanglement stressors associated with the Proposed Action (Alternative 2) "may affect, but are not likely to adversely affect" sea turtle species that may occur in the PRC Study Area (see Table 3.4-12 in Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Regulatory Conclusions). The "may affect" conclusion is associated with only wires/cables and parachutes used mostly in the Chesapeake Bay Water Range.

Ingestion

This section analyzes the potential impacts on sea turtles from the various types of ingestion stressors associated with non-explosive munitions and other MEM planned with the Preferred Alternative (refer to Section 3.0.2.3.7, Identifying Stressors for Analysis, Ingestion Stressors, for supporting details).

The following types of MEM would be expended that could become ingestion stressors during testing and training activities in the PRC Study Area: live gun ammunition (small- and medium-caliber), flechettes, chaff[6], flare casings (including plastic end caps, flare O-rings, and pistons), and decelerators/parachutes. Solid metal materials, such as small-caliber projectiles, sink rapidly to the bottom. Lighter plastic items may be caught in currents, and could remain in the water column for hours to weeks or indefinitely, before sinking (e.g., plastic end caps [from chaff cartridges], flare O-rings, or plastic pistons [from flare cartridges]). Fragments of the type of ingestible MEM listed above could also pose a risk to sea turtles. The expenditure of these MEM would primarily occur in the Chesapeake Bay Water Range and be focused near fixed targets, recovery areas and/or aim points, as well as possibly at the dip points located north of the water range. The Hannibal Target munition concentration area represents the location with the highest percent coverage of MEM (relative to the square footage of the munition concentration location) of 0.0132 percent (about 7,322 out of 55,437,000 square feet). The annual footprint of MEM in the PRC Study Area is relatively low with overall percent coverage of MEM in the Chesapeake Bay Water Range being 0.0004 percent (about 19,211 out of 5,140,955,570 square feet) under the Preferred Alternative (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis). Ingestible materials represent a relatively small portion of MEM. Therefore, the relatively low MEM footprint is further reduced when the portion of non-ingestible MEM is removed, and thus further reducing the likelihood of encountering ingestible MEM associated with the Proposed Action.

In addition, the Chesapeake Bay, including the PRC Study Area (see Figure 3.3-2, Characterization of the PRC Water Column During the Warm Season in Terms of Salinity and Dissolved Oxygen (Minimums)), experiences seasonal depletions of dissolved oxygen (termed "hypoxia"), which further reduces the likelihood of a sea turtle encountering ingestible MEM, particularly in the Chesapeake Bay Water Range. Hypoxic conditions may occur in the benthic environment from May to September, when sea turtles

[6]Discounted as a threat to biological resources in Section 3.4.3.1 (Environmental Consequences, No Action Alternative).

occur in the Bay, and last approximately 120 days (Murphy et al., 2011). The seasonal hypoxia can reduce benthic food resources (e.g., fish, molluscs, and sea grass) by 90 percent (Sturdivant et al., 2014), which corresponds to relatively poor habitat for benthic foraging sea turtles (green, Kemp's ridley, and loggerhead sea turtles). Therefore, there is a low probability of co-occurrence between activities expending MEM and green, Kemp's ridley, and loggerhead sea turtles.

Small- and medium-caliber projectiles include all sizes up to and including 2.25 inches in diameter; flechettes are about 2 inches in length. These are solid metal munitions so even if a sea turtle did try to bite a larger munition, the munition would not break apart and be ingestible. Ingestion of munitions is not expected to occur in the water column because the munitions sink quickly and settle on the bottom. A sea turtle would have to be immediately adjacent to falling munitions, mistake sinking munitions for prey items, and react quickly enough to ingest the sinking material. This chain of events is highly unlikely given the Navy's mitigation measures, distribution and seasonal occurrence of sea turtles in the study area, rapid sinking of munitions in the water column, and general movement speed of the animals involved. Instead, munitions are most likely to be encountered by species that forage on the bottom.

Based on the dispersion characteristics of chaff, sea turtles could occasionally come in direct contact with chaff fibers while at the water's surface and while submerged. There is some potential for chaff fibers to be incidentally ingested along with other prey items, particularly if the chaff fibers attach to other floating marine debris. However, the threat of chaff fibers on biological resources was discounted in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Pollutants). Pistons, end caps, and O-rings from chaff cartridges and flares would also be released into the marine environment, where they would persist for long periods and could be ingested by sea turtles while initially floating on the surface, and sinking through the water column. The end caps, O-rings, and pistons would eventually sink in saltwater to the bottom ((Spargo, B.J. & Collins, M., 2007), which reduces the likelihood of ingestion by sea turtles that feed at or near the surface or in the water column, e.g., leatherback sea turtles. Bottom-feeding sea turtles (e.g., green, Kemp's ridley, and loggerhead sea turtles), however, would be at an increased risk if these items were deposited in potential benthic feeding areas and before these items would be encrusted or buried.

Only the small-sized decelerators/parachutes (up to 2 feet in diameter) expended with sonobuoys and lightweight torpedoes pose an ingestion risk to marine life. The majority of the decelerators/parachutes (from sonobuoys) would be expended in the deeper waters of the Chesapeake Bay Water Range and at the dip points north of the water range and may remain on the surface for 5 to 15 seconds before sinking to the bottom (Environmental Science Group, 2005). After sinking to the bottom, it could be available for potential ingestion by a sea turtle feeding on or near the bottom, particularly if bottom currents are present causing the canopy to billow temporarily. Conversely, the decelerator/parachute could be buried by sediment in most soft bottom areas or colonized by attaching and encrusting organisms, which would further stabilize the material and reduce the potential for an ingestion risk.

For the most part, MEM would most likely only be incidentally ingested by individuals feeding at the surface or on the bottom in the precise location where these items were expended and deposited, respectively. The impacts of ingesting MEM would be limited to cases where an individual sea turtle might eat an indigestible item too large to be passed through the gut. Green, Kemp's ridley, and loggerhead sea turtles that have recruited to benthic foraging grounds in the Chesapeake Bay are more likely to encounter MEM, particularly munitions, of ingestible size that settle on the bottom as opposed to MEM that floats at the surface (e.g., flare end caps and pistons) since these species feed along the bottom. There is a low probability that leatherbacks that forage in coastal waters could be impacted given that they primarily feed at or near the surface and in the water column. Given the depth profile of the Chesapeake Bay Water Range (Figure 3.4-4 in Section 3.4.2.3, Affected Environment, Invertebrates), munitions would be expended in waters that are within the benthic foraging ability (dive depth) of green, Kemp's ridley, and loggerhead sea turtles. For example, adult loggerheads may be found foraging in ocean waters as deep as 656 feet (200 meters) (Hochscheid, 2014). Juvenile sea turtles (e.g., green sea turtles) may rest and forage in waters as deep as approximately 98.4 feet (30 meters) (Hochscheid, 2014), although they usually prefer shallower waters for foraging habitat (Seminoff et al., 2015). MEM other than munitions that would remain floating on the surface (e.g., pistons and end caps from flares) are too small to pose a risk of intestinal blockage to any sea turtle that happened to encounter it. The sea turtle would not be preferentially attracted to MEM, with the possible exception of small decelerators/parachutes that may appear similar to the prey of some sea turtle species that feed on jellyfish and similar organisms. Green, Kemp's ridley, and loggerhead sea turtles can be generalist feeders and occasionally feed on jellyfish; however, juveniles and adults of these species, which occur in the Chesapeake Bay, would primarily be bottom feeders (Burgett et al., 2018; Donaton et al., 2019; Holloway-Adkins & Hanisak, 2017; Rizzi et al., 2019; Seney, 2016; Servis et al., 2015). Leatherback sea turtles predominately prey upon jellyfish (National Marine Fisheries Service and U.S. Fish and Wildlife Service, 2013; Wallace et al., 2015).

As MEM breaks down, tiny metal or plastic particles may be released in the water column or sediment and taken up by sea turtles while foraging or indirectly from their prey resources. Microplastics in the aquatic environment are well documented, and interactions with biota have been described worldwide (Lusher et al., 2016), especially for sea turtles (Nelms et al., 2016; Pham et al., 2017; Rizzi et al., 2019). Plastic is the primary type of debris found in marine and coastal environments, and plastics are the most common type of marine debris ingested by sea turtles (Schuyler et al., 2014). All seven species of sea turtles are reported to be affected by plastic debris (Nelms et al., 2016). Rizzi et al., (2019) sampled five sea turtle species for marine litter ingestion and found that the green turtle showed the highest frequency of occurrence for ingested items, especially plastic items (e.g., packaging and hard fragments) and balloons. Hard plastic fragments and fishing lines were also found in the gastrointestinal tract of loggerheads turtles.

Considering the composition of most MEM associated with the Proposed Action (e.g., metal and cement/sand) and its very limited coverage on the bottom (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis), the contribution of the Proposed Action to overall microplastic concentrations in the PRC Study Area and environment should be considered miniscule. As a result, potential impacts from microscopic fragments are anticipated to be insignificant for the four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) that are present in the PRC Study Area. Sublethal impacts due to ingestion of MEM used in testing and training activities may cause short-term or long-term disturbance to an individual sea turtle because (1) if a turtle were to incidentally ingest and swallow a projectile, decelerator/parachute, chaff and flare component, or MEM fragment, it could potentially disrupt its feeding behavior or digestive processes; and (2) if the item is particularly large in proportion to the turtle ingesting it, the item could become permanently encapsulated by the stomach lining, with a rare chance that this could impede the turtle's ability to feed or take in nutrients. With regard to what happens if a sea turtle actually ingests MEM, Schuyler et al. (2014) noted that less than 10 percent of sea turtles (out of a sample size of 454 sea turtles) that ingested a wide range of debris suffered mortality, and 4 percent of sea turtles necropsied were killed by plastics ingestion (out of a sample size of 1,106 necropsied sea turtles). Adverse impacts from ingestion of MEM would be limited to the unlikely event that a sea turtle would be harmed by ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. A sea turtle may attempt to ingest a projectile or fragment and then reject it when it realizes it is not a food item. Therefore, potential impacts of MEM ingestion would be limited to the unlikely event in which a sea turtle might suffer a negative response from ingesting an item that becomes embedded in tissue or is too large to be passed through the digestive system. The Navy considers the likelihood of this occurring to be very low. Potential impacts of exposure to MEM are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for the four species of sea turtles)that are present in the PRC Study Area.

Green, Kemp's ridley, and loggerhead sea turtles may encounter expended MEM from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may encounter MEM in the spring and summer when this species may occur in the waters in/around the Bay. MEM would primarily be expended in the deeper waters of the Chesapeake Bay Water Range, where Kemp's ridley, leatherback, and loggerhead sea turtles may occur, but in an area where green sea turtles are unlikely to occur (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species). The Bay experiences seasonal hypoxia when sea turtles may occur, and this greatly reduces sea grass, which is not found within the water range (Figure 3.4-1 in Section 3.4.2.2, Affected Environment, Vegetation). Within the limited areas where the bottom is not seasonally hypoxic (e.g., Hannibal Target ordnance concentration area), metallic MEM may oxidize/corrode or become buried in sediment, reducing the likelihood of bottom feeders such as Kemp's ridley and loggerhead sea turtle from encountering them.

- Juvenile and adult green sea turtles are primarily bottom feeders that may forage on macroalgae, invertebrates, but mostly consume seagrass (Bjorndal, 1997; Burgett et al., 2018; Holloway-Adkins & Hanisak, 2017; Nagaoka et al., 2012; Sampson & Giraldo, 2014). Given juvenile and adult green sea turtle habitat preference for sea grass flats, they would be more likely to occur in shallow areas of the Bay such as the waters around Bloodsworth Island Range, where no munitions have been dropped or fired since 1996 and activities are not proposed to resume there. In addition, low numbers of live green sea turtles have been sighted in the middle Bay (Barco et al., 2018a) and a few stranded green sea turtles have been recorded in the middle and upper portions of the Bay (Maryland Department of Natural Resources, 2019b; Virginia Aquarium & Marine Science Center, 20 (Maryland Department of Natural Resources, 2019c; Virginia Aquarium & Marine Science Center, 2019) 19), where MEM may be expended.
- Juvenile and adult Kemp's ridley sea turtles may forage for shrimp and fish, but mostly consume crabs (Frick et al., 1999; Marquez, 1994; Seney, 2016), and the seasonal hypoxia could greatly reduce these benthic food resources in the water range. Kemp's ridley turtles (dead and live) have been recorded in the deeper waters of the water range, especially during spring and summer. However, Kemp's ridley turtles utilize the Bay for foraging habitat and tagged turtles have been found to spend more time and forage in shallower waters closer to shore such as small inlets and flats, where their preferred prey, the blue crab, occurs (Barco et al., 2017; Barco et al., 2018b) and where exposures to MEM are less likely to occur.
- Leatherback sea turtles may encounter and be impacted by expended MEM in the Chesapeake Bay Water Range, given it is a pelagic species that prefers open water. Because leatherback

turtles are more likely to feed at or near the surface, they are more likely to encounter materials at the surface than other species that primarily feed along the bottom. For example, the non-munitions material that floats in the water such as flare pads and pistons may pose an ingestion risk for this species given their feeding behavior and prey choice (e.g., jellyfish). The leatherback turtle would not be preferentially attracted to these non-munitions MEM, with the possible exception of small decelerators/parachutes that may appear similar to jellyfish. Leatherback sea turtles may mistake debris for prey; one study found 34 percent of dead leatherbacks to have ingested various types of plastic such as bags (Mrosovsky et al., 2009). Although leatherbacks have been observed annually in the Chesapeake Bay, they are not common and are unevenly distributed (Barco & Lockhart, 2015).

- Juvenile and adult loggerhead sea turtles may forage on crabs, shrimp, sea urchins, and fish (Bjorndal, 2003; Donaton et al., 2019; Rizzi et al., 2019), and the seasonal hypoxia could greatly reduce these benthic food resources in the water range. Tagged loggerhead turtles have been found to regularly occur in the deeper waters of the water range, especially during the summer while they are foraging (Barco et al., 2017; Barco et al., 2018b). However, the probability of co-occurrence is low, since loggerheads seem to prefer to forage/travel throughout the Bay with the changing water temperatures (e.g., forage in the lower part of the Bay during spring/fall and middle/upper part of the Bay during summer (Barco & Lockhart, 2016; Barco et al., 2017). Loggerhead turtles start to leave the Bay in the fall as they migrate south to warmer waters (Barco & Lockhart, 2016; Barco et al., 2017).

Based on the discussion presented above, the likelihood that a sea turtle would encounter and subsequently ingest an MEM associated with Navy testing and training activities in the PRC Study Area is considered low, and ingestible MEM are generally expected to cause an insignificant impact to the four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) that are present in the PRC Study Area.

Impact of Ingestion Stressors (Determination)

Ingestion stressors associated with the Proposed Action (Alternative 2) "may affect, but are not likely to adversely affect" sea turtle species that may occur in the PRC Study Area (see Table 3.4-12 in Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Regulatory Conclusions, for species-specific determinations). The "may affect" conclusion is associated with only the smallest MEM used only in the Chesapeake Bay Water Range.

Indirect/Secondary

This section analyzes the potential impacts on sea turtles from indirect/secondary effects associated with the Proposed Action (refer to Section 3.4.3.1, Environmental Consequences, No Action Alternative, Indirect/Secondary, for analysis approach).

Stressors from the Proposed Action could lead to secondary or indirect impacts on sea turtles via impacts to their habitat, predators, and prey resources. The effects of proposed activities on sea turtle habitat, predators, and prey resource availability are covered in their respective biological resources sections (see the Vegetation, Invertebrates, and Fishes subsections in Sections 3.4.3.1, 3.4.3.2, and 3.4.3.3, for the No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative), respectively). The impact of the Proposed Action on estuarine habitats (including barren substrate) is covered in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment).

Navy activities that add metals and chemicals into the marine environment have not demonstrated long-term impacts on sea turtle habitat (see Section 3.3, Water Resources and Sediments, and Section 3.4.7, Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). Metals are introduced into the water and sediments from multiple types of non-explosive munitions and other MEM. Available research indicates metal contamination is localized and that bioaccumulation resulting from munitions cannot be demonstrated (Kelley et al., 2016; Koide et al., 2016). Specifically in sampled marine life living on or around munitions on the seafloor, metal concentrations could not be definitively linked to the munitions since comparison of metals in sediment next to munitions show relatively little difference in comparison to other "clean" marine sediments used as a control/reference (Koide et al., 2016). MEM, specifically munitions, would not likely remove habitat for sea turtles as MEM expenditures are projected to cover a miniscule area of bottom within the PRC Study Area (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis). Several Navy testing and training activities add chemicals into the marine environment that are potentially harmful in concentration; however, through rapid dilution, toxic concentrations are unlikely to be encountered by sea turtles. Research has demonstrated that perchlorate did not bioconcentrate or bioaccumulate, which was consistent with the expectations for a water soluble compound (Furin et al., 2013). Furthermore, bioaccumulation of chemicals introduced by Navy activities to levels that would significantly alter water quality and degrade sea turtle habitat has not been documented.

Navy activities that add metals and chemicals into the marine environment have not demonstrated long-term impacts on prey availability for sea turtles (see Sections 3.4.3.1 through 3.4.3.3, Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts). Research has demonstrated that some smaller marine organisms are attracted to metal munitions as a hard substrate for colonization or as shelter (Kelley et al., 2016; Smith & Marx Jr., 2016). Although this would likely increase prey availability for some benthic foraging sea turtles that feed on molluscs (e.g., juvenile and adult loggerheads), the relatively low density of metals deposited by testing and training activities compared to concentrated dump and range sites (e.g., Vieques) would not likely substantively benefit sea turtles. In addition, activities that involve the use of non-explosive munitions and MEM typically occur in parts of the Chesapeake Bay Water Range, which experiences seasonal hypoxia when sea turtles occur in the Bay. This seasonal hypoxia could greatly reduce benthic food resources in the water range, e.g., seagrass beds for foraging juvenile and adult green sea turtles are not found within the water range.

Bioaccumulation of metals from munitions in prey species has not been demonstrated and no effects to prey availability from metals and chemicals are known to occur. Whereas some metals and contaminants associated with microplastics also bioaccumulate, the physiological impacts on biological resources begin to occur only after several trophic transfers concentrate the pollutants. Bioaccumulation is therefore most pronounced at higher trophic levels (e.g., large predatory fish, birds, marine mammals). In addition, the contribution to overall microplastic pollution from the Preferred Alternative (Alternative 2) is likely miniscule.

Indirect/secondary stressors from Navy testing and training activities in the PRC Study Area are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for the four species of sea turtles (green, Kemp's ridley, leatherback, and loggerhead sea turtles) that are present in the PRC Study Area.

Green, Kemp's ridley, and loggerhead sea turtles may be exposed to indirect/secondary stressors associated with testing and training activities from spring to fall when these species migrate in/out of the Chesapeake Bay, and the leatherback sea turtle may be exposed to indirect/secondary stressors in the spring and summer when this species may occur in the waters in/around the Bay (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats, for the species). Based on the analysis presented above, the potential for indirect/secondary stressors to affect green, Kemp's ridley, leatherback, and loggerhead sea turtles is considered discountable.

Impact of Indirect/Secondary Stressors (Determination)

Indirect/secondary stressors associated with the Proposed Action (Alternative 2) "may affect, but are not likely to adversely affect" sea turtle species that may occur in the PRC Study Area (see Table 3.4-12 in Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Regulatory Conclusions, for species-specific determinations). The "may affect" conclusion is associated with minimal adverse effects of the Proposed Action on sea turtle habitats, predators, and prey resources.

Stressors Combined

This section analyzes the potential impacts on sea turtles from all stressors associated with the Preferred Alternative (Alternative 2). Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Stressors Combined) provides the analysis approach for biological resources. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in the sections above. An analysis of the combined impacts of all stressors considers the potential consequences of individual (nonadditive), additive and synergistic stressors, as described below.

Additive Stressors – There are generally two ways that a sea turtle could be exposed to multiple additive stressors. The first would be if an animal were exposed to multiple sources of stress from a single event or activity within a single testing or training event (e.g., a mine warfare event may include the use of a sound source and a vessel).

The potential for a combination of these impacts from a single activity would depend on the range to effects of each of the stressors and the response or lack of response to that stressor. Most of the proposed activities generally involve the use of moving platforms (e.g., aircraft and vessels) that may produce one or more stressors; therefore, it is likely that if a sea turtle were within the potential impact range of those activities, multiple stressors may impact it simultaneously or sequentially. Individual stressors that would otherwise have minimal to no impact, may combine to have a measurable response. However, due to the wide dispersion of stressors, speed of the platforms, general dynamic movement of many testing and training activities, and behavioral avoidance exhibited by sea turtles, it is very unlikely that a highly mobile sea turtle would remain in the potential impact range of multiple sources or sequential test events. Secondly, a sea turtle could be exposed to multiple testing and training activities over the course of its life, although, testing and training activities are generally separated in space and time in such a way that it would be unlikely that any individual sea turtle would be exposed to stressors from multiple activities within a short timeframe. However, sea turtles with a home range intersecting an area of concentrated Navy activity (e.g., Chesapeake Bay Water Range), where multiple stressors is more likely to occur, have elevated exposure risks. Even in these areas, relatively few individuals would be impacted compared to their overall population size given their seasonal occurrence (late spring to fall) within the PRC Study Area.

Synergistic Stressors – Multiple stressors may also have synergistic effects. For example, sea turtles that react to a sound source (behavioral response) from acoustic stressors could be more susceptible to physical strike and disturbance stressors via a decreased ability to detect and avoid threats. Sea turtles that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to entanglement and physical strike stressors via malnourishment and disorientation. These interactions are speculative, and without data on the combination of multiple Navy stressors, the synergistic impacts from the combination of Navy stressors are difficult to predict in any meaningful way. The scenario of a rare ingestion stressor and entanglement stressor affecting the same (rare) sea turtle in the PRC Study Area should be considered so remote as to be discountable.

Impact of Stressors Combined (Determination)

Combined stressors associated with the Preferred Alternative (Alternative 2) "may affect, and are likely to adversely affect" sea turtle species that may occur in the PRC Study Area (see Table 3.4-12 in Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Regulatory Conclusions, for species-specific determinations). The "may affect" conclusion is based on the potential for activities with multiple stressors to affect a sea turtle or multiple sea turtles, the potential for combined individual stressors, and additive and synergistic effects.

Sturgeon Species

This analysis focuses on sturgeon species or distinct population segments that are listed as either endangered or threatened under the ESA. In the PRC Study Area, two ESA-listed sturgeon species may occur, Atlantic sturgeon and shortnose sturgeon. In addition, based on telemetry data, only Atlantic sturgeon from three of the five designated distinct population segments, Chesapeake Bay, New York Bight, and Carolina, are likely to be found in the PRC Study Area. As such, Atlantic sturgeon belonging to the Gulf of Maine and the South Atlantic DPSs are not expected to occur within the PRC Study Area and will not be impacted by the Proposed Action.

Atlantic sturgeon also has several designated critical habitats that occur within the PRC Study Area including:

- Nanticoke River, Maryland
- Marshyhope Creek, Maryland
- Potomac River, Maryland
- Rappahannock River, Virginia
- York River, Virginia

Acoustic

This section analyzes the potential impacts on ESA-listed sturgeon from the various types of acoustic stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors, for supporting details). This section includes analysis of the potential impacts from: (1) air-based assets, (2) water-based assets, and (3) non-explosive munitions and other MEM.

As described in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Acoustic), most fish species, including sturgeon, detect sound through particle motion, which diminishes rapidly with distance from the sound source. Therefore, the distance at which they may detect a sound is likely very limited. The distant sound pressure or frequency component of sound is more likely to be encountered by a fish.

Impacts from Air-based Assets

Shortnose sturgeon and Atlantic sturgeon belonging to the Chesapeake Bay, New York Bight, and Carolina DPSs may be exposed to aircraft-generated overflight noise throughout the PRC Study Area. Aircraft produce extensive airborne noise from either turbofan or turbojet engines. The more intensive of these sounds would be concentrated around PRC airfields where aircraft are closer to the ground and which are primarily away from areas where sturgeon are more likely to occur. Aircraft produce extensive airborne noise. Aircraft overflights have the potential to affect surface waters and, therefore, to expose fish occupying those upper portions of the water column to sound. Sturgeon may be exposed to fixed-wing or rotary-wing aircraft-generated noise wherever aircraft overflights occur; however, sound is primarily transferred into the water from air in a narrow cone under the aircraft. Sturgeon would have to be at or near the surface at the time of an overflight to be exposed to appreciable sound levels.

Noise generated by fixed-wing aircraft traveling at subsonic speeds is temporary in nature and extremely variable in intensity. Higher altitude flights (above 3,000 feet) can occur anywhere within the PRC Study Area and are unlikely to impact sturgeon. However, certain missions require flights at altitudes as low as 600 feet. These low-altitude flights can produce underwater noise as loud as 152 dB rms re 1 µPa and occur only in designated areas (see low-altitude airspace depicted in Figure 3.4-1). There is a possibility that some sturgeon near the surface may react to the disturbance; however, it is unlikely that sturgeon would display a significant response to subsonic overflights by fixed-wing aircraft given the briefness of occurrence.

A severe, but infrequent, type of aircraft noise is the sonic boom, produced when a fixed-wing aircraft exceeds the speed of sound, also referred to as supersonic. Supersonic flight is described in more detail in Section 3.0.2.3.1.1 (Aircraft and Aerial Targets (Air-Based Assets)).Between 200 and 250 supersonic events would occur annually under the Proposed Action (Table 2.3-1, Annual PRC Operational Tempo per Alternative: Activities and Assets). The majority of these events would occur in R-4008 and take place at an altitude above 30,000 feet (Figure 1.3-2, PRC Airspace). In addition, up to two flights per year may occur in the Chessie ATCAA (Figure 1.3-2). Sonic booms may also occur as part of supersonic weapons separation events that can occur up to three times per year and are limited to R-4005 where inert weapons release is permitted on Hooper Target, Hannibal Target, and supersonic aim points, and can be captured by Atlantic Test Ranges instrumentation (Figure 1.3-2). During these events, aircraft descend at supersonic speed toward the targets in the Chesapeake Bay Water Range, dropping below 10,000 feet prior to testing the weapon's separation, resulting in a much more focused and intense sound exposure level. For a more detailed description of sonic boom events, see Section 3.0.2.3.1 (Identifying Stressors for Analysis, Acoustic Stressors).

Typical supersonic flights at Mach 2.0 at 30,000 feet (10 km) produce underwater sound levels of approximately 159 dB peak re 1 µPa peak. Due to the brief and dispersed nature of supersonic overflights, the risk of masking other biologically important sounds is very low. However, during supersonic weapons separation tests, the underwater sound level produced is substantially more intense, likely resulting in startle reactions and avoidance behaviors by exposed sturgeon. The sound levels produced, however, would not rise to the level of causing injury to sturgeon present in the vicinity of the test.

Similar to fixed-wing aircraft, noise generated from rotary-wing aircraft is also temporary in nature and extremely variable in intensity. In general, helicopters produce lower-frequency sounds and vibration at a higher intensity than fixed-wing aircraft (Richardson et al., 1995; Pepper et al., 2003). Helicopters operate over a wide-portion of the PRC Study Area, as depicted by the low-altitude airspace in Figure 3.4-1. Certain activities require helicopters to hover in place for extended periods of time (less than 15 minutes). A UH-60 hovering at 82 feet (25 meters) above the surface of the water produces a sound level of approximately 145 dB rms re 1 µPa at 3.3 feet (1 meter) below the surface (Bousman & Kufeld, 2005). This sound level is low enough to likely not result in a behavioral reaction in sturgeon and would unlikely be loud enough to mask important biological sounds. If masking were to occur, it would only be during periods when a sturgeon is at the surface while a hovering helicopter is directly overhead. The likelihood of a sturgeon remaining near both physical and acoustic stressors from a low-hovering helicopter should be considered highly unlikely.

Impacts of Aircraft on Critical Habitat

Aircraft noise will be produced in the vicinity of all critical habitats designated for Atlantic sturgeon that occur within the PRC Study Area, including the Nanticoke River, Marshyhope Creek, Potomac River, Rappahannock River, and York River (Figure 3.4-6). However, all aircraft flights over the York and Rappahannock Rivers will be conducted at altitudes greater than 25,000 feet and most subsonic fixed-wing aircraft flights over the Potomac River, Nanticoke River, and Marshyhope Creek will be conducted at a minimum altitude of 3,000 feet. Some low-altitude flights by fixed-wing aircraft may occur over the Potomac and Nanticoke Rivers at altitudes as low as 600 feet (see low-altitude airspace depicted in Figure 3.4-1). High-altitude supersonic flights (greater than 30,000 feet) in the Chessie ATCAA (Figure 1.3-2, PRC Airspace) may occur over the Rappahannock River, York River, Nanticoke River, and Marshyhope Creek one to two times per year. Rotary-wing aircraft use may occur over the Potomac and Nanticoke Rivers at lower altitudes (see low-altitude airspace depicted in Figure 3.4-1); however, they would only be transiting over these areas on the way to other locations and, therefore, any noise produced would be of an extremely short duration. Designated physical and biological features of the critical habitat would not be impacted by noise produced from aircraft overflights. Noise produced by aircraft may potentially result in minor behavioral responses in individuals (e.g., startle) but would not impede movement to and from spawning sites.

Impacts from Water-based Assets

Noise generated by various sonars and vessel/underwater device propulsion systems is associated with the Preferred Alternative.

Impacts from Sonars and Transducers

Sonar sources covered by the Proposed Action include DICASS sonobuoys and navigational and dipping sonars. Whereas most navigational sonars are considered *de minimis* disturbances (less than 160 dB rms re 1 µPa), dipping sonars and DICASS sonobuoys can have higher source levels and potential impacts. However, potential direct injuries from dipping sonars and DICASS sonobuoys are unlikely because of the relatively lower peak pressures and slower rise times than stressors with a strong shock wave (e.g., pile driving, explosives). The potential impact of mid-frequency sonar on sturgeon is, therefore, limited to behavioral responses from exposure to the sound. While the range of sounds detectable by sturgeon, which have a swim bladder not involved in hearing, overlaps with the lowest levels of mid-frequency sonar, their greatest level of sensitivity involves detecting particle motion at frequencies below 1 kHz. Therefore, it is unlikely that sturgeon would respond to the sounds emitted by dipping sonar, which range in frequency from 1 to 10 kHz (Table 3.0-6, Mid-Frequency ASW Sonar Characteristics). Due to the frequency range used by sonobuoys (8 kHz; Table 3.0-6), sturgeon would not be able to detect the sounds produced. The use of mid-frequency sonars would only occur in the main stem of the Chesapeake Bay and would not overlap with any of the designated critical habitats for Atlantic sturgeon.

Impacts from Propulsion System Noise

Shortnose sturgeon and Atlantic sturgeon may be exposed to vessel noise from testing and training activities throughout the year. Exposure to vessel noise would most likely result in brief periods of masking, physiological stress, or behavioral reactions, but these impacts would not be expected to compromise the health of an individual, nor lead to population-level effects. The probability for masking to occur would be higher at near to moderate distances from the vessel (up to hundreds of meters) but would decrease with increasing distance. In addition, most behavioral reactions, such as startle responses, would occur during the onset of a sound presentation, but would not likely last long and sturgeon would be expected to return quickly to baseline behavior patterns. Overall, these described effects would be minor and unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding or sheltering, and are unlikely to lead to injury.

Testing and training activities that produce vessel noise overlap designated critical habitat for Atlantic sturgeon, primarily in the Potomac River. Suitable fish passage is one of the physical and biological features identified for designated Atlantic sturgeon critical habitat. Vessel noise produced by testing and training activities may act as a sonic obstacle that could alter sturgeon movement. However, it is anticipated that the effects of vessel noise on Atlantic sturgeon movement and passage would be temporary and minor for several reasons. First, the proposed activities will not occur in any migration corridor for a duration that would alter sturgeon movement, or impede sturgeon from accessing spawning or rearing habitat. Second, the effects on passage are expected to be localized and only occur in the upper portion of the water column, meaning there would not be a complete blockage of passage, and likely only temporary, minor changes in sturgeon movement to avoid the immediate vicinity of the activities.

Impacts from Non-explosive Munitions and Other Military Expended Materials

All use of non-explosive munitions and other MEM is confined to established SDZs, and mostly within the Chesapeake Bay Water Range. Munitions (e.g., bombs, rockets, missiles, torpedoes, small- and medium-caliber guns, etc.) are released with the highest concentrations near the fixed targets, recovery areas, and/or aim points within the Chesapeake Bay Water Range. Shortnose sturgeon and Atlantic sturgeon belonging to the Chesapeake Bay, New York Bight, and Carolina DPSs may be exposed to weapons firing and impact noise from testing and training activities throughout the year within the confines of the Chesapeake Bay Water Range, particularly in the vicinity of the fixed targets.

Weapons firing noise lacks the duration and high intensity to cause mortality, injury, or hearing loss. In addition, due to the brief and dispersed nature of weapons noise, masking is also unlikely. Therefore, mortality, injury, and hearing loss in sturgeon would be extremely unlikely and, thus, are not discussed further in this analysis. Potential impacts considered are short-term behavioral or physiological reactions (e.g., swimming away and increased heart rate).

Within the Bay environment, weapons firing noise is mostly limited to approximately 3 km around the fixed targets. Most of the weapons firing noise produced is from the use of small- and medium-caliber ammunition. Under the Preferred Alternative, up to 59,000 small-caliber and 19,000 medium-caliber munitions may be fired in the Chesapeake Bay Water Range annually resulting in sound levels of 109 dB peak re 20 µPa (approximately 141 dB peak re 1 µPa underwater) and 118 dB peak re 20 µPa (approximately 150 dB peak re 1 µPa underwater), respectively. Rocket firing results in the highest intensity, low-frequency weapons firing noise with a sound level of 137 dB peak re 20 µPa, which translates to approximately 169 dB peak re 1 µPa just under the water's surface. Rocket firing would occur up to 638 times annually in the Chesapeake Bay Water Range.

If sturgeon are exposed to weapons firing noise, they may exhibit behavioral reactions or physiological stress. Due to the nature of training or testing events where numerous weapons are fired repeatedly over a short period of time, particularly for small- and medium-caliber weapons, sturgeon may potentially be exposed multiple times within a short period. However, any physiological stress and behavioral reactions would likely be short-term (seconds or minutes) and substantive costs or long-term consequences for individuals or populations would not be expected. Overall, these described effects would be minor, are unlikely to lead to a significant disruption of normal behavior patterns such as breeding, feeding or sheltering, and are unlikely to lead to injury.

Sound due to missile and target launches is typically at a maximum during initiation of the booster rocket and rapidly fades as the missile or target travels downrange. Many missiles and targets are launched from aircraft, which would produce minimal sound in the water due to the altitude of the aircraft at launch. Behavioral reactions would likely be short-term (minutes) and are unlikely to lead to long-term consequences for individuals or populations.

Any objects that are dropped and impact the water with great force could produce a loud broadband sound at the water's surface. Non-explosive bombs and intact missiles and targets could produce a large impulse upon impact with the water surface (McLennan M. W., 1997). Sturgeon within a few meters could experience some temporary hearing loss, although the probability is low of the non-explosive munitions landing within this range while a sturgeon is near the surface. Sturgeon within the area may hear the impact of an object on the surface of the water and would likely alert, dive, or avoid the immediate area. Impact noise would not be expected to induce significant behavioral reactions from sturgeon, and long-term consequences for individuals and populations are unlikely.

Weapons firing would be limited to the Chesapeake Bay Water Range and would not overlap with designated critical habitat for Atlantic sturgeon.

Impacts from Acoustic Stressors (Determination)

Acoustic stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, shortnose sturgeon and Atlantic sturgeon belonging to the New York Bight, Chesapeake Bay, and Carolina DPSs. Acoustic stressors associated with the Proposed Action will have no effect on critical habitat designated for Atlantic sturgeon.

Physical Disturbance and Strike

This section analyzes the potential impacts on ESA-listed fish species, Atlantic sturgeon and shortnose sturgeon, from the various types of physical disturbance and strike stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.2, Identifying Stressors for Analysis, Physical Disturbance and Strike Stressors, for supporting details). The physical disturbance and strike stressors that may impact ESA-listed sturgeon are generated from water-based assets and non-explosive munitions and other MEM. Information on the potential impacts of physical disturbance and strike stressors on fish species in general is contained in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Physical Disturbance and Strike). The following sections contain additional information directly pertaining to the ESA-listed species.

Impacts from Water-based Assets

A number of proposed activities under the Preferred Alternative involve water-based assets (e.g., surface vessels, in-water or bottom devices) that have the potential to impact ESA-listed Atlantic and shortnose sturgeon.

Atlantic Sturgeon

Atlantic sturgeon have been documented to be susceptible to vessel strikes, particularly in estuarine and riverine environments where the waters are shallower and more restricted (Brown & Murphy, 2010; Balazik et al., 2012b; Foderaro, 2015). Brown and Murphy (2010) found that 28 deaths of Atlantic sturgeon in the Delaware Bay and the Delaware River were reported over the four-year period of 2005 to 2008. Of those, 50 percent were determined to be caused by vessel collisions, although the size and type of the vessels was unknown. An unknown number of additional sturgeon were likely struck by vessels, but were not included in this total as the bodies were too decomposed to accurately determine the cause of death. Based on an egg-per-recruit analysis of the Delaware River population, the authors concluded that an annual mortality rate of 2.5 percent of the females could have adverse impacts on the population (Brown & Murphy, 2010).

In New York, over the period of 2012 through 2014, there were 76 known Atlantic sturgeon fatalities attributed to vessel strikes around the Tappan Zee Bridge on the Hudson River, in addition, over two dozen more were reported during the first six months of 2015 (Foderaro, 2015). This reflects a significant increase when compared to the previous three-year period (2009 through 2011) during which only six sturgeon fatalities were documented. Many have attributed this increase in sturgeon mortality to the increase in vessel traffic associated with the expansion of the Tappan Zee Bridge, which began in 2012. However, the strandings may also, in part, be the result of an increased effort in monitoring for fish strandings that accompanied the bridge expansion project. Regardless, it illustrates the level of susceptibility of Atlantic sturgeon to vessel strikes within the Hudson River system.

In Virginia, Balazik et al. (2012b) investigated Atlantic sturgeon mortalities due to vessel strikes that occurred in upstream areas of the James River. Between 2007 and 2010, 31 strandings of Atlantic sturgeon were reported in tidal portions of the James River, 83 percent of which showed indication of vessel interactions (i.e., heads or other body parts jaggedly cut or removed) (Balazik et al., 2012b). All mortalities attributed to vessel strikes had suffered injury along the top of their bodies, suggesting the individuals were alive at the time of the strike (dead carcasses float belly-up due to the gases formed during decomposition concentrating in the abdominal cavity). Balazik et al. (2012b) found that most (84 percent) of the reported mortalities occurred in a relatively narrow reach of river in the fall, known to be used by Atlantic sturgeon during their spawning migrations. That reach has been channelized to accommodate cargo-ship traffic. The extent of the damage to the carcasses within this stretch of the river suggests interaction with large container ships rather than smaller recreational vessels (although recreational vessels also have the ability to injure sturgeon). Based on observations of three fish implanted with acoustic transmitters, Balazik et al. (2012b) concluded that, when moving, the tracked individuals occurred in water depths overlapping with the draft of ocean cargo vessels (about 23 feet), but were rarely in depths overlapping the draft of tugboats and small recreational craft (about 3 to 7 feet). The fish were detected in the navigation channel of the river 69 percent of the time. However, due to the very small sample size (three fish), the applicability of the conclusions to the larger population is uncertain.

Little is known about the susceptibility of sturgeon to vessel strikes outside of river systems. To rectify this, efforts to document Atlantic sturgeon mortalities in the lower James River and the Chesapeake Bay were initiated in 2015 through the combined effort of the Virginia Commonwealth University, the Virginia Aquarium, and the Navy. Prior to 2015, most sturgeon mortalities went unreported and those that were reported through existing stranding networks (e.g., local sea turtle or marine mammal stranding networks) were rarely documented. Data on strandings from 2015 and 2016 compiled by researchers at the Virginia Commonwealth University illustrate that vessel strikes of Atlantic sturgeon occur with some frequency within the main stem of the Chesapeake Bay (Balazik M. T., 2016). Seven Atlantic sturgeon strandings were reported in the main stem of the Chesapeake Bay in 2015 and an additional 12 were reported in 2016, the first two years that strandings were officially reported and documented. The total number of actual strandings each year was likely much higher, but several factors limit the reporting of sturgeon strandings. Most of the general public that may encounter a stranding: (1) does not know what a sturgeon is or what it looks like, (2) does not realize that sturgeon are listed under the ESA, or (3) is not aware that a stranding should be reported, or whom to contact to report it, if they do.

The occurrence and prevalence of Atlantic sturgeon ship strikes in the Chesapeake Bay has been documented (Balazik et al., 2012b; Balazik, 2016; Hilton, Kynard, Balazik, Horodysky, & Dillman, 2016), as noted above. A large spawning population of Atlantic sturgeon exists in the James River (Balazik et al., 2012a) and Navy-funded research identified a small spawning population in York River system in 2013 (Hager et al., 2014; Kahn et al., 2014). In addition, early research suggests that there may also be spawning populations in both the Nanticoke River system (Stence, 2020) and the Rappahannock River (Balazik M. T., 2015). The Potomac River, as well as others in the northern portion of the Chesapeake Bay, may also support spawning populations of Atlantic sturgeon, although these rivers have yet to be investigated.

Based on data collected from the telemetry arrays in the PRC Study Area (Figure 3.4-6), Atlantic sturgeon from the Chesapeake Bay DPS, and, to a much lesser extent, the New York Bight and Carolina DPSs, may be present within the PRC Study Area (Ogburn & Anguilar, 2020; Secor & O'Brien, 2020; Stence, 2020). Adults are typically present in the waters of the PRC Study Area between April and November. Juveniles and subadults may be present year-round.

The Navy conducts up to 1,100 testing and training activities annually in the PRC Study Area, equating to approximately 5,000 to 6,000 hours, which include water-based assets (Table 3.0-7, Annual Dipping Sonar and Sonobuoy Testing and Training Events). Many of these activities involve high-speed (greater than 10 knots) vessel movements and maneuvering. Over 1,100 hours of high-speed vessel and in-water device movements occur annually within the PRC Study Area. High-speed vessel maneuvers further increase the potential risk of vessel and in-water device strikes by reducing the available reaction time of both the fish and vessel operator to an impending strike. In addition, 67 percent of the vessel and in-water device activities that involve high-speed movements under the Proposed Action are unmanned, further reducing the potential to avoid a strike, should one arise. While most sturgeon would likely occur lower in the water column below the draft of most of the vessels used, a portion may still be found near surface and be susceptible to strike by surface vessels. In-water devices, particularly those moving greater than 10 knots, although relatively rare, have the potential to strike a sturgeon anywhere they may co-occur (except on or near the bottom). Given the importance of the Chesapeake Bay and its tributaries to Atlantic sturgeon, the shallower depths at which sturgeon potentially occur within the Bay and rivers, and the amount of testing and training activities involving high-speed vessel movements, there is a low probability that a strike of Atlantic sturgeon could occur during testing and training activities under the Proposed Action.

As Atlantic sturgeon belonging to the Chesapeake Bay DPS are more likely to occur in the PRC Study Area, it is possible, yet unlikely, that a strike may occur. Despite being unlikely, it is not discountable that it could happen. Members belonging to the New York Bight and Carolina DPSs have also been recorded as occurring in the PRC Study Area, yet their occurrence is so rare, and the chance of a strike so remote, as to be discountable.

While the PRC Study Area overlaps several areas designated as critical habitat for Atlantic sturgeon, including the Nanticoke River, Marshyhope Creek, Potomac River, Rappahannock River, and York River, vessel and in-water device activity would only potentially occur in the Potomac River and, to a very unlikely extent, the Nanticoke River. Suitable fish passage is one of the physical and biological features identified for designated Atlantic sturgeon critical habitat. Activities involving the use of vessels or in-water devices within the Potomac or Nanticoke Rivers may act as a physical obstacle that could alter sturgeon movement. However, any potential effects on Atlantic sturgeon movement and passage would be temporary and minor for several reasons. First, the proposed activities will not occur in any migration corridor for a duration that would alter sturgeon movement, or impede sturgeon from accessing spawning or rearing habitat. Second, the effects on passage are expected to be localized and only occur at the surface of the water column, meaning there would not be a complete blockage of passage, resulting in only temporary, minor changes in sturgeon movement to avoid the immediate vicinity of Navy's activities.

Shortnose Sturgeon

Shortnose sturgeon primarily occur in riverine habitats during the warmer summer months, but may occur in the deeper depths of the main stem of the Chesapeake Bay during the cooler winter months. As a result, encounters with vessels and in-water devices during testing and training activities under the Proposed Action would be more unlikely than for Atlantic sturgeon. Shortnose sturgeon could potentially encounter vessels and in-water devices in the main stem of the Chesapeake Bay and in the lower Patuxent and Potomac Rivers where vessel activities may occur. However, only three potential ship strikes of shortnose- sturgeon have been documented along the Atlantic coast, although only one was confirmed as a ship strike: two in the Delaware River in 2007 and 2008, and one in the Kennebec River in 2008 (Shortnose Sturgeon Status Review Team, 2010). Given the extremely low potential for encounters with vessels and in-water devices during testing and training activities and the small number of documented ship strikes, the likelihood for a vessel or in-water device strike of a shortnose- sturgeon to occur would be discountable/insignificant.

Impacts from Non-explosive Munitions and Other Military Expended Materials

Some activities associated with the Proposed Action generate MEM in the following categories: (1) munitions; and (2) other MEM (e.g., sonobuoys, marine markers). Potential impacts of MEM resulting from ingestion, entanglement, and pollutants are discussed in those subsections, respectively.

As described in Section 3.0.2.3.1 (Identifying Stressors for Analysis, Acoustic Stressors), use of MEM would primarily occur in the Chesapeake Bay Water Range and be focused near fixed targets, recovery areas and/or aim points, where Atlantic and shortnose sturgeon present in the PRC Study Area could occur. Marine markers will also be expended at the Patuxent River Seaplane Area, where sturgeon may also be present. Expended materials include small- and medium-caliber ammunition, rockets, missiles, torpedoes, AMNS munitions, marine markers, and sonobuoys. These materials can be dropped, fired, or launched, resulting in different potentials for striking fish.

The primary concern is the potential for a sturgeon to be struck with an MEM at or near the water's surface, which could result in injury or death. While disturbance or strike from an item as it descends through the water column is possible, it is less likely, because many objects generally sink through the water slowly, after losing their initial velocity, and can be avoided by most sturgeon. Materials will slow in their velocity as they approach the bottom of the water, and will likely be avoided by any sturgeon that happen to be in the vicinity foraging in benthic habitats. Therefore, the discussion of MEM strikes primarily focuses on the potential of a strike at or near the surface of the water.

Atlantic Sturgeon

Adult Atlantic sturgeon are likely to be present in the main stem of the Chesapeake Bay between April and November each year, while juveniles and sub-adults have the potential to be present year-round (Ogburn & Anguilar, 2020; Secor & O'Brien, 2020; Stence, 2020). Episodic periods of hypoxic conditions can occur throughout the main stem of the Bay, particularly in the deeper waters, during the warmer summer months (Murphy et al., 2011). These conditions vary in severity, locality, and duration between years based on hypoxic volume, nitrogen loads, and stratification resulting from the extremely large variability in freshwater flow through the Bay's major tributaries (Murphy et al., 2011). Such hypoxic conditions may restrict Atlantic sturgeon from utilizing certain areas of the main stem of the Bay, such as around the targets, during these periods, particularly juveniles (Schlenger, et al., 2013). However, these conditions may also force sturgeon transiting through these areas higher in the water column, thus making them more susceptible to potential strike.

Balazik et al. (2012b) noted that when sturgeon were sedentary they tended to be near the bottom, but when actively swimming they would occur higher in the water column. There is a possibility that an individual Atlantic sturgeon at or near the surface may be struck if they are in the target area at the point of physical impact at the time of munitions delivery. Expended munitions may strike the water surface with sufficient force to cause injury or mortality. However, the likelihood of an Atlantic sturgeon, which is rare to begin with, being at or near the surface at the exact time and location of impact for an expended munition or material is so remote as to be considered discountable.

The use of MEM as part of the Proposed Action will be confined to the Chesapeake Bay Water Range and the Patuxent River Seaplane Area and will not overlap with any designated critical habitat for Atlantic sturgeon.

Shortnose Sturgeon

Shortnose sturgeon typically prefer shallow, riverine environments during the warmer months of the year, yet seek out deeper waters in the main stem of the Chesapeake Bay during the cooler months (National Marine Fisheries Service, 2020a). As a result, shortnose sturgeon would not be susceptible to MEM strikes during the summer and early fall. While potentially occurring in areas of MEM use during the colder months of the year, shortnose sturgeon typically associate with the deeper areas of the Bay and would not be expected to be exposed to direct strikes at or near the surface. In addition, shortnose sturgeon should be able to avoid MEM descending through the water column to settle on the bottom, given the depth and the loss of speed and momentum by the MEM.

Impacts from Physical Disturbance and Strike Stressor (Determination)

Physical disturbance and strike stressors associated with the Proposed Action (Alternative 2) may affect, and are likely to adversely affect, Atlantic sturgeon belonging to the Chesapeake Bay DPS that may occur in the PRC Study Area. Physical disturbance and strike stressors associated with the Proposed Action

(Alternative 2) may affect, but are not likely to adversely affect, shortnose sturgeon, Atlantic sturgeon belonging to the New York Bight and Carolina DPSs, and designated critical habitat for Atlantic sturgeon that may occur in the PRC Study Area.

Energy

This section analyzes the potential impacts on sturgeons from the various types of energy stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.5, Identifying Stressors for Analysis, Energy Stressors, for supporting details). However, this section includes analysis of the potential impacts from only in-water electromagnetic devices (e.g., mine neutralization systems) and high-energy laser. In-air electromagnetic stressors are not applicable to sturgeons because in-air electromagnetic energy is transmitted over short distances and it does not penetrate the water.

In-Water Electromagnetic Devices

Events involving electromagnetic mine neutralization systems occur in the Chesapeake Bay Water Range, typically between the NAS Patuxent River shoreline and Hooper Target, but may also occur in the SDZ around Bloodsworth Island. For the Preferred Alternative, no more than 26 events using in-water electromagnetic devices are planned per year within the PRC Study Area.

Shortnose sturgeon and Atlantic sturgeon belonging to the Chesapeake Bay, New York Bight, and Carolina DPSs, which are known to be capable of detecting electromagnetic energy, may be exposed to activities that involve the use of in-water electromagnetic devices in the Chesapeake Bay Water Range and in the vicinity of Bloodsworth Island. The types of electromagnetic devices used in the Proposed Action simulate the electromagnetic signature of a large vessel passing through the water column, so the expected response would be similar to the response elicited by the electromagnetic signature of any large vessel passing in close proximity.

Impacts on sturgeon as individuals or populations resulting from the use of in-water electromagnetic devices during training activities would be discountable because of: (1) the relatively low intensity of the magnetic fields generated (2,300 microteslas at the source and diminishing to below the level of the Earth's magnetic field beyond 13 feet (4 meters) of the source (U.S. Department of the Navy, 2005c); (2) the highly localized potential impact area; (3) the fact that the devices are turned off for most activities; and (4) the localized and infrequent nature of the activities (hours per year). Some individuals may have a detectable response to electromagnetic exposure, but the fields generated are typically well below physiological and behavioral responses of magnetoreception in fishes, such as sturgeon, and any impacts would be temporary with no anticipated impact on an individual's growth, survival, annual reproductive success, lifetime reproductive success (i.e., fitness), or species recruitment, and are not expected to result in population-level impacts.

The use of electromagnetic devices as part of the Proposed Action will be confined to the Chesapeake Bay Water Range and in the vicinity of Bloodsworth Island and will not overlap with any designated critical habitat for Atlantic sturgeon.

Directed Energy Weapon System Testing

Directed energy weapon systems testing may occur under the Preferred Alternative (Alternative 2) within the Chesapeake Bay Water Range and Bloodsworth Island Range SDZ. All high-energy laser use will follow the laser safety standard operating procedures and guidance documents indicated in Table 2.5-1 (Standard Operating Procedures), including a requirement that the intended target be positively identified and confirmed before activating a directed energy weapon. Whereas the path of a directed energy weapon from origin platform to the target could briefly intersect an animal at the water's surface, the thermal effects would be momentary as the weapon tracks its moving target. Aquatic animals near the water surface may be injured to some degree. The high-energy weapons are also characterized as short-range, which limits their effects on incidental targets. However, because sturgeon only infrequently occur at the surface, the likelihood of a sturgeon being at the surface at the exact time and location of energy weapon use is so unlikely as to be discountable.

Impacts from Energy Stressor (Determination)

Energy stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect shortnose and Atlantic sturgeon that may occur in the PRC Study Area. Energy stressors will have no effect on critical habitat designated for Atlantic sturgeon occurring within the PRC Study Area.

Entanglement

This section analyzes the potential impacts on ESA-listed sturgeon from the various types of entanglement stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.6, Identifying Stressors for Analysis, Entanglement Stressors, supporting details). This section includes analysis of the potential entanglement from wires/cables and decelerator/parachutes. Given the large size of sturgeon, even juveniles, flare O-rings would pose little risk and will not be discussed further.

The impacts of entanglement on individual fish are highly variable, ranging from temporary disorientation to mortality due to predation or physical injury. Most entanglement of fish involve abandoned or discarded nets, lines, and other materials that form loops or incorporate rings at or just below the surface, where commercial fishing activity is concentrated (Derraik, 2002; Laist, 1997; 1987; Helfman et al., 2009; Macfadyen et al., 2009; Keller et al., 2010). A 25-year dataset assembled by the Ocean Conservancy reported that fishing line, rope, and fishing nets accounted for 68 percent of fish entanglements, with the remainder entanglements occurring due to encounters with various items such as bottles, cans, and plastic bags (Ocean Conservancy, 2010). No cases of fish entanglement have been reported resulting from MEM (Ocean Conservancy, 2010). The species affected the most depends on many factors, including orientation to the surface and the presence of rigid or protruding features that increase the risk of entanglement compared to fishes with smoother, more streamlined bodies (Macfadyen et al., 2009). As a result of the five rows of armored protrusions, known as scutes, along its body, sturgeon are likely more susceptible to entanglement than most fish species.

Impacts of Wires and Cables

Shortnose sturgeon and Atlantic sturgeon belonging to the Chesapeake Bay, New York Bight, and Carolina DPSs may be exposed to wires and cables from testing and training activities within the Chesapeake Bay Water Range. Activities involving the use of AMNS or sonobuoys would result in the expenditure of both cables and wires.

AMNS cables are composed of tactical fiber, which is relatively brittle and readily breaks if knotted, kinked, abraded against sharp objects, or looped beyond the items' bend radius of 3.4 mm (Corning Incorporated, 2005; Raytheon Company, 2015). If the fiber becomes looped around an underwater object or organisms, it does not tighten unless it is under tension. Such an event would be unlikely based on its method of deployment and its resistance to looping after it is expended. The tactical fibers are often designed with controlled buoyancy to minimize the fiber's effect on vehicle movement. The tactical fiber would be suspended within the water column during the activity, and then be expended and sink to the bottom (effective sink rate of 1.45 cm/second) where it would be susceptible to abrasion and burial by sedimentation. Additionally, the very small number, up to five under the Preferred Alternative, that are expended limits encounter rates with fiber-optic cables. Therefore, while fiber optic cables present an entanglement risk to sturgeon, it is unlikely that an entanglement event would occur and most entanglements would be temporary (seconds to a few minutes) before the sturgeon could free itself and resume normal activities.

Sonobuoys associated with the Proposed Action consist of two units and wires (that extend out to a maximum of 1,500 feet) that create a rigid underwater framework with large spaces in which even adult sturgeon can pass freely through. The tensile breaking strength of the sonobuoy wire and rubber tubing is no more than 40 pounds (for more information on the sonobuoy assembly refer to Section 3.0.2.3.6, Identifying Stressors for Analysis, Entanglement Stressors). Sonobuoys remain suspended in the water column for up to eight hours, after which they sink to the bottom. This increases the likelihood that a sturgeon could encounter a sonobuoy wire either while it is suspended or as it sinks. While approximately 160 sonobuoys may be expended each year under the Preferred Alternative, up to 50 percent (approximately 67) of practice sonobuoys used during testing activities are designed to not fully open and, therefore, do not present any entanglement risk. If a wire were to wrap around an adult or juvenile sturgeon, it would likely break soon after entanglement or break while bending into potentially entangling loops due to the material's low breaking strength.

Based on the discussion presented above, the likelihood that a sturgeon would encounter a wire or cable associated with Navy testing and training activities in the PRC Study Area, and become entangled, is low, and impacts, if any, would likely be minor.

No testing or training activities involving the use of wires and cables would occur near areas designated as critical habitat for Atlantic sturgeon.

Impacts of Decelerators/Parachutes

Aerial-launched sonobuoys, light-weight torpedoes, illumination flares, and some aerial targets used during testing and training activities are deployed with a decelerator/parachute. Once a decelerator/ parachute has been released to the water, it may pose a potential entanglement risk to shortnose sturgeon and Atlantic sturgeon belonging to the Chesapeake Bay, New York Bight, and Carolina DPSs both in the water column and on the seafloor.

Sonobuoys and torpedoes use small nylon decelerators/parachutes (up to 48 inches in diameter) and illumination flares use medium nylon decelerators/parachutes (up to 19 feet in diameter). While decelerators/parachutes associated with lightweight torpedoes and illumination flares are recovered, those associated with sonobuoys are not. However, many of these decelerators/parachutes have weights affixed to their attachment lines to speed their sinking. As a result, small parachutes typically only remain at the surface for 5 to 15 seconds before sinking to the seafloor (Environmental Sciences Group, 2005). The small decelerators/parachutes have multiple attachment cords up to 3 feet in length. As many as 160 small decelerators/parachutes are deployed in the Chesapeake Bay Water Range and at the sonar dipping points annually under the Preferred Alternative. Due to their limited amount of time suspended in the water column, it is very unlikely that a sturgeon would encounter or become entangled in a small or medium decelerator/parachute in the water column. However, there is a higher likelihood of sturgeon encountering expended decelerators/parachutes on the seafloor while foraging. While the chance of an encounter and subsequent entanglement is still remote, the canopy and the numerous attachment lines associated with decelerators/parachutes combined with the ridges and scutes on a sturgeon may increase the likelihood of entanglement, should an encounter occur, when compared to most other fish species. Shortnose sturgeon, which overwinter in the deeper waters of the Chesapeake Bay, and juvenile, subadult, and adult Atlantic sturgeon belonging to the Chesapeake Bay DPS would be most at risk for encountering expended small and medium decelerators/parachutes. Due to the rarity of occurrence of Atlantic sturgeon from the New York Bight and Carolina DPSs in the PRC Study Area, it is highly unlikely that an encounter would occur, much less result in an entanglement, and is, therefore, considered discountable.

Aerial targets, or drones, use large cloth and nylon decelerators/parachutes that are up to 50 feet in diameter and contain up to 28 suspension line of varying lengths, ranging from 40 to 70 feet. As these parachutes lack the weights common to small and medium decelerators/parachutes and, therefore, will remain at the surface for some time following deployment. This feature enables the recovery of all large decelerators/parachutes by range support vessels following deployment. As a result, entanglement by sturgeon in large decelerators/parachutes is highly unlikely given the small time they are present in the water and the fact that they remain near the surface. As there have been no documented cases of sturgeon being entangled in large decelerators/parachutes during their recovery, it can be assumed that potential impacts to sturgeon from these devices are discountable.

No testing or training activities involving the use of decelerators/parachutes would occur near areas designated as critical habitat for Atlantic sturgeon.

Impacts from Entanglement Stressor (Determination)

Entanglement stressors associated with the Proposed Action (Alternative 2) may affect, and are likely to adversely affect, shortnose and Atlantic sturgeon belonging to the Chesapeake Bay DPS that may occur in the PRC Study Area. Entanglement stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, Atlantic sturgeon belonging to the New York Bight and Carolina DPSs that may occur in the PRC Study Area. Entanglement stressors will have no effect on critical habitat designated for Atlantic sturgeon occurring within the PRC Study Area.

Ingestion

This section analyzes the potential impacts on ESA-listed sturgeon from the various types of ingestion stressors associated with MEM planned with the Preferred Alternative (refer to Section 3.0.2.3.7, Identifying Stressors for Analysis, Ingestion Stressors, for supporting details).

Shortnose sturgeon and Atlantic sturgeon belonging to the Chesapeake Bay, New York Bight, and Carolina DPSs may be exposed to expended munitions from testing and training activities. Sturgeon may encounter munitions or fragments of munitions as part of MEM from testing and training activities occurring in the Chesapeake Bay Water. Sturgeons feed on benthic organisms such as crustaceans (e.g., amphipods, shrimps), worms, molluscs, and some fish, primarily by sucking prey from the substrate (National Marine Fisheries Service, 2013). Therefore, munitions and fragments of munitions on the bottom or within the substrate could possibly be mistaken for a food item or could be incidentally taken along with other food items. An encounter with a casing would not necessarily lead to ingestion or swallowing of the item, as a fish might “taste” the item and then expel it (Felix et al., 1995). However, the hard body parts (i.e., shells) of some natural sturgeon prey items could increase the likelihood of ingestion due to similarity of physical characteristics. Relatively small, smooth objects such as small-caliber casings would likely pass through the digestive tract without causing harm because the size of the material is not expected to cause blockage or exert other deleterious health effects, particularly considering the typical diet of sturgeon of hard-shelled organisms. Sturgeon routinely consume molluscs, such as clams and other hard-shelled organisms, as part of their diet and pass the shell through their digestive tract with no complication.

As MEM break down, tiny metal or plastic particles may be released in the water column or sediment and taken up by benthic feeders, such as sturgeon. Microplastics in the aquatic environment are well documented, and interactions with biota, including numerous fish species have been described worldwide (Lusher et al., 2016). Plastic waste in saltwater chemically attracts hydrocarbon pollutants such as polychlorinated biphenyls (PCBs) and dichlorodiphenyltrichloroethane (DDT), which accumulate up to 1 million times more in plastic than background levels in the environment (Mato et al., 2001). Sturgeon can mistakenly consume these pollutant-laden particles, containing elevated levels of toxins, with or instead of their prey. Rochman et al. (2015) found marine debris in 28 percent of the individual fish examined and in 55 percent of all fish species analyzed. Ribic et al. (2010) concluded that the vast majority of marine debris along the Atlantic coast was produced by either land-based (38 percent), general-source debris (42 percent), or ocean-based (20 percent) recreational and commercial sources; no items of military origin were differentiated. Considering the composition of most MEM associated with the Proposed Action (e.g., metal, cement/sand) and its very limited coverage on the bottom (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis), the contribution of the Proposed Action to overall microplastic concentrations in the environment should be considered miniscule.

The intact MEM produced from testing and training activities would be limited to the Chesapeake Bay Water Range and the Patuxent River and would not overlap with designated critical habitat for Atlantic sturgeon. In addition, no testing or training activities involving the production of microscopic fragments would occur near areas designated as critical habitat for Atlantic sturgeon.

Impacts from Ingestion Stressor (Determination)

Ingestion stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, shortnose sturgeon and Atlantic sturgeon that may occur in the PRC Study Area. Ingestion stressors will have no effect on critical habitat designated for Atlantic sturgeon occurring within the PRC Study Area.

Indirect/Secondary

This section analyzes the potential impacts on sturgeon from indirect/secondary effects associated with the Proposed Action (refer to Section 3.4.3.1, Environmental Consequences, No Action Alternative, Indirect/Secondary, for supporting details).

Stressors from the Proposed Action could lead to secondary or indirect impacts on sturgeon via impacts to their habitat, predator, and prey resources. Sturgeon eat various benthic invertebrates and some fish. For impacts on these food resources and potential predators, refer to their respective biological resources sections (see Sections 3.4.3.1 through 3.4.3.3, Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts). The potential impact of the Proposed Action on the estuarine habitats utilized by sturgeon (including unconsolidated substrate [e.g., sand, mud]) is covered in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment).

Navy activities that add metals and chemicals into the marine environment have not demonstrated long-term impacts on sturgeon habitat (see Section 3.3, Water Resources and Sediments, and Section 3.4.7, Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). Metals are introduced into the water and sediments from multiple types of non-explosive munitions and other MEM. Available research indicates metal contamination is localized and that bioaccumulation resulting from munitions cannot be demonstrated (Kelley et al., 2016; Koide et al., 2016). Specifically, in sampled marine life living on or around munitions on the seafloor, metal concentrations could not be definitively linked to the munitions since comparison of metals in sediment next to munitions show relatively little difference in comparison to other "clean" marine sediments used as a control/reference (Koide et al., 2016). MEM, specifically munitions, would not likely remove habitat for sturgeon as MEM expenditures are projected to cover a miniscule area of bottom within the PRC Study Area (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis). Several Navy testing and training activities add chemicals into the marine environment that are potentially harmful in concentration; however, through rapid dilution, toxic concentrations are unlikely to be encountered by sturgeon. Research has demonstrated that perchlorate did not bioconcentrate or bioaccumulate, which was consistent with the expectations for a water soluble compound (Furin et al., 2013). Furthermore, bioaccumulation of chemicals introduced by Navy activities to levels that would significantly alter water quality and degrade sturgeon habitat has not been documented.

Another indirect/secondary effect is bioaccumulation of pollutants. Whereas some metals and contaminants associated with microplastics bioaccumulate, the physiological impacts on biological resources begin to occur only after several trophic transfers concentrate the pollutants. Bioaccumulation is therefore most pronounced at higher trophic levels (e.g., large predatory fish, birds, marine mammals). Filter- or deposit-feeding invertebrates (e.g., clams, worms) have the greatest potential to ingest small plastic fragments and any associated pollutants could be incorporated into the food chain (National Oceanic and Atmospheric Administration Marine Debris Program, 2014b; Wright et al., 2013). Ingestion by these types of organisms is the most likely pathway for degraded MEM to enter the food web and impact sturgeon. Transfer of microplastic particles to higher trophic levels was demonstrated in one experiment (Setala et al., 2016). However, the contribution from Navy activities to overall microplastic pollution from the Proposed Action is likely miniscule.

Indirect/secondary stressors from testing and training activities in the PRC Study Area are not expected to result in substantial changes in an individual's behavior, growth, survival, annual reproductive success, lifetime reproductive success (fitness), or species recruitment, and as such are not expected to result in population-level impacts for the two sturgeon species (Atlantic and shortnose) that are present in the PRC Study Area.

Adult Atlantic sturgeon may be exposed to indirect/secondary stressors associated with testing and training activities from spring to fall when they migrate in and out of the Chesapeake Bay, and juvenile and subadult Atlantic sturgeon may be exposed to indirect/secondary stressors year-round in the Bay (refer to Section 3.4.4.1, Federal Threatened or Endangered Species – National Marine Fisheries Service Jurisdiction, Status of Affected Species and Critical Habitats). Shortnose sturgeon typically inhabit the deeper waters of the Bay during the cooler months of the year and may be exposed to indirect/secondary stressors during those periods. Accordingly, potential impacts from indirect/secondary stressors to individual sturgeon would be discountable as they are unlikely to occur or rise to the level of measurable impacts as suggested by the analysis presented above.

Impact of Indirect/Secondary Stressors (Determination)

Indirect/secondary stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect shortnose and Atlantic sturgeon that may occur in the PRC Study Area. The "may affect" conclusion is associated with minimal adverse effects of the Proposed Action on sturgeon habitats, predators, and prey resources.

Stressors Combined

This section analyzes the potential impacts of all stressors associated with the Preferred Alternative on ESA-listed sturgeon. Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Stressors Combined) includes the analysis approach/metrics for biological resources. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in the sections above. An analysis of the combined impacts of all stressors considers the potential consequences of additive and synergistic stressors, as described below.

Additive Stressors - There are generally two ways that a sturgeon could be exposed to multiple additive stressors. The first would be if a fish were exposed to multiple sources of stress from a single event or activity within a single testing or training event (e.g., a mine warfare event may include the use of a sound source and a vessel). The potential for a combination of these impacts from a single activity would depend on the range to effects of each of the stressors and the response or lack of response to that stressor. Most of the proposed activities generally involve the use of moving platforms (e.g., aircraft and vessels) that may produce one or more stressors; therefore, it is likely that if a sturgeon were within the potential impact range of those activities, multiple stressors may impact it simultaneously or sequentially. Individual stressors that would otherwise have minimal to no impact, may combine to have a measurable response. However, due to the wide dispersion of stressors, speed of the platforms, general dynamic movement of many testing and training activities, and behavioral avoidance exhibited by sturgeon, it is very unlikely that a fish would remain in the potential impact range of multiple sources or sequential testing and training exercises. Exposure to multiple stressors is more likely to occur in areas where testing and training activities are concentrated (e.g., Chesapeake Bay Water Range). Even in these areas, relatively few individuals would be impacted compared to their overall population size given their seasonal occurrence (late spring to fall) within the PRC Study Area.

Synergistic Stressors - Multiple stressors may also have synergistic effects. For example, sturgeon that react to a sound source (behavioral response) from acoustic stressors could be more susceptible to physical strike and disturbance stressors via a decreased ability to detect and avoid threats. Sturgeon that experience behavioral and physiological consequences of ingestion stressors could be more susceptible to entanglement and physical strike stressors via malnourishment and disorientation. Similarly, sturgeons that may be weakened by disease or other factors that are not associated with Navy testing and training activities may be more susceptible to stressors analyzed in this EIS. These interactions are speculative, and without data on the combination of multiple Navy stressors, the synergistic impacts from the combination of Navy stressors are difficult to predict in any meaningful way. Though the scenario of a rare ingestion stressor and entanglement stressor affecting the same sturgeon in the PRC Study Area should be considered so remote as to be discountable.

Impact of Stressors Combined (Determination)

Combined stressors associated with the Proposed Action (Alternative 2) "may affect, and are likely to adversely affect" Atlantic and Shortnose sturgeon species that may occur in the PRC Study Area. The "may affect" conclusion is based on the potential for activities with multiple stressors to affect a sturgeon or multiple sturgeons, the potential for combined individual stressors, and additive and synergistic effects.

Cumulative Effects

Cumulative effects under the ESA are defined as effects resulting from future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation. This section identifies any planned future state and private activities that may occur in the portions of the PRC Study Area inhabited by ESA-listed sturgeon and sea turtles. This includes activities that are presently occurring but not yet completed (refer to Section 4.3, Cumulative Impact Analysis, Past, Present, and Reasonably Foreseeable Future Actions, for details): (1) Expansion of the Mattaponi and Nanticoke Rural Legacy Areas, (2) Chesapeake Bay Bridge Crossing, (3) Construction of a Second Span on the Thomas Johnson Bridge, and (4) recreational and commercial vessel traffic.

Regulatory Conclusions

Regarding compliance with the ESA and species under the jurisdiction of the NMFS, the Navy has determined that all ESA-listed species and distinct population segments that may be present in the PRC Study Area may be affected by the Proposed Action (Preferred Alternative, Alternative 2), and some are likely to be adversely affected by physical disturbance and strike or ingestion stressors from water-based assets and/or MEM (Table 3.4-12). Therefore, consultation with NMFS will be conducted.

Table 3.4-12 Effects Determinations for the Preferred Alternative (Alternative 2) on Threatened or Endangered Species/Distinct Population Segments Under the Jurisdiction of the National Marine Fisheries Service

Species	***Designation Unit***	***Designation Status***	***Acoustics***	***Disturbance/Strike***	***Energy***	***Entanglement***	***Ingestion***	***Indirect/Secondary***	***Stressors Combined***
Atlantic Sturgeon	Carolina DPS	E	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Chesapeake Bay DPS	E	NLAA	LAA	NLAA	LAA	NLAA	NLAA	LAA
	New York Bight DPS	E	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA
	Critical Habitat	NA	NE	NLAA	NE	NE	NE	NE	NLAA
Green Sea Turtle	North Atlantic Ocean DPS	T	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	LAA
Kemp's Ridley Sea Turtle	———	E	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	LAA
Leatherback Sea Turtle	———	E	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	LAA
Loggerhead Sea Turtle	Northwest Atlantic Ocean DPS	T	NLAA	LAA	NLAA	NLAA	NLAA	NLAA	LAA
Shortnose Sturgeon	———	E	NLAA	NLAA	NLAA	LAA	NLAA	NLAA	LAA

Key: DPS = distinct population segment; E = endangered; LAA = likely to adversely affect; NA = not applicable; NE = no effect; NLAA = not likely to adversely affect; T = Threatened.

3.4.4.2 Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction

This section serves as the assessment for species covered under the ESA (USFWS jurisdiction).

Status of Affected Species and Critical Habitats

The following listed and proposed species may be present in the PRC Study Area described in Chapter 2 (Proposed Action and Alternatives) and Section 3.0 (Introduction) of this document:

- Eastern black rail (*Laterallus j. jamaicensis*) – Proposed Threatened
- Northern long-eared bat (*Myotis septentrionalis*) – Listed Threatened
- Red knot (*Calidris canatus rufa*) – Listed Threatened
- Tiger Beetles (2 species)
    - Northeastern beach tiger beetle (*Cicindela d. dorsalis*) – Listed Threatened
    - Puritan tiger beetle (*Cicindela puritan*) – Listed Threatened
- West Indian manatee (*Trichechus manatus*) – Listed Threatened

There are no critical habitats for these species present in the PRC Study Area.

This section describes the affected environment for both proposed and currently listed species, organized into the following categories of information:

- Status and Management
- Habitat and Geographic Range
- Population Trends
- Predator and Prey Interaction
- Species-specific Threats

Eastern Black Rail

Status and Management

The eastern black rail is currently a species proposed for listing as "Threatened" under the ESA, based on a 12-month finding delivered to the Federal Register (U.S. Fish and Wildlife Service, 2019). The species is already protected by the MBTA and designated as a "Bird of Conservation Concern," in addition to its state listing as endangered (Maryland Natural Heritage Program, 2016).

Habitat and Geographic Range

Eastern black rail habitat consists of tidal or nontidal herbaceous wetlands (e.g., marshes, wet meadows) occupying a range of salinities (U.S. Fish and Wildlife Service, 2019). They may also be found in small patches of upland habitat surrounded by herbaceous wetlands. However, the species prefers high saltmarsh habitat (Wilson et al., 2007).

Whereas the species is possible in suitable habitat across the mid-western and eastern United States, its current distribution is limited to a narrow band of coastal wetlands extended from Texas to southern New Jersey. In the PRC Study Area, the species is a known breeder on the Delmarva Peninsula and during the spring-summer nesting period (Rambo, 2020a). The species was described as “unlikely” on PRC land and water areas (U.S. Department of the Navy, 2017c).

Population Trends

Insufficient information is available to determine population trends for eastern black rails (U.S. Fish and Wildlife Service, 2019). However, declining trends in their marshy habitat (refer to Section 3.4.2.1, Affected Environment, Environmental Baseline) and model results suggests a corresponding decline in the population of eastern black rails (U.S. Fish and Wildlife Service, 2018b)

Predator and Prey Interactions

The species is probably a generalized feeder on small food items in its habitat, including insects, snails, and seeds (Audubon Society, 2019). Native predators ranging from raptors to snakes and coyotes, foxes, raccoons, and some larger wading birds have documented predation of eastern black rails (USFWS, 2019a). The eggs and young of this ground-nesting bird are particularly vulnerable to a wide array of predators.

Species-Specific Threats

Species-specific threats to the eastern black rail include invasive predatory species, diseases, sea level rise, and various land management activities by humans (U.S. Fish and Wildlife Service, 2019). Habitat fragmentation and decline resulting from the filling and draining of wetlands has resulted in a corresponding degradation and loss of eastern black rail habitat. Habitat fragmentation and decline can also occur because of humans maintaining or expanding upland habitat in the face of rising sea level and global climate change. The timing of fire suppression and mosquito control activities can also impact their nesting, nursery, and foraging habitats.

Northern Long-eared Bat

The PRC Study Area falls within the geographic range of and supports habitat for the northern long-eared bat. Mist-netting and acoustical surveys conducted at NAS Patuxent River and OLF Webster (2012–13) identified *Myotis* calls that could be attributed to this species; however, no northern long-eared bats were physically captured and subsequent reexamination of the calls was inconclusive. Additional mist netting and acoustical surveys conducted at both NAS Patuxent River and OLF Webster in 2012, 2013, 2015, 2016, and 2018 have not verified species presence (U.S. Department of the Navy, 2017c; Smith J. , 2020c). Accordingly, since routine annual surveys have not documented the northern long-eared bat as being present in the PRC Study Area, and, because of species decline from white-nose syndrome (as explained below) that will most likely will hinder the future expansion of the species into the area, the Proposed Action will have no effect on the species and it will not be analyzed further in this section.

Red Knot

Red knots are found on the Atlantic coast of the United States and Canada. They belong to the subspecies *C. canutus rufa* (Cornell Lab of Ornithology, 2013). This subspecies of red knot, referred to as the rufa red knot, is listed as threatened under the ESA.

Status and Management

Four petitions to emergency list the red knot have been submitted since 2004, and in December 2014, the USFWS listed the red knot as threatened under the ESA (Federal Register 79[238]: 73706-73748, December 11, 2014). Currently there is no designated critical habitat for the red knot, nor are there any developed conservation plans available from the USFWS.

Habitat and Geographic Range

The species breeds on the central Canadian arctic tundra but migrates down and winters along the Atlantic and gulf coasts from southern New England to Florida, and as far south as South America (Cornell Lab of Ornithology, 2013). Red knots will briefly use important stopover areas such as the Delaware Bay to forage before returning to their breeding grounds each year.

During migration stopovers along the mid-Atlantic coast, the red knot uses coastal, sandy habitats near estuaries for foraging (Cornell Lab of Ornithology, 2013). Red knots migrate in large flocks and stop over at the same coastal sites along the Atlantic coast during spring migration to feed on eggs of horseshoe crabs (*Limulus polyphemus*). In particular, Delaware Bay is one of the largest known spring (mid-May to early June) stopover sites for this species (Federal Register 71[176]: 53756-53835, September 12, 2006) (Clark et al., 1993). Sandy beaches and intertidal flats that may harbor migrating red knots can be found in the PRC Study Area (Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3) located at least 37 miles from the nearest coastal shoreline, and over 70 miles from the mouth of Delaware Bay. The species is considered a “rare migrant” in the PRC Study Area (U.S. Department of the Navy, 2017c). The Bloodsworth Island Range in particular has the sort of habitats and proximity to coastal migratory routes that may attract red knots. However, red knots could also visit the beaches and intertidal flats farther west, along the shoreline of NAS Patuxent River (Figure 3.4-3).

Population Trends

The red knot population was previously estimated at 100,000 to 150,000 individuals in the 1980s (Niles et al., 2008). However, annual aerial and ground surveys of Delaware Bay show fluctuation but generally a downward trend. Population surveys during the stopover period in the spring of 1998 at Delaware Bay estimated 50,000 red knots. In 2004, the same survey was repeated and the estimated population was substantially lower at 18,000 (Niles et al., 2008). Surveys of red knots at both migration stopover sites and wintering grounds continually show substantial population declines in recent decades (Federal Register 71[176]: 53756-53835, September 12, 2006). Studies from 1994 to 2002 also show decreased annual adult survival rates related to these population declines (Niles et al., 2008).

Predator and Prey Interactions

Red knots forage by surface pecking and probing for intertidal invertebrates and various species of mussels and other shellfish (Cornell Lab of Ornithology, 2013). During spring migration, a major food source for red knots are horseshoe crab eggs; millions of which can be found in the Delaware Bay during the second half of May (Botton et al., 1994). Horseshoe crabs and their eggs are also common in the PRC Study Area, along sheltered beaches and intertidal flats (National Oceanic and Atmospheric Administration Office of Response and Restoration, 2016; Chesapeake Bay Program, 2018c; Virginia Institute of Marine Science, 2018). Red knot migration coincides with the horseshoe crabs laying their eggs, allowing birds to restore their fat reserves to continue their northward migration to their breeding grounds in the arctic (Cornell Lab of Ornithology, 2013; Tsipoura & Burger, 1999).

Outside of the breeding grounds, red knot predators include peregrine falcon (*Falco peregrinus*), merlin (*Falco columbarius*), northern harrier (*Circus cyaneus*), short-eared owl (*Asio flammeus*), great black-backed gull (*Larus marinus*), and accipiters (*Accipiter* spp.) (Niles et al., 2008). Some of these species can be found in the PRC Study Area (refer to Section 3.4.2.6, Affected Environment, Birds).

Species-Specific Threats

The red knot is threatened under the ESA mainly by habitat loss and degradation of foraging resources such as reduction of horseshoe crab populations (U.S. Fish and Wildlife Service, 2010). Horseshoe crabs are harvested for their blood for biomedical research and their eggs for bait in the conch and eel fishing industries; consequently, the reduction in the amount of horseshoe crab eggs available for red knots, especially in Delaware Bay, is believed to be the cause of lower weight gain in red knots during migratory stopovers and contributing to lower adult survival (Niles et al., 2008). Beach erosion, shoreline protection and stabilization projects, human disturbance, limited food resources, oil spills, red tides, hunting, and severe weather all threaten the stability of the population (Niles et al., 2008; U.S. Fish and Wildlife Service, 2010). Because large percentages of the entire population gather at single sites during migration (i.e., Delaware Bay) and winter, the species is especially vulnerable to loss of key resources at these sites (Clark et al., 1993; Cornell Lab of Ornithology, 2013; Niles et al., 2008). Loss of key resources in other locations is relatively less important to the red knot.

Tiger Beetle Species

There are two tiger beetle species that may occur in the PRC Study Area that are also listed under the federal ESA: northeastern beach tiger beetle (*Cincindela dorsalis dorsalis*) and puritan tiger beetles (*Cicindela puritan*).

Northeastern Beach Tiger Beetle

Status and Management

Although northeastern beach tiger beetles once swarmed along the sandy beach from Cape Cod to Chesapeake Bay (Leng, 1902), the species is now extirpated from nearly this entire region (Fenster et al., 2006). Due to their decline in range and abundance, the USFWS placed northeastern beach tiger beetles on the list of federally threatened species in 1990 (U.S. Fish and Wildlife Service, 1994). The factors responsible for their threatened status include coastal development and associated narrowing or elimination of their breeding and feeding habitats (U.S. Fish and Wildlife Service, 1994).

Habitat and Geographic Range

Northeastern beach tiger beetles prefer naturally wide sandy beaches (greater than 6 meters [20 feet]) with moderately well-sorted sands having a mean grain size of 0.5 to 0.6 mm, and relatively compacted sediment with averages of 69 pounds per square inch (psi) and 110 psi at depths of 10 to 15 cm, respectively (Fenster et al., 2006). The majority of low tide shoreline around NAS Patuxent River is classified as sandy beach or intertidal flat (National Oceanic and Atmospheric Administration Office of Response and Restoration, 2016). A substantial percentage of beaches on PRC land areas have been surveyed for habitat suitability (Knisley, 2012; Smith J. , 2020a), and other beaches in St. Mary's County have not been surveyed at all (Knisley et al., 2016). Neither OLF Webster nor Bloodsworth Island have habitat even remotely suitable for *C. d. dorsalis*. Outside of naval installation boundaries, there are a number of sandy shorelines in the PRC Study Area that could be inhabited by the northeastern beach tiger beetle. The species may also be flying between suitable beach environments outside of naval installation boundaries, though likely for only short distances (less than 10 km) (Knisley, 2012) and very low to the surface (altitudes less than 20 feet), based on generic insect studies (Glick, 1939).

A few adult individuals of the northeastern beach tiger beetle have been observed in past years at NAS Patuxent River (U.S. Department of the Navy, 2017c). The beetles documented within the installation coinciding with a large population observed approximately 9.7 km away, in Calvert County, that later left the area (Knisley, 2012). To date, no larval tiger beetles of this species have been observed on NAS Patuxent River, and surveys conducted as recently as 2012 showed that the NAS properties currently lack the preferred habitat characteristics in terms of grain size, beach width, and low levels of human activity (Knisley, 2012). The closest population currently known is 27 km away at Western Shores in Calvert County, which is probably too far for adults to disperse. However, the emergence of source population less than 10 km away remains a possibility that could attract “scouts” to PRC land area shorelines.

Population Trends

The population status of northeastern beach tiger beetle in the PRC Study Area may be declining significantly based on a surveys of beaches in Calvert County, Maryland, and along the southern shore of the Potomac River (in Virginia) from 1980s and 1990s through 2014 (Knisley et al., 2016; Knisley & Fenster, 2009). These surveys did not include locations within PRC land areas. Despite the declines, the population may periodically increase after hurricanes scour away vegetation on beaches that is unfavorable to the tiger beetle (Knisley & Fenster, 2009). The trend of increasing storm intensity with climate change could actually benefit the species, if not for continued development and redevelopment along the shores of Chesapeake Bay (Section 3.4.2.1, Affected Environment, Environmental Baseline).

Predator and Prey Interactions

Northeastern beach tiger beetle larvae are sedentary predators that feed on small arthropods, which they capture from the mouth of their burrows. Adults actively prey on arthropods, especially amphipods, but will also scavenge on dead fish and crabs (U.S. Fish and Wildlife Service, 1994). Predators of adult tiger beetle include birds, wolf spiders, and assilid flies (U.S. Fish and Wildlife Service, 1994). An ant-like parasitic wasp of the genus *Methocha* limits larval survival. Mortality during development is high, and only 5 percent of larvae survive to the adult stage.

Species-Specific Threats

The primary threats to this species (from human activities) include beach nourishment with unsuitable materials and narrowing or elimination of beaches with shoreline stabilization and increasing erosion (U.S. Fish and Wildlife Service, 1994) where beaches cannot migrate with sea level rise.

The remaining population of puritan tiger beetles in Chesapeake Bay is highly susceptible to habitat loss and degradation (U.S. Fish and Wildlife Service - Chesapeake Bay Field Office, 2019a). Shoreline development and bluff stabilization are the most serious threats. Shoreline structures have been found to destroy habitat directly or promote growth of vegetation on cliff faces that makes them unsuitable for tiger beetle larvae. Natural threats include flooding, parasites, and insect predators.

Puritan Tiger Beetles

Status and Management

Puritan tiger beetles have disappeared from much of their range in the northeastern United States (U.S. Fish and Wildlife Service - Chesapeake Bay Field Office, 2019a). Due to their decline in range and abundance, the USFWS placed Puritan tiger beetles on the list of federally threatened species in 1990.

Habitat and Geographic Range

Puritan tiger beetles inhabit bluffs and beaches along the upper Chesapeake Bay (Knisley & Fenster, 2009). Habitat for Puritan tiger beetle larvae is restricted to naturally eroding bluffs, where they live in deep burrows after digging into sandy deposits on non-vegetated portions of the bluff face or at the base of the bluff. They are most abundant at sites where the bluffs are long and high with little or no vegetation and composed of yellow or red sandy soil.

The majority of the shoreline around NAS Patuxent River is classified as sandy beach or intertidal flat (Figure 3.4-3). However, there are no sandy bluffs along the installation shorelines (National Oceanic and Atmospheric Administration Office of Response and Restoration, 2016) and therefore no suitable habitat for larvae. The species was also not collected during the Knisley (2012) tiger beetle survey. Neither OLF Webster nor Bloodsworth Island have habitat even remotely suitable for Puritan tiger beetles. Outside of naval installation boundaries, there are a number of sandy shorelines and bluffs in the PRC Study Area that could be inhabited by the puritan tiger beetle. The species may also be flying between suitable beach environments outside of naval installation boundaries, though likely for only short distances (less than 10 km) (Knisley, 2012) and very low to the surface (altitudes less than 20 feet), based on generic insect studies (Glick, 1939).

Population Trends

The population status of puritan tiger beetle in the PRC Study Area may be declining based on a survey of Calvert County beaches in 2002–09 (Knisley, 2009). More recent surveys in the Cliffs of Calvert (nearest NAS Patuxent River) suggest a continued decline of the species in the PRC Study Area (U.S. Fish and Wildlife Service - Chesapeake Bay Field Office, 2019b). These surveys did not include the PRC land areas specifically. Despite the declines, the population may periodically increase after hurricanes scour away vegetation on beaches that is unfavorable to the tiger beetle (Knisley, 2009). The trend of increasing storm intensity with climate change could actually benefit the species, if not for continued development and redevelopment along the shores of Chesapeake Bay (Section 3.4.2.1, Affected Environment, Environmental Baseline).

Predator and Prey Interactions

The predatory and prey interactions for puritan tiger beetles are likely similar to those of northeastern beach tiger beetles described previously.

Species-Specific Threats

The remaining population of puritan tiger beetles in Chesapeake Bay is highly susceptible to habitat loss and degradation (U.S. Fish and Wildlife Service - Chesapeake Bay Field Office, 2019a). Shoreline development and bluff stabilization are the most serious threats. Shoreline structures have been found to destroy habitat directly or promote growth of vegetation on cliff faces that makes them unsuitable for tiger beetle larvae. Natural threats include flooding, parasites, and insect predators.

West Indian Manatee (Trichechus manatus manatus)

Status and Management

In 2017, the USFWS issued a final rule to down-list the West Indian manatee from endangered to threatened under the ESA (82 Federal Register 16668–16704, April 5, 2017). The West Indian manatee is still considered a depleted and strategic stock under the MMPA. The West Indian manatee is divided into the Florida (*Trichechus manatus latirostris*) and Antillean (*Trichechus manatus manatus*) subspecies (Lefebvre et al., 2001). Only the Florida subspecies would occur in the PRC Study Area. There is no designated critical habitat for the West Indian manatee north of Florida.

Habitat and Geographic Range

Manatees are found in coastal marine, brackish, and freshwater habitats. They are typically found in seagrass beds, canals, creeks, embayments, and lagoons near the mouths of rivers and sloughs (Lefebvre et al., 2000). Food, water temperatures, and freshwater resources influence habitat selection. Florida manatees are found throughout the southeastern United States. Because manatees are a subtropical species with little tolerance for cold, they are generally restricted to the inshore and coastal waters of peninsular Florida during the winter, when they shelter in or near warm-water springs, industrial effluents, and other warm-water sites (Hartman, 1979; Lefebvre et al., 2001; Stith et al., 2006). In warmer months, manatees leave these sites and can disperse great distances. Individuals have been sighted as far north as Massachusetts, as far west as Texas, and in all states in between (Fertl et al., 2005; Rathbun, 1988). Warm-weather sightings are most common in Florida, coastal Georgia, and Alabama, but increased sightings have been reported in mid-Atlantic states such as North Carolina and Virginia between June and October (Cummings et al., 2014). The West Indian manatee, has been reported in the PRC Study Area; and is considered a regular, but infrequent visitor to the middle and upper Chesapeake Bay from June through September, when water temperatures exceed 20° C (Cummings et al., 2014).

Population Trends

Demographic analyses indicate that the Florida stock of manatees is increasing or stable throughout much of Florida (Runge et al., 2004; Runge et al., 2007). A survival rate analysis for the Florida manatee, conducted from 1982 through 2015, identifies a survival rates for four regions in Florida ranging from 97 to 98 percent (Runge et al., 2017). The fastest growing segment of this stock is found in the St. Johns River, with a growth rate of 6.2 percent (95 percent confidence interval 3.7 to 8.1 percent) (Runge et al., 2004). Population modeling of the Florida manatee predicts that assuming all current threats remain constant; there is less than a 2.5 percent chance that the southeastern U.S. population of Florida manatees will fall below 4,000 individuals over the next 100 years (Runge et al., 2017). Estimates for the approximate number of manatees in Florida in 2015–16 was 8,810, of which 4,810 were on the west coast of Florida and 4,000 were on the east coast (Hostetler et al., 2018). However, mortality rates in recent years are on the rise, with Florida seeing 824 deaths in 2018 (10 Tampa Bay, 2020). This is the highest mortality recorded between 2013 and 2018.

The USFWS's 12-month finding to reclassify the West Indian manatee from endangered to threatened, further confirms that populations are improving. Although the ranking of threats to the species have not changed, the impacts of those threats is considered lower due to a better understanding of the resiliency of the population (Runge et al., 2015).

Predator and Prey Interactions

West Indian manatees are herbivorous and are known to consume more than 60 species of plants. They typically feed on bottom vegetation, plants in the water column, and shoreline vegetation, such as hyacinths and marine seagrasses (Reynolds, 2009). In some areas, they are known to feed on algae, parts of mangrove trees (Jefferson et al., 2015; Mignucci-Giannoni & Beck, 1998), seeds, acorns, sponges, and invertebrates (Fitt, 2020). West Indian manatees are generally considered to have no natural predators. Most of the identified causes of death are from human interactions, such as boat collisions, or in Florida, cold stress (Florida Fish and Wildlife Conservation Commission, 2020). Based on overlaps in habitat use, the likelihood exists of opportunistic attack by large predators, and evidence for a single shark attack was recorded for Puerto Rico in 2001, though in 27 years this is the first recorded incident and none have been recorded in Florida (Mignucci-Giannoni et al., 2003).

Species-Specific Threats

The Florida manatee is negatively impacted by cold stress, hurricanes, toxic red tide poisoning, habitat destruction (such as loss of seagrass), and other natural and human-made factors. However, vessel strikes are the single greatest cause of death for Florida manatees, accounting for 24 percent of manatee deaths in Florida during the last 30 years (Jett, 2010). A review of research on the effectiveness of laws reducing boat speeds in areas of known manatee habitat indicated that reducing boat speeds in specific areas is an appropriate, reasonable, and defensible management action, although more studies on the effectiveness of boat speed reduction have been recommended (Calleson & Frohlich, 2007).

Effects on Federal Threatened or Endangered Species (USFWS Jurisdiction)

The purpose of this section is to document analysis of the potential impacts of the Proposed Action (specifically, the Preferred Alternative, Alternative 2) on listed species and/or critical habitats. The criteria for analysis conclusions is described in introduction of Section 3.4.4 (Federal Endangered Species Act – Biological Assessments). The analysis approach for direct, indirect/secondary, and combined stressors was provided in Section 3.4.3.1 (Environmental Consequences, No Action Alternative).

The summary and tabular conclusions for this section are provided in Section 3.4.4.2 (Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction, Regulatory Conclusions).

Eastern Black Rail

Sections 3.4.3.1 through 3.4.3.3 (Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts) includes a more-in-depth analysis of potential stressor impacts from the Proposed Action on uncommon wading birds that are documented in the PRC Study Area. The analysis for eastern black rails follows from this discussion, with particularly focus on the activities impacting the preferred habitat for eastern black rail: high salt marsh (i.e., tidal marsh). The distribution of marshes in the PRC Study Area is depicted in Figure 3.4-1 and Figure 3.4-2. The following stressors can be discounted as having no effect on eastern black rails:

- Physical disturbance and strike, pollutants (covered in Sections 3.2, Air Quality, and 3.3, Water Resources and Sediments), entanglement, and ingestion stressors from non-explosive munitions and other MEM – Associated materials do not occur in or near any tidal marshes; they occur over deep, open waters of the Chesapeake Bay and Patuxent River. Also, potentially entangling or ingestible materials are not likely to travel far from where they impacted open water areas, as described in Sections 3.0.2.3.6 and 3.0.2.3.7 (Identifying Stressors for Analysis, Entanglement Stressors and Ingestion Stressors, respectively).

- Low-energy electromagnetic or non-weaponized directed energy from air-, water-, and land-based assets – Most of the proposed activities generating low-energy sources do not come close enough to tidal marshes to even potentially affect eastern black rails before an associated physical disturbance; the activities occur mostly far overhead with mobile aircraft (e.g., aircraft flight operations), in deep, open waters of the PRC Study Area (e.g., surface vessel activities, mine countermeasure systems), or in previous disturbed land areas within PRC land area boundaries (e.g., ground-based activities). For the relatively few activities that may take place over marsh habitats outside the airfield environment, the effect of low-energy electromagnetic and non-weaponized directed energy sources was discounted for biological resources in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Energy).

Acoustic

Large tidal marsh areas occur both within the airfield environment (around Harper's and Pearson Creeks) and outside the airfield environment in the low-altitude airspace (e.g., Bloodsworth Island Range, Eastern Shore of Maryland, Northern Neck of Virginia). Rare birds, such as the eastern black rail, could experience helicopter noise during transits at greater than 75 feet AGL and small UAS noise at even lower altitudes. The noise generated from the occasional fixed-wing aircraft at higher altitudes (greater than 600 feet AGL) over tidal marshes is not expected to have any significant effects on native birds. The physical disturbance of a low-flying or hovering aircraft could combine with the associated acoustic stressor to affect an eastern black rail during important life functions (e.g., foraging, breeding, nesting). However, the activity level outside the airfield environment is very localized and infrequent and the occurrence of eastern black rails within the installation boundaries (including the airfield environment) is considered unlikely (U.S. Department of the Navy, 2017c). Even in the airfield environment around Harper's and Pearson Creeks, the chance of a low-flying or hovering aircraft impacting a rare bird during an important life function is possible but unlikely based on the low probability of coincidence and only behavioral/stress responses anticipated. Mobile water- and land-based assets are generally quieter than associated aircraft and do not operate in or near the tidal marsh environment. Occasional low-altitude sonic booms and weapons firing noise occurring around the fixed targets in the Chesapeake Bay Water Range are far from potential black rail habitats, and the impulsive sound levels reaching them may only cause a brief startle reaction. Acoustic stressors are also not considered among the major threats facing eastern black rail populations (Section 3.4.4.2, Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction, Status of Affected Species and Critical Habitats).

Accordingly, acoustic stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the eastern black rail.

Physical Disturbance and Strike

The probability of striking a rare and likely absent bird species is unlikely, based on the areas where strike risk to birds is elevated (e.g., airfield environment). The developed/open space habitat in the airfield environment is also not attractive to eastern black rails. Whereas the airfield environment around Harper's and Pearson Creeks may be attractive to a black rail, the chance of a helicopter striking a rare and likely absent wading bird is low even here. Risks of strike is also possible outside the airfield environment with low-flying aircraft, such as helicopters and small UAS. However, the activity that may occur over tidal marsh is localized and infrequent, and preceded by a noise and physical disturbance stressor. Low altitude flights over the Bloodsworth Island Range (containing largest area of eastern black rail habitat among PRC land areas) are also limited to during winter or spring that represent half the seasons in which eastern black rails may occur in the PRC Study Area. The chance of an occasional low-flying or hovering aircraft impacting a rare bird during important life function is possible by unlikely based on this low probability of mostly temporary/minor effects. Mobile water- and land-based assets are much slower than associated aircraft and do not operate in or near the tidal marsh environment.

Accordingly, physical disturbance and strike stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the eastern black rail.

Energy

Directed energy weapons testing could impact an eastern black rail during flight, but the activity either takes place in a SDZ or over previous disturbed areas within installation boundaries that are confirmed to lack any sensitive biological resources. The chance of striking a rare or unlikely bird during flight with the occasional firing of directed energy weapons is possible but unlikely based on the remote probability of coincidence, standard operating procedures (Section 2.5, Standard Operating Procedures Included in the Proposed Action) and established avoidance/mitigation measures (Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) followed with counter-UAS testing.

Accordingly, energy stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the eastern black rail.

Indirect/Secondary

With regard to eastern black rail predators and prey/forage, the Proposed Action is unlikely to result in any population-level effects, or have any meaningful effect on eastern black rail habitat in terms of wetland vegetation, hydrology, and soils (refer to Sections 3.4.3.1 through 3.4.3.3, Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts, Indirect/Secondary).

Bioaccumulation of pollutants in eastern black rails is also unlikely because the species are low on the food chain and their prey (marsh insects) consume mostly plant material in an environment far removed from where materials associated with the pollutants are being expended.

Accordingly, indirect/secondary stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the eastern black rail.

Stressors Combined

Most of the proposed activities generally involve the use of moving platforms (e.g., aircraft, vessels) or MEM that may produce one or more stressors (e.g., acoustic, physical disturbance and strike, energy); therefore, if birds were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously or sequentially (e.g., physical disturbance, energy, and acoustic stressors precede strike potential). Individual stressors that would otherwise have minimal to no impact may combine to have a greater than minimal impact if they occur simultaneously. However, the combined effect of short-range physical disturbance, electromagnetic energy, and acoustic stressors has not been studied, and parsing out the effects would be difficult. Longer-range effects that would expose more birds to stressors are limited to behavioral responses to unusual sound pressures/frequencies.

Due to the wide dispersion of stressors, speed of the platforms, and general dynamic movement of many testing and training activities, it is highly unlikely that a bird would occur in the potential impact range of multiple stressors that combine to create additive effects (e.g., short-range, asset-based stressors adding to physical disturbance from MEM). Impacts would be more likely to occur to nesting birds and in areas where testing and training activities are concentrated (e.g., munition concentration areas within the Chesapeake Bay Water Range). In the very unlikely event of a coincidence, relatively few individuals would be impacted compared to their overall population size within the PRC Study Area, and the affected birds would likely be common/generalist species that are less vulnerable to population-level effects.

Accordingly, combined stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the eastern black rail. Avoidance and mitigation measures that further minimize potential impacts on native bids, including eastern black rails, are summarized in Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) and referenced in stressor-based analysis in Section 3.4.3 (Environmental Consequences).

Red Knot

Sections 3.4.3.1 through 3.4.3.3 (Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts) includes a more-in-depth analysis of potential stressor impacts from the Proposed Action on uncommon shorebirds that are documented in the PRC Study Area. The analysis for red knots follows from this discussion, with particularly focus on the activities impacting the preferred habitat for red knots: sandy beaches and intertidal flats in the estuarine environment. The distribution of beach and intertidal flats in the PRC Study Area is depicted in Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3. The following stressors can be discounted as having no effect on red knot:

- Physical disturbance and strike, pollutants (covered in Sections 3.2, Air Quality, and 3.3, Water Resources and Sediments), entanglement, and ingestion stressors from non-explosive munitions and other MEM – Associated materials do not occur in or near any sandy beaches or intertidal flats; they occur over deep, open waters of the Chesapeake Bay and Patuxent River. Also, potentially entangling or ingestible materials are not likely to travel far from where they impacted open water areas, as described in Sections 3.0.2.3.6 and 3.0.2.3.7 (Identifying Stressors for Analysis, Entanglement Stressors and Ingestion Stressors).
- Low-energy electromagnetic or non-weaponized directed energy sources from air-, water-, and land-based assets – Most of the proposed activities generating electromagnetic energy do not come close enough to sandy beaches or intertidal flats to even potentially affect red knots before an associated physical disturbance; the activities occur mostly far overhead with mobile aircraft (e.g., aircraft flight operations), in deep, open waters of the PRC Study Area (e.g., surface vessel activities, mine countermeasure systems), or in previous disturbed land areas within PRC land area boundaries (e.g., ground-based activities). For the relatively few activities that may take place over sandy beaches or intertidal flats outside the airfield environment, the effect of low-energy electromagnetic and non-weaponized directed energy sources was discounted for biological resources in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Energy).

Acoustic

Sandy beaches and intertidal flats occur around the airfield environment and outside the airfield environment in the low-altitude airspace (e.g., Bloodsworth Island Range, Eastern Shore of Maryland, Northern Neck of Virginia). Rare birds, such as the red knot, could experience helicopter noise during transits at greater than 75 feet AGL and small UAS noise at even lower altitudes. The noise generated from the occasional fixed-wing aircraft at higher altitudes (greater than 600 feet AGL) over beaches or intertidal flats is not expected to have any significant effects on native birds. The physical disturbance of a low-flying or hovering aircraft could combine with the associated acoustic stressor to affect a red knot during important life functions (e.g., foraging) in the PRC Study Area. However, the activity level outside the airfield environment is very localized and infrequent and the occurrence of red knots along installation beaches or intertidal flats is considered "rare" (U.S. Department of the Navy, 2017c). The chance of an occasional low-flying or hovering aircraft impacting a rare bird during foraging is possible but unlikely based on the low probability of coincidence and only behavioral/stress responses anticipated. Mobile water- and land-based assets are generally quieter than associated aircraft and do not generally operate in or near the beach/intertidal flat environment. Occasional low-altitude sonic booms and weapons firing noise occurring around the fixed targets in the Chesapeake Bay Water Range are far from potential red knot habitats, and the impulsive sound levels reaching them may only cause a brief startle reaction. Acoustic stressors are also not considered among the major threats facing red knot populations (Section 3.4.4.2, Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction, Status of Affected Species and Critical Habitats).

Accordingly, acoustic stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the red knot.

Physical Disturbance and Strike

The probability of striking a rare bird species is unlikely, based on the areas where strike risk to birds is elevated (e.g., airfield environment). The developed/open space habitat in the airfield environment is also not attractive to red knots. Risks of strike is also possible outside the airfield environment with low-flying aircraft, such as helicopters and small UAS. However, the activity that may occur over beaches or intertidal flats is localized and infrequent, and preceded by a noise and physical disturbance stressor. Low altitude flights over the Bloodsworth Island Range (containing relatively undisturbed habitat for red knots) are also limited to during winter or spring that represents half the seasons in which red knots may occur in the PRC Study Area. The chance of an occasional low-flying or hovering aircraft impacting a rare bird during important life function is possible by unlikely based on this low probability of mostly behavioral/stress responses anticipated. Mobile water- and land-based assets are much slower than associated aircraft and generally do not operate in or near beaches or intertidal flats.

Accordingly, physical disturbance and strike stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the red knot.

Energy

Directed energy weapons testing could impact a red knot during flight, but the activity either takes place in a SDZ or over previous disturbed areas within installation boundaries that are confirmed to lack any sensitive biological resources. The chance of striking a rare bird during flight with the occasional firing of directed energy weapons is possible but unlikely based on the remote probability of coincidence, standard operating procedures (Section 2.5, Standard Operating Procedures Included in the Proposed

Action) and established avoidance/mitigation measures (Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) followed with directed energy weapon testing.

Accordingly, energy stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the red knot.

Indirect/Secondary

With regard to red knot predators and prey/forage, the Proposed Action is unlikely to result in any population-level effects and will have no meaningful effect on red knot habitat in terms of intertidal flat or beach characteristics (refer to Sections 3.4.3.1 through 3.4.3.3, Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts, Indirect/Secondary).

Bioaccumulation of pollutants in red knots is also unlikely because the species are low on the food chain and their prey (small beach invertebrates) consume mostly plant material in an environment far removed from where materials associated with the pollutants are being expended. However, red knots also consume shellfish that may have filtered some pollutant-laden microplastic particles originating from the Proposed Action, though the probability is low considering the miniscule contribution to overall microplastic from the Proposed Action (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis)

Accordingly, indirect/secondary stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the red knot.

Stressors Combined

Most of the proposed activities generally involve the use of moving platforms (e.g., aircraft, vessels) or MEM that may produce one or more stressors (e.g., acoustic, physical disturbance and strike, energy); therefore, if birds were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously or sequentially (e.g., physical disturbance, energy, and acoustic stressors precede strike potential). Individual stressors that would otherwise have minimal to no impact may combine to have a greater than minimal impact if they occur simultaneously. However, the combined effect of short-range physical disturbance, electromagnetic energy, and acoustic stressors has not been studied, and parsing out the effects would be difficult. Longer-range effects that would expose more birds to stressors are limited to behavioral responses to unusual sound pressures/frequencies.

Due to the wide dispersion of stressors, speed of the platforms, and general dynamic movement of many testing and training activities, it is highly unlikely that a bird would occur in the potential impact range of multiple stressors that combine to create additive effects (e.g., short-range, asset-based stressors adding to physical disturbance from MEM). Impacts would be more likely to occur to nesting birds and in areas where testing and training activities are concentrated (e.g., munition concentration areas within the Chesapeake Bay Water Range). In the very unlikely event of a coincidence, relatively few individuals would be impacted compared to their overall population size within the PRC Study Area, and the affected birds would likely be common/generalist species that are less vulnerable to population-level effects.

Accordingly, combined stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, the red knot. Avoidance and mitigation measures that further minimize potential impacts on native birds, including red knots, are summarized in Section 3.10 (Summary of

Potential Impacts to Resources and Impact Avoidance and Minimization) and referenced in the stressor-based analysis in Section 3.4.3 (Environmental Consequences).

Tiger Beetle Species

Sections 3.4.3.1 through 3.4.3.3 (Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts) include a more-in-depth analysis of potential stressor impacts from the Proposed Action on shore invertebrates that are documented in the PRC Study Area. The analysis for ESA-listed tiger beetles follows from this discussion, with particularly focus on the activities impacting the preferred habitat for tiger beetles in the PRC Study Area: sandy beaches along the estuarine shorelines. The distribution of beach and intertidal flats in the PRC Study Area is depicted in Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3. The following stressors can be discounted as having no effect on tiger beetles:

- Physical disturbance and strike, pollutants (covered in Sections 3.2, Air Quality, and 3.3, Water Resources and Sediments), entanglement, and ingestion stressors from non-explosive munitions and other MEM – Associated materials do not occur in or near any sandy beaches or intertidal flats; they occur over deep, open waters of the Chesapeake Bay and Patuxent River. Also, potentially entangling or ingestible materials are not likely to travel far from where they impacted open water areas, as described in Sections 3.0.2.3.6 and 3.0.2.3.7 (Identifying Stressors for Analysis, Entanglement Stressors and Ingestion Stressors). Whereas plastic fragments may travel farther, tiger beetles are active predators that likely consider plastic fragments to be nonfood items.
- Low-energy electromagnetic or non-weaponized directed energy sources from air-, water-, and land-based assets – Most of the proposed activities generating low energy sources do not come close enough to sandy beaches or intertidal flats to even potentially affect tiger beetles before an associated physical disturbance; the activities occur mostly far overhead with mobile aircraft (e.g., aircraft flight operations), in deep, open waters of the PRC Study Area (e.g., surface vessel activities, mine countermeasure systems), or in previous disturbed land areas within PRC land area boundaries (e.g., ground-based facilities). For the relatively few activities that may take place over sandy beaches or intertidal flats outside the airfield environment, the effect of low-energy electromagnetic and non-weaponized directed energy sources was discounted for biological resources in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Energy).
- Weaponized high-energy lasers or high-power microwaves from air-, water-, and land-based assets – None of the proposed targets (e.g., small UAS, small vessel) would be operating on a beach environment such that ground-oriented tiger beetles could be struck.

<u>**Acoustic**</u>

As described in the Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Acoustic), antenna-sensing insects cannot generally detect distance sound pressures from even low-frequency sources. Whereas insects are more likely to feel the particle motion aspect of acoustic disturbance, even particle motion from high intensity sounds diminishes substantially with distance such that only insects very close would be affected. Additionally, there are no studies subjecting beach tiger beetles to acoustic stressors to go beyond a generalization based on other insects. The effect of acoustic disturbance would also likely be indistinguishable from the physical disturbance potential, which was considered discountable (Physical Disturbance and Strike). Acoustic stressors are also not considered among the major threats facing beach tiger beetle populations (Section 3.4.4.2, Federal Threatened or Endangered Species – U.S. Fish and Wildlife Service Jurisdiction, Status of Affected Species and Critical Habitats).

Accordingly, acoustic stressors associated with the Proposed Action (Alternative 2) would have no effect on the northeastern beach tiger beetle or puritan tiger beetle.

Physical Disturbance and Strike

Beach tiger beetles are alert and highly mobile and they typically fly only short distances very close to the ground in the highly localized beach environments they inhabit. As such, the physical disturbance and strike stressors that may impact beach tiger beetles are only small UAS, beaching water-based assets, and mobile land-based assets. With the possible exception of low-flying helicopters, larger aircraft are flying high enough to avoid any potential physical impacts on the beach tiger beetles. The physical disturbance from low-flying helicopter (e.g., wind buffeting) along the shoreline could affect a tiger beetle, but the probability is low considering the rarity of the species and the activity along installation beaches (e.g., terrain following training). Water-based assets that are not beaching would not even disturb tiger beetles based on their short-range reactions to disturbance and typical operating depths. The chance of striking a tiger beetle crossing the water to scout potential habitats on PRC land areas should also be considered discountable/insignificant based on documented sightings of the species.

For activities planning to coincide with (marginal) beach tiger beetle habitat on PRC land areas, installation natural resources staff would be consulted to ensure there are no sensitive species present. Even without consulting natural resources staff, the chance of striking a tiger beetle species that has been encountered rarely or not at all on PRC beaches (northeastern beach tiger beetle and puritan tiger beetle, respectively) with activities that are also rare/unexpected along PRC beaches should be considered discountable. Realistic testing locations for detecting land-based targets do not require a beach environment unless the presence of shallow water is also required. Furthermore, standard operating procedures and established avoidance and mitigation measures ensure that sensitive resources are not impacted (details in Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization), which likely steers activities away from tiger beetle habitats. The Proposed Action also does not contribute to the major physical disturbance threats facing beach tiger beetle populations.

Accordingly, physical disturbance and strike stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect the northeastern beach tiger beetle or puritan tiger beetle.

Indirect/Secondary

With regard to tiger beetle predators and prey/forage, the Proposed Action is unlikely to result in any population-level effects or have no meaningful effect on tiger beetle habitat in terms of intertidal flat or beach characteristics (refer to Sections 3.4.3.1 through 3.4.3.3, Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts).

Bioaccumulation of pollutants in tiger beetles is unlikely because the species are low on the food chain and their prey (beach invertebrates) consume mostly plant material in an environment far removed from where materials associated with the pollutants are being expended.

Accordingly, indirect/secondary stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, northeastern beach tiger beetle or puritan tiger beetle.

<u>**Stressors Combined**</u>

Most of the proposed activities generally involve the use of moving platforms (e.g., aircraft, vessels) or MEM that may produce one or more stressors (e.g., acoustic, physical disturbance and strike, energy); therefore, if northeastern beach or puritan tiger beetles were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously or sequentially (e.g., physical disturbance, energy, and acoustic stressors precede strike potential). Individual stressors that would otherwise have minimal to no impact may combine to have a greater than minimal impact on individuals, if they occur simultaneously. However, the combined effect of short-range physical disturbance, electromagnetic energy, and acoustic stressors has not been studied and it would be difficult to parse out the effects. Moreover, longer-range effects that would expose northeastern beach or puritan tiger beetles to stressors are not supported by the analysis.

Due to the wide dispersion of stressors, speed of the platforms, and general dynamic movement of many testing and training activities, it is unlikely that a northeastern beach or puritan tiger beetle would occur in the potential impact range of multiple stressors that combine to create additive effects (e.g., short-range, asset-based stressors adding to physical disturbance from MEM). In the very unlikely event of a coincidence, relatively few individuals would be impacted compared to their overall population size within the PRC Study Area. A combination of assets and stressors in an area could also expose beach invertebrates to less harmful effects (e.g., acoustic or physical disturbance stressors) before the more damaging ones (e.g., physical strike) which may give some them an opportunity to minimize impacts on themselves.

Accordingly, combined stressors associated with the Proposed Action (Alternative 2) may affect, but are not likely to adversely affect, on the northeastern beach tiger beetle or puritan tiger beetle. Avoidance and mitigation measures that may further minimize potential impacts on terrestrial invertebrates, including tiger beetles, are summarized in Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) and referenced in the stressor-based analysis in Section 3.4.3 (Environmental Consequences).

West Indian Manatee

All the Proposed Action stressors may affect West Indian manatees, though some sub-stressors (e.g., land-based assets) are discounted because manatees are restricted to aquatic environments and there would be no co-occurrence. Individual manatees have been sighted on a regular, but infrequent basis in the middle and upper Chesapeake Bay from June through September; therefore, the potential for a manatee to be impacted by Proposed Action stressors would limited by infrequent occurrence in the PRC Study Area.

<u>**Acoustic**</u>

This section includes analysis of the potential impacts from: (1) air-based assets, (2) water-based assets, and (3) non-explosive munitions and other MEM (e.g., weapons firing/impact noise).

Manatees have a fully aquatic ear that uses bone and fat channels in the head to conduct sound to the ear (Ketten, 1998). The hearing of West Indian manatee underwater is most sensitive at 10 KHz at greater than approximately 60 dB re 1 µPa, and a hearing range from 0.3 to 50 kHz at greater than approximately 116 and 135 dB re 1 µPa, respectively (U.S. Department of the Navy, 2017e). The range of vocalizations for West Indian manatees is similar to their range hearing, with dominant energy at frequencies below 20 kHz (Wartzok & Ketten, 1999; Richardson et al., 1995).

Impacts from Air-based Assets

There are few data on the effects of aircraft overflight on sirenians (i.e., manatees and dugongs). Rathbun (1988) studied the reaction of West Indian manatees to both fixed-wing aircraft and helicopters used during census surveys. The manatees did not react to a fixed-wing aircraft moving at approximately 80.7 miles per hour (130 km per hour) at 525 feet (160 meters) altitude; however, animals did react to a helicopter below approximately 328 feet (100 meters) moving at speeds of 0 (hovering) to 20 km (12.4 miles) per hour by startling from rest and diving to deeper waters. The stressor that caused the reaction (e.g., acoustic, physical disturbance) was not determined. Hodgson et al. (2013) conducted a pilot study to conduct aerial surveys of dugongs using an unmanned aerial vehicle flown at altitudes of 500, 750, and 1,000 feet; no behavioral responses were mentioned but noise levels were much lower than for manned fixed-wing aircraft. Similarly, a fixed-wing unmanned vehicle flying at 328 feet (100 meters) did not disturb manatees (Jones IV et al., 2006; Smith et al., 2016). The pilot study demonstrates that distance to the aircraft and aircraft type may impact if and how a manatee will respond.

Fixed- and rotary-wing aircraft are used during a variety of testing and training activities throughout the PRC Study Area, but most proposed activities at low altitudes would be concentrated around the airfield environment and away from manatee habitat in nearshore estuarine waters. Even over shallow-water foraging habitats (e.g., seagrass beds), the minimum altitude of subsonic fixed-wing aircraft is about 600 feet AGL, which is above the altitude that manatees have shown reactions to fixed-wing aircraft (Rathbun, 1988). However, PRC aircraft can be much louder than the survey aircraft referenced in Rathbun (1988). For example, An F/A-18 flying at 1,000 feet AGL produces an underwater sound level of 138 dB re 1 µPa at peak frequencies closer to the low range of manatee hearing. Also, rotary-wing aircraft fly low enough to cause a reaction in manatees without consideration for louder PRC aircraft (Hodgson et al., 2013); low hovering or transiting helicopter could produce somewhat higher underwater noise levels and a physical disturbance aspect that likely preempts any effect due to sound. In the estuarine environment, the maximum level of aircraft noise would likely be from low-altitude sonic booms focused on fixed targets in the Chesapeake Bay Water Range.

Potential impacts from low-altitude sonic booms and helicopter overflights associated with terrain following, mine countermeasures (e.g., OASIS), anti-submarine warfare (e.g., dipping sonar), and search and rescue training could occur in the summer months if a manatee were present, but the exposure to disturbing noise levels apart from the airfield environment would be brief and infrequent. The area of impact would also be limited by the narrow range of conditions necessary for sound to penetrate into water as well as avoidance/mitigation measures that require looking out for marine mammals before starting an activity (refer to Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization, for more information). Most of these activities also require deep, open waters that are far removed from shallow-water foraging habitat attractive to manatees (e.g., seagrass beds). Smaller UAS are more likely to be encountered in shallow-water foraging habitat, but they are generally slower and quieter than manned helicopters and are not expected to impact manatees.

Impacts from Water-based Assets

Noise generated by various sonars and vessel/underwater device propulsion systems is associated with the Preferred Alternative.

Sonars and Other Transducers

Few data exist on manatee responses to sonar or other sounds in the water and while some studies on reactions to HF and VHF sonars are available. No criteria for TTS or PTS has been developed by the USFWS for manatees and NMFS indicates that no TTS data for sirenians exist, but uses an estimation of TTS onset at the frequency of best hearing by assuming that, at the frequency of best hearing, the numeric difference between the auditory threshold (in dB SPL) and the onset of TTS (in dB SEL) would be similar to that observed in other marine mammal species groups (National Marine Fisheries Service, 2018). As such, the avoidance/mitigation measures described in the Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) for dolphins also address impacts on manatees.

There has been some work using side scan and fish-finding sonar to detect manatees (Gonzalez-Socoloske et al., 2009; Gonzalez-Socoloske & Olivera-Gomez, 2012; Niezrecki, 2010). These are typically very-high-frequency systems, with frequencies over 200 kHz, although in some cases frequencies of 50 kHz were used. The response of the manatees to the sonar was not the focus of these studies, but, when reported, the authors stated that no response was observed. Reactions to high-frequency and very-high-frequency sonars are not likely to be comparable to MFAS due to the limit of high-frequency hearing in manatees being below 50 kHz. Studies have also been conducted on the efficacy of using pingers to warn manatees about the presence of vessels or fishing gear. Bowles et al. (2001) observed brief startle responses to pingers sweeping 10 to 80 kHz in two of nine manatees tested. Dugongs in Australia were exposed to 3.5 and 10 kHz pingers with source levels around 133 dB re 1 µPa, with no significant responses observed and continued foraging throughout the experiment (Hodgson & Marsh, 2007). In contrast, wild dugongs (a similar species) in Thailand exposed to 3.5 kHz tones at 141 dB re 1 µPa did not approach the source within 328 feet (100 meters), while playbacks of dugong calls elicited approaches within 33 feet (10 meters) (Ichikawa et al., 2009); this study is considered a more appropriate comparison source to naval MFAS.

Sonar sources covered by the Proposed Action include navigational, dipping sonars, and DICASS sonobuoys. Whereas most navigational sonars are considered *de minimis* disturbances, dipping sonars and sonobuoys can have higher source levels and potential impacts. The limited data available seems to indicate that West Indian manatees are relatively tolerant of sonar and other active acoustic sources; however, there is a lack of focused studies on the impacts of mid-frequency sound sources and it is possible there may be impacts if the manatee and the stressor co-occur. Co-occurrence is unlikely given (1) dipping sonar is used very infrequently for short durations in only the deeper waters of the Bay and (2) established avoidance/mitigation measures require lookouts to monitor for marine mammals prior to activating sonar.

Propulsion System Noise

Manatees may respond to vessel movement in shallow water via acoustic and possibly visual cues by moving away from the approaching vessel, increasing its swimming speed, and moving toward deeper water (Miksis-Olds, 2007; Nowacek et al., 2004). In manatees, call rates and call amplitude were affected by noise that shared dominant frequencies of vessels, with call rates decreasing during feeding and socializing. Differential effects were also seen on call type based on the presence or absence of calves (Miksis-Olds & Tyack, 2009). Similarly, call rates in dugongs did not change in the presence of vessels, but call durations were longer and more harmonics were present when boats passed within 1,312 feet (400 meters) (Ando-Mizobata et al., 2014). These changes in vocalizations varied with the frequency of the noise, the type of call being produced, and the behavioral or social context; taken together, these changes may indicate that responses to vessel noise are dependent on behavioral and environmental contexts. Gaspard et al., (2012) predicts that manatees are capable of hearing nearby boats as long as the noise they generate exceeds the background noise within their hearing range, which is very broad. Due to most PRC water-based activity occurring in deeper open waters, and the short range to detection/reaction (approximately 400 meters [1,312 feet]), it is highly unlikely this vessel noise stressors would overlap with the rare occurrence of a manatee in the shallow margins of the PRC Study Area during the summer months.

Impacts from Non-explosive Munitions and Other Military Expended Materials

All use of non-explosive munitions and other MEM is confined to established SDZs, and mostly within the Chesapeake Bay Water Range. Munitions (e.g., bombs and small- and medium-caliber guns) are released with the highest concentrations near the fixed targets, recovery areas, and/or aim points within the Chesapeake Bay Water Range. However, occasional weapons firing and associated impact noise occurring around the fixed targets in the Chesapeake Bay Water Range is far from potential manatee habitat. The most intense underwater noise from weapons firing of 169 dB re 1 µPa around the fixed targets would diminish to approximately 116 dB re 1 µPa at 3,415 meters (2.12 miles) (intensity associated with manatee response to low-frequency sound), based on practical spreading assumptions. It is therefore unlikely that manatees inhabiting nearshore waters would be exposed to the disturbing sound levels from weapons firing/impact noise originating mostly greater than 3.5 km away (Figure 2.1-3, Chesapeake Bay Water Range Munition Concentration Areas). The rare occurrences of manatees in summer months only (mostly nearshore) and limited weapons firing/impact noise, makes the co-occurrence of manatees and MEM-noise essentially discountable.

Impacts from Acoustic Stressor (Summary)

Acoustic stressors associated with the Proposed Action (Alternative 2) "may affect, but are not likely to adversely affect" the West Indian manatee. The may affect conclusion is associated with localized and infrequent air- and water-based assets and weapons firing/impact noise that is unlikely to be close enough to manatee habitat (e.g., nearshore seagrass beds) to temporarily affect manatee behavior in the very unlikely event that one is present in the PRC Study Area.

Physical Disturbance and Strike

The greatest potential for physical disturbance and strike stressors to impact the manatee would be from water-based assets and to a much lesser extent MEM. Since manatees are restricted to aquatic environments, there would be no co-occurrence with air-based or land-based assets and no strike potential. The acoustic stressor analysis covers the physical disturbance aspects of air-based assets, because the research presented does not distinguish between disturbance from noise and the physical presence of air-based assets.

Impacts from Water-based Assets

West Indian manatees are particularly susceptible to vessel collisions (both collisions with the hull and propeller strikes) because they hover near the surface of the water, move very slowly, and spend most of their time in inshore waters where vessel traffic tends to be more concentrated (Calleson & Frohlich, 2007; Gerstein, 2002; Runge et al., 2007; Haubold et al., 2006). Vessel strikes are the direct agent of most human-caused deaths to adult West Indian manatees (Rommel, 2007). The USFWS indicates that manatees are probably struck by smaller watercraft more often, but the likelihood of mortality is dependent on the force of collision, which is a factor of the speed and size of the vessel. Martin et al. (2015) found that the expected number of manatee and boat encounters in a given area increased with vessel speed and distance traveled by the boat. The findings in Rycyk et al. (2018) on manatee response time to slower vessels suggest collisions with slow-moving vessels are less likely to be lethal compared to high-speed vessels.

Not all collisions are fatal, as evidenced by the fact that most West Indian manatees in Florida bear scars from previous boat strikes (Rommel, 2007). In fact, the Manatee Individual Photo-identification System identifies more than 3,000 Florida manatees by scar patterns mostly caused by boats, and most catalogued manatees have more than one scar pattern, indicative of multiple boat strikes (81 Federal Register 1000–1026, January 8, 2016). Nonlethal injuries may reduce the breeding success of females (Haubold et al., 2006) and may lower a manatee’s immune response (Halvorsen & Keith, 2008).

Most activities using vessels, in-water devices, or bottom devices would be conducted in deeper, open water of the PRC Study Area, primarily within the Chesapeake Bay Water Range. The vast majority of high-speed movement is represented by fuel-powered surface vessels (with exposed propellers) operating in the Chesapeake Bay Water Range where depths are mostly greater than 13 feet (4 meters) (Figure 3.4-4). The greatest potential for strike from water-based assets would be from high-speed vessel operation transiting navigation channels connecting basins to deep, open waters of the Chesapeake Bay Water Range. Water-based asset movement at high speed elsewhere is rare and vessel beaching is not permitted in the Bloodsworth Island Range, which is surrounded by seagrass foraging habitat.

Since manatees are rare warm-season visitors to the PRC Study Area and are more likely to occur in nearshore waters and seagrass beds; the likelihood of encountering water-based assets operating mostly in deeper water during testing and training is so low as to be discountable. Standard operating procedures described in Section 2.5 (Standard Operating Procedures Included in the Proposed Action) also require that both vessels and in-water devices operate at minimum distances from shore to include allowances for sufficient depth and swell conditions.

Impacts from Munitions and Other Military Expended Materials

Since manatees are rare warm-season visitors to mostly nearshore seagrass beds in the PRC Study Area, the likelihood of encountering non-explosive munitions or other MEM expended infrequently and mostly in deeper water during testing and training is extremely low. Munitions and other MEM associated with the Proposed Action (Alternative 2), air and water-based assets and MEM is not expected to occur in the vicinity of manatee habitat (e.g., nearshore seagrass beds). However, there could be some risk of affecting a manatee in the very unlikely event that one is present in the PRC Study Area.

Impacts from Physical Disturbance and Strike Stressors (Summary)

Physical disturbance and strike stressors associated with the Proposed Action (Alternative 2) “may affect, but are not likely to adversely affect” the West Indian manatee. The may affect conclusions are associated with only localized and infrequent water-based assets and MEM that is unlikely to be close enough to manatee habitat (e.g., nearshore seagrass beds) to temporarily disturb or strike a manatee in the very unlikely event that one is present in the immediate area.

Energy

Manatees are not known to be particularly sensitive to electromagnetic fields. As such, the conclusions in Sections 3.4.3.1 through 3.4.3.3 (Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts, Energy) for both low-energy sources (e.g., electromagnetic and laser) may be applied to the rare occurrence of a manatee in the shallow water around mostly Bloodsworth Island Range seagrass beds in the PRC Study Area. The conclusion for uncommon species was an unlikely coincidence of discountable stressors with an animal, which is especially true for manatees passing through shallow-water areas where the associated activities do not generally occur.

With regard to directed energy weapon testing, small UAS targets disabled in the Bloodsworth Island Range SDZ may fall in shallow waters near seagrass beds, and small vessel targets may operate in shallow water. However, the coincidence of both targets and directed energy beams with a rare manatee is either impossible (surface to air scenarios) or unlikely (air to surface or surface to surface) and the resulting thermal effects would be minimal, given their mostly submerged position in the water column as well as large size, thick skin, and small eyes.

Energy stressors associated with the Proposed Action (Alternative 2) “may affect, but are not likely to adversely affect” the West Indian manatee. The may affect conclusion is associated with in-water electromagnetic devices and directed energy weapon systems that may infrequently come close enough to manatee habitat (e.g., nearshore seagrass beds) to expose a manatee to elevated electromagnetic or directed energies in the very unlikely event that a manatee is present in the immediate area.

Entanglement

This section includes analysis of the potential entanglement from wires/cables and decelerator/parachutes. Flare O-rings are too small to represent an entanglement risk to manatees.

Entanglements have been documented for manatees (Beck & B., 1991; Forrester et al., 1975; O'Shea et al., 1985). Manatee foraging behaviors may predispose them to entanglement with fishery gear because they are extremely tactile, meaning they need to be in close proximity or physically touching an object in order to gain extensive information about it (Adimey et al., 2014). In addition, manatees have limited abilities to detect finer objects, such as monofilament, until it is already wrapped around them (Adimey et al., 2014), leading to an increased risk of entanglement (Bauer et al., 2012).

Both sonobuoy wires and fiber-optic cables are single lines attached at one end to a device (sonobuoy or AMNS munition, respectively) with either a small float or nothing at the other end. These wires and cables would not be considered an anchored netting or line below a large float that could present a risk of entanglement for manatees. Small decelerator/parachutes on sonobuoys are also deployed and not recovered by range support vessels (other parachutes are recovered soon after deployment). These small parachutes (18-inch diameter) have multiple cords anchored to a weight to aid in sinking, though the space between cords is too small to present an entanglement risk to manatees. These materials are also releases in deeper waters of the Chesapeake Bay Water Range and far from shallow-water foraging habitat attractive to manatees.

The mobility of these materials after deployment is also limited by the generally slow tidal currents in the area. After settling in the vast expands of depositional habitat (e.g., subtidal flats, shoals) next to deeper channels, the materials will eventually become buried in sediment or encrusted by marine growth, which would eliminate or further reduce the already low risk of entanglement. The material could be exposed again after storm events that temporarily change the pattern of deposition and erosion in the Chesapeake Bay, but the slightly increased risk of entanglement is probably negligible. There are also relatively few entangling materials deployed compared to the miniscule area of bottom impacted by MEM with the Proposed Action (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis).

Entanglement stressors associated with the Proposed Action (Alternative 2) “may affect, but are not likely to adversely affect” the West Indian manatee. The may affect conclusion is associated with some MEM accessories (e.g., wires/cables, small parachutes) that may infrequently come close enough to manatee habitat (e.g., nearshore seagrass beds) to pose a conceivable risk of entangling a manatee in the very unlikely event that one is present in the study area.

Ingestion

Manatees feed on seagrass beds in relatively shallow coastal or estuarine waters. In a comprehensive review of documented ingestion of debris by marine mammals, the West Indian manatee had ingestion records that included monofilament line, plastic bags, string, twine, rope, fishhooks, wire, paper, cellophane, and rubber bands (Laist, 1997). Some researchers suggest that manatees incidentally ingest fishing gear and plastic while foraging on plants in shallow habitats, where debris can accumulate and become entwined in the food resources (Adimey et al., 2014; Beck & B., 1991). Ingestion of fishing gear can cause impaction, abdominal infections, inversions of the intestine (Beck & B., 1991) and other indirect effects. However, none of the MEM associated with the Proposed Action that could be incidentally ingested by manatees (e.g., gun ammunition casings, flare O-rings) are not expected to drift into seagrass beds located far from the deeper waters of the Chesapeake Bay Water Range where most MEM is deployed (Figure 3.4-1 and Figure 3.4-2). The risk of a rare manatee encountering a rare ingestible item associated with the Proposed Action and actually consuming it should be considered discountable.

As MEM breaks down, tiny metal or plastic particles may be released in the water column or sediment. Microplastics in the aquatic environment are well documented, and interactions with biota have been described worldwide (Lusher et al., 2016). Plastic waste in saltwater chemically attracts hydrocarbon pollutants such as PCBs and DDT, which accumulate up to 1 million times more in plastic than background levels in the environment (Mato et al., 2001). However, manatees are considered rare warm-season visitors to mostly nearshore seagrass beds in the PRC Study Area where most MEM and associated pollutants do not generally occur. Considering the composition of most MEM associated with the Proposed Action (e.g., metal, cement/sand) and it very limited coverage on the bottom (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis), the contribution of the Proposed Action to overall microplastic concentrations in the environment should be considered miniscule. Based on the limited expenditures and the natural degradation processes, it is expected that even if a manatee were to occur in the areas where pollutants persisted from testing and training activities, exposure potential would be so low as to be discountable.

Ingestion stressors associated with the Proposed Action (Alternative 2) “may affect, but are not likely to adversely affect” the West Indian manatee. The may affect conclusion is associated with some MEM accessories (e.g., flare O-rings, plastic fragments) that may infrequently come close enough to manatee habitat (e.g., nearshore seagrass beds) to pose a conceivable risk of incidental ingestion in the very unlikely event that one is present in the study area.

Indirect/Secondary

Manatee likely have no natural predators in the PRC Study Area. Manatee inhabit shallow, sheltered waters where they eat various estuarine plants that may be adverse affected by the Proposed Action vessels (Section 3.4.7, Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). Manatees may also eat sponges growing on hard substrates (e.g., artificial substrate). However, standard operating procedures and established protective measures direct vessels away from shallow-water hazards (e.g., sponge habitat) and seagrass beds (refer to Section 2.5, Standard Operating Procedures Included in the Proposed Action, for standard operating procedures). Because manatees are mostly plant eaters, bioaccumulation of pollutants associated with the Proposed Action is highly unlikely. Accordingly, the lack of any significant/substantial impacts on manatee habitats/food resources suggests a corresponding lack of significant indirect/secondary impacts on the rare manatee that visits the PRC Study Area.

Indirect/secondary stressors associated with the Proposed Action (Alternative 2) "may affect, but are not likely to adversely affect" the West Indian manatee. The may affect conclusion is associated with only water-based asset movement that may affect manatee foraging habitat (e.g., seagrass).

Stressors Combined

Most of the proposed activities generally involve the use of moving platforms (e.g., aircraft, vessels) or MEM that may produce one or more stressors; therefore, if a manatee were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously or sequentially (e.g., physical disturbance, energy, and acoustic stressors precede strike potential). Individual stressors that would otherwise have minimal to no impact, may combine to have a greater than minimal impact if they occur simultaneously. However, the combined effect of short-range physical disturbance, electromagnetic energy, and acoustic stressors has not been studied and the parsing out of effects would be difficult. Longer-range effects that are more likely to affect a manatee are not supported by the analysis.

Due to the wide dispersion of stressors, speed of the platforms, and general dynamic movement of many testing and training activities, it is unlikely that a manatee would occur in the potential impact range of multiple stressors that combine to create additive effects (e.g., short-range, asset-based stressors adding to physical disturbance from MEM); the likelihood of a rare species (e.g., West Indian manatee) encountering a rare instance of additive effects potential should be considered discountable.

Combined stressors associated with the Proposed Action (Alternative 2) "may affect, but are not likely to adversely affect" the West Indian manatee. The may affect conclusion is based on the potential for an individual activity to affect a manatee, activities including multiple stressors, the potential for combined individual stressors, as well as additive and synergistic effects. Avoidance and mitigation measures that further minimize potential impacts on marine mammals, including manatees, are summarized in Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) and referenced in the stressor-based analysis for West Indian manatees. For example, both anti-submarine warfare and mine countermeasure testing activities required trained look-outs for manatee and other marine mammals using elevated platforms (i.e., helicopters) prior to active testing.

Cumulative Effects

Cumulative effects under the ESA are defined as effects resulting from future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation. This section identifies any planned future state and private activities that may occur in the portions of the PRC Study Area inhabited by ESA-listed birds, tiger beetles, and West Indian manatee. This includes activities that are presently occurring but not yet completed (refer to Section 4.3, Cumulative Impacts, Past, Present, and Reasonably Foreseeable Future Actions, for details): (1) Expansion of the Mattaponi and Nanticoke Rural Legacy Areas, (2) Expansion of the St. Mary's County Airport, (2) Chesapeake Bay Bridge Crossing, (3) Construction of a Second Span on the Thomas Johnson Bridge, and (4) recreational and commercial vessel traffic.

Regulatory Conclusions

Regarding compliance with the federal ESA and species under the jurisdiction of the USFWS, the Navy has determined that all but one ESA-listed species (northern long-eared bat) may be affected by the Proposed Action (Preferred Alternative, Alternative 2) (Table 3.4-13). However, no species would be likely adversely affected. Therefore, consultation with USFWS will be conducted.

Table 3.4-13 Effects Determinations for the Preferred Alternative (Alternative 2) on Threatened or Endangered Species Under the Jurisdiction of the U.S. Fish and Wildlife Service

Species/Common Name	*Designation Status*	*Acoustics*	*Disturbance/Strike*	*Energy*	*Entanglement*	*Ingestion/Pollutants*	*Indirect/Secondary*	*Stressors Combined*
Eastern Black Rail	P	NLAA	NLAA	NLAA	NE	NE	NLAA	NLAA
Northeastern Beach Tiger Beetle	T	NE	NLAA	NE	NE	NE	NLAA	NLAA
Puritan Tiger Beetle	T	NE	NLAA	NE	NE	NE	NLAA	NLAA
Northern Long-Eared Bat	T	NE	NE	NE	NE	NE	NE	NE
Red Knot	T	NLAA	NLAA	NLAA	NE	NE	NLAA	NLAA
West Indian Manatee	T	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA	NLAA

Key: NE = no effect; NLAA = not likely to adversely affect; P = proposed candidate; T = threatened.

3.4.5 Marine Mammal Protection Act – Biological Assessment

This section serves as the assessment for species covered under the MMPA. The purpose of this section is to describe the status of effected species and review the Proposed Action alternatives in sufficient detail to determine to what extent the Proposed Action (Preferred Alternative) may "take" any of marine mammal species that may occur in the PRC Study Area, per definition of "take" described in Section 3.4.1.3 (Regulatory Setting, Marine Mammal Protection Act).

For West Indian manatees, the only marine mammal species potentially present in the PRC Study Area and listed by the federal Endangered Species Act, refer to Section 3.4.4.2 (Federal Threatened or Endangered Species Act – U.S. Fish and Wildlife Jurisdiction) for the status information and analysis details supporting the take determination in this section.

3.4.5.1 Status of Affected Species

There are marine mammal species (other than West Indian Manatee) with potential occurrence in the PRC Study Area: bottlenose dolphin, harbor porpoise, harbor seal, and humpback whale. All marine mammal species with potential occurrence in the PRC Study Area are primarily found in the lower Chesapeake Bay, particularly near the mouth of the Bay. Other marine mammal species have occurred sporadically in the middle Bay, but their occurrence is considered extralimital to the PRC Study Area due to the enclosed environment and estuarine conditions. When these species occur in the middle Chesapeake Bay, it is typically as a single animal. Species with recorded occurrence in the middle Bay include the minke whale, fin whale, North Atlantic right whale, sei whale, short-beaked common dolphin, gray seal, and harp seal (Barco & Swingle, 2014). Additionally, NMFS and regional stranding networks would closely monitor the occurrence of the critically endangered North Atlantic right whale in the middle Chesapeake Bay, and communication with these entities on sighting information would allow the Navy to avoid the area of the sightings. Given their extralimital occurrence, these species are not analyzed further.

Bottlenose dolphin and harbor porpoise are the only species with a regular occurrence in the middle Chesapeake Bay. Some species that were once considered rare in the lower Chesapeake Bay are now increasing. For example, the harbor seal was once considered very uncommon in Virginia (Potter, 1991) but now occur regularly in the lower Chesapeake Bay (Ampela et al., 2019; Jones et al., 2018). They would still be considered rare in the middle Chesapeake Bay including the PRC Study Area. The last record of a live harbor seal within the study area was on March 7, 2014, in the Potomac River off the coast of St. George's Island.

Humpback whales occur regularly in the lower Chesapeake, and our understanding of their habitat use around and in the Chesapeake Bay is increasing (Aschettino et al., 2018) but they would still be considered extralimital in the middle Chesapeake Bay due to the estuarine environment. However, due to their increasing regularity in the lower Chesapeake Bay and increased potential in the middle Chesapeake, they will be analyzed here.

Bottlenose Dolphin (*Tursiops truncatus*)

Status and Management

Along the U.S. East Coast, the bottlenose dolphin stock structure is well studied. There are currently 53 management stocks identified by NMFS in the western North Atlantic and Gulf of Mexico, including oceanic, coastal, and estuarine stocks (Hayes et al., 2017); (Hayes et al., 2018); (Waring et al., 2015); (Waring et al., 2016). The bottlenose dolphins that utilize the Chesapeake Bay are most likely from the Western North Atlantic Southern Migratory Coastal Stock (Hayes et al., 2018).

Habitat and Geographic Range

The bottlenose dolphin occurs in tropical to temperate waters of the Atlantic Ocean as well as inshore, nearshore, and offshore waters of the Gulf of Mexico and U.S. East Coast (Hayes et al., 2017; Hayes et al., 2018; Waring et al., 2015; Waring et al., 2016). They generally range between 45° north and 45° south latitude (Jefferson et al., 2015; Wells & Scott, 2008). They occur in most enclosed or semi-enclosed seas in habitats ranging from shallow, murky, estuarine waters to deep, clear offshore waters in oceanic regions (Jefferson et al., 2015; Wells et al., 2009). The coastal morphotype of bottlenose dolphin is continuously distributed along the Atlantic coast south of Long Island, New York, around the Florida peninsula, and along the Gulf of Mexico coast.

Bottlenose dolphins occurring in the Chesapeake Bay are part of the Western North Atlantic Southern Migratory Coastal Stock. During the warm-water months of July through August, the stock is presumed to occupy coastal waters north of Cape Lookout, North Carolina, to Assateague, Virginia, including Chesapeake Bay (Hayes et al., 2018). Within the Chesapeake Bay, the bottlenose dolphin is less abundant and more dispersed in contrast to the observed occurrence along the ocean coast of Virginia (Swingle, 1994). The bottlenose dolphin is known to use the entire Bay but is especially common in the mouth of the Chesapeake Bay (Blaylock R. A., 1988; Swingle, 1994; Barco et al., 1999). Acoustic monitoring data indicate that dolphins are present in the lower Chesapeake Bay and coastal waters of Virginia Beach nearly every day (Lammers et al., 2015). Seasonally, diminished acoustic activity was observed in that area for the February timeframe. Visual surveys found the greatest abundance in the lower Chesapeake Bay during the fall in an area from the shore out to 3.7 km, extending from Naval Station Norfolk down to the Virginia/North Carolina border (Engelhaupt et al., 2015).

Few systematic surveys have been conducted in the Chesapeake Bay; these include the 1995, 2002, and 2004 Mid-Atlantic Tursiops Surveys, aerial surveys of the lower Chesapeake Bay and coastal waters of Virginia prior to the 1987 to 1988 mass mortality event that affected that stock (Blaylock R. A., 1988), and boat and aerial surveys conducted in the lower Chesapeake Bay and Virginia Beach areas in July through October 1980 and May through June 1981 (Blaylock R. A., 1984; Garrison et al., 2003; National Marine Fisheries Service-Southeast Fisheries Science Center, 2004). More recently, aerial and acoustic surveys have been conducted from 2015 to 2017 around the PRC Study Area (Richlen et al., 2018).

Aerial and acoustic surveys for marine mammals took place in the Chesapeake Bay near NAS Patuxent River from April 2015 to November 2017 (Richlen et al., 2018). The surveys show that there are clear seasonal peaks in dolphin activity in May through July, with almost all activity taking place from April to August. Sightings were concentrated primarily in the southern portion of the survey area, near the confluence of the Potomac River and the Chesapeake Bay, with the exception of three sightings that occurred in the Chesapeake Bay north of NAS Patuxent River.

The Chesapeake Bay experiences extreme seasonal temperature changes in contrast to offshore regions (Reshetiloff, 2004). As a result, the sea surface temperature undergoes dramatic fluctuations throughout the year (1.1° to 28.9°C). Marine mammal movements in and out of the Chesapeake Bay may be affected by these temperatures directly or indirectly if these fluctuations affect the movement of prey. Bottlenose dolphin migrations out of the Chesapeake Bay waters in the fall are typically triggered when sea surface temperatures drop below 16°C. Most bottlenose dolphin sightings in the Chesapeake Bay occur in waters with sea surface temperature above 16°C (Barco et al., 1999; Hayden, 2007).

Population Trends

There are limited data available to assess population trends for the western North Atlantic Southern Migratory Coastal stock (Hayes et al., 2017). There is an estimated 3,751 dolphins in the stock (coefficient of variation [CV] = 0.60). This stock was likely impacted by the 2013-2015 morbillivirus unusual mortality event.

Aerial surveys were flown in the vicinity of NAS Patuxent River from April 2015 to November 2017 (Richlen et al., 2018), which found average summer abundances for bottlenose dolphins in the Chesapeake Bay were 104 dolphins (95 percent confidence interval of 26 to 420), and 19 dolphins (4 to 89) for the Potomac River. Density of dolphins in Chesapeake Bay was 0.2893 individuals per square km.

This peak density was estimated for July and October of 2016, and has a high degree of uncertainty based on coefficients of variation of 1.30 for July and 1.24 for October (Richlen et al. 2018).

Predator and Prey Interactions

Bottlenose dolphins are opportunistic feeders, taking a variety of fishes, cephalopods, and crustaceans (Wells & Scott, 1999) and using a variety of feeding strategies (Shane et al., 1986; Barros & Wells, 1998; Barros & Myrberg Jr., 1987). Nearshore bottlenose dolphins prey predominantly on coastal fishes and cephalopods (Mead & Potter, 1995). In the Chesapeake Bay, dolphins are likely targeting spot, croaker, and menhaden (Blaylock 1985). This species is known to be preyed on by killer whales and sharks (Wells & Scott, 1999).

Species-Specific Threats

Bottlenose dolphins along the Atlantic coast from New York to Brevard County, Florida experienced elevated stranding rates from July 2013 to March 2015 (National Marine Fisheries Service, 2020d). There were over 1,600 recorded strandings over the course of the event. Necropsy results indicated the main cause was cetacean morbillivirus, which was also the cause of a similar event in 1987–88. Some of the dolphins also had evidence of active *Brucella* sp. bacterial infections.

Harbor Porpoise (*Phocoena phocoena*)

Status and Management

The Gulf of Maine–Bay of Fundy stock is the only stock of harbor porpoise under NMFS management within the PRC Study Area. The Gulf of Maine–Bay of Fundy stock is the largest contributor to the aggregation of harbor porpoises found off the mid-Atlantic states (Hayes et al., 2017).

Habitat and Geographic Range

Harbor porpoises inhabit cool temperate-to-subpolar waters, often where their preferred prey, Atlantic herring, aggregate (Watts & Gaskin, 1985). Thus, they are frequently found in shallow waters, most often near shore, but they sometimes move into deeper offshore waters up to a depth of 1,800 meters (1.1 miles) (Westgate et al., 1998). Harbor porpoises are rarely found in waters warmer than 63 °F (17 °C) (Read, 1999).

During winter (January to March), intermediate densities (0.0 to 45.49 animals/100km^2; mean 2.61; OBIS-SEAMAP) of harbor porpoises can be found in waters off New Jersey to North Carolina (Waring et al., 2016). In addition to harbor porpoises from the Gulf of Maine–Bay of Fundy stock, harbor porpoises sighted off the mid-Atlantic states during winter include porpoises from other western North Atlantic populations (Rosel et al., 1999).

Harbor porpoise are regularly found in the Chesapeake Bay, typically in and around the mouth of the Bay, when water temperatures are cooler (late winter to early spring, 3 to 15 °C [47 to 59 °F); however, abundance and density would be very low (Blaylock R. , 1985; Morgan et al., 2002; Prescott & Fiorelli, 1980; Polacheck et al., 1995). Inland waters of Virginia and North Carolina are considered part of the normal habitat of the harbor porpoise (Polacheck et al., 1995). The vast majority of harbor porpoise strandings in Virginia waters (including the Chesapeake Bay) are between January and May, with a peak between March and May (Polacheck et al., 1995; Cox et al., 1998; Morgan et al., 2002; Swingle et al., 2007). A few records are documented in or near the Chesapeake Bay in the summer. For instance, two mid-July 1984 sightings are recorded outside the mouth of the Chesapeake Bay (Canadian Wildlife

Service, 2006), and an early July 1996 stranding is documented on the shore of the James River. However, these out-of-season occurrences can be considered extralimital.

Population Trends

A recent trend analysis has not been conducted for the Gulf of Maine/Bay of Fundy stock of harbor porpoises (Hayes et al., 2017). The latest SAR abundance estimate is 95,543 (CV=0.31); however only a small fraction would enter the bay. Most occurrence of this species is in northern latitudes.

Predator and Prey Interactions

This species preys on a variety of fish, especially high fat pelagic species such as herring, sprat and anchovy, and cephalopods (Bjorge & Tolley, 2009; Berrow & Rogan, 1996; Santos & Pierce, 2003). The harbor porpoise is known to be attacked and killed by killer whales and common bottlenose dolphins (Jefferson et al., 2015).

Species-Specific Threats

Harbor porpoises have been documented as bycatch in a variety of fisheries, including sink and drift gillnets (Hayes et al., 2017). Climate change may also impact this species, causing longer residency times and diet changes in some habitats (Heide-Jørgensen et al., 2011).

Harbor Seal (*Phoca vitulina*)

Status and Management

Although the stock structure of the western North Atlantic harbor seals (*P. v. concolor*) is unknown, harbor seals that occur along the coasts of the eastern United States and Canada represent a single population (Hayes et al., 2017; Temte et al., 1991).

Habitat and Geographic Range

The harbor seal is one of the most widely distributed seals, found in temperate to polar coastal waters of the northern hemisphere (Jefferson et al., 2015). Harbor seals occur in nearshore waters and are rarely found more than 20 km from shore; they frequently occupy bays, estuaries, and inlets (Baird, 2001). Individual seals have been observed several kilometers upstream in coastal rivers (Baird, 2001). Haul-out sites vary but include intertidal and subtidal rock outcrops, sandbars, sandy beaches, and even peat banks in salt marshes

Harbor seal distribution along the U.S. Atlantic coast has shifted in recent years, with an increased number of seals reported in southern New England to the mid-Atlantic region. Winter haul-out sites for a small number of seals (less than 50) have been reported for Chesapeake Bay and near Oregon Inlet, North Carolina (Waring et al., 2016). During land-based counts in lower Chesapeake Bay from November 2014 to April 2018, average counts of seals has increased from 10 in 2014–2015 to 23 in 2017–2018, with a maximum number of 45 seals counted on a survey (Jones et al., 2018). Additionally, 100 seals have been uniquely identified through photo identification (Jones et al., 2018). Four harbor seal strandings were reported in 2017 and two in 2018 for the coast of Virginia (Swingle et al., 2018). The harbor seal is considered a regular part of the marine fauna of the lower Chesapeake Bay.

Population Trends

A trend analysis has not been conducted for this stock (Hayes et al., 2017). The number of harbor seals in U.S. Atlantic waters increased from the 1980s to 2010 (Waring et al., 2010); however, 2012 population estimates were lower than previous estimates. This lower estimate was not considered a population decline because surveys efforts did not cover the entire population area in coastal Maine, therefore a portion of the population was not included in the survey counts (Hayes et al., 2017). The abundance estimates calculated from a Lincoln-Peterson model for the 2015–2018 Chesapeake Bay and Virginia Eastern Shore haul-out surveys ranged from 88 (95 percent confidence interval of 47.67 to 128.66) to 168 (95 percent confidence interval of 134.96 to 201.11) individual harbor seals (Jones et al., 2018)

Predator and Prey Interactions

The main prey species of the harbor seal are cod, hake, mackerel, herring, salmon, sardines, smelt, shad, capelin, sand eels, sculpins, and flatfish (Burns, 2008). Sand eels are the main prey for individuals foraging in the southern portion of their range, while cod is the main prey in other geographic areas. Harbor seals are also known to feed on cephalopods and crustaceans (Burns, 2008). Killer whales and sharks are known to prey on adult harbor seals, and pups may be preyed on by eagles, ravens, gulls, and coyotes (Burns, 2008; Weller, 2008).

Species-Specific Threats

There are no significant species-specific threats for harbor seals in the western North Atlantic, although some animals are bycaught in commercial fisheries (Hammill et al., 2010; Hayes et al., 2017). From 2010 to 2014, the total human-caused mortality and serious injury to harbor seals was estimated to be 389 per year, 377 (CV = 0.13) of which were from U.S. gillnet, bottom trawl, mid-water trawl, and purse seine fisheries combined (Hayes et al., 2017). An unusual mortality event for harbor seals (and gray seals) was declared in July 2018 (National Marine Fisheries Service, 2020b). Over 3,000 seals of both species have stranded from Maine to Virginia since July 2018. The cause is still being investigated, however the main pathogen in seals examined thus far is phocine distemper virus.

Humpback Whale (*Megaptera novaeangliae*)

Status and Management

Humpback whales are divided into 14 distinct population segments and revise the listing status of each breeding population (81 Federal Register 62260–62320, September 8, 2016). All humpback whales feeding in the North Atlantic are considered part of the West Indies DPS (Bettridge et al., 2015), including the Gulf of Maine stock. The West Indies DPS feeding range primarily includes the Gulf of Maine, eastern Canada, and western Greenland (80 Federal Register 22304–22345, April 21, 2015) and breeding grounds include waters of the Dominican Republic and Puerto Rico (81 Federal Register 62260–62320, September 8, 2016).

For management purposes in U.S. waters, NMFS identified stocks that are based on feeding areas. Although the western North Atlantic population was once treated as a single management stock, the Gulf of Maine stock has been identified as a discrete subpopulation based on strong fidelity of humpbacks feeding in that region (Hayes et al., 2017). The Gulf of Maine stock is the only stock of humpbacks in the Atlantic managed under NMFS jurisdiction. However, it should be noted that several other discrete humpback whale subpopulations, based on feeding grounds, are in the western North

Atlantic, including the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland (Hayes et al., 2017).

Habitat and Geographic Range

An increase in the number of humpback whale sightings in the vicinity of the Chesapeake Bay was noted in the early 1990s (Swingle et al., 1993) along with increases in strandings in the mid-Atlantic region (Wiley et al., 1995; Barco et al., 2002). Mid-Atlantic waters are now considered a supplemental feeding ground for juvenile and adult humpback whales, primarily during December through March (Swingle et al., 1993; Barco et al., 2002; Aschettino et al., 2018) with some whales arriving in the mouth of the Chesapeake Bay as early as October (Aschettino et al., 2018). One winter sighting in the northern portion of the Chesapeake Bay was an individual known as "Bulls Eye" that was observed lunge feeding at the Chesapeake Bay Bridge near Annapolis, Maryland, in March 1992, a distance of over 200 km northwest into the Chesapeake Bay (Swingle et al., 1993).

As noted earlier, humpback whales are most likely to occur in the Chesapeake Bay between January and March; however, year-round usage of the area is possible based on sighting and stranding data in both mid-Atlantic waters and the Chesapeake Bay itself from the fall and summer (Swingle et al., 2007; Barco et al., 2002).

Population Trends

The current abundance estimate is 1,396 in the Gulf of Maine stock, and current data suggest that the stock is steadily increasing in numbers (Hayes et al., 2018). This is consistent with an estimated average growth trend of 3.1 percent (SE=0.005) in the North Atlantic population overall for the period 1979 to 1993 (Hayes et al., 2018).

Predator and Prey Interactions

Humpback whales feed on a variety of invertebrates and small schooling fishes. The most common invertebrate prey are krill; the most common fish prey are herring, mackerel, sand lance, sardines, anchovies, and capelin (Clapham & Mead, 1999). Feeding occurs both at the surface and in deeper waters, wherever prey is abundant. The humpback whale is the only species of baleen whale that shows strong evidence of cooperation when feeding in large groups (D'Vincent et al., 1985). Humpback whales were observed using "bubble nets" to herd prey (Jefferson et al., 2015). Bubble nets are a feeding strategy where the whales dive and release bubbles of air that float up in a column and trap prey inside; the humpbacks then lunge through the column of trapped prey to feed.

This species is known to be attacked by both killer whales and false killer whales, as evidenced by tooth rake scars on their bodies and fins (Jefferson et al., 2015).

Species-Specific Threats

Minimum annual rates of human-caused mortality and serious injury to the Gulf of Maine humpback whale stock averaged 9.05 animals per year from 2010 to 2014 (Hayes et al., 2017). Mortalities and serious injuries were recorded for large whales in the Northwest Atlantic from 1970 to 2009 (Van der Hoop et al., 2013). Of 473 records of humpback whales, cause of death could be attributed for 203. Of the 203, 116 (57 percent) mortalities were caused by entanglements in fishing gear, and 31 (15 percent) were attributable to vessel strikes. NMFS has declared an unusual mortality event for humpback whale strandings along the Atlantic coast beginning January 2016, where increased mortalities have been observed from Maine through Florida. As of the development of this document, 110 cases have been reported necropsies were performed on approximately half of the whales. Of those examined, 50 percent showed evidence of human interaction, either ship strike or entanglement (National Marine Fisheries Service, 2020c).

3.4.5.2 Effects of the Proposed Action on Marine Mammal Species

Marine mammals are restricted to aquatic environments; therefore, there would be no co-occurrence with air- or land-based assets for physical strike potential. Acoustic and energy stressors from land-based assets are not applicable to marine mammals because of the greatly reduced transmission of sound and energy across the air/water interface and lack of close proximity with use of land-based assets. Ground-based assets will therefore not be discussed further.

This section covers the potential for a take resulting from the Proposed Action (Preferred Alternative, Alternative 2). The summary conclusions for this section are provided in Section 3.4.5.3 (Regulatory Conclusions).

Acoustic

This section analyzes the potential impacts on marine mammals from the various types of acoustic stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors, for supporting details). This section includes analysis of the potential impacts from air-based assets, water-based assets, and MEM.

Information regarding relevant aspects of marine mammals hearing is provided in the respective sub-stressors sections below (e.g., airborne hearing in “Impacts from Air-based Assets”).

Impacts from Air-based Assets

The impact of aircraft overflights is one of the least well-known sources of potential behavioral response by any species or taxonomic group, and so many generalities must be made based on the little data available. There is some data for each taxonomic group; taken together it appears that in general, marine mammals have varying levels of sensitivity to overflights depending on the species and context.

Most in-air sound would be reflected at the air-water interface. Depending on atmospheric conditions, in-air sound can refract upwards, limiting the sound energy that reaches the water surface. This is especially true for sounds produced at higher altitudes. Underwater sounds from aircraft would be strongest just below the surface and directly under the aircraft. Any sound that does enter the water only does so within a narrow (within 13 degrees) cone below the sound source that would move with the aircraft. For the common situation of a hovering helicopter, the SPL in water is estimated at approximately 145 dB re 1 µPa for an H-60 helicopter hovering at 50 feet. For an example fixed-wing flight, the sound pressure underwater would be about 128 dB re 1 µPa for an F/A-18 traveling at 250 knots at 3,000 feet altitude. About 50 percent of testing and training flights (this includes fixed- and rotary-wing aircraft and UAS) would occur at higher altitudes (3,000 feet and higher). Supersonic aircraft, if flying at low altitudes, could generate an airborne sonic boom that may be sensed by marine mammals while at the surface, or as a low-level impulsive sound underwater.

Fixed and rotary-wing aircraft are used during a variety of testing and training activities throughout the PRC Study Area. Helicopters might hover during mine countermeasure activities at altitudes of 75 to 100 feet over the water. Additionally, in the north of the Chesapeake Bay Water Range, hovering helicopters may deploy dipping sonar from a line. Hovering may increase the duration of noise exposure compared to fixed-wing aircraft. The most common responses of cetaceans to overflights were short surfacing durations, abrupt dives, and percussive behavior (breaching and tail slapping) (Nowacek et al., 2007). Other behavioral responses such as flushing and fleeing the area of the source of the noise have also been observed (Holst et al., 2011; Manci et al., 1988). Richardson et al. (1995) noted that marine mammal reactions to aircraft overflight largely consisted of opportunistic and anecdotal observations lacking clear distinction between reactions potentially caused by the noise of the aircraft and the visual cue an aircraft presents. In addition, it was suggested that variations in the responses noted were due to generally other undocumented factors associated with overflights (Richardson et al., 1995). These factors could include aircraft type (single engine, multi-engine, jet turbine), flight path (altitude, centered on the animal, off to one side, circling, level and slow), environmental factors (e.g., wind speed, sea state, cloud cover) and locations where native subsistence hunting continues and animals are more sensitive to anthropogenic impacts, including the noise from aircraft.

Christiansen et al. (2016b) measured the in-air and underwater noise levels of two unmanned aerial vehicles, and found that in air the broadband source levels were around 80 dB re 20 µPa at 1m, while at a 3.3 feet (1 meter) underwater received levels were 95 to 100 dB re 1 µPa when the vehicle was only 16 to 33 feet (5 to 10 meters) above the surface, and were not quantifiable above ambient noise levels when the vehicle was higher. Therefore if an animal is near the surface and the unmanned aerial vehicle is low, it may be detected, but in most cases these vehicles are operated at much higher altitudes (e.g., over 30 meters [98 feet]) and so are not likely to be heard. Mysticetes such as the humpback whale either ignore or occasionally dive in response to aircraft overflights (Koski et al., 1998). Variable responses to aircraft have been observed in toothed whales, though overall little change in behavior has been observed during flyovers. Some toothed whales dove, slapped the water with their flukes or flippers, or swam away from the direction of the aircraft during overflights; others did not visibly react (Richardson et al., 1995). Smaller delphinids generally react to overflights either neutrally or with a startle response (Würsig et al., 1998). Richardson et al. (1995) noted that pinniped responsiveness to aircraft overflights generally was dependent on the altitude of the aircraft, the abruptness of the associated aircraft sound, and life cycle stage (breeding, molting, etc.). In general, pinnipeds are unresponsive to overflights, and may startle, orient towards the sound source or increase vigilance, or may briefly re-enter the water, but typically remain hauled out or immediately return to their haul-out location (Blackwell et al., 2004; Gjertz & Børset, 1992). Pinniped reactions to rocket launches and overflight at San Nicholas Island were studied from August 2001 to October 2008 (Holst et al., 2011). California sea lions startled and increased vigilance for up to 2 minutes after a rocket overflight, with some individuals moving down the beach or returning to the water. Harbor seals had the most pronounced reactions of the species observed with most animals within approximately 4 km of the rocket trajectory leaving their haul-out sites for the water and not returning for several hours. The authors concluded that the effects of the rocket launches were minor with no effects on local populations evidenced by the growing populations of pinnipeds on San Nicholas Island (Holst et al., 2011).

Marine mammals could encounter noise from air-based assets during testing and training if their presence occurred coincident in space and time as aircraft overflights. The most intense and frequent aircraft noise would be directed in and around the airfield environment and away from estuarine waters. Aircraft noise away from the airfield environment is characterized as localized and infrequent and concentrated mostly in the Chesapeake Bay Water Range. Behavioral disturbances are likely to be brief and minor, if they occur at all. Bottlenose dolphin would be most likely to co-occur in time and space as air-based assets. Seasonally, harbor porpoise, and harbor seal could be exposed to noise from air-based assets if on the rare occasion they were present in the PRC Study Area. Humpback whales are considered extralimital to the PRC Study Area due to the enclosed environment and estuarine conditions. Although regular visitors to the lower Chesapeake Bay, when this species occurs in the middle Chesapeake Bay, it is typically as a single animal. Therefore, the likelihood of encountering noise due to air-based assets during Navy testing and training in the PRC Study Area is so low as to be discountable.

Impacts from Water-based Assets

Noise generated by various sonars and vessel/in-water device propulsion systems is associated with the Preferred Alternative.

Sonars and Other Transducers

Sonar sources covered by the Proposed Action include navigational, dipping sonars, and DICASS sonobuoys. Whereas most navigational sonars are considered *de minimis* (greater than 200 kHz or less than 160 dB rms re 1 µPa at 1m; refer to Section 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors, for full definition) disturbances, dipping sonars and sonobuoys can have higher source levels and potential impacts. Marine mammals present in the PRC Study Area may be exposed to sonar and other transducers throughout the PRC Study Area, but mostly in and around the Chesapeake Bay Water Range. The potential impacts from sonar and other transducers in these areas would be highly localized and infrequent in space and duration.

As described in Section 3.0.2.3.1 (Identifying Stressors for Analysis, Acoustic Stressors), functional checks of MFAS dipping sonar systems may occur at four discrete “dip points” located north of the Chesapeake Bay Water Range. A functional check of the dipping sonar system is conducted by a single MH60R helicopter hovering over one of the dip points located in the middle Chesapeake Bay. The sonar transducer is lowered into the water via a cable and winch to a predetermined depth. Once in the water and at the intended depth, the transducer is activated, and a sonar ping is emitted. Multiple pings may be emitted at multiple depths during a single functional check. After completion of the functional check, the transducer is reeled in via the cable and a winch, and the helicopter departs. The Preferred Alternative also includes functional checks of MFAS sonobuoys in conjunction with the dipping sonar.

Bottlenose dolphins are the only marine mammal species regularly occurring in the middle- and upper-Chesapeake Bay, as documented in the affected environment section. Therefore, bottlenose dolphin was the only marine mammal included in the acoustic modeling serving as the basis for this analysis.

The analysis of potential effects of underwater sound on bottlenose dolphins is focused on acoustic transmissions from the MFAS dipping sonar system, as modeling results indicated that this system is more likely to result in an exposure than the MFAS sonobuoys. Although the analysis primarily focuses on the effects from the dipping sonar system, the same analysis and conclusions apply to MFAS sonobuoys producing sound at a much lower source level. Exposure to active sonar transmissions could cause a physiological or a behavioral response in a bottlenose dolphin. Multiple factors were considered and incorporated into the quantitative analysis, including sound source characteristics, bottlenose dolphin occurrence and distribution, bottlenose dolphin hearing range, duration of exposure to a sound source, impact thresholds for bottlenose dolphins, and characteristics of the environment. Quantitative analysis indicated only behavioral impacts would occur to bottlenose dolphins from proposed activities in the PRC. Therefore, only behavioral impacts are further discussed.

A “behavioral response” occurs when the “normal” behavior or patterns of behavior of an animal are disrupted in response to an acoustic exposure. The behavioral response of marine mammals becomes important when the change is biologically significant. An activity is biologically significant when it affects an animal’s ability to grow, survive, and reproduce. The behavioral response of an animal to an anthropogenic sound would depend on the frequency, duration, temporal pattern, and amplitude of the sound as well as the animal’s prior experience with the sound and the context in which the sound is encountered (i.e., what the animal is doing at the time of the exposure). Other variables such as the animal’s gender, age, the activity it is engaged in during a sound exposure, the distance from the sound source, and whether it is perceived as approaching or moving away can also affect the way an animal responds to a sound (Wartzok et al., 2003).

Southall et al. (2007; 2019) synthesized data from many past behavioral studies and observations to determine the likelihood of behavioral reactions at specific sound levels. While in general the louder the sound source the more intense the behavioral response, it was clear that the proximity of a sound source and the animal’s experience, motivation, and conditioning were also critical factors influencing the response (Southall et al., 2007; 2019). After examining all of the available data, the authors concluded that the derivation of thresholds for behavioral response based solely on exposure level was not supported because context of the animal at the time of sound exposure was an important factor in estimating response.

A behavioral response can also be due to the dipping sonar “masking” biologically relevant sounds. The likelihood that MFAS transmissions from the dipping sonar system would mask sounds important to bottlenose dolphins in the Chesapeake Bay is low, because 1) the pulse lengths of acoustic transmissions would be short and within a narrow band of frequencies; 2) the duty cycle (time on vs. time off) of the transmissions would be low; and 3) the duration of each functional check event would be brief and infrequent, totaling only a few hours a year.

Harassment criteria for marine mammals are evaluated based on thresholds developed from observations of trained cetaceans exposed to intense underwater sound under controlled conditions (Schlundt et al., 2000; Finneran et al., 2005; Finneran et al., 2003). These data are the most applicable because they are based on controlled, tonal sound exposures within the tactical sonar frequency range, and because the species studied were bottlenose dolphins or are closely related to bottlenose dolphins. These (and other) studies reported deviations from an animal’s normal trained behavior when exposed to levels of sound (Schlundt et al., 2000).

The criteria and thresholds that were used to determine the potential effects from the Proposed Action on bottlenose dolphins were developed in accordance with NMFS and are consistent with those used in Phase III of the Navy’s at-sea environmental planning program (U.S. Department of the Navy, 2017e). The sound criteria used to estimate how many mid-frequency cetaceans might be disturbed to some biologically important degree by underwater noise are based primarily on behavioral observations of only a few species, but bottlenose dolphins are one of those species. A more detailed description of the criteria and thresholds used to estimate potential effects on all marine mammals from non-impulsive sound sources can be found in the Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis Technical Report (U.S. Department of the Navy, 2017e).

Bottlenose dolphins are likely to exhibit a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonars and other active acoustic sources. Potential behavioral responses include, but are not limited to, avoiding exposure or continued exposure, behavioral disturbance (including distress or disruption of social or foraging activity), habituation to the sound, becoming sensitized to the sound, or not responding to the sound. The likelihood that a behavioral response would occur is based on a probabilistic function (i.e., termed a behavioral response function), that relates the likelihood (i.e., probability) of a behavioral response to the received SPL (U.S. Department of the Navy, 2017e). The BRF is used to estimate the percentage of an exposed population that is likely to exhibit altered behaviors or behavioral disturbance at a given exposure SPL (Table 3.4-14).

Table 3.4-14 Criteria and Thresholds for Underwater Sounds Used in the Analysis of Effects on Bottlenose Dolphins[1]

Hearing Group	***Species***	***Physiological Criteria***		***Behavioral Criteria***
		Onset TTS	***Onset PTS***	
Mid-Frequency Cetaceans[2]	Most delphinids, beaked whales, med and large toothed whales	178 dB SEL (Type II weighted)	198 dB SEL (Type II weighted)	Mid-frequency behavioral response function dose response function

Key: dB = decibels; PTS = permanent threshold shift; SEL = sound exposure level; TTS = temporary threshold shift.
Notes:
1. Bottlenose dolphins are in the mid-frequency cetacean hearing group. As such, the thresholds listed for this hearing group are the only ones used in this analysis.
2. The threshold values provided are assumed for when the source is within the animal's best hearing sensitivity. The exact threshold varies based on the overlap of the source and the frequency weighting.

Using the Navy Acoustics Effects Model (NAEMO), non-impulsive acoustic sources (e.g., sonar) are grouped into bins that are defined in accordance with their fundamental acoustic properties such as frequency, source level, beam pattern, and duty cycle. Each bin is characterized by the most conservative parameters for all sources within that bin. Specifically, bin characteristics for non-impulsive sources were selected based on (1) highest source level, (2) lowest geometric mean frequency, (3) highest duty cycle, and (4) largest horizontal and vertical beam patterns. "De minimis" sources are removed from quantitative analysis because they are not anticipated to result in takes of protected marine mammal species.

The use of source classification bins provides the following benefits:

- Provides the ability for new sensors to be covered under existing authorizations, as long as those sources fall within the parameters of a "bin."
- Allows analysis to be conducted in a more efficient manner, without any compromise of analytical results.
- Simplifies the source utilization data collection and reporting requirements under MMPA authorizations if necessary.
- Ensures a conservative approach to all impact estimates, as all sources within a given class are modeled at the lowest frequency, highest source level, or longest duty cycle within that bin.
- Provides a framework to support the reallocation of source usage (sonar hours) between different source bins.

The binned approach likely overestimates the numbers of bottlenose dolphins that would be affected in a biologically important manner by the Proposed Action. The modeling also does not consider the mitigating effect of established protective measures observed when conducting dipping sonar. As a mitigation, prior to conducting a functional check, the helicopter crew would visually survey for bottlenose dolphins over an area defined by a 1 nm radius centered on the dip point in use. If a bottlenose dolphin were observed in the survey area, the functional check would be halted or delayed until the bottlenose dolphin is thought to have moved outside of the survey area based on the animal's speed and direction. Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) provides a detailed description of avoidance and mitigation measures protecting marine species that would be implemented by the Proposed Action.

The sightability of a marine species is an important factor in determining how effective visual surveys would be in mitigating potential effects to those species. Bottlenose dolphins are gregarious, are typically found in pods of approximately 15-80 individuals, and are frequently observed at or near the surface (Blaylock R. A., 1984; Richlen et al., 2018). Visual surveillance from an approaching or hovering helicopter would be highly effective in detecting the presence of, and therefore avoiding, bottlenose dolphins prior to and while conducting a functional check. Environmental factors that affect the marine species sightability include the time of day, sea state, and the presence of any adverse weather conditions or glare. The sea state in the area of the Chesapeake Bay where and when functional checks would take place is typically low, providing optimal conditions for being able to sight an animal's dorsal fin above the water's surface. The use of a helicopter as the survey platform would provide an elevated viewing location to minimize glare. Finally, the activity would not occur in adverse weather conditions because they create unsafe flying conditions that could pose a safety or security risk to the pilots.

NAEMO was used to predict the number of bottlenose dolphins that would be affected by sound from the proposed use of dipping sonar and MFAS sonobuoys. The criteria from Table 3.4-14 were used in modeling a set of defined operational scenarios:

- Scenario 1: Dipping Sonar Testing
- Scenario 2: Dipping Sonar Proficiency Training
- Scenario 3: Dipping Sonar with Sonobuoy Testing

No more than two functional check events would be conducted within a 24-hour period; however, for logistical reasons it is unlikely that more than one event would occur within a 24-hour period. The acoustic parameters of the both the dipping sonar system and sonobuoy are provided in Section 3.0.2.3.1.2 (Acoustic Stressors, Vessels (and Other Water-based Assets), Sonar and Other Transducers). The two sources fall into the MF4 and MF5 bins (mid-frequency active sources that produce signals between 1 and 10 kHz respectively). Under Alternative 2, all three scenarios would occur up to a maximum of 39 times per year for active dipping sonar and 13 times per year for MFAS sonobuoys. There would be an approximate total of approximately four hours of sonar operation per year.

Bottlenose dolphins are not present in the middle Chesapeake Bay in late fall and winter; therefore, there would be no potential for acoustic exposures during approximately half of a calendar year under any scenario. In spring and summer, when bottlenose dolphins are present in the study area, there is a potential for bottlenose dolphins to be exposed to acoustic transmissions from the proposed functional check events. Based on an analysis that integrated bottlenose dolphin density estimates, acoustic transmissions from dipping sonar and sonobuoys, and the physical characteristics of the Bay affecting sound transmission, the NAEMO model predicted zero temporary or permanent threshold shifts in hearing sensitivity to bottlenose dolphins because of the Proposed Action. The model did predict up to six acoustic exposures (per event) that may result in a behavioral reaction by bottlenose dolphins in summer and up to one behavioral exposure in spring. These results would apply to all three alternatives.

However, all predicted exposures would be avoided by observing established protective measures. The mitigations should eliminate all the potential effects on dolphins because: 1) a hovering helicopter provides an ideal vantage point for observing for bottlenose dolphins; 2) bottlenose dolphins are frequently visible near the water's surface, travel in groups, and are known for displaying visible surface behaviors; and 3) the sea state in the Chesapeake Bay, where functional checks would take place, is typically low, making the Bay particularly conducive for marine mammal observation throughout the year. While modeling was only conducted for species commonly encountered in the PRC Study Area, the very rarely encountered harbor porpoises and harbor seals would still be spotted by the helicopter aircrew, if present and would be afforded the same protections.

Propulsion System Noise

Proposed activities involving vessel movements in the study area occur intermittently and in a more limited area compared to commercial/recreational vessels. In the PRC Study Area, vessels and underwater devices associated with the Proposed Action are used mainly for testing purposes and occur less frequently than either training activities in general or aircraft testing in the study area. Based on the hours of operation proposed with the Preferred Alternative, vessel activity within mostly the Chesapeake Bay Water Range would be localized and infrequent.

Effects from propulsion system noise on marine mammals would most likely be either in the form of masking, or behavioral responses. The response of a marine mammal to an anthropogenic sound may depend on the frequency, duration, temporal pattern and amplitude of the sound as well as the animal's prior experience with the sound and their behavioral state (i.e., what the animal is doing and their energetic needs at the time of the exposure) (Ellison et al., 2011). The number of individuals affected would likely be very small relative to overall population sizes.

Behavioral disturbances are likely to be brief and minor, if they occur at all, and no long-term consequences to the population would be anticipated. The impact of dipping sonar on bottlenose dolphins was determined to be essentially discountable with the implementation of established avoidance and mitigation measures (refer to Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization, for details). Bottlenose dolphins are habituated to busy coastal environments and often approach vessels to bow ride. Seasonally, harbor porpoise and harbor seal could be exposed to noise from water-based assets if, on the rare occasion, they were present in the PRC Study Area, and their presence occurred coincident in space and time as proposed vessel or in-water device activity. Humpback whales are considered extralimital to the PRC Study Area due to the enclosed environment and estuarine conditions. When these species occur in the middle Chesapeake Bay, it is typically as a single animal. Therefore, the likelihood of encountering noise due to water-based assets during Navy testing and training in the PRC Study Area is so low as to be discountable. Exposure to proposed sonar and vessel/device operation would therefore be unlikely to impact survival, growth, recruitment, or reproduction of marine mammals.

Impacts from Munitions and Other Military Expended Materials

Noise generated by various MEM (e.g., small-caliber weapons fire, inert bomb splash) is associated with the Preferred Alternative. All use of MEM is confined to established SDZs, and mostly within the Chesapeake Bay Water Range. Non-explosive munitions (e.g., bombs and small and medium-caliber projectiles) are expended with the highest concentrations near the fixed targets, recovery areas and/or aim points within the Chesapeake Bay Water Range. Only marine markers and search and rescue kits may be expended in the other SDZ (Patuxent River Seaplane Area). Explosive munitions are not used in the Chesapeake Bay Water Range.

A weapon fired from a ship on the surface of the water propagates a blast wave away from the gun muzzle into the water. The received sound level generated by rockets firing 1,000 feet overhead is 137 dB peak re 20 µPa. Animals at the surface of the water, in a narrow footprint under a weapons trajectory, could be exposed to noise and may exhibit brief startle reactions, avoidance, diving, or no reaction at all. Due to the short-term, transient nature of gunfire noise, animals are unlikely to be exposed multiple times within a short period. Additionally, gunfire will be from aircraft high overhead and (2) that MEM splash noise is also a consideration—a reaction difficult to distinguish from the physical disturbance aspect. Behavioral reactions would likely be short-term (minutes) and are unlikely to lead to substantial costs or long-term consequences for individuals, species, or stocks.

Behavioral disturbances are likely to be brief and minor, if they occur at all, and no long-term consequences to the population would be anticipated. Bottlenose dolphin are the most likely to encounter noise from munitions and other MEM during testing and training. Seasonally, harbor porpoise and harbor seal could be exposed to noise from munitions and other MEM if, on the rare occasion, they were present in the PRC Study Area, and their presence occurred coincident in space and time as the use of non-explosive munitions and other MEM. Humpback whales are considered extralimital to the PRC Study Area due to the enclosed environment and estuarine conditions. When these species occur in the middle Chesapeake Bay, it is typically as a single animal. Therefore, the likelihood of encountering noise due to munitions and other MEM during Navy testing and training in the PRC Study Area is so low as to be discountable.

Impacts from Acoustic Stressors (Summary)

Acoustic stressors associated with the Proposed Action (Alternative 2) would not result in the unintentional taking of marine mammals incidental to those activities, as defined by the MMPA. Takes are not expected from the use of MFAS systems (dipping sonar and sonobuoys) under the Proposed Action. This conclusion also applies to West Indian manatee (refer to Section 3.4.4.2, Effects on Federal Threatened or Endangered Species (USFWS Jurisdiction), West Indian Manatee, Acoustic, for supporting details).

Physical Disturbance and Strike

This section analyzes the potential impacts on marine mammals from the various types of physical disturbance and strike stressors associated with the Preferred Alternative on marine mammals (refer to Section 3.0.2.3.2, Identifying Stressors for Analysis, Physical Disturbance and Strike Stressors, for supporting details). However, the intense noise often associated with most close-range physical disturbances has a combined effect on marine mammals that was covered under the acoustic stressor section. The remainder of this section therefore focuses on the potential for actually striking an animal. The physical strike stressors that may impact marine mammals within the PRC Study Area include (1) water-based assets; and (2) non-explosive munitions and other MEM.

The Navy uses highly qualified operators to maintain awareness of the surrounding environment, including observance of the waterway for marine mammals as well as objects in the water. The Navy vessel operators practice safe navigation, and are trained to take proper action to avoid collisions.

Impacts from Water-based Assets

Based on the hours of operation proposed with the Preferred Alternative, the activity of water-based assets would be localized and infrequent in PRC Study Area. The vast majority of high-speed movement is represented by fuel-powered surface vessels (with exposed propellers) operating in the Chesapeake Bay Water Range where depths are mostly greater than 13 feet (4 meters) (Figure 3.4-4). The total hours of surface vessel operation would be roughly split between use as range support or combatant and patrol, and use as a target coincident with detection systems and/or MEM. Use of mobile in-water devices (e.g., UUVs, in-water electromagnetic devices, and mobile subsurface targets) is relatively rare but somewhat less confined to the Chesapeake Bay Water Range, though they require at least 4-meter (13-foot) depths to operate safely. These hydrodynamic devices also employ an enclosed battery powered propeller and typically operate at relatively slow speeds.

In general, odontocetes such as the harbor porpoise or bottlenose dolphin, move quickly and seem to be less vulnerable to vessel strikes than other cetaceans; however, bottlenose dolphin have at least occasionally suffered from vessel strikes (Bloom & Jager, 1994; Von Waerebeek et al., 2007; Wells & Scott, 1997). Overall, collision avoidance success is dependent on a marine mammal's ability to identify and locate the vessel from its radiated sound and the animal's ability to maneuver away from the vessel in time.

Available literature suggests based on their smaller body size, maneuverability, larger group sizes, and hearing capabilities, odontocetes are not as likely to be struck by a Navy vessel as mysticetes. When generally compared to mysticetes, odontocetes are more capable of physically avoiding a vessel strike, and, since some species occur in large groups, they are more easily seen when they are closer to the water surface. In addition, no vessel strikes of marine mammals have been reported due to Navy inshore testing and training activities. Therefore, the Navy does not anticipate that it will strike bottlenose dolphins and harbor porpoise as a result training and training activities in inshore waters.

Ship strikes were not reported as a global threat to pinniped populations by (Kovacs et al., 2012). Pinnipeds in general appear to suffer fewer impacts from vessel strikes than do cetaceans or sirenians. This may be due, at least in part, to the large amount of time they spend on land (especially when resting and breeding) and their high maneuverability in the water. A review of seal stranding data from Cape Cod, Massachusetts, found that from 1999 to 2004, the Cape Cod Stranding Network recorded 622 pinniped strandings. Of these 622 strandings, 11 (approximately 2 percent) were found to be caused by boat collisions. Mortalities of pinnipeds (specifically harbor seals and gray seals) have initially been attributed to injuries sustained from ducted propellers on vessels such as workboats, tugs, and other support vessels (Bexton et al., 2012). However, further investigations have lead researchers to conclude that injuries that appeared to be the result of propellers were actually due to gray seal predation, cannibalism, and infanticide (Brownlow et al., 2016).

Vessel strikes have been documented for almost all of the mysticete species, including humpback whales (Douglas et al., 2008; Lammers et al., 2003; Von Waerebeek et al., 2007). Generally, mysticetes are larger than odontocetes and are not able to maneuver as well as odontocetes to avoid vessels. In addition, mysticetes do not typically aggregate in large groups and are therefore can be difficult to detect visually from the water surface in some situations, such as rougher sea states.

Some in-water devices, such as UUVs, and in-water devices towed from unmanned platforms, that move slowly through the water are less likely to strike marine mammals than a surface vessel because the mammal could easily avoid the object. In-water devices towed by manned platforms are unlikely to strike a marine mammal because of the observers on the towing platform and other standard safety measures employed when towing in-water devices. The OASIS is reported to move up to 25 knots, and some UUVs can move over 10 knots. The likelihood of physical strike is higher for faster moving devices; however, the devices would be closely monitored by observers. It is possible that marine mammal species that occur in areas that overlap with in-water device use associated with the Proposed Action may experience some level of physical disturbance, but it is not expected to result in more than a momentary behavioral response.

The Navy will implement mitigation to avoid potential impacts from vessel and towed in-water device strikes on marine mammals throughout the PRC Study Area. Mitigation includes training Lookouts and watch personnel with the Marine Species Awareness Training (which provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures), and requiring underway vessels and in-water devices that are towed from manned surface platforms to maneuver to maintain a specified distance from marine mammals.

Bottlenose dolphin are the most likely to encounter water-based assets during testing and testing. This species is fast and easily able to maneuver around vessels or in-water devices. Additionally, bottlenose dolphins are frequently visible near the water’s surface, travel in groups, and are known for displaying visible surface behaviors; and the sea state in the Chesapeake Bay is typically low, making the Bay particularly conducive for marine mammal observation throughout the year. Visual observation by Navy lookouts would greatly reduce the potential for interaction with bottlenose dolphin. While it is highly unlikely, there is still potential for interaction with vessels or in-water devices. However, no -long-term consequences to the population would be anticipated.

Seasonally, harbor porpoise and harbor seal might encounter water-based assets during testing and training. This species would easily be able to maneuver around vessels or in-water devices in most circumstances and typically avoid getting close to vessels. Additionally, the sea state in the Chesapeake Bay is typically low, making the Bay particularly conducive for marine mammal observation throughout the year. Visual observation by Navy lookouts would greatly reduce the potential for interaction with harbor porpoise. While it is highly unlikely, there is still potential for interaction with vessels or in-water devices. However, no long-term consequences to the population would be anticipated. Humpback whales are considered extralimital to the PRC Study Area due to the enclosed environment and estuarine conditions. When these species occur in the middle Chesapeake Bay, it is typically as a single animal. Therefore, the likelihood of encountering water-based assets during Navy testing and training in the PRC Study Area is so low as to be discountable.

Impacts from Non-explosive Munitions and Other Military Expended Materials

While no strike from MEM has ever been reported or recorded, the possibility of a strike still exists. The primary concern is the potential for a marine mammal to be hit with an MEM at or near the water’s surface, which could result in injury or death, as small caliber gun ammunition could penetrate the water with high velocities down as far as 1.5 to 8 feet (Noonan & Steves, 1970). While disturbance or strike from an item falling through the water column is possible, it is not very likely because the objects generally sink slowly through the water based on the weights of expended materials and can be avoided by most marine mammals. Therefore, the discussion of MEM strikes focuses on the potential of a strike at and just below the surface of the water. Additionally, the likelihood of a marine mammal being in the exact location of MEM strike at the same time is low. The annual footprint of MEM within the study area is 0.0004 percent, or 21,194 of 5,140,955,570 square feet (refer to Appendix E, Military Expended

Materials and Physical Disturbance and Strike Analysis, for supporting details). Compared to overall bottlenose dolphin density of 0.2893 individuals per square km (or 10,763,910 square feet), the chance of a dolphin being struck is very low, and would be even lower for species that are considered rare. Additionally, visual observation of the area would allow marine mammals to be avoided.

The maximum annual percent coverage of MEM in the water range is 0.0002 percent under the No Action Alternative (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis). The annual footprint of MEM in the munition concentration areas is also no greater than 0.0075 percent; the Hannibal Target munition concentration area also represents the location where higher quality habitat for estuarine animals and water birds (e.g., shell bottom in shallow area above seasonal hypoxia) coincides with the highest percent coverage of MEM, which is mostly gunfire rounds. The miniscule area of the MEM footprint on the bottom is further reduced to the extent munitions strike/embed in their target during testing and training scenarios.

Bottlenose dolphin are the most likely to encounter munitions and other MEM during testing and training. Bottlenose dolphins are frequently visible near the water's surface, travel in groups, and are known for displaying visible surface behaviors; and the sea state in the Chesapeake Bay is typically low, making the Bay particularly conducive for marine mammal observation throughout the year. Visual observation by Navy lookouts would greatly reduce the potential for interaction with bottlenose dolphin. While it is highly unlikely, there is still potential for interaction with non-explosive munitions and other MEM. However, no long-term consequences to the population would be anticipated.

Seasonally, harbor porpoise or harbor seal could encounter non-explosive munitions and other MEM during testing and training. Humpback whales are considered extralimital to the PRC Study Area due to the enclosed environment and estuarine conditions. Although humpback whales are regular visitors to the lower Chesapeake Bay, when this species occurs in the middle Chesapeake Bay, it is typically as a single animal. The sea state in the Chesapeake Bay is typically low, making the Bay particularly conducive for marine mammal observation throughout the year. Visual observation by Navy lookouts would greatly reduce the potential for interactions. When these species occur in the middle Chesapeake Bay, it is typically as a single animal. The likelihood of encountering munitions and other MEM during Navy testing and training in the PRC Study Area is so low as to be discountable.

Impacts from Physical Disturbance and Strike Stressors (Summary)

Physical disturbance and strike stressors associated with the Proposed Action (Alternative 2) would not result in the unintentional taking of marine mammals incidental to those activities, as defined by the MMPA. This conclusion is associated with only movement of water-based assets and MEM in mostly the Chesapeake Bay Water Range. This conclusion also applies to West Indian manatee (refer to Section 3.4.4.2, Effects on Federal Threatened or Endangered Species (USFWS Jurisdiction), West Indian Manatee, Physical Disturbance and Strike, for supporting details).

Energy

This section analyzes the potential impacts on marine mammals from the various types of energy stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.5, Identifying Stressors for Analysis, Energy Stressors, for supporting details). This section includes analysis of the potential impacts from only in-water electromagnetic devices. In-air electromagnetic stressors are not applicable to marine mammals because they are transmitted over short distances in the air and not underwater.

Impacts from In-Water Electromagnetic Devices

Neither regulations nor scientific literature provide threshold criteria to determine the significance of the potential effects from actions that result in generation of an electromagnetic field. Data regarding the influence of electromagnetic fields on cetaceans are inconclusive and are based primarily on the assumptions that marine mammals can sense variations in the earth's magnetic field and that they use those magnetic field variations for navigation. Although it is not fully understood, based on the available evidence described above, it is probable that marine mammals use the earth's magnetic field for orientation or migration (Walker et al., 1992). If a marine mammal was in proximity of an electromagnetic field source associated with Navy training, emitting a field strong enough to be detected, and that animal is sensitive to the exposure, it is conceivable that this electromagnetic field could have an effect on a marine mammal, primarily impacting that animal's navigation.

Most of the early research investigated the possible correlations of where live-stranding locations occurred to determine if there was an associated local variation in the earth's magnetic field (Kirschvink, 1990), including the harbor porpoise, which had live-stranding locations that correlated with areas where the earth's magnetic field was locally weaker than surrounding area. These statistical associations for locally weaker areas represented a total intensity variation of less than 0.05 microtesla in the magnetic field (Kirschvink et al., 1986). While this correlation seemed to have also been demonstrated for bottlenose dolphins in the Atlantic (Kirschvink et al., 1986; Normandeau Associates et al., 2011), reviewed available information on electromagnetic and magnetic field sensitivity of marine organisms (including marine mammals) and concluded there was behavioral, anatomical, and theoretical evidence indicating that cetaceans sense magnetic fields.

Anatomical evidence suggests the presence of magnetic material in the brain of bottlenose dolphin, and humpback whale, and in the tongue and lower jawbones of harbor porpoise (Bauer et al., 1985; Kirschvink et al., 1986). Kuzhetsov (1999) conducted experiments exposing bottlenose dolphins to permanent magnetic field intensities of 32, 108, and 168 microteslas and showed both behavioral and physiological reactions during 79 percent, 63 percent, and 53 percent of the trials, respectively (as summarized in Normandeau Associates et al. (2011)). Behavioral reactions included sharp exhalations, acoustic activity, and movement, and physiological reactions included a change in heart rate. Kremers et al. (2014) conducted another experiment to observe the spontaneous reactions of captive bottlenose dolphins from a magnetized device compared to a demagnetized device. Results from this experiment confirmed that dolphins are capable of perceiving magnetic fields from a distance of more than 5 feet (1.5 meters) from the 1.2 tesla magnetic strength device; creating a magnetic field with a strength of approximately 0.051 to 0.240 tesla between 2 to 5 cm (0.8 to 2 inches) from the source (Kremers et al., 2014). The dolphins approached the magnetized device with shorter latency compared to the demagnetized device that was identical in form and density and otherwise undistinguishable through echolocation (Kremers et al., 2014). The findings also suggest that dolphins may be able to discriminate between two items based on their magnetic properties (Kremers et al., 2016). It is still unclear whether magnetic fields are attractive or repulsive to dolphins (Kremers et al., 2014; Kremers et al., 2016) and further studies on the magnetic perception threshold on dolphin behavior need to be conducted (Kremers et al., 2016).

Potential impacts on marine mammals associated with electromagnetic fields are most likely dependent on the animal's proximity to the source and the strength of the magnetic field. Because the device creating the electromagnetic field is towed or is on an unmanned vehicle, it may not be possible to distinguish whether an avoidance reaction of an animal is the result of physical disturbance from the towed object or unmanned or from the presence of the electromagnetic field. Electromagnetic fields associated with naval testing and training activities are relatively weak (only 10 percent of the earth's magnetic field at 24 meters [79 feet]), temporary, and localized. Once the source is turned off or moves from the location, the electromagnetic field is gone. A marine mammal would have to be within the electromagnetic field (approximately 200 meters [79 feet] from the source) during the activity to detect it. Additionally, the electromagnetic field strength of the OASIS would be masked by the earth's magnetic field beyond 13 feet (4 meters).

Available literature on marine mammals involve investigating their ability to sense an electromagnetic field due to the potential it then may have on navigation and migration behaviors. Direct impacts on feeding or reproductive behaviors have not been documented, and impacts on marine mammals feeding and engaging in reproductive behaviors are not anticipated. If marine mammals are in fact sensitive to small variations in electromagnetic fields, any impacts from Navy testing and training would be temporary and minor, and natural behavioral patterns would not be significantly altered or abandoned based on the Navy's electromagnetic device having: (1) generated a relatively low-intensity magnetic field (essentially mimicking the magnetic field of a steel vessel); (2) a very localized magnetic field proximate to the moving electromagnetic device; (3) been maneuvered by the Navy to maintain a specified distance away from marine mammals, as stated with regard to vessels and towed in-water devices in Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization), which consequently would provide some avoidance of electromagnetic devices that are towed from manned platforms; and (4) a short duration (hours) of use, if turned on at all.

Bottlenose dolphin are the most likely to encounter In-Water Electromagnetic Devices during testing and training. Disturbances (e.g., temporary disorientation) from in-water electromagnetic devices are likely to be brief and minor, if they occur at all, and no long-term consequences to the population would be anticipated.

Seasonally, harbor porpoise or harbor seal could encounter In-Water Electromagnetic Devices during testing and training. Humpback whales are considered extralimital to the PRC Study Area due to the enclosed environment and estuarine conditions. Although humpback whales are regular visitors to the lower Chesapeake Bay, when this species occurs in the middle Chesapeake Bay, it is typically as a single animal. Disturbances (e.g., temporary disorientation) from in-water electromagnetic devices are likely to be brief and minor, if they occur at all. The likelihood of encounter is so low as to be discountable.

Impacts from Directed Energy

As discussed in Section 3.0.2.3.5.4 (Directed Energy), high-energy laser weapons testing involves the use of up to 1 megawatt and high-power microwave systems testing mainly involves the use of narrowband (1 to 5 gigahertz) and wideband (100 to 500 megahertz) levels of directed energy against air, surface, or land targets. These weapons systems are deployed from air, land, or surface platforms. High-energy lasers create small but critical failures in potential targets and are used at short ranges from the target. High-power microwaves produce impacts on electronics systems and would be turned on an average of three seconds per firing event with up to two firings per day. The primary target focus for directed energy weapons testing is air-based targets (e.g., small UAS targets), with a smaller number of targets being water-based (e.g., vessels).

The primary concern for directed energy weapons systems training and testing is the potential for marine mammals to be struck by a directed energy weapon (e.g., high-energy laser beam), at or near the water's surface, which could result in injury or death, resulting from burns from the weapon. Whereas the path of a directed energy weapon from origin to target could briefly intersect a marine mammal at the water surface, the thermal effects would be momentary as both the firing platform and target would be in motion since the weapon tracks its target.

Marine mammals could only be exposed to a directed energy weapon if the beam missed the target. Should the beam strike the sea surface, individual marine mammals at or near the surface could be exposed. The potential for exposure to a directed energy weapon decreases as the water depth increases. Because directed energy weapon platforms are typically aircrafts and vessels, marine mammals would likely transit away or dive in response to other stressors, such as vessel or aircraft noise and physical presence before any effects could occur from the weapon. In addition, the likelihood of an exposure due to the directed energy weapons systems planned with the Proposed Action is further reduced because of the: (1) highly localized potential impact area, (2), limited range and temporary duration of the directed energy weapons, and (3) both the firing platform and the target would be in motion, thus potential encounters with directed energy would be very brief.

Impacts from Energy Stressors (Summary)

Energy stressors associated with the Proposed Action (Alternative 2) would not result in the unintentional taking of marine mammals incidental to those activities, as defined by the MMPA. This conclusion is associated with only in-water electromagnetic devices used mostly in the Chesapeake Bay Water Range. This conclusion also applies to West Indian manatee (refer to Section 3.4.4.2, Effects on Federal Threatened or Endangered Species (USFWS Jurisdiction), West Indian Manatee, Energy, for supporting details).

Entanglement

This section analyzes the potential impacts on marine mammals from the various types of entanglement stressors associated with the Preferred Alternative (refer to Section 3.0.2.3.6, Identifying Stressors for Analysis, Entanglement Stressors, for supporting details). This section includes analysis of the potential entanglement from wires/cables and decelerator/parachutes. Flare O-rings are 1.4 inches in diameter and therefore do not pose an entanglement risk due to their size.

Marine mammals could encounter these materials, and, if encountered, may have the potential to entangle them the surface, in the water column, or along the bottom. Since potential impacts depend on how a marine mammal encounters and reacts to items that pose an entanglement risk, the following paragraphs discuss research relevant to specific groups or species. Risk factors such as animal size, sensory capabilities, and foraging methods are also considered in the potential risk for entanglement. Most entanglements discussed are attributable to marine mammal encounters with fishing gear or other nonmilitary materials that float or are suspended at the surface. The properties and size of MEM makes entanglement unlikely.

Since, there has never been a reported or recorded instance of a marine mammal entangled in MEM (Henry et al., 2016; National Oceanic and Atmospheric Administration Marine Debris Program, 2014a), the Navy considered the available literature and reports on entanglement. These reports indicate that active and derelict fishing gear is the predominant cause of entanglement. The reason for this, and the ways that fishing gear may be different from MEM are as follows: (1) fishing gear is most often used in areas of high productivity where marine mammals may congregate and feed, (2) fishing gear is designed to trap/entangle marine life and are made with a high breaking strength to withstand prolonged use in the ocean environment; MEM are not designed to persist in the ocean environment for long periods of time and are not designed to entangle or capture marine life, and (3) fishing gear and ropes are designed to float or be suspended in the water column for long periods of time, whereas most MEM sink immediately and rapidly.

There are many documented entanglement reports of humpback whales (National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). For humpback whales, there are records directly linking entanglement to marine debris as opposed to active fishing gear (Baulch & Perry, 2014; Laist, 1997). Entanglement of many large whales most often begins with rope being caught in its baleen plates. Based on feeding adaptations for mysticetes, oral entanglement may pose one of the greatest threats to survival, due to impaired foraging and possibly loss of function of the hydrostatic seal (formed when upper and lower lips come together and keep the mouth closed), requiring the whale to expend energy to actively keep the mouth closed during swimming (Cassoff et al., 2011). Impaired foraging could lead to deterioration of health, making the animal more susceptible to disease or eventual starvation over a long period. Compounding the issue, trailing lengths of rope or line may become wrapped around the animal's appendages as it struggles to free itself (Kozuck, 2003), limiting the animal's mobility. This reduced mobility can also reduce foraging success or even limit the animal's ability to surface. Notably, the single acute cause of entanglement mortalities has been associated with drowning from multiple body parts being entangled (Cassoff et al., 2011).

Common sources of entanglements for mysticetes include line and net fragments attached through the mouth or around the tail and flippers (National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). Rope diameter and breaking strengths may also determine an animal's ability to break free from entanglement. Increased rope strength has been found to be positively correlated with injury severity in right whales, but not for humpback whales (Knowlton et al., 2016).

In the western North Atlantic, entanglement in fishing gear is a known cause of humpback whale injury and mortality, with all components of both pot and gillnet gear documented during 30 separate humpback whale entanglement events (Johnson et al., 2005). This study also found one entanglement event involving a vessel anchor line rather than fishing gear. Overall, between 6 and 26 percent (average 12 percent) of the population exhibits evidence of new entanglement injuries every year (Robbins, 2009), though the proportion of entanglements due to fishing gear is unknown. Available data indicate that males typically have more entanglement scars than females and may become entangled more frequently. Juvenile whales were found to have a higher rate of entanglement and be more at risk of serious injury and mortality when entangled than mature animals of the same species (Robbins, 2009; Robbins, 2010).

MEM is expected to sink to the ocean floor. It is possible that marine mammals could encounter these items within the water column as they sink to the bottom. Less buoyant items that sink faster are not as likely to become entangled with a marine mammal compared to more buoyant materials that would sink slower to the floor. Humpback whales that feed near or at the bottom in the areas where activities make use of MEM could encounter items that have already sunk and, therefore, do not have to be present at the precise time when items are expended. Though considered extralimital in the middle Chesapeake Bay, humpback whales are the only mysticete occurring in the PRC Study Area that regularly feeds near the bottom and would have the additional risk of being exposed to entangling MEM that have already sunk. Harbor seals can also entangled in nets and fishing line when young and then grow with the lines wrapped around their necks or appendages, causing deep wounds and eventually death.

Odontocete species with documented records of marine debris entanglement, excluding fishing gear, include both the bottlenose dolphin, and harbor porpoise (National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). Bottlenose dolphins are the most commonly entangled odontocete, with most entanglements involving monofilament line, net fragments, and rope attached to appendages (National Oceanic and Atmospheric Administration Marine Debris Program, 2014a). Juvenile harbor porpoises exposed to 0.5-inch-diameter white nylon ropes in both vertical and horizontal planes treated the ropes as barriers, more frequently swimming under than over them. However, porpoises feeding on fish in the area crossed the ropes more frequently and became less cautious, suggesting that rope poses a greater risk in a feeding area than in a transit area. For harbor porpoises feeding on the bottom, rope suspended near the bottom is more likely to entangle than rope higher in the water column because the animals' natural tendency is to swim beneath barriers (Kastelein et al., 2005).

The probability of a marine mammal being entangled in a single length of AMNS cable deployed very infrequently in the Chesapeake Bay Water Range should be considered so remote as to be discountable. Likewise, the probability of a marine mammals encountering the wire framework of a rare sonobuoy deployment should be considered so remote as to be discountable. Even in the unlikely event of an encounter, the materials are not designed to entangle anything and would likely be ignored or avoided as obstacles. Both sonobuoy wires and AMNS fiber-optic cables will eventually become buried in sediment or encrusted by marine growth, which would eliminate or further reduce the entanglement potential. Most medium-large parachutes are recovered by range support vessels, so the risk of entangling a marine mammal would be discountable.

Bottlenose dolphin are the most likely to encounter entanglement stressors during testing and training. Seasonally, harbor porpoise or harbor seals could be exposed to noise from entanglement stressors if, on the rare occasion, they were present in the PRC Study Area, and their presence occurred coincident in space with an entanglement stressor. Additionally, harbor porpoise do not typically feed on the bottom. Humpback whales are considered extralimital to the PRC Study Area due to the enclosed environment and estuarine conditions. When these species occur in the middle Chesapeake Bay, it is typically as a single animal. Most potential entanglement stressors would not be in the water column for long, and the potential for occurrence in the water column is low due to the sparse distribution of materials being expended compared to the overall study area. Therefore, the likelihood of encountering entanglement stressors during Navy testing and training in the PRC Study Area is so low as to be discountable.

Entanglement stressors associated with the Proposed Action (Alternative 2) would not result in the unintentional taking of marine mammals incidental to those activities, as defined by the MMPA. This conclusion is associated with only wires/cables and parachutes used mostly in the Chesapeake Bay Water Range. This conclusion also applies to West Indian manatee (refer to Section 3.4.4.2, Effects on Federal Threatened or Endangered Species (USFWS Jurisdiction), West Indian Manatee, Entanglement, for supporting details).

Ingestion

This section analyzes the potential impacts on marine mammals from the various types of ingestion stressors associated with MEM proposed with the Preferred Alternative (refer to Section 3.0.2.3.7, Identifying Stressors for Analysis, Ingestion Stressors, for supporting details).

The following types of MEM would be expended that could become ingestion stressors during testing and training activities in the PRC Study Area: live gun ammunition (small- and medium-caliber), flechettes, chaff[7], flare casings (including plastic end caps and pistons, and flare O-rings), and decelerators/parachutes. Solid metal materials, such as small-caliber projectiles, sink rapidly to the bottom. Lighter plastic items may be caught in currents and could remain in the water column for hours to weeks, or indefinitely, before sinking (e.g., plastic end caps [from chaff cartridges] or plastic pistons [from flare cartridges]). Release of these MEM would primarily occur in the Chesapeake Bay Water Range and be focused near fixed targets, recovery areas and/or aim points. Ingestible materials represent a relatively small portion of MEM footprint. Therefore, the relatively low MEM footprint is further reduced when the portion of non-ingestible MEM is removed, and thus further reducing the likelihood of encountering ingestible MEM associated with the Proposed Action.

Since baleen whales feed by filtering large amounts of water, they like encounter and consume plastic debris at higher rates than other marine animals (National Oceanic and Atmospheric Administration Marine Debris Program, 2014b). Baleen whales are believed to routinely encounter microplastics within the marine environment based on concentrations of these items and baleen whale feeding behaviors (Andrady, 2011; Bergmann et al., 2015). Information compiled by Williams et al. (2011) listed humpback whale as one of the species of mysticetes known to have ingested debris including items the authors characterized as fishing gear, polyethylene bag, plastic sheeting, plastic bags, rope, and general debris. Besseling et al. (2015) documented the first occurrence of microplastics in the intestines of a humpback whale. Feeding behaviors of mysticete species suggest that potential encounters with ingestion stressors would only occur when the items are on the water surface at the same time and locations where animals are skim feeding or while engulfing prey in the water column as items sink to the bottom.

Small odontocetes may investigate or play with items within the environment, which may include biting or carrying an object; however, it is likely they would realize the object is not a food item. However, odontocetes are less likely to ingest debris accidentally during feeding, as they would focus on individual prey rather than filter feed.

Pinnipeds are opportunistic foragers, primarily feeding within the water column, but may also forage on the bottom. Bravo Rebolledo et al. (2013) reported plastics in the diet of harbor seals. Even though some pinniped species feed on the bottom, such as harbor seals, it is unlikely that pinnipeds would encounter and incidentally or mistakenly consume MEM associated with the proposed activities.

Research suggests that ingestion of certain nonfood items would not result in injury or mortality to an individual, if the items do not become embedded in tissue (Wells et al., 2008). Therefore, potential ingestion impacts from MEM would only occur in the unlikely event in which a marine mammal encounters an item, ingests it, and that item subsequently becomes embedded in tissue or is too large to pass through the digestive system. The Navy considers the likelihood of this occurring to be very low.

As MEM breaks down, tiny metal or plastic particles may be released in the water column or sediment. Microplastics in the aquatic environment are well documented, and interactions with biota have been described worldwide (Lusher et al., 2016). Plastic waste in saltwater chemically attracts hydrocarbon pollutants such as PCBs and DDT, which accumulate up to 1 million times more in plastic than background levels in the environment (Mato et al., 2001). Considering the composition of most MEM associated with the Proposed Action (e.g., metal, cement/sand) and it very limited coverage on the bottom (Appendix E, Military Expended Materials and Physical Disturbance and Strike Analysis), the

[7]Discounted as a threat to biological resources in Section 3.4.3.1 (Environmental Consequences, No Action Alternative).

contribution of the Proposed Action to overall microplastic concentrations in the environment should be considered miniscule.

Ingestion of MEM is likely to be incidental, with items being potentially consumed along with prey. Potential ingestion impacts from MEM would only occur in the unlikely event in which a marine mammal encounters an item, ingests it, and that item subsequently becomes embedded in tissue or is too large to pass through the digestive system. The Navy considers the likelihood of this occurring to be very low. Bottlenose dolphin are the most likely to encounter ingestion stressors during testing and training. Seasonally, harbor porpoise and harbor seal could encounter ingestion stressors during testing and training. Humpback whales are considered extralimital to the PRC Study Area due to the enclosed environment and estuarine conditions. When these species occur in the middle Chesapeake Bay, it is typically as a single animal. Therefore, the likelihood of encountering ingestion stressors during Navy testing and training in the PRC Study Area is so low as to be discountable.

Ingestion stressors associated with the Proposed Action (Alternative 2) would not result in the unintentional taking of marine mammals incidental to those activities, as defined by the MMPA. This conclusion is associated with only the smallest MEM used only in the Chesapeake Bay Water Range. This conclusion also applies to West Indian manatee (refer to Section 3.4.4.2, Effects on Federal Threatened or Endangered Species (USFWS Jurisdiction), West Indian Manatee, Ingestion, for supporting details).

Indirect/Secondary

This section analyzes the potential impacts on marine mammals from indirect/secondary effects associated with the Proposed Action (refer to Sections 3.4.3.1 through 3.4.3.3, Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts, Indirect/Secondary, for supporting details).

Stressors from the Proposed Action could lead to secondary or indirect impacts on marine mammals via impacts to their habitat, predators, or prey resources. The effects of proposed activities on marine mammal habitat (biotic components only), predators and prey resource availability are covered in their respective biological resources sections. The impact of the Proposed Action on estuarine habitats (including barren substrate) is covered in Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment). Marine mammals do not have any natural predators in the PRC Study Area. There is a possibility of prey species transferring ingested debris to predators that consume them as demonstrated by (Eriksson & Burton, 2003) for fur seals. This suggests that the risk of marine mammals ingesting debris may also depend on the likelihood that prey items would ingest debris. There is also the potential for some metals and contaminants associated with microplastics to bioaccumulate, with physiological impacts on biological resources occurring only after several trophic transfers concentrate the pollutants. Bioaccumulation is therefore most pronounced at higher trophic levels (e.g., large predatory fish, birds, marine mammals). However, the contribution to overall microplastic pollution from the Proposed Action is likely so low as to be discounted. Accordingly, the lack of any significant impacts on marine mammal habitats, predators, or prey resources suggests a corresponding lack of significant indirect/secondary impacts on marine mammal populations.

Indirect/secondary stressors associated with the Proposed Action (Alternative 2) would not result in the unintentional taking of marine mammals incidental to those activities, as defined by the MMPA. This conclusion is associated with minimal adverse effects of the Proposed Action on marine mammal habitats, predators, and prey resources. This conclusion also applies to West Indian manatee that are a rare summer occurrence in the PRC study area and mostly nearshore (refer to Section 3.4.4.2, Effects on Federal

Threatened or Endangered Species (USFWS Jurisdiction), West Indian Manatee, Indirect/Secondary, for supporting details).

Stressors Combined

This section analyzes the potential impacts on marine mammals from all stressors associated with the Preferred Alternative (Alternative 2). Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Stressors Combined) includes the analysis approach for biological resources. The analysis and conclusions for the potential impacts from each of the individual stressors are discussed in the sections above. An analysis of the combined impacts of all stressors considers the potential consequences of individual (non-additive), additive and synergistic stressors, as described below.

Most of the proposed activities generally involve the use of moving platforms (e.g., aircraft, vessels) or MEM that may produce one or more stressors; therefore, if a marine mammal were within the potential impact range of those activities, they may be impacted by multiple stressors simultaneously or sequentially (e.g., physical disturbance, energy, and acoustic stressors precede strike potential). Individual stressors that would otherwise have minimal to no impact, may combine to have a greater than minimal impact if they occur simultaneously. However, the combined effect of short-range physical disturbance, electromagnetic energy, and acoustic stressors has not been studied and the parsing out of effects would be difficult. Longer-range effects that are more likely to affect a marine mammal are supported by the analysis, though they are discounted when established protective measures are considered.

Due to the wide dispersion of stressors, speed of the platforms, and general dynamic movement of many testing and training activities, it is unlikely that a marine mammal would occur in the potential impact range of multiple stressors that combine to create additive effects (e.g., short-range, asset-based stressors adding to physical disturbance from MEM); the likelihood of a rare species (e.g., harbor porpoise, harbor seal) encountering a rare instance of additive effects potential should be considered discountable.

Given established avoidance and mitigation measures described in Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization), the combined stressors of the Preferred Alternative will not result in the unintentional taking of one or more individual marine mammals that would require a take authorization pursuant to section 101(a)(5)(A) of the Act. This conclusion also applies to West Indian manatee (refer to Section 3.4.4.2, Effects on Federal Threatened or Endangered Species (USFWS Jurisdiction), West Indian Manatee, Stressors Combined, for supporting details).

3.4.5.3 Regulatory Conclusions

Regarding compliance with the MMPA, and the five marine mammal species that may occur in the PRC study area (bottlenose dolphin, harbor porpoise, harbor seal, humpback whale, and West Indian manatee), the Proposed Action (Preferred Alternative, Alternative 2) would not result in the reasonably foreseeable “take” of marine mammals; therefore, an application for taking under the MMPA is not required (refer to Section 3.4.1.3, Regulatory Setting, Marine Mammal Protection Act, for criteria). The ability to mitigate to zero takes is based on the surface visibility and seasonality of the species, rarity of stressor activities for which mitigation measures apply, and platform heights used to observe for species.

3.4.6 Bird Protection Acts – Regulatory Conclusions

Regarding compliance with the Migratory Bird Treaty Act (MBTA), the Navy has determined that the Proposed Action may result in the incidental "take" of native birds protected by the MBTA under a maximum of activity (Preferred Alternative, Alternative 2). The term "take" as defined by the USFWS for MBTA purposes means to "pursue, hunt, shoot, wound, kill, trap, capture, or collect" (see Section 3.4.1.4, Biological Resources, Regulatory Setting, Bird Protection Acts, for more information). Under the MBTA's regulations that are applicable to military readiness activities (50 CFR part 21), the USFWS has promulgated a rule that authorizes the incidental take of MBTA-listed birds, provided they do not result in a significant adverse effects on their population. The proposed testing and training activities are not expected to result in any adverse impacts on listed bird populations with current standard operating procedures and mitigation measures (refer to analysis in Sections 3.4.3.1 through 3.4.3.3, Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts).

The term "take" as defined by the USFWS for Bald and Golden Eagle Protection Act (BGEPA) purposes means to "pursue, shoot, shoot at, poison, wound, kill, trap, capture, trap, collect, molest or disturb" (see Section 3.4.1.4, Biological Resources, Regulatory Setting, Bird Protection Acts, for more information). Whereas there is no exemption for military readiness activities from the BGEPA, a prohibited "take" is unlikely due to ongoing natural resources management efforts (e.g., test plan evaluation) as well as active avoidance of eagle nests and roosts by low-flying aircraft and weapons firing (refer to analysis in Sections 3.4.3.1 through 3.4.3.3, Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts). Per screening criteria from the USFWS, the proposed action does not require an eagle take permit (U.S. Fish and Wildlife Service - Chesapeake Bay Field Office, 2021) as documented in Appendix M (Bald and Golden Eagle Protection Act Documentation).

Pursuant to the MBTA, no prohibited take of any MBTA-protected migratory birds would occur under the Proposed Action (Preferred Alternative, Alternative 2). Pursuant to the BGEPA and implementing guidance, prohibited take of an eagle is unlikely due to the measures taken to avoid impacts to nesting habitat. No MBTA or BGEPA permit is therefore required.

3.4.7 Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment

The Magnuson-Stevens Fishery Conservation and Management Act provides for the conservation and management of the fisheries. Under the Act, EFH consists of the waters and substrate needed by fish to spawn, breed, feed, or grow to maturity (refer to Section 3.4.1.5, Regulatory Setting, Magnuson-Stevens Fishery Conservation and Management Act, for additional background information). Fishery Management Councils manage fisheries in terms of five basic life stages:

- eggs – individuals that have been spawned but not hatched and are completely dependent on the egg's yolk for nutrition
- larvae – individuals that have hatched and can capture prey
- juveniles individuals that are not sexually mature but possess fully formed organ systems that are similar to adults
- adults sexually mature individuals that are not necessarily in spawning condition

The MSA §301(b)(2) requires federal agencies to consult with NMFS on activities within the U.S. Exclusive Economic Zone that may adversely affect EFH (16 U.S.C. sections 1801 et seq.). The Proposed Action, including the Preferred Alternative, is described in Chapter 2 (Proposed Action and Alternatives).

The following sections first identify and describe designated EFH in the PRC Study Area and then assess the potential for adverse impacts from the Proposed Action.

3.4.7.1 Identification of Essential Fish Habitats for Assessment

National Marine Fisheries Service and regional Fishery Management Councils have identified EFH in major estuaries, bays, and rivers along the northeastern coast of the United States. In the portion of the Chesapeake Bay where the PRC Study Area is located, EFH is described for the following species (including prey/forage species):

- Black sea bass (*Centropristis striata*): The designated EFH for this benthic species includes structured bottom habitats (e.g., shellfish/seagrass beds, artificial reefs) in higher salinity estuarine, coastal, and offshore waters of the mid-Atlantic region (Mid-Atlantic Fishery Management Council, and Atlantic States Marine Fisheries Commission, 1998). The species is listed as "rare" in the Patuxent and Potomac River estuaries overlapping the PRC Study Area (Stone et al., 1994), which does not meet the minimum threshold of "common" described in the EFH designation for all life stages of black sea bass within inshore waters. However, Stone et al. (1994) designates black sea bass as common in the Chesapeake Bay main stem, which includes the Chesapeake Bay Water Range. Murdy et al. (1997) also lists the black sea bass as being common in the Mid-Bay from spring to late autumn. Black sea bass, like scup, are bottom feeders and share a very similar diet consisting of benthic invertebrates. However, black sea bass tend to consume more decapod crabs and fishes than scup (Lindquist et al., 1994; Smith & Link, 2010).
- Bluefish (*Pomatomus saltatrix*): EFH for juvenile and adult Bluefish includes pelagic water column of the PRC Study Area (Mid-Atlantic Fishery Management Council, and Atlantic States Marine Fisheries Commission, 1998), where the species is documented and common primarily from April through October (U.S. Department of the Navy, 2017c; Virginia Institute of Marine Science, 2018; Stone et al., 1994). The peak occurrence for either juveniles or adults in the study area is June through September (Stone et al., 1994). Bluefish feed primarily on Atlantic silversides from May through July and then shift to feeding almost exclusively on bay anchovy, the most abundant fish in the Bay, and striped anchovy from August through November (Gartland et al., 2006). Combined, the two anchovy species comprised between 56 percent and 96 percent of prey consumed by bluefish in the study (Chesapeake Bay Program, 2012; Gartland et al., 2006).
- Butterfish (*Peprilus triacanthus*): EFH for all life stages of butterfish includes pelagic waters of the PRC Study Area (Mid-Atlantic Fishery Management Council, 2010), where the species is considered uncommon (U.S. Department of the Navy, 2017c). Butterfish occur in the Chesapeake Bay from April through November, but spawning occurs from May through July, followed by presence of larvae in July through August (National Oceanic and Atmospheric Administration Office of Response and Restoration, 2016). The species was commonly collected by VIMS (2018) monitoring over the past 10 years in the southern portion of the PRC Study Area. Juvenile and adult butterfish feed upon a variety of small fish and invertebrates including zooplankton, comb jellies, shrimp, and worms (Cross et al., 1999).

- Clearnose skate (*Raja eglanteria*): The distribution of EFH was refined (New England Fishery Management Council, and National Marine Fisheries Service, 2016) to include either salinities generally too high for occupation in the PRC Study Area. The rare occurrence of clearnose skate in the PRC Study Area is also supported by VIMS (2018) monitoring that has collected only one individual in over 10 years. However, NAS Patuxent River natural resource staff have observed clearnose skates over the years in the shallow waters and seagrass beds surround Bloodsworth Island Range (Rambo, 2020a). The EFH described for juvenile and adult clearnose skate is sub-tidal benthic habitats (primarily soft substrates) from the shoreline to 98 to 131 feet (30 or 40 meters) (juveniles and adults, respectively) (New England Fishery Management Council, and National Marine Fisheries Service, 2016).
- Cobia (*Rachycentron canadum*): EFH for this species includes high salinity estuarine water column and seagrass beds in the Mid-Atlantic Bight (South Atlantic Fisheries Management Council, 1998), which may not include the PRC Study Area. Whereas the 2017 INRMP (U.S. Department of the Navy, 2017c) lists cobia as “probably common” during May through September, Shaffer and Nakamura (1989) documented a minimum salinity of 19 ppt for cobia, which is limited to the lower Chesapeake Bay. However, a state record cobia (for Maryland) was caught in the southern portion of the PRC water range (Maryland Department of Natural Resources state records 2018) where average high salinities are 15 to 17 ppt (Figure 3.3-2, Characterization of the PRC Water Column During the Warm Season in Terms of Salinity and Dissolved Oxygen (Minimums)) (Virginia Institute of Marine Science, 2018; Shaffer & Nakamura, 1989) . In the Chesapeake Bay, Arendt et al. (2001) analyzed the stomach contents of 78 cobia captured in the lower Chesapeake Bay. Fifty-nine percent of stomachs contained blue crabs and 55 percent contained lady crabs (*Ovalipes ocellatus*) with as many as 30 percent containing both species, indicating that crabs are by far the most important prey for cobia in the Bay. By contrast, clupeids occurred in just 1 to 2 percent.
- Summer flounder (*Paralicthys dentatus*): EFH for juvenile and adult summer flounder includes demersal (i.e., bottom) waters of the PRC Study Area (Mid-Atlantic Fishery Management Council, and Atlantic States Marine Fisheries Commission, 1998). Juveniles may use estuarine habitats such as SAV beds and open bay areas as nursery areas throughout the year, whereas adults generally inhabit shallow estuarine waters during the warmer months from May through September. Summer flounder are documented and common in the PRC Study Area (U.S. Department of the Navy, 2017c; Virginia Institute of Marine Science, 2018; Stone et al., 1994). Summer flounder in the Chesapeake Bay feed primarily on crustaceans (e.g., shrimp), which constituted an average of 72 percent to 100 percent of their diet (Buchheister & Latour, 2011). Although summer flounder do consume fish, including the clupeid bay anchovy, the study concluded that shrimp were the most important source of prey for summer flounder in the Bay.
- Scup (*Stenotomus chrysops*): EFH for scup includes Chesapeake Bay waters with warm-season salinities greater than 15 ppt (Mid-Atlantic Fishery Management Council, and Atlantic States Marine Fisheries Commission, 1998). EFH for juvenile and adult scup is further refined to include estuaries where they are considered common, abundant, or highly abundant. Designated EFH could be present in the PRC Study Area considering their minimum salinity preference (greater than 15 ppt) and the summer salinities depicted in Figure 3.3-2 (Characterization of the PRC Water Column During the Warm Season in Terms of Salinity and Dissolved Oxygen (Minimums)); the greater than 15 ppt zones during summer overlap the southern portion of the PRC water

range. The species was also commonly encountered by VIMS (2018) (Mid-Atlantic Fishery Management Council, and Atlantic States Marine Fisheries Commission, 1998)

- Windowpane flounder (*Scopthalmus aquosus*): EFH for juvenile and adult windowpane flounder includes the PRC Study Area where bottom habitats with a substrate of mud or fine-grained sand (New England Fishery Management Council, and National Marine Fisheries Service, 2016). Windowpane flounder could occur in the PRC Study Area throughout the year, though the species is considered uncommon (U.S. Department of the Navy, 2017c). The species was not collected by VIMS (2018) monitoring over the past 10 years in the PRC Study Area, suggesting an abundance described more accurately as "rare-absent." However, Murdy et al. (1997) listed windowpane as "a year-round Chesapeake Bay resident that is occasional to common in the upper Bay, extending as far north as the Choptank River." Juvenile and adult windowpane feed on fish larvae, shrimp and other small crustacean species (Chang et al., 1999).

The intent of the following sections is to consolidate the EFH designations into standardized categories and types to support analysis of Navy's activities for the PRC Study Area. The basic categories for descriptors of EFH include (1) water column, (2) topography/substrates, and (3) biotic habitat features. EFH designated in the PRC Study Area is described under these categories, and the analysis is directed at only the designated subset of EFH descriptors. The water column includes horizontal and vertical characteristics of the overlying water (e.g., currents, salinity zones). Topography and substrate refers to the vertical and horizontal dimensions of the bottom (e.g., sandy shoals, rocky outcrops) that may or may not feature living organisms. Biotic habitat features refer to living components of the water column and bottom (e.g., seaweeds, seagrass, oyster beds/reefs). The ecological functions of the water column, topography/substrate, and biotic habitat features for managed species and life stages are implied by their presence, extent and quality within an area. As such, an impact on the habitat is considered an impact on the species and life stages that use the habitat.

EFH that is either important to the long-term productivity of one or more managed species populations or deemed to be particularly vulnerable to degradation may be identified by fishery management councils and NMFS as a Habitat Area of Particular Concern (HAPC). HAPC are identified based on one or more of the following considerations (67 Federal Register 2379):

- the importance of the ecological function provided by the habitat;
- the extent to which the habitat is sensitive to human-induced environmental degradation;
- whether, and to what extent, development activities are, or will be, stressing the habitat type; and
- the rarity of the habitat type.

HAPC that overlap the PRC Study Area are described after the basic habitat categories of water column, topography/substrate, and biotic habitat features designated as EFH.

Water Column

The flow and quality of water in the water column are key factors linking fish, habitat, and people. A range of water column conditions supports the coastal fisheries ecosystems along the western Atlantic. Water column properties that may affect fishery resources include temperature, salinity, dissolved oxygen, total suspended solids, nutrients (nitrogen, phosphorus), and chlorophyll *a*. Other factors, such as depth, pH, water velocity and movement, and water clarity, also affect the distribution of aquatic organisms. Additionally, there is a growing body of literature addressing biologically relevant properties of the water column in terms of sound (Kunc et al., 2016). Water column parameters referenced in EFH include waters (e.g., offshore, nearshore, estuarine), vertical layers (e.g., pelagic, bottom), currents, and salinity zones. Any reference to waters (e.g., all estuaries) implies the inclusion of all water column and bottom habitats, unless selected vertical layers are implied (e.g., demersal species occupy demersal water column). Note that hydrographic descriptions of the water column included with EFH designations (e.g., offshore, nearshore, estuarine, pelagic/demersal) serve mostly to indicate the distribution of the species. Measureable and biologically relevant properties of the water column must therefore be inferred as essential when there is scientific literature supporting an impact on managed species in terms of their biological functions (e.g., contaminants that reduce fecundity of spawning adults, suspended sediments that disrupt feeding activity, anthropogenic sounds that mask biological-relevant sounds). Zones of salinity and dissolved oxygen are depicted in Figure 3.3-2.

- The estuarine, pelagic zone in the PRC Study Area is designated EFH for all life stages of bluefish, cobia, and butterfish, and egg/larval life stages of black sea bass, scup, summer flounder, and windowpane.
- The demersal water column is designated EFH for juvenile/adult black sea bass, juvenile/adult clearnose skate, scup, summer flounder, and windowpane.

Topography and Substrate

Substrate is defined herein as the nonliving material forming the topography of the bottom. The terms "soft bottom" and "hard bottom" have been used to convey both the substrate qualities and biological community of the bottom. As such, bottom mapping that does not confirm the presence of biotic habitat features can be safely classified as substrate and either a surface or foundation for associated biotic habitat features (e.g., soft or hard bottom communities). Whereas there are many classification systems spanning a range of spatial dimensions and granularity (Allee et al., 2000; Cowardin et al., 1979; Federal Geographic Data Committee, 2012; Kendall et al., 2001; United National Educational Scientific and Cultural Organization, 2009; Valentine et al., 2005), there are three general types of substrate based on the grain size of unconsolidated material: termed "soft," "hard," and "intermediate" substrate (as defined in this assessment). Soft substrate areas are dominated by mud (including clay and silt) or sand and are often too unstable for colonization by habitat-forming sedentary invertebrates (e.g., oysters) or attached seaweed. Hard substrate areas are dominated by rocks or consolidated bedrock that is stable enough for colonization by habitat-forming sedentary invertebrates or attached seaweed. Intermediate substrate areas are dominated by unconsolidated material larger than sand but smaller than rocks (e.g., shells, gravel, rubble). These areas may or may not be stable enough for habitat-forming sedentary invertebrates or attached seaweeds. Spatial and temporal variation in substrate is created by the interplay of surficial geology, currents and water quality at a location. Artificial structure (shipwrecks, artificial reefs, piers, pilings, targets, etc.) is another type of substrate that is based on material type and human origin that occurs in the PRC Study Area.

- Soft substrate (mud and sand) is designated EFH for juvenile/adult clearnose skate and windowpane (Figure 3.3-3, Characterization of Chesapeake Bay Water Range Bottom Types).
- Naturally hard/intermediate substrate (Figure 3.3-3) and artificial features (e.g., artificial reefs; Figure 3.4-4) describe EFH for black sea bass in the PRC Study Area.

Biotic Habitat Features

Living features of the water column or on the substrate are termed biotic habitat features, and include floating macroalgae (e.g., *Sargassum*), wetland shores, attached macroalgae beds (i.e., seaweed), submerged rooted vegetation beds (e.g., seagrass), sedentary invertebrate beds (e.g., clam beds), and reefs (e.g., oyster reefs). Biotic habitat features differ from biogenic habitats because they include only the living component of biogenic habitats that are part of the substrate dimension (e.g., a dead oyster reef is hard substrate). The ecological functions of biotic habitat features such as filtration and benthic-pelagic coupling (Marinella & Williams, 2003; Newell, 2004) are often greater than barren areas of only nonliving substrate.

- Tidal marsh plants, seaweeds, and seagrasses are designated HAPC for summer flounder, and therefore designated EFH by default (Figure 3.4-1 and Figure 3.4-2).
- Shellfish beds/reefs describe biotic feature EFH for black sea bass in the PRC Study Area (Figure 3.3-3, Characterization of Chesapeake Bay Water Range Bottom Types).

The Proposed Action stressors that may affect estuarine plants include only physical disturbance or strike, pollutants, and indirect/secondary effects on habitat and/or food resources. Electromagnetic energy or acoustic stressors are not expected to have any effect of plant species. Additionally, entanglement and ingestion effects are not applicable to vegetation of the affected environment. The biological factors most relevant to these stressors include distribution, density, and resilience of bay vegetation species. The Proposed Action stressors that may affect shellfish beds include physical disturbance or strike, electromagnetic energy, acoustics, ingestion, pollutants, and indirect/secondary effects on habitat, predators, and/or food resources.

Tidal Marsh Plants, Seagrass, and Seaweed

Tidal marsh systems are associated with drowned stream systems that now rely on the ebb and flow of the Chesapeake Bay tidal cycle. The tidal marsh areas comprise 63 acres on NAS Patuxent River, mainly along Pearson Creek, Goose Creek, Harper's Creek, and Pine Hill Run (Figure 3.4-2). On OLF Webster, tidal marshes comprise approximately 14 acres along the shoreline of the St. Mary's River and St. Inigoes Creek. Tidal marshes in the study area outside of Navy installations and established ranges are depicted on Figure 3.4-1; Bloodsworth Island vegetation is almost entirely tidal wetlands.

Seagrasses are vascular plants that live and grow completely underwater or touching the Bay surface. Seagrass is found in shallow areas where sufficient light for photosynthesis can penetrate the water (Figure 3.4-1 and Figure 3.4-2). The area of mapped seagrass depicted in the figure does not overlap with the Chesapeake Bay Water Range. Seagrass plays an important role in the ecological functioning of the Chesapeake Bay, providing habitat and food for many Bay species, acting as a nursery for many fishes and invertebrates, and serving as a nutrient buffer and sediment trap. It also fosters the development of an aquatic environment that is low in suspended sediments, dissolved nutrients, and phytoplankton.

SAV (i.e., submerged aquatic vegetation) surveys of the three tidal creeks on NAS Patuxent River (Harper's, Pearson, and Goose Creeks) have been conducted intermittently since 1977. These studies have found Widgeon Grass (*Ruppia maritima*) and Horned Pondweed (*Zannichellia palustris*) in Harper's, Pearson, and Goose Creeks. Results of the more recent studies are entered into the PRC land area geographic information system so that SAV beds can be geographically monitored. SAV surveys of the estuaries on OLF Webster have been conducted intermittently since 1995. A two-phase investigation was completed in 1996, when it was discovered that widgeon grass and horned pondweed appeared at different times. Due to the variation in emergence times of the two species found there, future surveys at both NAS Patuxent River and OLF Webster will also be conducted in two phases when possible. The current SAV population is adequate and stable, or even growing, with PRC land area waters. Modest fluctuations in quantities among the surveys are attributed to turbidity and time of year.

Estuarine plants also include various species of seaweed (e.g., *Ulva* spp., *Enteromorpha* spp.) and microscopic algae (e.g., diatoms). Seaweed grows mostly attached to hard substrate including both natural (e.g., oysters; Figure 3.3-3, Characterization of Chesapeake Bay Water Range Bottom Types) and artificial substrates (e.g., riprap, pilings, shipwrecks; Figure 3.4-4) where light and oxygen are sufficient for growth. Seaweed species can grow much deeper than seagrass species because they require less light penetration. The general location for growth of attached seaweed would be the zone above seasonal hypoxia depicted on Figure 3.3-2, Characterization of the PRC Water Column During the Warm Season in Terms of Salinity and Dissolved Oxygen (Minimums)). Estuarine seaweed can also grow detached in the water column, until it eventually washes up on shore to break-up/dry out. The distribution of living microscopic plants (e.g., phytoplankton, benthic microalgae) is anywhere in the water column where light and oxygen are sufficient for growth.

Bay seagrass species are resilient to moderate wave action in the shallow margins where they are mapped in the PRC Study Area (Figure 3.4-1). Low levels of disturbance are actually important for removing dead plant materials and algae from more resilient living vegetation. Widgeon grass is considered a first colonizer species by virtue of relatively rapid growth and recovery from localized disturbance or removal (Fonseca et al., 1998). Seaweeds also recover rapidly from localized disturbance or removal (Mach et al., 2007). Another prominent seagrass species in the PRC Study Area is Eelgrass *Zostera marina.* Eelgrass is more resilient to disturbance but grows slower and requires more time (24 months) to recover from localized removal (Boese et al., 2008). Recovery from less severe disturbances (e.g., propeller scarring) should be substantially less than 24 months.

Shellfish Beds/Reefs

Shellfish beds/reefs include primarily eastern oysters but also other shellfish species growing attached to hard substrate (e.g., ribbed mussels). Shellfish beds (i.e., shell bottom) covering less than 5 percent of the Chesapeake Bay Water Range are mapped in relatively shallow water where oxygen is sufficient for growth (Figure 3.3-3, Characterization of Chesapeake Bay Water Range Bottom Types). The highest concentration of shell bottom is mapped in the Shoal munition concentration area (24.39 percent), followed by Bay Forest (11.40 percent) and Hannibal Target (4.95 percent). Hooper Target Complex and the Supersonic Aim Point munition concentration areas are virtually devoid of shell bottom and occupy the zone of seasonal hypoxia. Shellfish can also be found growing on artificial substrates (e.g., riprap, pilings, shipwrecks, targets such as Hannibal Target; Figure 3.4-3 and Figure 3.4-4). Mapped shipwrecks (not placed as a target) are only present within the Hooper Target Complex and Supersonic Aim Point munition concentration areas. Aside from being a managed fishery species, oyster reef biomass in the Bay contributes to reducing excess carbon and nutrients in the water column that are responsible for increasing acidification and seasonal hypoxia (Coen et al., 1999; Grabowski & Peterson, 2007), and they are the primary builders of hard substrate, other than humans, in the Bay ecosystem.

Shellfish beds produce a large number of pelagic young (i.e., larvae) that experience a correspondingly high natural mortality rate. Maturation/recovery of oysters can take more than a year, depending on concentration of food and nonfood particles, and other factors.

Habitat Areas of Particular Concern

The HAPC for juvenile and adult summer flounder overlaps the PRC Study Area; the HAPC includes all native species of macroalgae (i.e., seaweed), seagrasses, and tidal macrophytes (e.g., marsh grasses) in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH. These habitats are mapped in Figure 3.4-1, Figure 3.4-2, and Figure 3.4-3.

3.4.7.2 Assessment of Impacts

This section evaluates how and to what degree the stressors and associated activities described in Section 3.0.2.3 (Identifying Stressors for Analysis) for the Proposed Action (Preferred Alternative, Alternative 2) could impact EFH and HAPC in the Fishery Management Council regions of the PRC Study Area. The relevant stressors vary in intensity, frequency, duration, and location within the PRC Study Area. The spatial analysis of the Proposed Action considers the stressor "footprints" and their co-occurrence with EFH and HAPC descriptors within Fishery Management Council boundaries.

The term stressor is broadly used in this document to refer to an agent, condition, or other stimulus, that may diminish the function, in terms of quantity or quality, of a designated EFH or HAPC for managed species. Each habitat type representing EFH or HAPC in the PRC Study Area is evaluated for potential impacts from individual stressors after considering standard operating procedures and established mitigation measures/regulations, followed by an analysis of the combined impacts of all stressors related to the Proposed Action.

The Magnuson-Stevens Act defines an adverse effect as "any impact which reduces the quality and/or quantity of EFH [and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions". For this assessment, identification of biologically relevant impacts on a descriptor of EFH or HAPC, either stated explicitly or implied, are sufficient for making determinations without necessarily referencing the specific mechanism of individual impact (e.g., direct, indirect).

The duration and intensity of effects must also be estimated for both individual and combined stressors. The duration of effects is based on either duration of stressor or recovery of the habitat (whichever is greater) (National Marine Fisheries Service, 2004):

- **temporary** – stressor duration or recovery in hours, days, or weeks
- **short-term** – stressor duration or recovery in less than 3 years
- **long-term** – stressor duration or recovery in more than 3 years but less than 20 years
- **permanent** – stressor duration or recovery in more than 20 years

The magnitude or intensity of impacts are characterized in terms of minimal, more than minimal but less than substantial, or substantial (National Marine Fisheries Service, 2004). Whereas assigning a determination for magnitude and intensity (in this document) is not required by NMFS, it is required by the OPNAV instruction 5090.1E because substantial effects require a standalone document and formal consultation. In order to clarify the difference between 'minimal' and 'substantial' impact findings and to ensure consistency of determinations, Navy developed criteria for supporting these determinations in the context of the activities proposed in this document. For the purpose of this assessment, minimal intensity stressors have numerous factors that minimize their effects, including infrequent and sparse occurrence, relatively benign nature of effects, typical avoidance of sensitive habitats, and/or unlikely coincidence with habitat. Stressors are considered substantial if they represent a relatively significant component of the primary threats to habitat introduced in Section 3.4.2.1 (Affected Environment, Environmental Baseline). An insignificant component of a primary threat is unlikely to interact with sensitive EFH (e.g., seagrass) or impact a miniscule portion of the habitat in the very unlikely event that an interaction occurs. Otherwise, even the smallest area of potentially damaged EFH would elevate the Proposed Action to having a substantial adverse effect despite the reality of an interaction that is unlikely and minimal in terms of potential impact.

The ecological functions of the water column, topography/substrate, and biotic habitat features for managed species and life stages are implied by their presence, extent and quality within an area. A Proposed Action stressor is therefore evaluated for impacts on a designated habitat if it has the potential to alter the quality or quantity of that habitat (e.g., water column, seagrass beds).

The summary and tabular conclusions for this section are provided in Section 3.4.7.3 (Regulatory Conclusions).

Impacts on Water Column and Prey Species

Whereas EFH designations do not specifically reference stressor-related properties of the water column as a quality of EFH, they do reference water column habitats in terms of hydrographic features (e.g., offshore, nearshore, estuarine, pelagic/demersal waters) with an implied connection to physical, chemical, and biological properties that are measureable and biologically relevant to managed species and/or their prey species.

Potential stressors on water column EFH from the Proposed Action include acoustic, physical disturbance and strike, pollutants, energy, entanglement, and ingestion. Indirect/secondary effects on the water column EFH from the Proposed Action are not applicable; the water column does not require habitat or predator/prey species. Some energy stressors are discounted as potential stressors on water column EFH (aircraft and land-based assets) and will not be discussed further in this section. Section 3.4.3 (Environmental Consequences) includes background and analysis of the Proposed Action stressors on fish that is nearly inseparable from impacts on water column EFH.

Alteration of water column EFH resulting from Proposed Action stressors could occur with the following:

- temporary changes in pressure (and particle motion close to the source) as acoustic energy propagates through the water column
- temporary displacement of water and associated stimuli that are not covered by other stressors
- presence and persistence of pollutants
- temporary changes in magnetic fields strength or voltage
- presence and persistence of ingestion stressors
- presence and persistence of entanglement stressors

In addition to direct impacts on federally managed fishery species (or their prey), physical disturbance or strike could affect the physical properties of the surrounding water (e.g., slight heating or increased dissolved gas concentrations due to turbulent mixing with the atmosphere), potentially affecting the suitability of the affected water mass as habitat for fishery species. However, physical changes to the water column would be very localized and temporary (persisting for only a few seconds or minutes).

The analysis in Sections 3.4.3.1 and 3.4.3.3 (Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts) for acoustic, physical disturbance and strike, energy, entanglement, ingestion, and indirect/secondary stressors on federally managed fishery species (and their prey) supports a minimal and temporary adverse effect on water column EFH from the Preferred Alternative; no population-level effects on estuarine invertebrates or fish from the Proposed Action stressors are anticipated. The analysis in Section 3.3.3 (Water Resources and Sediments, Environmental Consequences) for pollutants supports a minimal and temporary adverse effect on water column EFH from the Preferred Alternative; No current water or sediment quality standards would be violated by the Proposed Action, and fishery species (for which EFH is designated in the PRC Study Area) are not particularly susceptible to the chemical constituents of MEM or any unregulated pollutants associated with the Proposed Action.

Impacts on Topography and Substrate

The analysis in Section 3.3.3 (Water Resources and Sediments, Environmental Consequences) for physical disturbance supports a minimal and temporary adverse effect on topography and substrate EFH from the Preferred Alternative; the Proposed Action may generate minor, localized, and short-term increases in turbidity associated with resuspended sediments from physical disturbances to bottom sediments.

Impacts on Biotic Habitat Features

Potential stressors on shellfish bed EFH from the Proposed Action include acoustic, physical strike and disturbance, pollutants, energy, ingestion, and indirect/secondary effects. Potential stressors on estuarine plants EFH from the Proposed Action include physical disturbance and strike, pollutants, and indirect/secondary stressors. Vegetation, including estuarine plants EFH, would not be affected by acoustic, energy, ingestion, or entanglement stressors (refer to Section 3.4.3.1, Environmental Consequences, No Action Alternative, for supporting details).

Sections 3.4.3.1 through 3.4.3.3 (Environmental Consequences, No Action Alternative through Alternative 2 (Preferred Alternative) Potential Impacts) includes a more-in-depth analysis of potential stressor impacts from the Proposed Action on estuarine invertebrates that are documented in the PRC Study Area. The analysis for shellfish bed EFH follows from this discussion, with particularly focus on the activities impacting this biotic habitat feature.

Acoustic

Air-based assets, water-based assets (sonar and other transducers, vessel propulsion systems), land-based assets, and weapons firing/impact noise generate acoustic stressors associated with the Proposed Action (refer to Section 3.0.2.3.1, Identifying Stressors for Analysis, Acoustic Stressors, for supporting details). However, most proposed assets are discounted as potential acoustic stressors on benthic invertebrates (Section 3.4.3.1, Environmental Consequences, No Action Alternative, Acoustic), with the exception of low-altitude sonic booms, weapons firing/impact noise, and water-based asset noise centered around the dip points (e.g., dipping sonar) or fixed targets in the Chesapeake Bay Water Range.

Responses of sessile invertebrates to underwater noise from sonic booms, weapons firing/impact noise, and sonar/propulsion system noise are not well documented. Occasional low-altitude sonic booms and weapons firing/impact noise around the fixed targets in the Chesapeake Bay Water Range may cause a brief shell closure in exposed shellfish, particular around the Hannibal Target. The response is based a surrogate behavioral response criteria of 163 peak-to-peak dB re 1 µPa for fish described in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Acoustic). The very infrequent exposure to these impulsive sounds within a limited area of peak intensity suggests no meaningful effect on exposed shellfish bed EFH from these activities. The elevated noise levels generated by dipping sonars may also cause shell closure at the onset of exposure, but the activity is similarly infrequent and located far from Hannibal Target. Medium-large vessel noise generating low-frequency noise is more common in estuarine waters of the PRC Study Area, but less likely to elicit a response from shellfish as the sound slowly rises and falls within close proximity to a moving vessel (to exceed 163 dB peak-to-peak re 1 μPa).

Some research suggest the potential for premature settlement of oyster larvae exposed to non-impulsive underwater sounds that mimic reef sounds (Lillis et al., 2013). The oyster larvae tested were responding to reefs sounds recorded from 82 feet (25 meters) away. There is some overlap in the frequency range of oyster reef sounds (1.5 to 20 kHz) and both dipping sonar/active sonobuoy (1 to 10 kHz) and PRC vessel (0.1 to 2.5 kHz) noise, though intensity and pattern of sound production are very different; low intensity and continuous for reef noise, and high intensity and intermittent for the Proposed Action noises. Lillis et al. (2013) also admit there is not enough information to determine sound characteristics prompting settlement. Whereas there is a potential effect of the sonar on some oyster larval settlement, there are numerous factors mitigating a realistic impact. One factor is the degree to which substrate or larval recruitment are limiting restoration of bay oysters. If substrate is the primary limitation in the PRC Study Area, then larval recruitment is less of a factor. However, both factors contribute to restoration of bay oysters and it has been difficult to parse out their relative contributions due to monitoring challenges (Kennedy et al., 2011). Even if recruitment were more limiting than substrate availability, there is a remote likelihood of significant quantities of oyster larvae present during the warm season, coinciding with noise from dipping sonar, active sonobuoys, or PRC vessel movement occurring infrequently. The Proposed Action sounds are also intermittent and therefore mingled with ambient sound that may correct the larval settlement. It is also important to note that oyster larvae also settled without the presence of reef noise. Larvae in general have a very limited ability to move up or down in the water column. Furthermore, recent survey work by the Virginia Institute of Marine Science suggests large populations of oysters inhabit Navy piers in the Chesapeake Bay that have persisted despite a history of sonar use in the immediate area (Horton, 2016). Taken together, the mitigating factors suggest no population-level effect on living oyster reefs.

This analysis supports a minimal and temporary adverse effect on biotic features EFH from acoustic stressors associated with the Proposed Action (Alternative 2). The may affect conclusion is based on underwater noise from water-based assets (dipping sonar, active sonobuoys, and vessel propulsion systems).

Physical Disturbance and Strike

Physical disturbance and strike stressors associated with the Proposed Action include aircraft, water-based assets, land-based assets, and MEM (refer to Section 3.0.2.3.2, Identifying Stressors for Analysis, Physical Disturbance and Strike Stressors, for supporting details). However, only water-based assets and MEM may affect biotic features EFH.

Alertness, mobility, resilience (in terms of body and substrate hardness), and association with protective structures are relevant to physical disturbance and strike. Shellfish beds are sedentary, with hard-shells and sensory systems that respond to only short-range threats detected by touch. Shellfish beds are also provide structural refuge for other benthic organisms found mostly in shallower water in estuarine environments.

Impact from Water-based Assets

As with bottom substrates, physical disturbances and strikes of hard biotic habitat features by vessels or in-water devices would cause damage to the vessel and are avoided when possible. Seagrass beds and some natural oyster reefs (intermediate substrate composition) are vulnerable to physical disturbance that may not be avoided using standard operating procedures; the habitat could be damaged or disturbed during vessel operation without significant damage to a vessel. Whereas habitat areas set aside for restoration are often marked or located below navigation clearance, natural beds may not be visible and avoidable from the perspective of surface observers on a moving vessel. Whereas these shallow-water habitats would likely be avoided when transiting along established navigation corridors, they may not be avoidable during operation outside of established navigation channels. The results of a small number of studies suggest that the wave energy resulting from boat wakes produced in relatively narrow water bodies may affect oyster occurrence (Bilkovic et al., 2017).

Seaweed, seagrass, and marsh shorelines may be present in locations where vessels and in-water devices occur, but the impacts to plant habitat would mostly be indirect because vessels and in-water devices typically avoid direct contact with the bottom that could damage/impede the vessel or in-water device. This is particularly true for seaweed species that grow mostly attached to hard substrate (e.g., shipwrecks, pilings, riprap, oysters). Estuarine seaweed (e.g., *Enteromorpha*, *Ulva*, and *Codium* species) also grows rapidly, even detached from substrate, and require relatively low levels of light penetration that make them more resilience to brief and localized disturbance and turbidity that can be generated from Proposed Action vessels and in-water devices.

Seagrass species would not damage any vessel or in-water device and neither would brief contact with the soft substrate within which seagrass grows. Vessels may therefore impact seagrass beds by striking or disturbing them in the water column or on the bottom (Spalding et al., 2003). Whereas seagrasses are resilient to the lower levels of wave action that occur in sheltered estuarine shorelines, they are susceptible to vessel propeller scarring (Sargent et al., 1995; Stevenson et al., 1979; Dunton & Schonberg, 2002) and substrate erosion by vessel wakes (Orth et al., 2010). However, vessel wakes cause only localized effects that are not considered a significant threat to seagrasses populations (Orth et al., 2010). Furthermore, the Chesapeake Bay Water Range does not overlap mapped areas of seagrass where propeller scarring could occur. Only vessels and in-water devices operating elsewhere in the study area may impact seagrass beds. However, these activities are relatively sparse and infrequent compared to range support activities. Additionally, recovery from disturbances less severe than removal would be no more than days to weeks for seagrass species in the study area. Though seagrass need more light penetration than seaweed species, there should be no meaningful impact on seagrass beds from brief episodes of localized turbidity (generated by vessels and in-water devices) – chronic turbidity and nutrient enrichment are considered far more pressing issues (Orth et al., 2010). Damaged macroalgae beds inhabiting rocky intertidal zones recover more quickly from disturbance than seagrass (Mach et al., 2007).

Marsh wetlands may be damaged or disturbed during vessel operations that “nose up” to the shore or contribute erosive wave energies along sheltered estuarine shorelines. The most detrimental effect of vessels on some wetland areas is probably loss of vegetation from wave action (Bilkovic et al., 2017; Riggs, 2001; South Atlantic Fisheries Management Council, 1998; Zabawa & Ostrom, 1980). Erosion from boat traffic along the sheltered estuarine shoreline like the Atlantic Intracoastal Waterway is readily observable and is likely responsible for substantial loss of fringing wetland habitat (Riggs, 2001). However, most of the PRC Study Area shorelines are either highly developed with artificial structures or relatively exposed with a mixture of sediment shorelines and fringing wetlands (Figure 3.4-3). Erosion from vessel wakes is also not a major source of overall wetland impacts in the eastern United States (Mitsch et al., 2009) – shoreline stabilization and sea level rise are considered far more pressing issues. Navy vessels also make up a relatively small proportion of overall vessel traffic in the area.

The mostly intertidal oysters located very close to shore in the PRC Study Area are relatively unaffected by unlikely event of vessel scarring or disturbance due to their location and hard/more resilient nature; a function of oyster beds is actually buffering wave action (Coen et al., 1999). Vessel scarring has also not been implicated in the primary stressors on oyster habitat: overharvesting and disease are far more pressing issues (Coen et al., 1999). Natural oyster or mussel habitats not marked as obstructions may be adversely impacted if vessel operations call for “nosing up” on a shoreline, but the vessels would be moving slower on approach and should be able to avoid structures that could damage the vessel. The oyster beds/reefs mapped in the study area are located relatively close to shore (Figure 1.3-1, Characterization of the PRC Water Column During the Warm Season in Terms of Salinity and Dissolved Oxygen (Minimums)) and a measureable adverse impact from transiting is therefore not expected. Submerged oyster and mussel beds associated with obstructions in the PRC Study Area should be relatively unaffected by vessel scarring or disturbance do to general avoidance of vessel damage and the absence of obstructions classified as dangerously “awash” or covered/uncovered with the tides (National Oceanic and Atmospheric Administration, 2015). Oysters and mussels growing on vertical structures (mostly artificial) would not be located under navigable waters and would therefore not likely be subject to physical stressors of the Proposed Action. However, shellfish beds that are partially buried (e.g., clam aggregations) could be damaged by propeller scarring in shallow mud flats. However, the impact should be considered minimal considering the relatively low contribution of Navy vessels to overall vessel traffic, the low number of individual clams potentially impacted and the resilient hardness of clamshells. In the unlikely event of a vessel striking an estuarine shellfish bed or reef, the impacted biotic habitat features would recover over the short term.

Sessile or encrusting invertebrates (primarily oysters) that occur along sheltered shorelines subject to a high frequency of boat propeller- or wake-induced erosion can also be displaced (Grizzle et al., 2002; Zabawa & Ostrom, 1980). Increased erosion of shoreline banks or suspension of bottom sediments may cause turbidity that settles on oysters and causes the oysters to ingest more nonfood particles.

Stationary mine shapes are deployed from various platforms and secured with up to a 2,700 lb. concrete mooring block. Mine shapes and anchors are normally deployed over soft sediments and are generally recovered within 7 to 30 days following the completion of the training or testing events. Mine shapes would not be deployed in seagrass meadows because they are too shallow for typical deployments designed to simulate contact with a vessel transiting deeper channels. Anchors would also not be dropped near hard obstructions/snags supporting growth of attached seaweed or oysters. However, anchors may provide temporary attachment points for seaweed and oyster larvae that are subsequently removed from the water when the device is recovered. The effect of these losses should be discountable considering the vast numbers and naturally high mortality of oyster larvae; availability of hard substrate and passing phytoplankton is generally considered far more important for oyster populations than the loss of a few oyster larvae.

The anchoring of vessels may occur during high-value ordnance-recovery operations and other range support activities. No effect on seagrass beds would be expected due to their absence from the Chesapeake Bay Water Range. No effect on attached seaweed would be expected due to avoidance of anchoring in hard substrate where anchors may not be retrievable.

Because of their temporary nature, bottom devices would not permanently impact the biotic habitat features on which they are placed. The deployment of anchors, mine shapes or light salvage targets on intertidal oyster reefs, high relief shellfish habitats (e.g., obstruction/rocks), or emergent wetlands is also unlikely due to the targeted deployment environment described in the previous section on substrate impacts (e.g., soft substrate areas in navigation corridors, designated anchorages, pier-side locations, or beaches). Both the structured habitats and seagrass beds are typically limited to shallow-water margins where mines would not be expected.

Bottom devices deployed on deeper, soft bottom areas could impact sedentary invertebrate beds directly by crushing/compressing them, or indirectly by localized and temporary turbidity. However, estuarine organisms are typically adapted to a relatively dynamic sedimentary environment and naturally high turbidities (Nybakken, 1993). The impact of the devices is also temporary and localized. The direct impacts are likely not more than short-term considering the documented impact of bottom-disturbing fishing gear on most soft bottom communities (Auster & Langton, 1999). Objects placed on the bottom in deeper water may also provide temporary attachment points for sedentary invertebrate larvae that are subsequently removed from the water when the device is recovered. However, availability of hard substrate is generally more of a factor limiting sedentary invertebrate populations than availability of larvae.

Impacts from Non-explosive Munitions and Other Military Expended Materials

Most aircraft and aerial target stressors are not applicable to vegetation; only aerial targets landing hard on the water surface are analyzed in this section. Such aerial targets include an occasional large aerial target launched from the ATA, small UAS targets that are downed in the Chesapeake Water Range where no seagrass beds are mapped, and small UAS targets that down in the Bloodsworth Island Range SDZ where seagrass beds are mapped. Considering the planned recovery of large aerial targets, the probability of them striking any other estuarine plants (e.g., marsh plants), where they could be hidden from view, should be considered discountable.

The potential for impacts to estuarine vegetation from MEM would depend on the presence and amount of vegetation, and the size and number of MEMs. Areas expected to have the greatest density of expended materials are munition concentration areas in the Chesapeake Bay Water Range where the only plants include microscopic algae and various seaweed species growing mostly attached to hard substrate in water shallow enough for a minimum of light penetration and dissolved oxygen. Accordingly, seaweed may only grow in a relatively small portion of the Chesapeake Bay Water Range during the growing season. As such, the impact of MEM on seaweed should be considered discountable.

As with substrates, MEM have the potential to adversely impact biotic habitat features growing on or in the substrate (e.g., seagrass, oyster reefs, emergent wetlands) where they coincide with the Proposed Action. Due to their size and minimal weight, sparse concentrations of smaller items such as small-caliber projectile casings in the PRC Study Area are not expected to result in impairment of the substrate as habitat for biotic habitat features. Marine markers are larger but fewer are expended. Seagrass beds may be impacted by small UAS targets downed in the Bloodsworth Island Range SDZ. Aside from the relatively minimal areas of displaced substrate, there should be no other adverse impacts from small MEM on seagrass beds, oyster reefs (on intermediate-hard/artificial substrate), or emergent wetlands. Based on the expected duration of expended material impacts on substrate, the impact on associated biotic habitat features is expected to be similarly short-term.

Biotic habitat features on limited hard substrate (i.e., seaweed beds, oyster reefs) may overlap the potential impact footprint of expended projectiles, missiles, bombs, devices, accessories (e.g., parachutes, fiber-optic cables), and small UAS targets in the estuarine environment. The discussion of impacts on the habitat for oysters was covered in the previous section on topography/substrate. The impacts of falling/settling MEM on attached macroalgae and shellfish beds themselves are different than impacts to their habitat, with recovery expected over a range of durations based on studies of destructive fishing methods (Auster & Langton, 1999). Attached macroalgae that may be impacted on hard substrate is expected to recover rapidly (Mach et al., 2007).

Expended items may also provide new colonization sites for shellfish bed/reef species. Researchers found that sedentary reef invertebrates covered MEM in a bombing range over time (Smith & Marx Jr., 2016). However, sedentary invertebrate species on artificial substrates may differ from that of the surrounding natural community (Burt et al., 2009; Macreadie et al., 2011; Perkol-Finkel et al., 2006; Steimle & Zetlin, 2000). Within the Chesapeake Bay Water Range, there is relatively little bottom areas that is not seasonally hypoxic and comprised of soft mud that would tend to swallow relatively dense MEM. The bottom areas around Hannibal and Shoal targets are above the seasonal hypoxia zone and therefore the most likely candidates for both negative and positive impacts from MEM on shellfish beds.

Impacts of Physical Disturbance and Strike (Summary)

This analysis supports a minimal and temporary adverse effect on biotic features EFH from physical disturbance and strike stressors associated with the Preferred Alternative (Alternative 2). The may affect conclusion is based on movement of water-based assets and MEM.

Pollutants

The analysis in Section 3.3.3 (Water Resources and Sediments, Environmental Consequences) for pollutants supports a minimal and temporary adverse effect on biotic features EFH from the Preferred Alternative; No current water or sediment quality standards considered safe for aquatic life would be violated by the Proposed Action, and estuarine vegetation and shellfish bed invertebrates are not particularly susceptible to the chemical constituents of MEM.

Energy

The energy stressor analysis in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Energy) supports a minimal and temporary adverse effect on biotic features EFH from the Preferred Alternative; shellfish bed invertebrates may be affected by water-based electromagnetic energy fields (e.g., OASIS, MOPS) or directed energy stressors associated with the Proposed Action, but no population-level effects are anticipated.

Ingestion

Oysters, comprising most shellfish beds in the PRC Study Area, are filter-feeding organisms capable of collecting suspended material pieces that are very small or microscopic. For shellfish bed EFH, the only MEM of ingestible size for shellfish beds (other than microplastics) is microscopic fragments released as larger expended material degrades; chaff fibers were discounted as an impact on biological resources in Section 3.4.3.1 (Environmental Consequences, No Action Alternative, Pollutants). The analysis regarding filter-feeding invertebrates in general supports a minimal and temporary adverse effect on shellfish bed EFH from ingestion stressors associated with the Preferred Alternative; shellfish bed invertebrates may be affected by ingestible MEM fragments, but no population-level effects are anticipated.

Indirect/Secondary

Indirect/secondary stressors associated with Proposed Action affect the habitat, predator, or food resources of biotic feature EFH (refer to Section 3.4.3.1, Environmental Consequences, No Action Alternative, Indirect/Secondary, for supporting details). Prey availability as a stressor is not applicable to vegetation-based EFH in the study area and are not analyzed further in this section. Indirect/secondary relationships to affected habitat or prey species for shellfish bed EFH are as follows:

- Shellfish beds occupy various hard substrates in the Chesapeake Bay, including shell bottom, partially buried driftwood, and artificial structures (e.g., pier pilings, shipwrecks, artificial reefs).
- Shellfish are eaten by larger organisms including other invertebrates (e.g., oyster drills, boring sponges, blur crabs) and humans (refer to direct stressors under their respective biological resource sections).
- Shellfish consume suspended particulates including microalgae, nonliving organic matter (e.g., detritus), and nonfood particles (e.g., microplastics). For impacts on food resources, refer to the direct stressors under their respective biological resource sections.

The Preferred Alternative may alter the nonliving substrate for seaweed EFH/HAPC that may colonize exposed surfaces of MEM and other hard features on the bottom (Figure 3.4-4), thus adding to the available habitat for more seaweed. There is relatively little hard/artificial substrate in the Chesapeake Water Range where MEM is concentrated, and most of the bottom in those areas is seasonally hypoxic – meaning no seaweed would grow on the bottom where most MEM resides. An exception would be around Hannibal Target where the surrounding bottom is relatively shallow and MEM remaining only partially buried would likely be colonized by seaweed and/or shellfish species. The Preferred Alternative would not affect the nonliving substrate for seagrass EFH/HAPC because there should be no MEM falling into seagrass beds. No other Proposed Action stressors will create unsuitable substrate for seagrass. However, MEM falling on shellfish bed habitat (e.g., hard/artificial substrate) could somewhat reduce oyster colonization over the short term.

The availability of phytoplankton for shellfish bed EFH is an important aspect to consider that was discounted in Section 3.4.3 (Environment Consequences). The effect of the Proposed Action on vegetation foragers (e.g., marsh periwinkles) can also be considered discountable due to their vast numbers, resilience, and preferred habitat (e.g., estuarine marsh) relative to where the vast majority of proposed water-based activities will occur (e.g., Chesapeake Bay Water Range).

Another potential indirect/secondary impact is bioaccumulation of pollutants. Whereas some metals and contaminants associated with microplastics also bioaccumulate, the physiological impacts on biological resources begins to occur only after several trophic transfers concentrate the pollutants. Bioaccumulation is therefore most pronounced at higher trophic levels (e.g., large predatory fish, birds, marine mammals). Filter-feeding shellfish are among the invertebrates having the greatest potential to ingest small plastic fragments and any associated pollutants could be incorporated into the food chain (National Oceanic and Atmospheric Administration Marine Debris Program, 2014b; Wright et al., 2013). Ingestion by these types of organisms is the most likely pathway for degraded MEM to enter the Bay food web. Transfer of microplastic particles to higher trophic levels was demonstrated in one experiment (Setala et al., 2016). However, the contribution to overall microplastic pollution from the Proposed Action is likely miniscule.

Accordingly, the lack of any significant impacts on shellfish bed habitats, predators, or prey resources, and miniscule contribution of the Proposed Action to overall microplastic pollution suggests a corresponding lack of substantial indirect/secondary impacts on shellfish bed EFH. However, the analysis does support a potential minimal and short-term adverse effect on shellfish bed EFH.

Stressors Combined

None of the Proposed Action stressors on EFH in the PRC Study Area is anticipated to have greater than minimal impacts. There was either no measureable or likely impact of the stressor, or a temporary to short-term impact of minimal intensity that may occur. Taken together, the combined impact of dipping sonar, aircraft noise, vessel/in-water device movement, bottom devices, and MEM is more difficult to characterize. However, there are factors that minimize a potential combined impact. With regard to vessel movement and expended materials, the Navy contributes a very small amount to overall vessel traffic and expended materials of human origin in the PRC Study Area. Additionally, the various stressors often do not be occur in the same space and time (e.g., vessel movement and MEM, dipping sonar and aircraft noise). Refer to the relevant stressor sections for supporting details for each conclusion.

Impacts on Habitat Areas of Particular Concern

Refer to the conclusions for biotic feature EFH regarding the effect of the Proposed Action on HAPC for summer flounder: marsh fringes and seaweed/seagrass beds. The analysis supports a minimal and temporary adverse effect on summer flounder EFH/HAPC from Proposed Action stressors.

3.4.7.3 Regulatory Conclusions

Regarding compliance with the MSA and implementing regulations, the Navy has determined that a subset of stressors associated with the Proposed Action (aircraft noise, dipping sonar, surface vessel movement, bottom devices, and MEM) "may adversely affect" EFH in the Greater Atlantic Regional Fishery Office consultation area (Table 3.4-15). Therefore, consultation with NMFS will be conducted. However, with the application of current standard operating procedures and mitigation measures, it is anticipated that the Proposed Action (Preferred Alternative, Alternative 2) would have no more than a minimal adverse effect on those habitats. The impacts would be mostly physical disturbance from water-based assets and MEM on mostly resilient soft bottom habitats in areas that are seasonally hypoxic or sandy and exposed/subject to only short-term effects before burial.

Table 3.4-15 Effects Determinations for the Preferred Alternative (Alternative 2) on Essential Fish Habitats and Habitat Areas of Particular Concern

Essential Fish Habitats (Habitat-based Categories)	*Acoustics*	*Disturbance/ Strike*	*Pollutants*	*Energy*	*Entanglement*	*Ingestion*	*Indirect/ Secondary*	*Stressors Combined*
Water Column (Estuarine)	MA	MA	MA	MA	MA	MA	MA	MA
Topography/Substrate (Natural Substrate Types and Artificial Reefs)	NE	MA	NE	NE	NE	NE	NE	NE
Biotic Features (Estuarine Plants, Shellfish Beds/Reefs)	MA	MA	MA	NE	NE	MA	MA	MA
Habitat Areas of Particular Concern (Estuarine Plants)	NE	MA	MA	NE	NE	NE	MA	MA

Key: MA = may adversely affect; NE = no effect.

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3.5 Public Health and Safety

This discussion of public health and safety includes consideration for any activities, occurrences, or operations that have the potential to affect the safety, well-being, or health of members of the public. A safe environment is one in which there is no, or optimally reduced, potential for death, serious bodily injury or illness, or property damage. The primary goal is to identify and prevent potential accidents or impacts on the general public.

Public health and safety within this Environmental Impact Statement discusses information pertaining to flight safety, including the potential for aircraft mishaps and bird/animal aircraft strike hazards (BASH), and Accident Potential Zones (APZs). The Air Installation Compatible Use Zone (AICUZ) Program, which is discussed in Section 3.6 (Land Use), delineates APZs. APZs do not predict the likelihood of an aircraft mishap, but they predict the most likely location of an aircraft accident, if one were to occur. The Department of Defense (DoD) defines an APZ as a planning tool for local planning agencies. The APZs follow departure, arrival, and flight-pattern tracks from an airfield and are based upon historical accident data.

Additionally, this section addresses range safety considerations. That is, potential risks and associated safety measures are evaluated with respect to the use of non-explosive munitions and other military expended materials (MEM), and/or electromagnetic, laser, or microwave systems utilized as part of proposed testing or training operations.

Environmental health and safety risks to children are also addressed. Specifically, this section identifies and assesses potential environmental health and safety risks that may result from proposed activities and whether these risks disproportionately affect children residing within the Patuxent River Complex (PRC) Study Area.

Navy studies have determined that munitions constituents do not present an unacceptable risk to human health in associated with the use of military munitions in testing or training in the Chesapeake Bay Water Range (U.S. Department of the Navy, 2013c). This includes potential impacts associated with consumption of fish or other seafood harvested in this area. Consequently, potential impacts to human health resulting from usage of the Chesapeake Bay Water Range are not discussed further in this section.

3.5.1 Public Health and Safety, Regulatory Setting

The following provides an overview of the regulatory or policy setting associated with flight and range safety and with assessing environmental health and safety risks to children.

3.5.1.1 Flight Safety

Flight safety is based on the physical risks associated with aircraft flight. Military aircraft fly in accordance with Federal Aviation Administration (FAA) Regulations Part 91, *General Operating and Flight Rules*, which govern such things as operating near other aircraft, right-of-way rules, aircraft speed, and minimum safe altitudes. These rules include the use of testing and training flight areas, arrival and departure routes, and airspace restrictions, as appropriate, to help control air operations. All tenant commands also comply with Naval Air Station (NAS) Patuxent River policies, standard operating procedures (SOPs), and other guidance related to flight safety.

Naval aviators must also adhere to the flight rules, air traffic control, and safety procedures provided in Navy guidance. For example, the Navy employs standard safety procedures and precautions, such as the *Naval Air Training and Operating Procedures Standardization General Flight and Operating Instructions* (Commander, Naval Air Forces Manual 3710.7) (U.S. Department of the Navy, 2016c), to make safe operations standard for all personnel. This manual also provides standard language, communication methods, nomenclature, and flight and operating procedures, as well as processes and procedures that improve combat readiness and achieve a substantial reduction in aircraft mishaps, thereby safeguarding people and resources. Additionally, NAS Patuxent River aircrews must also adhere to the NAS Patuxent River *Air Operations Manual* (NAS Patuxent River Instruction [NASPAXRIVINST] 3710.5X) (U.S. Department of the Navy, 2017a) and course rules. All flight crews receive a course rules brief, and all squadrons conduct safety standdowns to go over safety training.

There is no generally recognized threshold of flight safety that defines acceptable or unacceptable conditions. Instead, the focus of airspace managers is to reduce risks through a number of measures. These measures include, but are not limited to, providing and disseminating information to airspace users, setting appropriate standards for equipment performance and maintenance, defining rules governing the use of airspace, and assigning appropriate and well-defined responsibilities to the users and managers of the airspace.

The Navy values safety and professionalism and has adopted many measures to promote aviation safety within the naval aviation community. All personnel are provided continuous safety training throughout their career with the Navy. Specifically, all Navy pilots use state-of-the-art simulators for training purposes that include all facets of flight operations and comprehensive emergency (such as mechanical failure or bird strike) response procedures that minimize the mishap risks associated with pilot error. Maintenance crews are highly trained to perform preventative maintenance actions, maintenance repairs, diagnostic testing of the repair, and flight safety inspections on each aircraft in accordance with Navy regulations.

Maintenance activities are monitored to ensure that aircraft are equipped to withstand the rigors of testing and training events, and to identify any maintenance trends that may require a more comprehensive solution. The Navy will periodically initiate “safety standdowns” to promote aviation safety training along with personal discipline and responsibility. A standdown is an organized break from operations where personnel discuss potential safety-related issues. Safety standdowns are an effective tool for reducing aviation safety risks by focusing on the human factor in aviation safety that complements the traditional skills-based training that Navy pilots and maintenance crews receive.

Aircrews involved in testing or training exercises must be aware that nonparticipating aircraft and vessels are not precluded from entering the area and may not comply with Notices to Airmen (NOTAMs) or Notices to Mariners. Aircrews are required to maintain a continuous lookout for nonparticipating aircraft while operating in restricted areas under Visual Flight Rules. In general, aircraft carrying munitions are not allowed to fly over public or commercial vessels. When these safety measures are implemented, risks are minimized, though not eliminated.

Mishap Prevention

The primary goal of a flight safety program is the prevention of mishaps that could result in damage to property, injury, or loss of life. The military services define four categories of aircraft mishaps, with two categories (Classes A and B) defined as the most serious (U.S. Department of Defense, 2018c):

- **Class A mishap**. The resulting total cost of damages to government-owned and other property is $2 million or more, a DoD aircraft is destroyed (excluding unmanned aerial systems [UAS] Groups 1, 2, or 3), or an injury or occupational illness results in a fatality or permanent total disability.
- **Class B mishap**. The resulting total cost of damages to government-owned and other property is $500,000 or more but less than $2 million. An injury or occupational illness results in permanent partial disability, or three or more personnel are hospitalized for inpatient care (which, for mishap-reporting purposes only, does not include just observation or diagnostic care) as a result of a single mishap.

Note: UAS Groups 1 to 3 range in gross takeoff weight from 1 to 1,320 pounds, travel at speeds up to 250 knots, and operate at altitudes up to 18,000 feet above ground level (U.S. Department of Defense, 2018c). Due to the cost associated with these systems, they would not exceed the $2 million threshold.

Navy flying squadrons periodically perform mishap drills to simulate how to respond to an aircraft mishap properly. Each squadron must also develop a pre-mishap plan that describes the steps that must be taken when a mishap occurs. The plan also anticipates all reasonable eventualities and devises measures to cope with them. Deficiencies are identified through periodic drills designed to ensure the plan's smooth execution when a mishap occurs, focusing on the flow of information. A checklist of items to complete when executing the plan is standardized. While the contents of each squadron's pre-mishap plan may vary slightly, all plans attempt to be all-inclusive and address coordination with local commands, nearby military aviation facilities, local news media, area law enforcement officials, civil fire and rescue agencies, the U.S. Environmental Protection Agency, the FAA, and plans for medical services.

With respect to UAS, to minimize any potential hazards, the Navy specifically selects UAS testing and training areas to avoid overflights of densely populated areas.

3.5.1.2 Bird/Animal Aircraft Strike Hazards

Potential bird/animal aircraft strikes are another safety concern for aircraft operations. Aircraft strikes of birds or other animals (e.g., bats and deer) are a safety concern because of the potential for damage to aircraft, or injury to pilots or local populations, if an aircraft crash should occur in a populated area.

Aircraft may encounter birds at altitudes of 3,000 feet above mean sea level or higher. However, most reported bird strikes occur at an elevation of less than 1,000 feet above ground level (Federal Aviation Administration, 2007; U.S. Department of the Air Force, 2004). Birds, in particular, are drawn to the typical open, grassy areas and warm pavement of an airfield. Although most bird and animal strikes do not result in crashes, they may cause structural and mechanical damage to aircraft. Due to the speed of the aircraft, collisions with birds or other animals can happen with considerable force.

To reduce the potential for collisions between aircraft and birds, or other animals, BASH plans are developed for military airfields in accordance with Office of the Chief of Naval Operations Instruction (OPNAVINST) 3750.21 (*Policy for Administering the Bird/Animal Aircraft Strike Hazard Program in the U.S. Navy*) (U.S. Department of the Navy, 2017f); the Commander, Navy Installations Command *Navy BASH Program Implementing Guidance* (U.S. Department of the Navy, 2011b); the FAA Advisory Circular 150/5200-33B (Federal Aviation Administration, 2007); and other related guidance. BASH plans account for seasonal migration patterns, when BASH risks to aircraft can increase. To reduce the potential for BASH, the FAA and the military recommend that land uses that attract birds (e.g., agricultural fields, landfills) be located at least 10,000 feet from an airfield.

3.5.1.3 Accident Potential Zones

In the 1970s and 1980s, recognizing the need to identify areas of accident potential, the armed services conducted studies of historical aircraft accidents throughout the United States. The studies showed that most aircraft mishaps occurred on or near the runway, with the likelihood of mishaps diminishing with distance.

Based on these studies, the Navy and other services have identified APZs. These APZs do not predict the likelihood of an aircraft mishap, but they do predict the most likely location of an aircraft accident, if one were to occur. APZs follow departure, arrival, and pattern flight tracks and are based upon analysis of flight operations data, historical aircraft accident data, and the location of accidents relative to the airfield. While the likelihood of a mishap is remote, the Navy recommends restricting people-intensive uses within these zones.

As discussed in Section 3.1.5 (Ambient Airborne Noise, Regulatory Setting), airfield safety clearances and APZs are depicted at military airfields under the AICUZ program. Navy guidance provides for administering the AICUZ program, which recommends land uses that are compatible with noise levels, accident potential, and obstruction clearance criteria for military airfield operations. The intent of the AICUZ program is to protect the health, safety, and welfare of members of the public who live and work near the military airfields while meeting national security needs, addressing community concerns about aircraft noise and accident potential, and preserving the military flying mission.

APZs are located near airfield runways and depicted on maps for planning purposes. The Navy recommends that the intensity and density of land uses within APZs be minimal or low to ensure the maximum protection of public health and property. The geometry and criteria for applying standard APZs for runways are defined in OPNAVINST 11010.36C, *Air Installations Compatible Use Zones (AICUZ) Program* (U.S. Department of the Navy, 2008a). Class A runways are primarily used by small light aircraft and are ordinarily less than 8,000 feet long. Class B runways encompass all other runways. NAS Patuxent River runways are 11,800, 9,700, and 5,000 feet in length. Therefore, NAS Patuxent River has both Class B and Class A runways according to the definition. Outlying Field (OLF) Webster runways are both 5,000 feet in length and are classified as Class A. Clear Zones (CZs) and APZs for Class A and B runways are defined as follows:

- **Clear Zone:**

  Class A – CZ is 1,000 feet wide and 3,000 feet in length and extends from end of runway**.**

  Class B – CZ extends 3,000 feet immediately beyond the runway. It measures 1,500 feet wide at the end of the runway and 2,284 feet wide at its outer edge.

  The CZ is required for all active runways and should remain undeveloped as it has the highest potential for accidents.

- **APZ 1:**

  Class A – APZ 1 is 1,000 feet wide and extends 2,500 feet from the Clear Zone.
  Class B – APZ 1 extends 5,000 feet beyond the CZ, with a width of 3,000 feet.

  An APZ 1 is typically rectangular; however, when circumstances warrant, the APZ 1 may be curved to correspond with predominant flight tracks. An APZ 1 area is provided for flight tracks that experience 5,000 or more annual operations (departures or arrivals).

- **APZ 2:**

  Class A – APZ 2 is 1,000 feet wide and extends 2,500 feet from the end of APZ 1.
  Class B – APZ 2 extends 7,000 feet beyond APZ 1, with a width of 3,000 feet.

  Like APZ 1, the geometric configuration of APZ 2 may also be curved.

Most land uses within the CZ are incompatible with military aircraft operations. For this reason, the Navy's policy is to acquire sufficient real property interests in land within the CZ to ensure that incompatible development does not occur. Within APZ 1 and APZ 2, varieties of land uses are compatible; however, high-density residential and people-intensive uses (e.g., schools, apartments) should be restricted because of the greater risk in these areas.

In this Environmental Impact Statement, potential impacts attributable to the number of operations conducted at NAS Patuxent River and OLF Webster are analyzed in accordance with OPNAVINST 11010.36C, which sets APZ requirements for Navy airfields. The number and types of operations proposed under each alternative determine whether changes may be warranted under the AICUZ program.

3.5.1.4 Range Safety

Of paramount concern to personnel at the PRC is ensuring the safety of the public, testing and training participants, and property during aircraft flight testing. This is achieved through careful flight test planning that adheres to SOPs (U.S. Department of the Navy, 2005d). Qualified safety personnel participate throughout the test process, from initial planning, through aircraft maintenance and instrumentation, to actual performance of the flight test. A detailed test plan, subject to stringent peer review, is developed for all flight tests. This test plan identifies project requirements, approaches to meeting those requirements (including test flight profiles), and a safety plan. The safety plan addresses aircraft, range, and operational safety issues (U.S. Department of the Navy, 1998).

Naval Air Warfare Center Aircraft Division Instruction (NAVAIRWARCENACDIVINST) 3710.1A, *Range Safety Manual* (U.S. Department of the Navy, 2010b), is the guide for planning weapon systems test and training operations and summarizes the procedures for safely conducting all operations, while both the *Range Safety Manual* and DoD Instruction 3200.16, *Operational Range Clearance* (U.S. Department of Defense, 2017a), assign responsibilities and prescribe procedures for conducting range clearance (e.g., unexploded ordnance and munitions debris). Additionally, several other SOPs relating to the various aspects of safety are followed. Testing activities have their own procedures that require that safety be considered in any testing event. For example, the Navy's *Operational Test Director's Manual* (Commander Operational Test and Evaluation Force Instruction 3980.2I) (U.S. Department of the Navy, 2019e) prescribes policies and procedures for the planning, conducting, and reporting of operational test and evaluation of new and improved naval weapons and warfare support systems.

The Range Safety Team is responsible for developing range safety policy and defines range safety processes and procedures for specific air, ground, and surface and subsurface tests. The team identifies test hazards, performs risk analyses, develops risk control measures, and ensures that test events progress within predetermined acceptable limits. The Range Safety Team reviews and approves SOPs for range support of weapons testing and training events, as well as hazardous range operations, including energetics operations and radio frequency and laser operations. Final authority and accountability for all aspects of safety rest with the Range Commander.

3.5.1.5 Environmental Health Risks and Safety Risks to Children

Executive Order (EO) 13045, *Environmental Health Risks and Safety Risks to Children*, issued on April 21, 1997, requires each federal agency to "make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and shall . . . ensure that its policies, programs, activities, and standards address disproportionate risks to children." This order was issued because a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks.

3.5.2 Public Health and Safety, Affected Environment

3.5.2.1 Flight Safety

The mixture of fixed-wing jet, fixed-wing propeller, rotary-wing aircraft, and UAS, as well as noise-abatement restrictions result in complex traffic patterns and procedures within the PRC Study Area. In accordance with Navy guidance presented earlier in this section, safety, inspection, and maintenance procedures are designed to ensure public health and safety. Through the Naval Safety Center and Fleet Safety Center, the Navy promotes a proactive and comprehensive safety program designed to reduce, to the greatest extent possible, any potential adverse impacts on public health and safety from testing and training activities.

Within the PRC Study Area, the *NAS Patuxent River Air Operations Manual* (NASPAXRIVINST 3710.5X) (U.S. Department of the Navy, 2017a) presents rules designed to promote aviation safety, as well as meet testing and operational requirements. Any exceptions to these rules must be requested and submitted in the project plan, which is reviewed by the Atlantic Test Ranges (ATR) Sustainability Office to ensure compliance with the current complex EIS. Additionally, the *NAS Patuxent River Air Operations Manual* provides rules and regulations for the performance of flight operations at NAS Patuxent River and OLF Webster, and within all assigned PRC airspace. Compliance with this manual is mandatory for all pilots based at or using the NAS Patuxent River, OLF Webster, and assigned PRC airspace.

Changes to existing course rules and operating procedures in Special Use Airspace (e.g., restricted areas) are communicated by the FAA's NOTAM process to inform aircrews of items that affect safety, local flight data, temporary flight restrictions, and special notices. Aircrews involved in testing or training exercises must be aware that nonparticipating aircraft are not precluded from entering the area and may not comply with these NOTAMs. Aircrews are required to maintain a continuous lookout for nonparticipating aircraft while operating in restricted areas under Visual Flight Rules.

Mishap Prevention

The primary safety concern regarding military aircraft testing and training operations is the potential for aircraft mishaps to occur. Aircraft mishaps could be caused by mid-air collisions with other aircraft or objects, weather, mechanical failures, pilot error, or BASH. Although mishap rates from previous years cannot predict future mishap rates, reviewing mishap data from previous years is helpful in providing perspective. As discussed previously, aircraft mishaps are categorized based on the extent of property damage, loss of life, or disability they cause, with Class A mishaps being the most severe.

Over the years spanning from 2008 to 2019, there have been three Class A mishaps in the NAS Patuxent River/OLF Webster area—two involving manned aircraft and one involving a UAS (U.S. Department of the Navy, 2019f):

- **September 2009:** An aircraft overran the end of a runway at NAS Patuxent River during landing, and impacted construction equipment. The two individuals on board ejected successfully with no injuries. It was determined that the mishap was the result of pilot error. The aircraft was destroyed, along with some runway infrastructure, including edge lights, runway end lights, and an arresting gear cable.
- **June 2012:** A UAS crashed into an unpopulated coastal marsh region 22 miles east of NAS Patuxent River due to equipment failure. The mishap resulted in the destruction of the UAS. There were no injuries, fatalities, or damage to non-DoD property due to the mishap.
- **October 2019:** An E-6B aircraft struck a bird during a touch-and-go landing associated with a system test and evaluation, and sustained damage to one of its four engines. The plane landed safely and there were no injuries. The engine was replaced, and the plane was returned to service. Due to the cost of the engine (i.e., greater than $2 million), this incident was classified as a Class A mishap.

As discussed earlier, the Navy has implemented numerous procedures to minimize the potential for an aircraft mishap; however, in the unlikely event of an aircraft emergency or mishap, the Navy maintains emergency and mishap response plans to guide responses to aircraft accidents. These plans assign responsibilities and prescribe functional activities necessary to react to mishaps, whether on or off the installation. Response would normally occur in two phases. The initial response focuses on rescue, evacuation, fire suppression, safety, elimination of energetic devices, securing the area, and other actions immediately necessary to prevent loss of life or further property damage. The second phase is the mishap investigation, which involves an array of organizations whose participation would be governed by the circumstances associated with the mishap and actions required to be performed (U.S. Department of Defense, 2018c).

3.5.2.2 Bird/Animal Aircraft Strike Hazards

As discussed earlier in this section, potential bird/animal (wildlife) aircraft strikes are a major safety concern for aircraft operations. Over the 11-year period of 2008 to 2018, there were approximately 210 wildlife-aircraft strikes within the PRC Study Area. Most incidents involved bird-aircraft collisions. There were also several incidents involving land-based species (groundhog and deer). Approximately 8 percent of the strikes resulted in damage to the aircraft, with a cumulative damage amount of approximately $47,000 (U.S. Department of the Navy, 2019g). At OLF Webster, three bird-aircraft strikes were reported during the same period, with no significant damage incurred by the aircraft (U.S. Department of the Navy, 2019h). None of these incidents resulted in a Class A or Class B mishap, with the exception of the previously noted incident in October 2019, when an E-6B aircraft struck a bird during a touch-and-go landing and sustained damage to one of its four engines (Class A mishap).

The *NAS Patuxent River Air Operations Manual* (NASPAXRIVINST 3710.5X) describes procedures designed to reduce aircraft exposure to bird and animal hazards on and about the airfield (U.S. Department of the Navy, 2017a). Additionally, NAS Patuxent River has prepared a BASH Plan (NASPAXRIVINST 3750.5H) that outlines procedures to minimize the potential for strikes between wildlife and aircraft during operations at both NAS Patuxent River and OLF Webster. The plan details responsibilities of personnel dealing with the hazard, practices to reduce BASH potential, and guidelines to decrease the attractiveness of the NAS Patuxent River and OLF Webster airfields to wildlife (U.S. Department of the Navy, 2014). Additionally, airfield users are made aware of potential hazards via the Automatic Terminal Information Service and other radio broadcasts whenever bird/animal activities are observed or reported. The following condition codes are set by Air Traffic Control and used for rapid communication of bird activity information (U.S. Department of the Navy, 2017a):

- **Code Red:** This code represents heavy concentration of wildlife on or directly above the active runway, in the immediate vicinity of a low-level route, testing or training area, or other locations that represent an immediate hazard to safe flying operations. Aircrews should thoroughly evaluate mission need before operating in areas under Code Red. Wildlife dispersal crews shall be dispatched immediately to these areas.
- **Code Yellow:** Concentrations of wildlife are observable in locations that represent a probable hazard to safe flying operations, or conditions exist (such as weather or known flight/migration patterns) that are likely to result in the presence of dangerous concentrations of birds and other wildlife on or around the airfield. Code Yellow requires increased vigilance by all agencies and extreme caution by aircrews. Wildlife dispersal crews should monitor these areas closely and conduct dispersal activities as deemed necessary.
- **Code Green:** This code represents normal wildlife activity with a low probability of hazards.

The Bird Hazard Working Group (composed of members of Air Operations, Public Works Environmental, and U.S. Department of Agriculture personnel) uses various techniques to reduce BASH risk, including vegetation manipulation, bioacoustics, pyrotechnics, use of the Bird Avoidance Model and a radar system called eBirdRad, and lethal control as permitted. Due to the scarcity of strikes at OLF Webster, as well as the slower landing speeds and reduced numbers of aircraft using this airfield, a modified BASH reduction program is in effect.

If a strike event does occur, a BASH report is completed and submitted to the Naval Safety Center. Additionally, the tower or flight planning is made aware of the event so a foreign-object debris sweep of the area can be conducted, and any wildlife remains removed from the airfield, to reduce the attraction of other animals and for identification. Finally, the installation maintains a U.S. Department of Agriculture wildlife biologist who is available to minimize strike hazards by dispersing, removing, and depredating birds, deer, or other hazardous wildlife from the airfield (U.S. Department of the Navy, 2014).

3.5.2.3 Accident Potential Zones

Flight operations for military airfields are analyzed during the AICUZ process to determine whether APZs are warranted. This analysis includes arrival, departure, and pattern flight tracks. Generally, APZs are warranted for predominant flight tracks that have 5,000 or more operations per year.

Figure 3.5-1 and Figure 3.5-2 present APZs at NAS Patuxent River and OLF Webster, respectively. At NAS Patuxent River, APZ 1 and APZ 2 encompass a total of approximately 24 and 1,000 acres, respectively. For NAS Patuxent River, the AICUZ process only identified the APZs that extend over land (Figure 3.5-1); however, an AICUZ update for OLF Webster identified the APZs over land as well as water (Figure 3.5-2). Note that OLF Webster does not have APZ 1 areas.

At OLF Webster, the APZ 2 were designed to account for operational variability of aircraft (e.g., UAS) operating at the installation. Limiting factors that were incorporated into APZ geometry development include noise abatement concerns that encourage UAS operations to remain over the water and away from populated areas, to the maximum extent possible. This operational condition formed the variable APZ 2 footprints for the different runway approaches. As shown on Figure 3.5-2, the resulting APZs are wider than the standard 1,000-foot-wide dimension to account for the UX-24 UAS mission at OLF Webster. Approximately half of CZ and APZ areas are over water; the remainder is over land with 226 acres off of the installation just south of the airfield and overlying the St. Inigoes State Forest (U.S. Department of the Navy, 2017g).

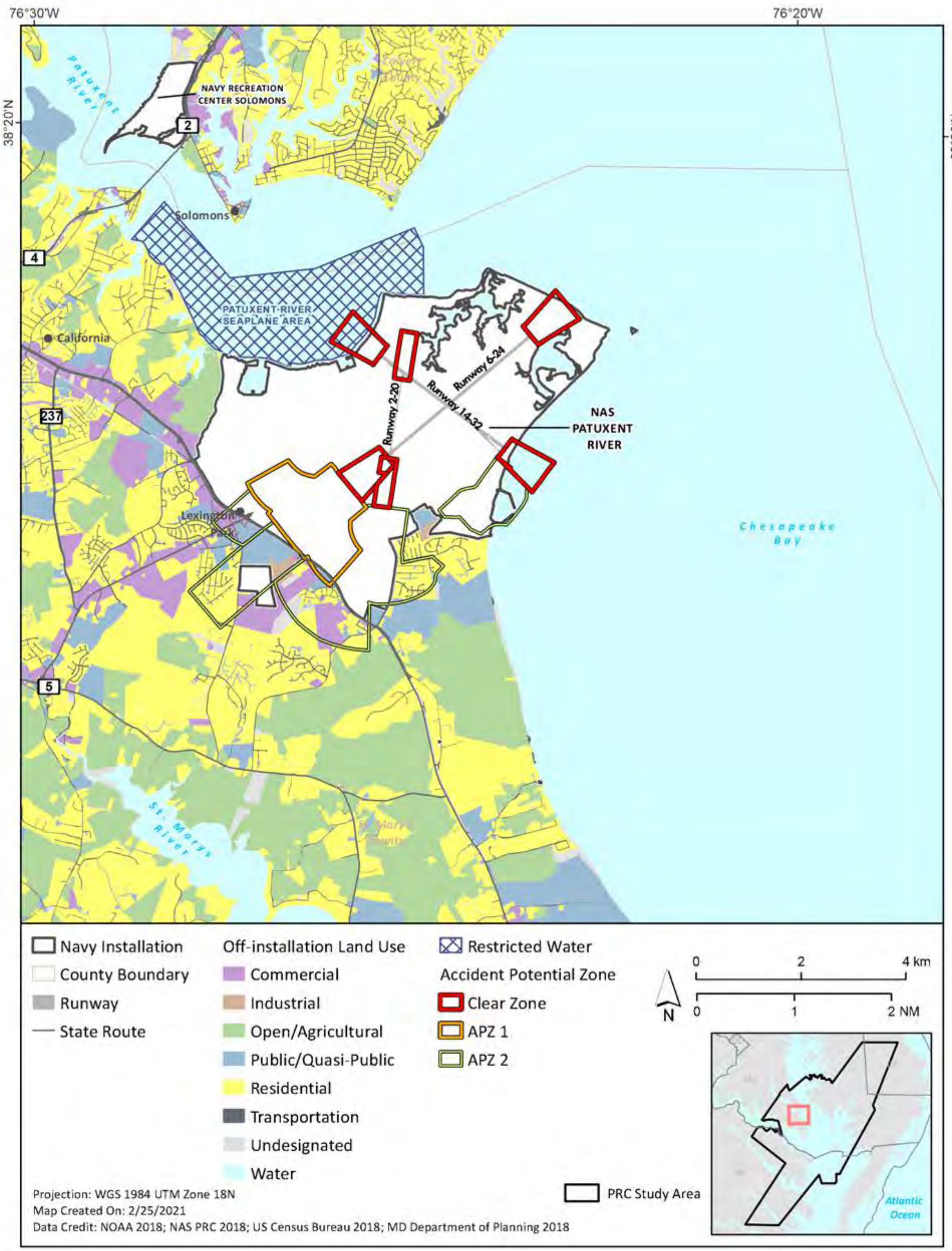

Figure 3.5-1 Accident Potential Zones and Clear Zones at NAS Patuxent River

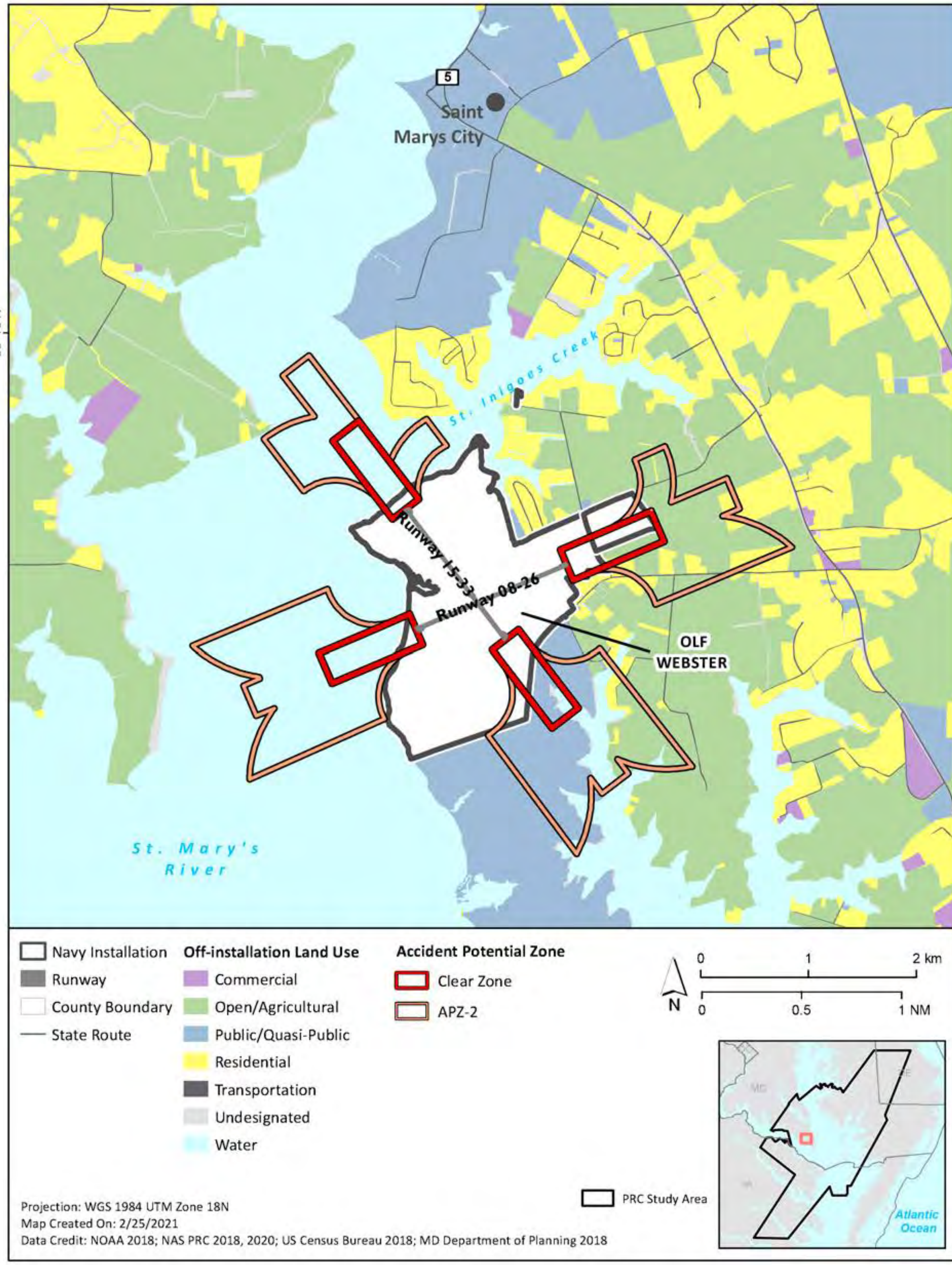

Figure 3.5-2 Accident Potential Zones and Clear Zones at OLF Webster

In addition to the CZ, there is a lateral CZ (called the primary surface) that extends outward for 500 feet on each side and for the length of the runways at both installations.

At NAS Patuxent River, residential areas located to the southeast of the installation in the Lexington Park, Southampton, Southgate Park, Cedar Cove, and Forest Park neighborhoods are within or adjacent to APZ 1 and APZ 2. Additionally, some low-density residential development is located within APZ 2 to the southwest of the installation. Low-density residential use is not compatible with APZ 1, while land-use compatibility guidance recommends that residential uses not exceed one to two dwelling units per acre in APZ 2. At OLF Webster, two parcels of land extend under the CZ. These parcels have occupied homes on them; however, the homes themselves are not within the CZ.

3.5.2.4 Range Safety

Military and civilian activities have taken place simultaneously in Southern Maryland for decades; however, for public safety reasons, military activities are typically confined to secured PRC air, water, and land areas. Where military and civilian activities coexist in the same space, there are rules and practices that guide the Navy's use of aircraft and vessels in shared areas. During all testing and training events, the Navy implements SOPs (Table 2.5-1, Standard Operating Procedures) to ensure that Navy activities do not negatively interact with civilian activities, preventing potential conflicts and harm to civilians. (Note: The focus of the ATR Range Safety Office is ballistic and energetic munitions, directed energy, and unmanned operations. Other organizations address safety issues discussed in this section.)

Whether military or civilian, vessel operators have a duty to abide by maritime requirements as administered by the U.S. Coast Guard. While in transit, Navy surface-vessel operators are alert at all times, travel at a safe speed for the prevailing conditions, use state-of the-art satellite navigational systems, and are trained to take proper action to avoid collisions. For all moving Navy vessels, including range support boats, personnel watch surrounding waters to ensure that potential obstacles are identified. Navy lookout personnel are highly qualified and experienced observers of the Bay environment. As noted in Table 2.5-1 (Standard Operating Procedures), the Navy follows SOPs U.S. Coast Guard Commandant Instructions M16114.5C, *Boat Crew Seamanship Manual*, in (U.S. Coast Guard, 2017a) and M16130.2F, *National Search and Rescue Supplement* (U.S. Coast Guard, 2013a).

In the PRC Study Area, the Navy tests and trains using a variety of weapon or sensor systems, including non-explosive munitions, live-fired small- and medium-caliber gun ammunition and rockets, low- and high-energy laser systems, and electromagnetic radiation (i.e., microwaves).

The Navy has implemented rigorous procedures to ensure safety is a primary consideration for all testing and training activities. ATR elevated, coastal, fixed-site radars are the primary radar search sources, and Atlantic Targets and Marine Operations (ATMO) range clearance boats are the primary visual search sources for detecting vessels on the Chesapeake Bay Water Range. Range clearance boats also use their onboard surface search radars to augment their primary responsibility of visual search for detecting low radar cross-section vessels. The number of range clearance vessels required to clear a hazard pattern and maintain visual/radar coverage to identify nonparticipant vessels is determined by hazard pattern size, expected boat traffic for hazard pattern location, and number/position of range clearance boats. Boat crews communicate to the range controllers any condition that results in degraded range-clearance capability, and any boat captain that discovers an unplanned safety risk shall exercise the "No Vote" to suspend hazardous activities until those with the proper risk-acceptance authority are notified before resuming operations (U.S. Department of the Navy, 2020b).

In addition to the measures discussed above, the range must also be able to safely contain the hazard area of the weapons and equipment employed. The hazard area is based on the size and performance characteristics of the weapon, and it includes a safety buffer around the target. The size of the buffer zone is determined by the type of activity. For activities with a large hazard area, special sea- and air-surveillance measures are implemented to make sure the area is clear before the activities commence. Before munitions are expended, the target area is cleared by aircraft or range support boats to ensure that it is clear of personnel, vessels, and other nonparticipants. Testing and training activities are delayed, moved, or cancelled if there is a question about the safety of the public (U.S. Department of the Navy, 2010b).

Aircraft returning to NAS Patuxent River with hung ordnance will normally be approved for straight-in approach to Runways 24 or 32 or a left downwind approach to Runway 14 to allow aircraft to remain over water to the maximum extent possible (Figure 1.3-3, NAS Patuxent River). The aircraft with unexpended ordnance will use normal recovery procedures unless the weapon/attachment point is nonstandard or is an untested design. The pilot is responsible for determining appropriate recovery for the specific unexpended ordnance condition. After landing, aircraft with unexpended non-explosive munitions may taxi to the line area (U.S. Department of the Navy, 2017a).

Specific guidance related to range safety was previously discussed in Section 3.5.1.4 (Range Safety). Additionally, Navy explosives safety policy is based on the requirements of DoD 6055.9-STD, DoD *Ammunition and Explosives Safety Standards* (U.S. Department of Defense, 2012). This DoD standard establishes uniform safety requirements applicable to ammunition and energetics and to personnel and property exposed to the potentially damaging effects of an accident involving ammunition and energetics during, among other things, testing, training, transportation, handling, storage, maintenance, and disposal.

Lasers are also used by the Navy during testing and training within the PRC Study Area (Section 3.0.2.3.5, Energy Stressors). The Navy uses lasers for precision range finding, as target designation/illumination devices for engagement with laser-guided weapons, and for mine detection and mine countermeasures, as well as for nonlethal deterrents. The Navy observes strict precautions and has written instructions for laser users, to ensure that nonparticipants are not exposed to intense light energy. Laser safety procedures for aircraft require an initial pass over the target before laser activation to ensure that target areas are clear. During actual laser use, aircraft run-in headings are also restricted to avoid unintentional contact with personnel or nonparticipants. All laser operations are conducted in accordance with established procedures, including the *Navy Laser Hazards Control Program* laser safety design requirements (OPNAVINST 5100.27B) (U.S. Department of the Navy, 2008b), *Department of Defense Handbook, Range Laser Safety* (Military Handbook 828C) (U.S. Department of Defense, 2017b), and the DoD Laser Protection Program (DoD Instruction 6055.15) (U.S. Department of Defense, 2018d). Please refer to Section 3.0.2.3.5.4 (Directed Energy) for additional information related to laser use and safety.

Additionally, the Navy routinely uses equipment that emit electromagnetic radiation. The electromagnetic environments of installation facilities can change with new or modified radar, electronic warfare, communications, and navigation transmitter installations. Changes could also occur to ordnance configuration, inventories, and operations. The Hazards of Electromagnetic Radiation Program at NAS Patuxent River is managed in accordance with the Navy Technical Manual: Naval Sea Systems Command Operational Publication 3565/Naval Air Systems Command (NAVAIR) 16-1-529 Volume 2 *Electromagnetic Radiation Hazards (U) (Hazards to Ordnance) (U)* (U.S. Department of the

Navy, 2008c). This document prescribes operating procedures and precautions to prevent initiation of electro-explosive devices in ordnance from electromagnetic radiation.

To avoid excessive exposures from electromagnetic energy, aircraft, instrumentation, systems, and ground test facilities are operated within the PRC in accordance with SOPs that establish minimum separation distances between electromagnetic energy emitters and people, munitions, and fuels (Table 2.5-1, Standard Operating Procedures). Thresholds for determining hazardous levels of electromagnetic energy to humans, munitions, and fuel have been determined for electromagnetic energy sources based on frequency and power output, and practices are in place to protect the public from electromagnetic radiation hazards. For example, the Navy assessed the hazards of electromagnetic radiation to personnel and fuel to determine if maximum permissible exposures are exceeded in normally occupied areas and evaluated the overall potential for electromagnetic hazards (U.S. Department of the Navy, 2016a). Established procedures to minimize these hazards include setting the heights and angles of electromagnetic energy transmissions to avoid direct exposure, posting warning signs, establishing safe operating levels, and activating warning lights when radar systems are operational. Other measures include allowing only 10 “groups” of aircraft to operate within the PRC restricted areas at any one time, to limit the amount of electromagnetic energy emitted from airborne platforms at any given time. Please refer to Sections 2.1.2.7 (Directed Energy Systems Testing) and 3.0.2.3.5.4 (Directed Energy) for additional information related to electromagnetic radiation use and safety.

3.5.2.5 Environmental Health Risks and Safety Risks to Children

According to EO 13045, Protection of Children from Environmental Health Risks and Safety Risks (April 21, 1997), a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children’s neurological, immunological, digestive, and other bodily systems are still developing; children eat more food, drink more fluids, and breathe more air than adults, in proportion to their body weight. Children’s size and weight may diminish their protection from standard safety features, and their behavior patterns may make them more susceptible to hazards because they are less able to protect themselves. As a result, EO 13045 states “[To] the extent permitted by law and appropriate, and consistent with the agency’s mission, each Federal agency: (a) shall make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children; and (b) shall ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.”

Studies show that environments with sustained high background noise can have a variety of effects on children, including effects on learning and cognitive abilities and various noise-related physiological changes. Children under the noise contours that are greater than 65 A-weighted decibels (dBA) day-night average sound level (DNL) are at a greater risk of experiencing these impacts (Section 3.1, Ambient Airborne Noise).

To determine whether children are subjected to disproportionate risks or impacts, the number of children potentially affected by airborne noise was identified using U.S. census data. The baseline for analyzing health risks and safety risks to children is based on the census geographic area that either fully or partially fall within noise contours above 65 dBA DNL in the modeled affected environment. The analysis also considers schools and other sensitive receptors (e.g., community or childcare centers) located within noise contours representing levels greater than 65 dBA DNL in the modeled affected environment.

Table 3.5-1 provides a list of census geographic areas subject to aircraft noise levels greater than 65 dBA DNL within the affected environment around NAS Patuxent River. The table includes information on the total population and the percentage of residents under 18 years of age (children) living in each affected census geographic area. Table 3.5-2 presents noise level ranges and affected populations under 18 years of age within the affected environment. (Note: Aircraft noise levels are less than 65 dBA DNL at all locations on and near OLF Webster [Section 3.1.6.3, Installation Noise Environment]).

Table 3.5-1 Total Population and Children within 65 dBA DNL or Greater Under Existing Conditions

Census Geographic Area	*Total Population*	*Total Population Affected (65 dBA DNL or greater)*	*Percent Population Aged Under 18*	
			Number	*Percent*
240098609003, Calvert County, MD	1,319	0	0	0
240098610032, Calvert County, MD	1,487	21	4	19.0
240378759011, St. Mary's County, MD	2,168	343	57	16.7
240378759013, St. Mary's County, MD	4,081	86	23	26.7
240378759021, St. Mary's County, MD	3,256	824	251	30.5
240378759023, St. Mary's County, MD	2,253	16	2	12.5
Total	**14,564**	**1,290**	**337**	
Maryland	5,996,079		1,347,613	22.5
Calvert County, MD	90,824		21,739	23.9
St. Mary's County, MD	110,979		27,488	24.8

Source: (U.S. Census Bureau, 2019)
Key: dBA = A-weighted decibels; DNL = day-night average sound level; MD = Maryland.

Table 3.5-2 Range of Noise Levels and Affected Populations Under Existing Conditions

Range of Average Noise Levels (dBA DNL)	*Total Affected Off-Installation Population*	*Population Aged Under 18*
65–69	1,290	337
70–74	0	0
75–79	0	0
80–84	0	0
85+	0	0
Total >65	**1,290**	**337**

Key: > = greater than; dBA = A-weighted decibels; DNL = day-night average sound level.

Assuming the population affected by the noise above 65 dBA DNL has similar demographic characteristics to the population of its census geographic area, an estimated 337 children would reside in areas affected by noise louder than 65 dBA DNL. No children would be affected by noise levels above 70 dBA DNL.

Additionally, as presented in Section 3.1.6.3 (Installation Noise Environment), seven schools and one community activity center are located within the noise contours representing noise levels above 65 dBA DNL. Two of these schools (Our Lady Star of the Sea School and Lexington Park Elementary) could experience up to two noise events per hour that could result in potential classroom interference if windows were maintained open. Two other schools (Green Holly Elementary School and Spring Ridge Middle School) and the activity center could experience up to one interference event per hour with windows open. With the windows closed, only two schools (Lexington Park Elementary School and Our Lady Star of the Sea School) could experience interference events and at a frequency of one per hour.

Additionally, the risk of an aircraft mishap resulting from aircraft operations, especially within designated CZs and APZs, may create a potential disproportionate safety risk if children are more likely to be exposed. Table 3.5-3 shows the total population and population under age 18 (children) estimated to be within APZ 2 at NAS Patuxent River and OLF Webster. No populations are located within an APZ 1 or CZ at either location. As shown in Table 3.5-3, 671 children are estimated to reside within APZ 2 at NAS Patuxent River, and 18 children are estimated to reside within APZ 2 at OLF Webster.

CZs and APZs represent areas of higher risk of incidents based on historical mishap data at multiple airfields. However, unless there is a place where children congregate within an APZ, such as a school, there is not a disproportionate safety risk to children. Lexington Park Elementary School is located 500 feet away from NAS Patuxent River APZ 2. Although part of the school property extends into APZ 2, the affected area is wooded and undeveloped. No schools are located within the existing CZs or APZs at OLF Webster.

Table 3.5-3 Populations Residing Within the Accident Potential Zone Under Existing Conditions

Location	*APZ*	*Census Geographical Area*[1]	*Total Population*	*Population Under 18*[2]
NAS Patuxent River	APZ 2	240378759011	500	130
		240378759012	34	9
		240378759013	633	165
		240378759021	1,407	366
		240378760012	7	2
		Total	**2,581**	**671**
OLF Webster	APZ 2	240378762001	71	18

Key: APZ = Accident Potential Zone; NAS = Naval Air Station; OLF = Outlying Field.

Notes:

1. Data from (U.S. Census Bureau, 2019)
2. Number of children is based on the percentage of children within the general population (i.e., 26 percent), as estimated previously in this section.

3.5.3 Public Health and Safety, Environmental Consequences

The safety and environmental health analysis contained in the respective sections addresses issues related to the health and well-being of military personnel and civilians living within the PRC Study Area. Stressors that may potentially impact public health and safety are acoustic, physical disturbance/strike, and public interaction. Potential impacts from energy stressors would not occur from testing or training of energy systems because established safety procedures, including the use of safety footprints/buffer zones, would exclude the public from areas where any testing/training would occur. Potential impacts to public health and safety would not occur from the entanglement stressor as deployment of detection devices (e.g., sonobuoys), which pose entanglement hazards due to the presence of cables/wires, occur during testing and training, when access to the Chesapeake Bay Water Range by the public is restricted (Section 3.0.2.3.6, Entanglement Stressors). Additionally, sonobuoys sink to the sea floor after deployment, which would eliminate entanglement hazards to public vessels or swimmers.

This subsection provides information on hazards associated with flight safety, BASH, APZs/CZs, and range safety. Additionally, this subsection addresses the environmental health and safety risks to children. The region of influence is the entire PRC Study Area.

3.5.3.1 Public Health and Safety, No Action Alternative

Under the No Action Alternative, testing and training would continue as reflected in the affected environment and there would be no change to public health and safety related to flight safety, BASH, APZs/CZs, range safety, or environmental health and safety risks to children. The following discussion summarizes public health and safety elements under the No Action Alternative in terms of how these relate to identified stressors.

Acoustics

The acoustic stressor associated with aircraft operations may impact public health and safety by potentially resulting in a disproportionate impact on children as evaluated against the requirements of EO 13045. The number of flights and the aircraft types under the No Action Alternative would not differ from those previously presented under Section 3.5.2.5 (Environmental Health Risks and Safety Risks to Children). Table 3.5-1 and Table 3.5-2 include total population and the percentage of residents under 18 years of age (children) living in each affected census geographic area. Based on these tables, at NAS Patuxent River, an estimated 337 children would be affected under the No Action Alternative by noise levels above 65 dBA DNL (but below 69 dBA DNL), equating to approximately 26 percent of the exposed population. No children would be affected by noise levels above the 70 dBA DNL. Aircraft noise levels would be less than 65 dBA DNL at all locations on and near OLF Webster.

As shown in Table 3.5-1, under existing conditions, five census geographic units in the NAS Patuxent River area would be exposed to noise levels between 65 and 70 dBA DNL. However, only two of these census units (within 240378759013 and 240378759021) have potential for disproportional impacts because they include higher percentages of children (26.7 and 30.5 percent, respectively) than St. Mary's County as a whole (24.8 percent). Additionally, as discussed in Section 3.5.2.5 (Environmental Health Risks and Safety Risks to Children), two nearby schools could experience up to two noise events per hour that could result in potential classroom interference if windows are maintained open. Two other nearby schools and an activity center could experience up to one interference event per hour with windows open; with the windows closed, only the two schools could experience interference events and at a frequency of one per hour. Two factors would constitute an adverse impact to children: (1) the higher population of children in the two census geographic areas and (2) increased noise at schools causing speech interference at levels that may hinder the ability of children to learn.

As discussed in Appendix B, Section B.5.7 (Noise Effects on Children), several studies suggest that aircraft noise can impact the academic performance of school children. This research suggests that environments with sustained high background noise can have a variety of effects on children, including effects on learning and cognitive abilities and various noise-related physiological changes. Some studies have found an association between noise and teacher ratings of students' psychological health, but only for children with biological risk defined by low birth weight and/or premature birth. Researchers also found that children exposed to aircraft noise had higher levels of psychological distress and hyperactivity. As with studies of adults, the evidence suggests that chronic noise exposure is probably not associated with serious psychological illness, but there may be effects on well-being and quality of life. However, based on the limited scientific literature available, there is no definitive correlation between noise-related events and physiological changes in children. Further research is needed, particularly on whether hyperactive children are more susceptible to stressors such as aircraft noise. Additionally, the aircraft noise associated with the existing operations is intermittent; therefore, the Navy does not anticipate any significant disproportionate health impacts to children caused by aircraft noise.

Physical Disturbance/Strike

The physical disturbance/strike stressor may result in potential impacts to public health and safety from strikes between non-explosive munitions and other MEM used in testing and training and public users in the PRC Study Area (e.g., fishermen, divers). The potential for a direct physical interaction between the public and aircraft, vessels, targets, or expended materials would not change from current conditions. As discussed in Section 3.0.2.3.2 (Physical Disturbance and Strike Stressors), release of non-explosive munitions and other MEM primarily occurs in the Chesapeake Bay Water Range and is focused around the fixed targets and aimpoints shown in Figure 2.1-3 (Chesapeake Bay Water Range Munition Concentration Areas), limiting the potential for striking the public. Additionally, the Navy would continue to implement SOPs that protect public health and safety. These procedures include ensuring clearance of the area before commencing testing and training activities.

Commercial and recreational fishing activities could encounter MEM that could pose a strike risk. To minimize this possibility, the Navy recovers expended UAS targets and surface targets to the extent practicable to prevent a collision risk. Unrecoverable pieces of MEM are typically small (such as sonobuoys), constructed of soft materials (such as foam-filled plastic), or intended to sink to the bottom after their useful function is completed and, therefore, would not pose a strike risk to civilian vessels or equipment.

Public Interaction

The public interaction stressor considers potential impacts associated with flight safety, specifically aircraft mishaps and hazards posed by BASH. There would be no changes to the size or configuration of existing APZs/CZs at NAS Patuxent River or OLF Webster.

The existing airspace management practices identified previously (Section 3.5.2.1, Flight Safety) would continue to be practiced.

Under the No Action Alternative, there would be no changes to airfields used, aircraft mix, or annual level of flight hours over baseline levels; consequently, the potential for aircraft mishaps or BASH incidents would remain unchanged. As discussed in Section 3.5.2.1 (Flight Safety), the Navy has implemented numerous procedures to minimize the potential for an aircraft mishap. Additionally, the Navy maintains emergency and mishap response plans to guide responses to aircraft accidents.

The potential for BASH incidents to occur would also remain unchanged over the baseline. As discussed previously, dating back to at least 2008, there has been only one BASH-related Class A mishap. In October 2019, an E-6B aircraft struck a bird during a touch-and-go and sustained damage to one of its four engines. No Class B mishaps have been recorded. The Navy has implemented a robust program designed to reduce aircraft exposure to bird and animal hazards on and about the airfield. The program includes establishment of a BASH Plan and a Bird Hazard Working Group to implement procedures to minimize the potential for bird/aircraft strikes during operations. These procedures may include vegetation manipulation (e.g., cutting lawns/landscaping), bioacoustics (e.g., horns), pyrotechnics (e.g., noise cannons), and use of bird modeling and radar systems. Additionally, airfield users are made aware of potential hazards via radio broadcasts whenever bird/animal activities are observed or reported. If a strike does occur, procedures are established for post-incident reporting and coordination with agencies such as the Naval Safety Center and U.S. Department of Agriculture.

As previously discussed, the risk of an aircraft mishap within designated APZs may create a potential disproportionate safety risk if children are more likely to be exposed. Table 3.5-3 shows that 671 children are estimated to reside within APZ 2 at NAS Patuxent River, and 18 children are estimated to reside within APZ 2 at OLF Webster. Unless there is a place where children congregate within an APZ, such as a school, a disproportionate safety risk to children would not occur. Part of the property area associated with the Lexington Park Elementary School extends to within the APZ 2 at NAS Patuxent River; however, the affected area is wooded and undeveloped. Consequently, disproportionate safety risks to children would not be expected. No schools are located within the existing CZs or APZs at OLF Webster.

Recreational diving within the PRC Study Area takes place primarily at known diving sites, such as shipwrecks and reefs. The locations of these popular dive sites are well documented, dive boats are typically well marked, and diver-down flags are visible from a distance. As a result, dive sites would be easily avoided by vessels conducting testing or training activities. Similar knowledge and avoidance of popular fishing areas would minimize interactions between testing and training activities and recreational fishing.

The public may also encounter MEM, such as pieces of plastic or fabric that wash up on the shore. Most of this material does not pose a potential for safety impacts; however, other items, such as marine markers and flares, may pose potential safety impacts. Illumination flares, such as the ones expended over the Bay by military aircraft to use as markers, contain chemicals designed to burn at high intensity, allowing them to be visible from long distances. The chemicals (e.g., phosphorous) in unexpended or partially burned markers or flares can reignite when exposed to air or water, resulting in severe burns if handled. The rates associated with the failure of these items to ignite as intended (dud rate) is very low. For example, over the last three years, the dud rates for the most used marine marker (MK-59) and illumination flare (LUU-2) have been well under 1 percent. For activities in the Chesapeake Bay Water Range, ATMO personnel would remain in the area until all flares were verified to be extinguished.

With regard to vessel safety, the Navy practices the fundamentals of safe navigation. As specified in Section 3.5.2.4 (Range Safety), vessel operators must be alert at all times, travel at a safe speed for the prevailing conditions, and use state-of-the-art satellite navigational systems and are trained to take proper action to avoid collisions. The Navy also uses highly qualified operators to maintain awareness of the surrounding environment. For some specific testing activities, such as unmanned surface vehicle testing, a support boat would be used in the vicinity of the test to ensure safe navigation. Before releasing a weapon, launching a target, or radiating a laser, ATMO range support boats are required to determine that all safety criteria have been satisfied, which include using their onboard surface search radars to augment their primary responsibility of visual search for detecting low radar cross-section vessels. When applicable, the support boats would use aircraft and other boats to aid in navigation.

Stressors Combined

The acoustics stressor, when considered in conjunction with the physical disturbance/strike stressor and the public interaction stressor, would not result in any combined impacts. For example, the scenario where disproportionate impacts to children would occur with all stressors combined is rare. However, the physical disturbance/strike stressor and the public interaction stressor may pose a potential for combined impacts. Commercial and recreational fishing activities could encounter MEM that could pose a strike risk (physical disturbance/strike), while the public may also encounter MEM that wash up on the shore (public interaction). The potential for direct interaction or a strike between the public and Navy assets or expended materials would not change from current conditions. Established procedures described above (e.g., recovering expended targets and MEM and public avoidance of testing and training areas) would ensure physical disturbance/strike and public interaction stressors, singly or when combined, would not pose unacceptable risks to public health or safety.

3.5.3.2 Public Health and Safety, Alternative 1 Potential Impacts

Under Alternative 1, there would be no change in the type or location of testing and training activities when compared to the No Action Alternative with the exception of using marine markers in the Patuxent River Seaplane Area and testing sonobuoys at the dip points. There would also be an increase in the number of annual flight operations and most non-explosive munitions expended during testing and training. In addition, Alternative 1 would introduce the testing of new directed energy technologies to address new and emerging threats. The following discussion summarizes public health and safety elements under Alternative 1 in terms of how these elements affect identified stressors.

Acoustics

Table 3.5-4 lists census geographic areas subject to aircraft noise levels greater than 65 dBA DNL within the affected environment under Alternative 1. The table includes total population and the percentage of residents under 18 years of age (children) living in each affected census unit. Table 3.5-2 presents noise level ranges and affected populations, including those under 18 years of age, within the affected environment around NAS Patuxent River. (Note: Aircraft noise levels would be less than 65 dBA DNL at all locations on and near OLF Webster under Alternative 1 [Section 3.1.6.3, Installation Noise Environment].)

As shown in Table 3.5-4, under Alternative 1, five census geographic units in the NAS Patuxent River area would be exposed to noise levels between 65 and 70 dBA DNL. However, only two of these census units (within 240378759013 and 240378759021) have potential for disproportional impacts because they include higher percentages of children (26.7 and 30.5 percent, respectively) than St. Mary's County as a whole (24.8 percent). Assuming the population affected by noise above 65 dBA DNL has similar demographic characteristics to the population of its census units, an estimated 658 children would reside in areas affected by noise greater than 65 dBA DNL. This would be an increase of 321 children (658 versus 337) over the No Action Alternative. Also, as discussed in Section 3.1.7.2 (Ambient Airborne Noise, Alternative 1 Potential Impacts) and shown in Table 3.1-14 (Potential Classroom Interference Under Alternative 1), under Alternative 1, two schools would experience noise levels above 60 dBA (A-weighted decibels) (Our Lady Star of the Sea School and Lexington Park Elementary School). Additionally, the number of potential interference events for all nearby schools would increase by a total of seven events per hour over the No Action Alternative (see Table 3.1-14). Proposed flight activities would occur at any time during the day and would not be concentrated during the hours when schools would be in session (e.g., 7:00 a.m. to 3:00 p.m.). Additionally, these activities would occur throughout the year, including periods when schools would not be in session. The percentage of flying events at NAS Patuxent River conducted late at night (i.e., between 10:00 p.m. and 7:00 a.m.) would remain at 1 percent under Alternative 1.

Two factors would constitute an adverse impact to children: (1) the higher population of children in the two census units and (2) increased noise at schools causing speech interference at levels that may hinder the ability of children to learn. As discussed under the No Action Alternative, the limited scientific literature shows there is no definitive correlation between noise-related events and physiological changes in children. Additionally, the aircraft noise associated with the existing operations is intermittent; therefore, the Navy does not anticipate any significant disproportionate health impacts to children caused by aircraft noise.

Table 3.5-4 Total Population and Children Within the Affected Environment – Alternative 1

Census Geographical Area	*Total Population*	*Total Population Affected (65 dBA DNL or greater)*	*Percent Population Aged Under 18*	
			Number	*Percent*
240098609003, Calvert County, MD	1,319	7	1	14.2
240098610032, Calvert County, MD	1,487	57	10	17.1
240378759011, St. Mary's County, MD	2,168	809	135	16.7
240378759013, St. Mary's County, MD	4,081	257	69	26.7
240378759021, St. Mary's County, MD	3,256	1,400	427	30.5
240378759023, St. Mary's County, MD	2,253	110	16	14.7
	Total	**2,640**	**658**	
St. Mary's County, MD	110,979		27,488	24.8

Source: (U.S. Census Bureau, 2019)
Key: dBA = A-weighted decibels; DNL = day-night average sound level; MD = Maryland.

Physical Disturbance/Strike

As discussed under the No Action Alternative, the Navy would continue to conduct testing and training activities at current locations except for the use of marine markers in the Patuxent River Seaplane Area and sonobuoys at the dip points. Because all activities would only occur within designated areas, the potential for a direct physical strike between the public and aircraft, vessels, targets, or expended materials would not change from current conditions. For example, the Seaplane Area is a restricted water (as described in Section 1.3.3.3, Patuxent River Seaplane Area) and off limits to the public. Although the dip points are not restricted, there would be no strike/drop hazards associated with the deployment of sonobuoys at these areas because they would be deployed at low altitudes and visual surveillance would be conducted prior to the test to ensure that the area is clear of nonparticipants. Upon test completion, sonobuoys would be scuttled to avoid any navigation hazard to small vessels.

Testing of new directed energy technologies would occur within the PRC Study Area. Directed energy weapons, such as high-energy lasers, would not pose a physical disturbance/strike hazard; however, increased MEM related to directed energy weapons testing (such as expended UAS targets) may create a physical disturbance/strike hazard. Additionally, the Navy would continue to implement SOPs that protect public health and safety.

Public Interaction

Under Alternative 1, there would be no change to the designated testing and training airspace areas or to the overall manner in which Navy flight activities are conducted, though the average annual flight hours would increase by approximately 16 percent (23,400 flight hours versus 20,100 flight hours) over baseline levels. While the mix of aircraft types may change somewhat over time, this would not affect the overall operating characteristics. The increase in flight operations has a potential to increase the risks for aircraft mishaps. Current aircraft flight-safety policies and procedures (as described in Section 3.5.2.1, Flight Safety) would continue under Alternative 1. Additionally, the increase in the number of flight operations under Alternative 1 would result in a potential for BASH incidents to similarly increase. The overall risks associated with bird-aircraft strikes is expected to remain low. The Navy would continue to implement an aggressive BASH program to minimize the potential for any future bird/wildlife-aircraft strikes, as discussed in Section 3.5.2.2 (Bird/Animal Aircraft Strike Hazards).

As previously discussed, the risk of an aircraft mishap within designated APZs may create a potential disproportionate safety risk, if children are more likely to be exposed. As shown on Table 3.5-3, 671 children are estimated to reside within APZ 2 at NAS Patuxent River, and 18 children are estimated to reside within APZ 2 at OLF Webster. Population growth trends based on 2000, 2010, and 2017 census data show an average 1.43 percent annual population growth for counties within the PRC Study Area (U.S. Census Bureau, 2000; 2010; 2017a). This continued trend would potentially result in minor future increases for populations including children residing within the APZs at NAS Patuxent River and OLF Webster. However, unless there is a place where children congregate within an APZ, such as a school, a disproportionate safety risk to children would not occur.

As discussed above, there would also be no hazards associated with deployment of sonobuoys at the dip points as these would be scuttled upon test completion to avoid any navigation hazard to small vessels.

Testing with directed energy weapons, such as high-energy lasers and high-power microwaves, would follow strict procedures to ensure that nonparticipants are not exposed to intense light energy. As discussed in Section 3.5.2.4 (Range Safety), laser safety procedures for aircraft would include an initial pass over the target to ensure that target areas are clear. On-scene ATMO range support boats would also be used to ensure that all laser safety criteria have been satisfied. During testing, the high-power microwave system would be turned on for an average of three seconds per firing event with up to two firing events per day. All high-power microwave events would be conducted in accordance with the electromagnetic safety radiation SOPs and guidance documents indicated in Table 2.5-1 (Standard Operating Procedures).

Stressors Combined

The acoustics stressor, when considered in conjunction with the physical disturbance/strike stressor and the public interaction stressor, would not result in any combined impacts. The potential for combined impacts from the physical disturbance/strike and the public interaction stressors would be greater than under the No Action Alternative due to the increased operations. Regardless, established procedures described above would ensure that the physical disturbance/strike and public interaction stressors would pose no unacceptable risks to public health or safety.

3.5.3.3 Public Health and Safety, Alternative 2 (Preferred Alternative) Potential Impacts

Under Alternative 2, there would be no change in the type or location of testing and training activities when compared to the No Action Alternative with the exception of using marine markers in the Patuxent River Seaplane Area and testing sonobuoys at the dip points. There would be an increase in the number of annual flight operations and non-explosive munitions expended during testing and training. Alternative 2 would introduce the testing of new directed energy technologies to address new and emerging threats. The following discussion summarizes public health and safety elements under Alternative 2 in terms of how these elements affect identified stressors.

Acoustics

Table 3.5-5 lists census geographic areas subject to aircraft noise levels greater than 65 dBA DNL within the affected environment under Alternative 2. The table includes total population and the percentage of residents under 18 years of age (children) living in each affected census unit. Table 3.5-2 presents noise level ranges and affected populations, including those under 18 years of age, within the affected environment around NAS Patuxent River. (Note: Aircraft noise levels would be less than 65 dBA DNL at all locations on and near OLF Webster under Alternative 2 [Section 3.1.6.3, Installation Noise Environment]).

Table 3.5-5 Total Population and Children Within the Affected Environment – Alternative 2

Census Geographical Area	*Total Population*	*Total Population Affected (65 dBA DNL or greater)*	*Percent Population Aged Under 18*	
			Number	*Percent*
240098609003, Calvert County, MD	1,319	11	1	14.2
240098610032, Calvert County, MD	1,487	83	14	17.1
240378759011, St. Mary's County, MD	2,168	1,010	169	16.7
240378759013, St. Mary's County, MD	4,081	314	84	26.7
240378759021, St. Mary's County, MD	3,256	1,517	463	30.5
240378759023, St. Mary's County, MD	2,253	137	20	14.7
	Total	**3,072**	**751**	
St. Mary's County, MD	110,979		27,488	24.8

Source: (U.S. Census Bureau, 2019)
Key: dBA = A-weighted decibels; DNL = day-night average sound level; MD = Maryland.

As shown in Table 3.5-5, under Alternative 2, six census geographic units in the NAS Patuxent River area would be exposed to noise levels between 65 and 70 dBA DNL. However, only two of these census units (within 240378759013 and 240378759021) pose a potential for disproportional impacts because they include higher percentages of children (26.7 and 30.5 percent, respectively) than St. Mary's County as a whole (24.8 percent). Assuming the population affected by noise above 65 dBA DNL has similar demographic characteristics to the population of its census units, an estimated 751 children would reside in areas affected by noise above 65 dBA DNL. This would be an increase of 414 children (751 versus 337) over the No Action Alternative. Also, as discussed in Section 3.1.7.3 (Ambient Airborne Noise, Alternative 2 (Preferred Alternative) Potential Impacts) and shown in Table 3.1-21 (Speech Interference Events Per Average Daytime Hour Under Alternative 2), under Alternative 2, two schools would experience noise levels above 60 dBA (Our Lady Star of the Sea School and Lexington Park Elementary School). Additionally, the number of potential interference events for all nearby schools would increase by a total of 10 events per hour over the No Action Alternative (see Table 3.1-22, Potential Classroom Interference Under Alternative 2). The percentage of flying events at NAS Patuxent River conducted late at night (i.e., between 10:00 p.m. and 7:00 a.m.) would remain at 1 percent under Alternative 2.

Two factors would constitute an adverse impact to children: (1) the higher population of children in the two census geographic areas and (2) increased noise at schools causing speech interference at levels that may hinder the ability of children to learn. As discussed under the No Action Alternative, the limited scientific literature shows there is no definitive correlation between noise-related events and physiological changes in children. Additionally, the aircraft noise associated with the existing operations is intermittent; therefore, the Navy does not anticipate any significant disproportionate health impacts to children caused by aircraft noise.

Physical Disturbance/Strike

Under Alternative 2, there would be an increase in the number of annual operations and non-explosive munitions expended during testing and training. In addition, testing of new directed energy technologies would occur within the PRC Study Area. Directed energy weapons, such as high-energy lasers, would not pose a physical disturbance/strike hazard; however, increased MEM related to directed energy weapons testing (such as expended UAS targets) may create a physical disturbance/strike hazard. All activities would only occur within designated areas, minimizing the potential for a direct physical strike with the public. Additionally, the Navy would continue to implement SOPs that protect public health and safety.

Public Interaction

Under Alternative 2, there would be no change to the designated testing and training airspace areas or to the overall manner Navy flight activities are conducted, though the average annual flight hours would increase by approximately 29 percent (26,000 flight hours versus 20,100 flight hours) over baseline levels. While the mix of aircraft types may change somewhat over time, this would not affect the overall operating characteristics. The increase in flight operations has a potential to increase the risks for aircraft mishaps. Current aircraft flight-safety policies and procedures (as described in Section 3.5.2.1, Flight Safety) would continue under Alternative 2. Additionally, the increase in the number of flight operations under Alternative 2 would result in a potential for BASH incidents to similarly increase. The overall risks associated with bird-aircraft strikes is expected to remain low. The Navy would continue to implement an aggressive BASH program to minimize the potential for any future bird/wildlife-aircraft strikes.

Testing with directed energy weapons, such as high-energy lasers and high-power microwaves, would follow strict procedures to ensure that nonparticipants are not exposed to intense light energy. As discussed in Section 3.5.2.4 (Range Safety), laser safety procedures for aircraft would include an initial pass over the target to ensure that target areas are clear. On-scene ATMO range support boats would also be used to ensure all laser safety criteria have been satisfied. During testing, the high-power microwave system would be turned on for an average of three seconds per firing event with up to two firing events per day. All high-power microwave events would be conducted in accordance with the electromagnetic safety radiation SOPs and guidance documents indicated in Table 2.5-1 (Standard Operating Procedures).

As with Alternative 1, a disproportionate safety risk to children from the presence of the APZs would not occur under Alternative 2.

Stressors Combined

The acoustics stressor, when considered in conjunction with the physical disturbance/strike stressor and the public interaction stressor, would not result in any combined impacts. The potential for combined impacts from the physical disturbance/strike and the public interaction stressors would be greater than under the No Action Alternative due to the increased operations. Regardless, established procedures described above would ensure that the physical disturbance/strike and public interaction stressors would pose no unacceptable risks to public health or safety.

3.5.3.4 Alternatives Impact Summary

Summary of Impacts, Public Health and Safety

The Navy would continue to employ established safety requirements and protocols, as discussed in Section 2.5 (Table 2.5-1, Standard Operating Procedures) and Section 3.5.2.4 (Range Safety), related to the safe operation of electromagnetic, laser, and other such systems.

Acoustic:

No Action Alternative

- The Navy does not anticipate any significant disproportionate health impacts to children caused by aircraft noise (acoustics stressor). Potential impacts related to the physical disturbance/strike and public interaction stressors would be minor and established procedures would ensure that these stressors would not pose unacceptable risks to public health or safety.

Alternative 1

- There would be no disproportionate health impacts to children caused by aircraft noise (acoustics stressor). Increased operations would result in an increase in the number of children experiencing noise levels above 65 dBA DNL.

Alternative 2 (Preferred Alternative)

- Although operations would increase under this alternative, impacts would be the same as under Alternative 1.

Physical Disturbance/Strike:

No Action Alternative

- Release of non-explosive munitions primarily occurs in the Chesapeake Bay Water Range and is focused around the munition concentration areas, limiting the potential for striking the public. Additionally, the Navy would continue to implement SOPs that protect public health and safety. The Navy recovers expended UAS targets and surface targets to the extent practicable, to avoid them becoming a collision risk. Unrecoverable pieces of MEM are typically small (such as sonobuoys), constructed of soft materials (such as foam-filled plastic), or intended to sink to the bottom after their useful function is completed and, therefore, would not pose a strike risk to civilian vessels or equipment.

Alternative 1

- Although operations would increase under this alternative, impacts would be the same as under No Action Alternative because the Navy would continue to implement SOPs that protect public health and safety.

Alternative 2 (Preferred Alternative)

- Although operations would increase under this alternative, impacts would be the same as under No Action Alternative because the Navy would continue to implement SOPs that protect public health and safety.

Public Interaction:

No Action Alternative

- Under the No Action Alternative, there would be no changes to airfields used, aircraft mix, or annual level of flight hours over baseline levels; consequently, the potential for aircraft mishaps or BASH incidents would remain unchanged. Dive sites would be easily avoided by vessels conducting testing or training activities. Similar knowledge and avoidance of popular fishing areas would minimize interactions between testing and training activities and recreational fishing. The public may encounter MEM; however, most of this material does not pose a potential for safety impacts. ATMO personnel would remain in the area until all flares were verified to be extinguished. With regard to vessel safety, the Navy practices the fundamentals of safe navigation, requiring that vessel operators must be alert at all times, travel at a safe speed for the prevailing conditions, use state-of-the-art satellite navigational systems, and are trained to take proper action to avoid collisions.

Alternative 1

- Increased operations would increase the potential for flight mishap and BASH incidents, but established management strategies would minimize risk. There would be no change over existing conditions for potential impacts associated with vessels or MEM. Testing with directed energy weapons systems would follow strict procedures to ensure that nonparticipants are not exposed to these systems.

Alternative 2 (Preferred Alternative)

- Although operations would increase, impacts would be the same as under Alternative 1 because the same SOPs that protect public health and safety would continue.

Combined Stressors:

No Action Alternative

- The acoustics stressor, when considered in conjunction with the physical disturbance/strike stressor and the public interaction stressor, would not result in any combined impacts. However, the physical disturbance/strike stressor and the public interaction stressor may pose a potential for combined impacts. Commercial and recreational fishing activities could encounter MEM that could pose a strike risk (physical disturbance/strike), while the public may also encounter MEM that wash up on the shore (public interaction). The potential for direct interaction or a strike between the public and Navy assets or expended materials would not change from current conditions. Established procedures described above (e.g., recovering expended targets and MEM and public avoidance of testing and training areas) would ensure physical disturbance/strike and public interaction stressors, singly or when combined, would not pose unacceptable risks to public health or safety.

Alternative 1

- The potential for combined impacts from the physical disturbance and the public interaction stressors would be greater than under the No Action Alternative due to the increased operations. Regardless, established procedures described above would ensure the physical disturbance and public interaction stressors would pose no unacceptable risks to public health or safety.

<u>Alternative 2 (Preferred Alternative)</u>

- The potential for combined impacts from the physical disturbance and the public interaction stressors would be greater than under the No Action Alternative due to the increased operations. Regardless, established procedures described above would ensure that the physical disturbance and public interaction stressors would pose no unacceptable risks to public health or safety.

3.6 Land Use

This discussion of land use includes compatibility with current and planned land uses and the regulations, policies, or zoning that may control the proposed land use. The term *land use* refers to real property classifications that indicate either natural conditions or the types of human activity occurring on a parcel. Two main objectives of land use planning are to ensure orderly growth and compatible uses among adjacent property parcels or areas. However, there is no nationally recognized convention or uniform terminology for describing land use categories. As a result, the meanings of various land use descriptions, labels, and definitions vary among jurisdictions. Natural conditions of property can be described or categorized as unimproved, undeveloped, and natural or scenic areas. There is a wide variety of land use categories resulting from human activity. Descriptive terms often used include residential, commercial, industrial, agricultural, and public/quasi-public. Outdoor recreation is often an associated use of public/quasi-public land.

Land use is interrelated with other resource areas including noise, biological resources, public health and safety, and socioeconomics. Impacts on those resource areas are discussed in Sections 3.1 (Ambient Airborne Noise), 3.4 (Biological Resources), 3.5 (Public Health and Safety), and 3.7 (Socioeconomics), respectively. The impact analysis for this Environmental Impact Statement (EIS) for land use focused on those areas affected by the continuance of military testing and training activities in the Patuxent River Complex (PRC) Study Area to meet current and projected military readiness requirements. This analysis relies not only on zoning designations but also on compatible land use recommendations in Accident Potential Zones (APZs) (Section 3.5) and day-night average sound level (DNL) noise contours, as defined by the *Air Installations Compatible Use Zones Report for Naval Air Station Patuxent River, Patuxent River, Maryland* (U.S. Department of the Navy, 2009b).

3.6.1 Land Use, Regulatory Setting

Land use descriptions are often integrated into installation master planning documents and programs as well as local zoning laws. Local planning authorities use comprehensive planning to achieve community goals and aspirations for community development. The result is typically called a comprehensive plan or master plan that both expresses and regulates public policies on transportation, utilities, land use, recreation, and housing. In Maryland, the Maryland Department of Planning is the regulatory instrument used to implement planning goals and objectives.

The Office of the Chief of Naval Operations Instruction (OPNAVINST) 11010.40A establishes an encroachment management program to ensure operational sustainment that has direct bearing on land use planning on installations (U.S. Department of the Navy, 2020c). Additionally, the joint instruction OPNAVINST 11010.36C and Marine Corps Order 11010.16 provides guidance administering the Air Installations Compatible Use Zones (AICUZ) program (U.S. Department of the Navy, 2008a). The AICUZ program recommends land uses that are compatible with noise levels, accident potential, and obstruction clearance criteria for military airfield operations. OPNAVINST 3550.1A and Marine Corps Order 3550.11 provide guidance for a similar program, the Range AICUZ (RAICUZ). This program includes range safety and noise analyses and provides land use recommendations compatible with range compatibility zones and noise levels associated with military range operations (U.S. Department of the Navy, 2009b).

The AICUZ program was established in the early 1970s by the Department of Defense (DoD) to balance the need for aircraft operations with community concerns over aircraft noise and accident potential. The program goals are to protect the safety, welfare, and health of those who live and work near military airfields while preserving the military flying mission. Airfield safety footprints are identified (per AICUZ program parameters) and categorized into APZs, Clear Zones, and noise contours. Refer to Section 3.5 (Public Health and Safety) for more information on APZs.

Coastal zones are the interface between the land and water. In an effort to implement management measures that would restore and protect coastal waters, Congress enacted the Coastal Zone Management Act (CZMA). The CZMA of 1972 (16 United States Code 1451 et seq.), as amended through the Coastal Zone Reauthorization Amendments of 1990 and the Coastal Zone Protection Act of 1996, requires federal agencies to ensure development projects in the coastal zone are, to the maximum extent practicable, consistent with the enforceable policies of the approved state Coastal Zone Management Plans (CZMPs). However, federal lands, which are “lands the use of which is by law subject solely to the discretion of the Federal Government, its officers, or agents,” are statutorily excluded from the state’s “coastal uses or resources.” If, however, the proposed federal activity affects coastal uses or resources beyond the boundaries of the federal property (i.e., has spillover effects), the CZMA Section 307 federal consistency requirement applies.

CZMPs are based on federal laws, such as Section 404 of the Clean Water Act of 1977, and incorporate a number of state laws and authorities, such as the Chesapeake Bay Critical Area Law and Program, the Tidal Wetlands Act of 1970, the Nontidal Wetlands Protection Act of 1989, state erosion and sediment control laws, and the state Stormwater Management Act. Enforceable policies are given legal effect by state law and do not apply to federal lands, waters, or agencies or other areas or entities outside of a state’s jurisdiction unless authorized by federal law (CZMA does not confer such authority).

Coastal programs coordinate with the federal consistency review process as authorized under the CZMA. This provision allows states to review federal actions that may affect coastal uses and/or resources. As a federal agency, the Navy is required to determine whether its proposed activities would affect the coastal zone. This takes the form of a consistency determination, a negative determination, or a determination that no further action is necessary.

3.6.2 Land Use, Affected Environment

The following discussions provide a description of the existing conditions for the land use resources in the PRC Study Area. Because the Proposed Action does not include changes to land use within the boundaries of the installations or at Bloodsworth Island Range, this section focuses on land uses in surrounding areas beneath the PRC airspace.

Land uses include commercial, industrial, open/agricultural, public/quasi-public, residential, and undesignated areas. These land use categories are described below:

- **Commercial.** Offices, retail, restaurants, and other types of commercial establishments. For this analysis, airfields other than the PRC installation airfields were classified as commercial.
- **Industrial.** Includes manufacturing, warehousing, and other similar uses.
- **Open/agricultural.** Includes undeveloped land areas, agricultural areas, and grazing lands. This land could include single-family residences located on an agricultural parcel and areas with residential densities less than or equal to one dwelling unit per acre.

- **Public/quasi-public.** Publicly owned lands and/or land to which the public has access, including military installations, public buildings, schools, churches, cemeteries, hospitals, parks and publicly owned natural areas.
- **Residential.** Includes all types of residential housing (e.g., single- and multi-family residences and mobile homes) at a density greater than one dwelling unit per acre.

3.6.2.1 Land Use Compatibility

Land use compatibility includes an existing or committed land use or activity that can coexist with a neighboring use/activity or uses/activities without either creating or experiencing one or more off-site adverse effect(s). The objectives of compatible land use planning are to discourage land uses that are generally considered to be incompatible with proposed military activities and to encourage land uses that are more compatible.

The Navy has developed noise mitigation and monitoring measures, including public outreach and communications. In addition, the Navy’s noise abatement programs include establishing a real estate disclosure clause to notify prospective buyers of potential impacts from nearby military installations; working with planning and zoning commissions throughout the Southern Maryland region to address development in potentially impacted areas; and maintaining a toll-free Noise Disturbance hotline, which the public may use to report noise disturbance.

The region of influence for the land use compatibility assessment for this EIS is the land surrounding Naval Air Station (NAS) Patuxent River and Outlying Field (OLF) Webster, including the projected DNL noise contours (Figure 3.6-1 and Figure 3.6-2, respectively). Land use analysis compared existing land use surrounding these PRC installations with land use compatibility recommendations under the AICUZ program. The land underlying the PRC airspace used for testing and training activities is also described more generally for the wider region of influence.

NAS Patuxent River Adjacent Land Use

Waters of the Chesapeake Bay and Patuxent River surround NAS Patuxent River (Figure 3.6-1). Land use to the north of NAS Patuxent River, across the Patuxent River, includes Drum Point, a residential area bisected by a state highway Maryland Route 760 (MD 760). The Solomon’s Island area of Calvert County lies to the northwest of the installation and includes single-family residential, mixed-use, recreation, commercial, and uses supporting tourism. The installation is bordered by the six-lane state highway MD 235 corridor to the west and the Lexington Park community. Land use consists of open/agricultural, public/quasi-public land, commercial development, and residential. Lexington Park features shopping centers, retail, and service businesses, including office buildings, and multistory mixed-use residential areas, with both single- and multi-family residences (St. Mary's County, 2016a). Land use south of the installation includes residential areas, public/quasi-public lands, industrial, and commercial development.

The local planning authority in the NAS Patuxent River area is the St. Mary’s County Department of Land Use and Growth Management. The 2010 *St. Mary’s County, Maryland Comprehensive Plan* (St. Mary's County, 2010) designates the area around NAS Patuxent River as the Lexington Park Development District and provides a separate section of planning and design. This includes the 2016 *Lexington Park Development District Master Plan* (St. Mary's County, 2016a), which serves as an extension of the 2010 *St. Mary’s County, Maryland Comprehensive Plan*.

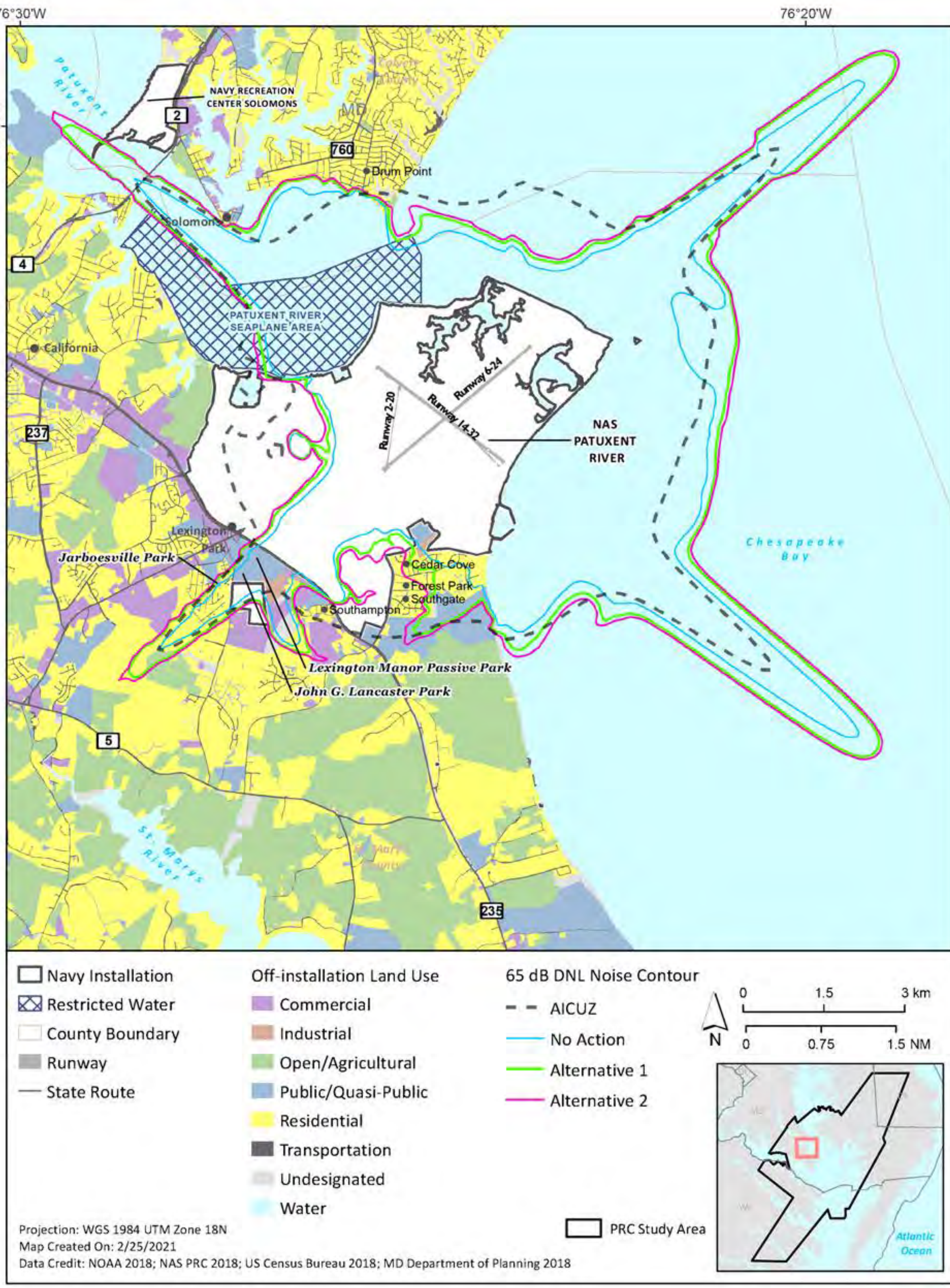

Figure 3.6-1 NAS Patuxent River Adjacent Land Use

Since the introduction of the AICUZ program in the 1970s, there has been an ongoing cooperative effort between the Navy and St. Mary's County to respect both the mission of NAS Patuxent River and the welfare of the surrounding community. In 2019, the commissioners of St. Mary's County and representatives of NAS Patuxent River completed a Joint Land Use Study update as part of the *Maryland Statewide Joint Land Use Study Response Implementation Strategy* (Maryland Department of Commerce, 2019). Additionally, the Tri-County Council for Southern Maryland developed the *Naval Air Station PAX Joint Land Use Study* in an attempt to mitigate existing compatibility issues, facilitate the prevention of future issues (i.e., encroachment, community safety, economic development, and sustainment of military activities and readiness), and improve coordination between the local communities and NAS Patuxent River (Matrix Design Group, 2015). The Joint Land Use Study, or Compatible Use Study, is a common planning process that is conducted around military installations throughout the country to prevent urban encroachment; safeguard the military mission; and protect public health, safety, and welfare. The Joint Land Use Study for NAS Patuxent River was originally completed in January 2015, with participation by the affected jurisdictions (Matrix Design Group, 2015).

In January 2017, the NAS Patuxent River Land Use Impact Study was completed to evaluate impacts on land use for areas surrounding NAS Patuxent River. The study specifically focused on aircraft operations and the continued protection of the health, safety, and welfare of the surrounding communities, as the Navy continuously seeks to encourage additional mission-compatible land uses within the existing AICUZ footprint. The study also focused on the Lexington Park Development District, encompassing the area underneath the AICUZ. Parcels and land use were evaluated and categorized as to their compatibility (U.S. Department of the Navy, 2017h).

NAS Patuxent River operations are compatible with surrounding land uses overall. However, the potential development of residential housing in areas around St. Mary's County may encroach on aircraft testing and training activities. Development in these areas is subject to loud noise and is discouraged to ensure mission compatibility (U.S. Department of the Navy, 2018c). Table 3.6-1 presents the land use classifications and compatibility guidelines for airspace and range operations. The categories used in the analysis and Table 3.6-1 combine various source data land use categories to generally align with those in the AICUZ and RAICUZ guidelines.

Residential areas in Lexington Park and those located along the southern border of the installation in the Southampton, Southgate Park, Cedar Cove, and Forest Park neighborhoods, or adjacent to APZ 1 and APZ 2 of the 2009 AICUZ study (Section 3.5.2.3, Public Health and Safety, Accident Potential Zones), are also a compatibility concern (U.S. Department of the Navy, 2009b). A large number of flight operations and numerous flight tracks persist over this residential area. Additionally, this low- and medium-density residential area is within the 65 A-weighted decibels (dBA) to 70 dBA DNL noise zone, which is not considered compatible under AICUZ guidelines (U.S. Department of the Navy, 2009b). APZs are located south and west of the installation, extending into the Lexington Park, Southampton, and Southgate Park neighborhoods (Figure 3.6-1) (U.S. Department of the Navy, 2009b).

Figure 3.6-1 illustrates that the AICUZ 65 dBA DNL contours extend approximately 3 to 3.5 nautical miles northwest, northeast, southwest, and southeast of Runways 06/24 and 14/32 and result mostly from the straight-in arrivals of fixed-wing jet aircraft. The 65 dBA to 70 dBA DNL noise zone extends into Calvert County to the north and affects a portion of a residential area on Solomon's Island, which is not considered compatible under AICUZ guidelines (U.S. Department of the Navy, 2009b).

Table 3.6-1 AICUZ/RAICUZ Land Use Classifications and Compatibility Guidelines

Land Use Category	***AICUZ Noise Exposure Level (dB ADNL)***				***RAICUZ Noise Compatibility Zones***		
	65–69 dB	***70–74 dB***	***75–79 dB***	***80+ dB***	***Noise Zone 1 <65 dB ADNL <62 dB CDNL <87 dB PK_{15}***	***Noise Zone 2 65 to <75 dB ADNL 62 to <70 dB CDNL 87 to <104 dB PK_{15}***	***Noise Zone 3 ≥75 dB ADNL ≥70 dB CDNL ≥104 dB PK_{15}***
Residential	No[1]	No[2]	No	No	Yes	No[4]	No
Industrial	Yes	Yes	Yes[2]	Yes[2]	Yes	Yes[5]	Yes[5]
Commercial	Yes[3]	Yes[3]	Yes[3]	No	Yes	Yes[5]	Yes/No[5]
Public/quasi-public	Yes[3]	Yes[3]	Yes[3]	No	Yes	Yes[5]	No
Open space/agriculture	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transportation	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Key: < = less than; ≥ = greater than or equal to; ADNL = A-weighted day-night average sound level; AICUZ = Air Installation Compatible Use Zone; CDNL = C-weighted day-night average sound level; dB = decibels; DNL = day-night average sound level; PK_{15} = single-event peak level exceeded by 15 percent of events (sound); RAICUZ = Range Air Installations Compatible Use Zone.

Notes:

This generalized land use table provides an overview of recommended land use. To determine specific land use compatibility measures, see OPNAVINST 3550.1A and 11010.36C

1. Measures to achieve recommended noise-level reduction (25 to 30 dB DNL) should be incorporated into the design and construction of the structures.
2. Measures to achieve recommended noise-level reduction should be incorporated into the design and construction of the structures.
3. Land use and related structures are generally compatible; however, measures to achieve recommended noise-level reduction should be incorporated into the design and construction of the structures.
4. Residential use is discouraged. Measures to achieve recommended noise-level reduction should be incorporated into the design and construction of the structures.
5. Land use and related structures are generally compatible; however, measures to achieve recommended noise-level reductions (25- to 35-dB noise-level reduction) should be incorporated into design and construction.

Outlying Field Webster Adjacent Land Use

OLF Webster is located 12 miles southwest of NAS Patuxent River. Adjacent land uses include open/agricultural, public/quasi-public, and residential areas (Figure 3.6-2). The residential areas adjacent to OLF Webster are located to the east, off Villa and Beachville Roads. These areas include the small, rural farming, fishing, and crabbing communities of St. Inigoes. A number of coves and creeks that connect to the St. Mary’s River border these areas.

Four APZs and Clear Zones located north, south, east, and west of the installation. The northern and western APZs extend over the water, while the eastern and southern APZs cross over residential, public/quasi-public, and open agriculture land use areas (Section 3.5.2.3, Public Health and Safety, Accident Potential Zones). Noise levels within the vicinity of OLF Webster do not exceed 65 dBA DNL, as shown on Figure 3.6-2.

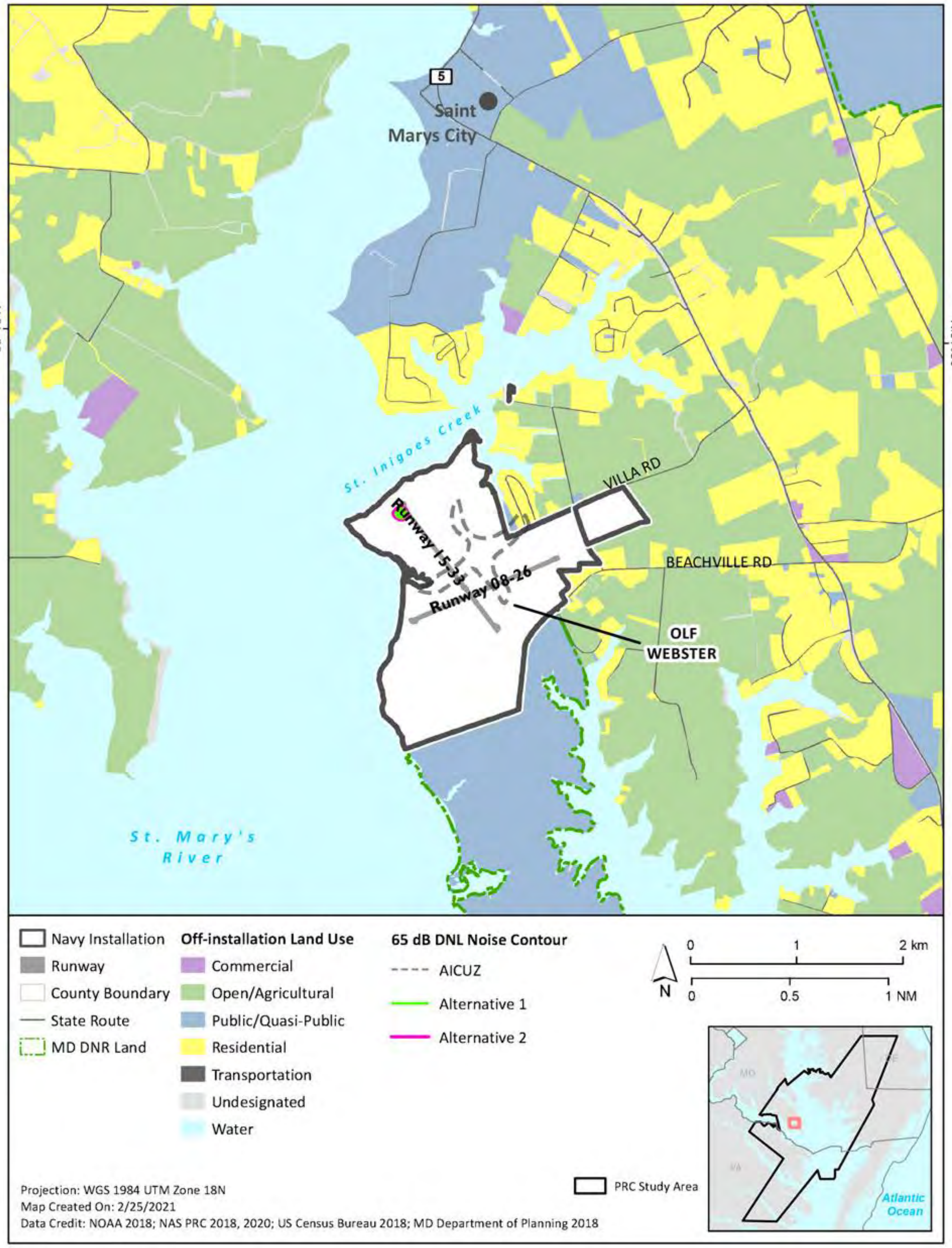

Figure 3.6-2 OLF Webster Adjacent Land Use

Regional Land Use (Beneath the PRC Airspace)

In Maryland, the PRC airspace partially or wholly overlies the counties of Calvert, Caroline, Dorchester, St. Mary's, Somerset, Talbot, and Wicomico. In Virginia, the PRC airspace overlies portions of Accomack, Charles City, Gloucester, King and Queen, Lancaster, Mathews, Middlesex, New Kent, Northumberland, Richmond, Westmoreland, and Williamsburg Counties. In Delaware, the PRC airspace overlies portions of Kent and Sussex Counties.

The predominant land uses underlying PRC airspace are residential, public/quasi-public, open space/agricultural, and commercial. This mixed pattern is consistent throughout southwest Delaware, Southern Maryland, the Eastern Shore of Maryland, and the Northern Neck of Virginia. Since the mid-1970s, however, the Maryland portion of the PRC Study Area has experienced an increase in land development with new low-density suburban residential and commercial development. Those portions nearest to metropolitan centers have grown the quickest, particularly western St. Mary's County and southern Calvert County. In particular, the new development is concentrated along MD 235 and in the Lexington Park area adjacent to the NAS Patuxent River boundary (Figure 3.6-1). New development is also noticeable in the Solomon's Island area with the new Solomon's Town Center containing a wide variety of businesses and the commercial tourism strip along the Patuxent River (U.S. Department of the Navy, 2009b). Despite residential growth, much of the landscape is still largely dominated by agriculture. According to estimates from the U.S. Department of Agriculture Natural Resources Conservation Service, there are more than 83,000 farm operations within the Chesapeake Bay area that produce more than 50 commodities, including poultry, corn, soybeans, wheat, fruits, and vegetables.

Recreation and Protected Areas

Land use analysis also considers the effects of noise on special management areas such as recreation and wildlife areas. Special management areas are generally natural areas within the PRC Study Area that are managed by different federal and state agencies to preserve valued resources. Within the PRC Study Area, these lands include areas managed by the U.S. Fish and Wildlife Service, U.S. Forest Service, National Park Service, Delaware Department of Natural Resources and Environmental Control, Maryland Department of Natural Resources, Virginia Department of Conservation and Recreation, and various state and county parks and recreation commissions. These recreation and protected areas are shown in Figure 3.6-3. Laws and regulations applicable to federal and state special management areas vary in scope and authority, depending on the purposes for which these areas were designated.

The primary uses of special management areas underlying the PRC airspace include outdoor recreational activities, including a wide variety of state and local parks, playgrounds, walking paths, sports fields, golf courses, river walks, forests, and natural areas. These lands include one National Wildlife Refuge (NWR) Complex, 22 wildlife areas/wildlife management areas, 17 natural areas, 5 state forests, 36 parks, and 13 open-space and open-water areas. There are several parks in the vicinity of PRC installations, including St. Mary's City Historical Park, Carver Heights Community Park, Point Lookout State Park, Lexington Manor Passive Park, Jarboesville Park, and John G. Lancaster Park. Note that John G. Lancaster Park is a Navy-owned park that is leased to St. Mary's County for recreational purposes. Current AICUZ noise exposure levels in all these areas underlying the PRC airspace are below 55 dBA onset-rate adjusted monthly DNL (L_{dnmr}) with the exception of three parks. Jarboesville Park and John G. Lancaster Park both experience noise exposure above 65 but less than 70 dBA DNL, and Lexington Manor Passive Park has areas exposed to levels greater than 70 dBA DNL but less than 75 dBA DNL. These noise exposure levels are generally considered compatible with outdoor recreation under AICUZ guidelines. In 2014, the Navy, St. Mary's County, The Conservation Fund, and Maryland Department of Natural Resources protected a 223-acre property slated for development south of the installation within the 60 to 70 dBA DNL AICUZ noise contours (as identified in the 2009 AICUZ study). St. Mary's County owns the property in fee and plans to turn it into a public park with water access (St. Mary's County, 2017), while the Navy retains an easement.

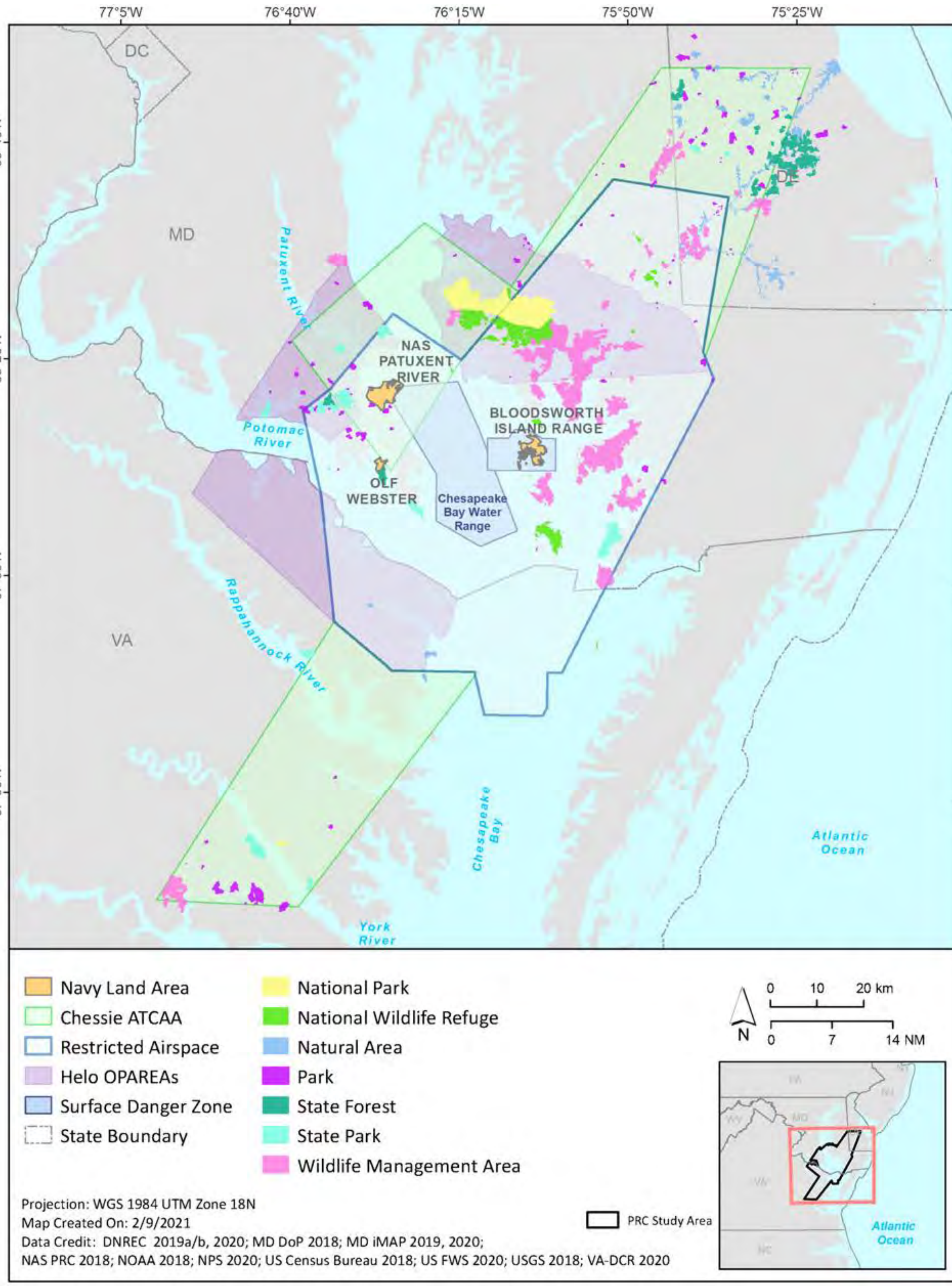

Figure 3.6-3 PRC Study Area Recreation and Protected Areas Under the Airspace

The Chesapeake Marshlands NWR Complex consists of approximately 39,441 acres and includes the Blackwater NWR, Eastern Neck NWR, Martin NWR and Susquehanna NWR (U.S. Fish and Wildlife Service, 2017). Approximately 37,061 acres (or 94 percent) of the complex underlie the PRC airspace.

Since 2010, NAS Patuxent River and the ATR have successfully preserved more than 11,000 acres in the PRC Study Area through extensive partnership between local communities and conservation groups. This conservation effort was completed through the DoD Readiness and Environmental Protection Integration (REPI) Program. The REPI Program supports cost-sharing agreements among military services, private conservation organizations, and state and local governments in order to secure land interests, such as easements, from willing landowners near military installations and ranges. REPI easements restrict certain uses to ensure land remains compatible with the military mission and serve as a key tool for combating encroachment.

3.6.2.2 Coastal Zone Management

Testing and training activities may involve use of shorelines at PRC installations, where operations and interface with nonmilitary water-based activities are controlled or restricted. None of these operations would directly impact public or private on-land activities or uses, as there is a 75-yard buffer from the shoreline at the installation. Additionally, operations are monitored for compatibility over time.

NAS Patuxent River, OLF Webster, Bloodsworth Island Range, and Chesapeake Bay Water Range are located within the coastal zone of Maryland. The Chesapeake and Coastal Service of the Maryland Department of Natural Resources is the lead state agency for coastal management and is responsible for enforcing Maryland’s federally approved coastal management plan. Portions of the PRC Study Area airspace extend over Virginia and Delaware. In Virginia, the Virginia Department of Environmental Quality serves as the lead agency that enforces the CZMP. In Delaware, the Delaware Department of Natural Resources and Environmental Control serves as the lead agency that enforces the CZMP.

As a component of the Maryland CZMP, the Chesapeake Bay Critical Area Program implements comprehensive plans and policies to protect land and water resources in the Chesapeake Bay Critical Area. Land use development standards and requirements established in the program are intended to foster more sensitive development activity for shoreline areas and minimize the adverse impacts of development and land use activities on water quality and natural resources. The State Critical Area includes all nonfederal land within 1,000 feet of the Bay and its tidal tributaries.

While there is legally no State Critical Area on NAS Patuxent River, the spirit of the law is captured by designation of 1,000-foot shoreline protection areas and 100-foot shoreline buffers. See Maps V-8 and V-9 in Annex V-B of the *2017 Integrated Natural Resources Management Plan* for an illustration of the shoreline protection zones for NAS Patuxent River and OLF Webster, respectively (U.S. Department of the Navy, 2017c).

Any actions within these areas are reviewed for impacts to state coastal resources, such as wetlands and tidal waters. In an effort to streamline these reviews, the DoD Regional Environmental Council worked with the state and applicable installations to complete a Memorandum of Understanding between DoD and Maryland concerning CZMA requirements and implementation of enforceable policies of Maryland’s CZMP. Additionally, lists of *de minimis* and environmentally beneficial activities were prepared and, as agreed to by both parties, may generally be carried out without further CZMA review or consultation. Examples of *de minimis* activities include exterior painting of buildings, repair of building foundations, routine grounds maintenance, and installation of devices to protect humans or animal life. Examples of environmentally beneficial activities include stormwater refits, vegetative invasive species management in accordance with installation’s approved *Integrated Natural Resources Management Plan*, and wetland creation and enhancement that does not involve excavation or clearing of forested buffers. The Memorandum of Understanding was signed by DoD and state representatives in May 2013.

Delaware, Maryland, and Virginia have federally approved CZMPs under Section 306 of the CZMA of 1972, as amended. These management plans provide for the protection of natural resources and the husbandry of coastal development. The CZMA provides a procedure for the states to review federal actions for consistency with their own approved coastal management program, and it also provides approved states with matching federal funding to administer their programs (US Department of Commerce, NOAA, February 1997).

Furthermore, Section 307 (c)(1) of the CZMA Reauthorization Amendments of 1979, states that each federal agency conducting or supporting activities affecting any land, water use, or natural resource of the coastal zone must do so in a manner to the maximum extent practicable, consistent with the enforceable policies of each state's CZMP and policies.

The Proposed Action has the potential to affect the coastal zones of Maryland and Virginia; therefore, a Coastal Consistency Determination will be prepared to comply with federal consistency requirements of the CZMA. The Navy has determined that the Proposed Action will not affect the coastal zone of Delaware; therefore, a Negative Determination will be prepared to comply with federal consistency requirements of the CZMA.

3.6.3 Land Use, Environmental Consequences

The location and extent of a proposed action is evaluated for its potential effects on the site of the action and adjacent land uses. Factors affecting a proposed action in terms of land use include its compatibility with on-site and adjacent land uses, restrictions on public access to land, or change in an existing land use that is valued by the community. For this Proposed Action, the effect of noise and compatibility with land uses adjacent to PRC installations and underlying PRC airspace is the primary consideration.

The acoustic stressor may potentially affect land use by impacting land use compatibility with any applicable land use or zoning regulation resulting from changes in noise levels associated with the Proposed Action. Other relevant factors include the types of land uses on adjacent properties and their proximity to the proposed military testing and training activities, the duration of the proposed activities, and their permanence. Land use impacts associated with acoustic stressors for each alternative were calculated reflecting existing standard operating procedures designed to minimize noise impacts (Table 2.5-1, Standard Operating Procedures). In addition, as noted in Section 3.6.2.1 (Land Use Compatibility), the Navy's noise abatement programs would continue to be implemented for all alternatives.

Land Use Compatibility

The analysis was conducted to identify land use categories within the DNL contours under each alternative in terms of land use compatibility adjacent to PRC installations. In addition, for the larger area of potential impact on land underlying the PRC airspace, the assessment considered the impact and compatibility of projected noise levels on general land uses, including recreational uses and protected areas (Table 3.6-1). For developed areas, the noise compatibility guidelines were used as a standard for interpreting impact on land use. No surface activities are proposed that would occur directly within the property boundaries of parks or recreation areas.

As noted in Section 3.6.2.2 (Coastal Zone Management), testing and training activities may involve use of shorelines at PRC installations, where operations and interface with nonmilitary water-based activities are controlled or restricted. Additionally, operations would be monitored for compatibility over time. Continued coordination with surrounding jurisdictions would minimize mutual encroachment into the future.

3.6.3.1 Land Use, No Action Alternative

Under the No Action Alternative, the Navy would continue testing and training activities within the PRC Study Area, as represented in Figure 3.6-4. There would be no changes to regional land use under baseline conditions, as presented in Table 3.6-2.

Table 3.6-2 NAS Patuxent River Adjacent Land Uses Exposed to DNL of 65 dB or Greater – Comparison of Alternatives

Land Use Category	*Noise Exposure dBA DNL (Acres Exposed)*					
	65–70 dBA	*70–75 dBA*	*75–80 dBA*	*80–85 dBA*	*≥85 dBA*	*Total*
			No Action Alternative[1]			
Residential[2]	229	0	0	0	0	**229**
Industrial	54	3	0	0	0	**57**
Commercial	36	0	0	0	0	**36**
Public/quasi-public[3]	164	40	7	1	0	**212**
Open space/ agriculture	1	0	0	0	0	**1**
Transportation	22	2	0	0	0	**24**
Undesignated[4]	35	0	0	0	0	**35**
Total land	**541**	**45**	**7**	**1**	**0**	**594**
Water	6,168	2,334	607	94	3	9,206
			Alternative 1 [5]			
Residential[2]	536	1	0	0	0	**537**
Industrial	50	19	0	0	0	**69**
Commercial	61	0	0	0	0	**61**
Public/quasi-public[3]	284	83	7	1	0	**375**
Open space/ agriculture	23	0	0	0	0	**23**
Transportation	36	3	0	0	0	**39**
Undesignated[4]	54	0	0	0	0	**54**
Total land	**1,044**	**106**	**7**	**1**	**0**	**1,158**
Water	7,400	3,166	807	161	7	11,541
			Alternative 2 [6]			
Residential[2]	627	18	0	0	0	**645**
Industrial	45	25	0	0	0	**70**
Commercial	68	8	0	0	0	**76**
Public/quasi-public[3]	342	92	8	1	0	**443**
Open space/ agriculture	29	0	0	0	0	**29**
Transportation	46	5	0	0	0	**51**
Undesignated[4]	38	18	0	0	0	**56**
Total land	**1,195**	**166**	**8**	**1**	**0**	**1,370**
Water	7,576	3,467	903	197	10	12,153

Sources: (Maryland Department of Planning, 2018)

Key: ≥ = greater than or equal to; dBA = A-weighted decibels; DNL = day-night average sound level; NAS = Naval Air Station.

Notes:

1. Total area affected by noise levels of 65 dBA DNL or above, including water, equals 9,800 acres.
2. Residential includes commercial residential, apartments, single-family homes, condominiums, and townhouse development.
3. Includes outdoor recreation areas, schools and hospitals
4. Spatial data specifies no land use category.
5. Total area affected by noise levels of 65 dBA DNL or above, including water, equals 12,699 acres.
6. Total area affected by noise levels of 65 dBA DNL or above, including water, equals 13,523 acres.

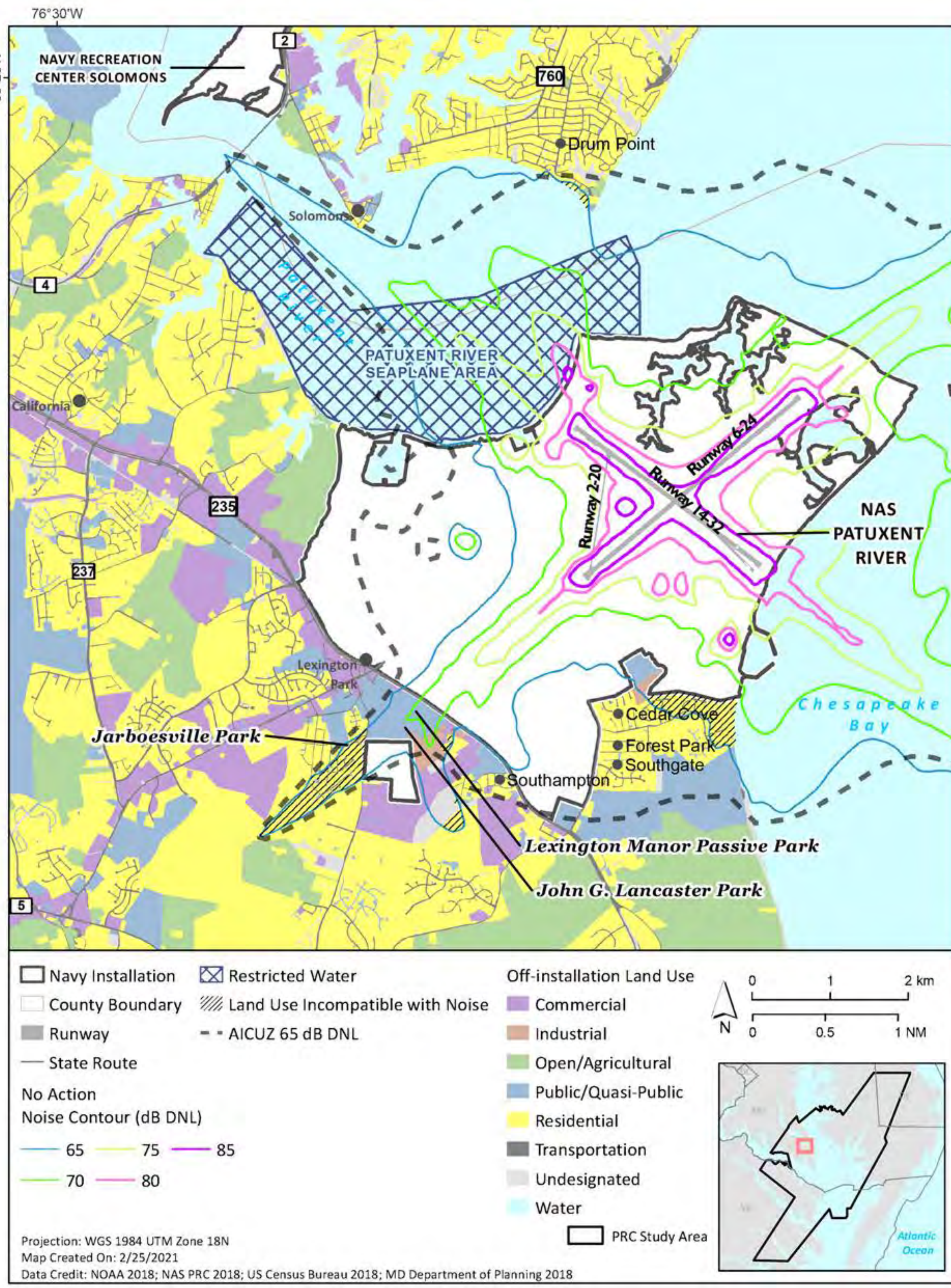

Figure 3.6-4 No Action Alternative Land Use for NAS Patuxent River

NAS Patuxent River Adjacent Areas

Adjacent to NAS Patuxent River, approximately 9,800 acres would be exposed to noise levels of 65 dBA DNL or greater under the No Action Alternative, with 9,206 of these acres occurring over water. The remaining 594 acres exposed to noise levels of 65 dBA DNL or greater would occur over land, including about 230 acres of residential land off the installation. Residential land use is not recommended with this level of noise exposure. The adjacent pocket of residential land consists mostly of housing and community areas and includes 26 acres of apartments and townhouse development. This includes an area directly south of the airfield (Cedar Cove apartments, homes along Keel and Mainsail Drives, homes at the east of Surfside and Sunburst Drives) and to the southwest (a few homes off of MD 235, homes in the neighborhood south of John G. Lancaster Park and south of Jarboesville Park). These areas all fall within the currently defined AICUZ footprint for NAS Patuxent River.

Under the No Action Alternative, about 36 acres of commercial land and 212 acres of public/quasi-public land are generally compatible with noise levels of 65 dBA DNL and greater, although noise-reduction construction may be recommended for future development based on specific proposed uses.

The greatest impulsive (single-event) noise associated with non-explosive munitions and other military expended materials (MEM) would continue to be concentrated around Hannibal and Hooper Target areas or at the Armament Test Area (ATA). No increase in peak munitions noise would occur for these firing locations. Minor increases in the frequency of gunnery and aerial target launches would cause minimal change in DNL for residential areas near the ATA. Sonic booms would remain below 40 dB CDNL on all land areas; sonic boom intensity would remain the same, and munitions noise would remain below 115 dBP (munitions peak noise level) on land (refer to Section 3.1, Ambient Airborne Noise, for more information).

Overall, the No Action Alternative represents a continuation of incompatible noise exposure to a small area of residential land off the installation. Operations under the No Action Alternative would not expose any new surrounding areas to incompatible noise levels compared to the current AICUZ conditions.

Outlying Field Webster Adjacent Land Use

Under the No Action Alternative, there are no areas off the installation exposed to noise levels of 65 dBA DNL or higher at OLF Webster. Using the AICUZ land use compatibility guidelines, no land uses are affected by incompatible noise levels. As described above in Section 3.6.2.1 (Land Use Compatibility, Outlying Field Webster Adjacent Land Use), the southern APZ and Clear Zones extend over some public-use and residential land. Operations under the No Action Alternative would not pose any new risks to surrounding land uses.

Regional Land Use (Beneath the PRC Airspace)

Noise exposure in areas underlying the PRC airspace would range from less than 35 dBA L_{dnmr} to a high of 52.9 dBA L_{dnmr} (Table 3.1-9, Baseline Noise Levels Beneath PRC Airspace). These levels are generally compatible with any land use underlying the airspace (Table 3.6-1). In some areas, low-flying helicopter operations may cause noticeable noise intermittently within the areas underlying the airspace (Figure 3.6-3); however, this noise is part of the past and current noise environment and has not inhibited land uses in the area.

Noise levels exceeding 115-dB peak (dBP) would not occur over any land areas and, therefore, land uses would remain unaffected by this level of noise (Figure 3.1-5, Baseline Munitions Peak Noise Levels (dBP)). As described Section 3.1.6.4 (Range Noise Environment), peak noise levels below 115 dBP have the potential to be disruptive but are typically associated with a low risk of complaints. Land areas along the shoreline to the west of Hooper Target may continue to experience peak noise levels below 115 dBP but greater than 87 dBP; at these levels, land use compatibility guidelines recommend attenuation for structures for residential land uses (Table 3.6-1). Much of the land in this area is rural residential (with very low density) and used for agriculture. Agriculture is compatible with peak levels below 115 dBP.

Recreation and Protected Areas

Effects of noise and overflights on recreational uses and protected areas under the No Action Alternative are essentially the same as described for the affected environment in Section 3.6.2 (Land Use, Affected Environment). Figure 3.1-8 (Noise Levels (dBA L_{dnmr}) Beneath PRC Airspace Areas) shows that the noise levels in the military airspace are below 55 dBA L_{dnmr}. The highest levels currently experienced under restricted area R-4005 (52.9 dBA L_{dnmr}) affect Point Lookout State Park. These levels are compatible with the recreational uses that occur at the park. Other protected areas under PRC airspace would experience noise levels ranging from less than 35 dBA L_{dnmr} to a high of 52.9 dBA L_{dnmr}. Much of this area is over water. These noise levels are generally considered compatible with any land uses underlying PRC airspace, including uses within protected areas. Under the No Action Alternative, three off-base local parks are exposed to noise levels of 65 dBA DNL or greater. Jarboesville Park and John G. Lancaster Park occur within the baseline noise contour of 65 dBA DNL for aircraft noise at NAS Patuxent River. Lexington Manor Passive Park is within the 70 dBA DNL noise contour (Figure 3.6-4). Outdoor recreational use is generally considered compatible with these noise exposure levels under the AICUZ guidelines.

3.6.3.2 Land Use, Alternative 1 Potential Impacts

The land area evaluated for Alternative 1 is composed of the same land and airspace as for the affected environment and the No Action Alternative. The increase in operations would alter the acoustic stressor, thereby potentially impacting land uses.

NAS Patuxent River Adjacent Land Use

An increase in aircraft operations of about 16 percent (Table 2.3-1, Annual PRC Operational Tempo per Alternative: Activities and Assets) under Alternative 1 would involve a similar increase in airfield arrivals and departures. Implementation of Alternative 1 would result in larger DNL noise contours encompassing a larger land area than under the No Action Alternative (Figure 3.6-5). Under Alternative 1, land areas adjacent to NAS Patuxent River exposed to noise levels of 65 dBA DNL would expand from about 594 acres under the No Action Alternative to about 1,158 acres (with an additional 11,541 acres within the noise contour over water) (Table 3.6-2 and Table 3.1-10, Off-Installation Acres and Population Exposed to Elevated Noise Levels Under Alternative 1). Specifically, an additional 308 acres of residential land to the south and southwest of the airfield would be newly exposed to noise levels at or above 65 dBA DNL under this alternative. This change would more than double the residential land exposed to incompatible noise compared to the No Action Alternative. The area that would be newly exposed is mostly public/quasi-public. Specific areas of residential land use newly affected by incompatible noise levels to the south of the airfield include homes along Willis Wharf Court and Mayflower Drive and a small part of the Riverbay Town Homes development. To the southwest, the portions of housing enclaves south of Jarboesville and John G. Lancaster Park that are within the 65 dBA DNL footprint would expand slightly. John G. Lancaster Park is owned by NAS Patuxent River and leased to St. Mary's County. Therefore, in the portion of John G. Lancaster Park that is beneath PRC airspace, activities are required to adhere to the AICUZ compatibility guidelines.

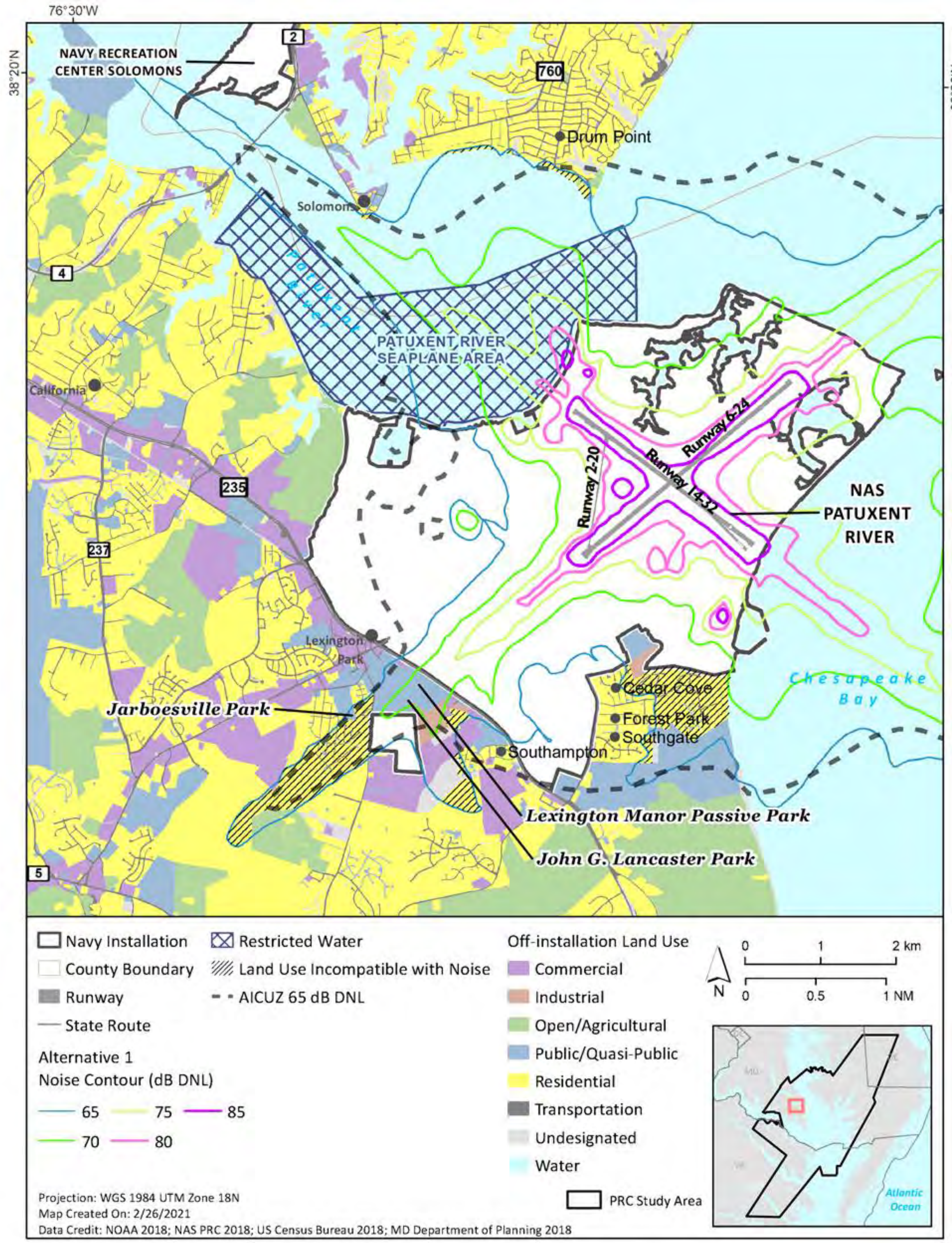

Figure 3.6-5 Alternative 1 Land Use for NAS Patuxent River

Noise associated with non-explosive munitions, and other MEM would increase slightly at Hannibal and Hooper Target areas as well as at the ATA. As noted in Section 3.1.7.2 (Ambient Airborne Noise, Alternative 1 Potential Impacts), gun firing at the ATA would continue to generate peak noise levels at the residences closest to the source (in the Cedar Cove area) that are associated with a moderate risk of complaints (i.e., between 115 and 130 dBP). Frequency of gun firing would increase slightly under Alternative 1, but these events would remain relatively infrequent, and the C-weighted DNL (CDNL) below 62 dB CDNL would not exceed land use compatibility noise level thresholds (e.g., 65 dB DNL) at off-installation locations. Noise from aerial target launches would continue to generate noise levels comparable to maximum sound levels of a jet aircraft overflight (see Table 3.1-12, Individual Overflight Noise Levels) and would not add measurably to DNL from a slight increase in the frequency of these operations. Affected residential areas would experience minimal change in compatibility conditions.

Sonic boom and munitions noise levels would remain below 40 dB CDNL at all land areas (Figure 3.1-9, Alternative 1 Sonic Boom and Munitions Noise Level (CDNL)). Sonic boom intensity would remain the same, and munitions peak noise from single explosive events would remain below 115 dBP over land (refer to Section 3.1.6, Ambient Airborne Noise, Affected Environment, for more information). As described in Section 3.1.6.4 (Range Noise Environment), peak noise levels below 115 dBP have the potential to be disruptive but are typically associated with a low risk of complaints. Land areas would continue to be unaffected by noise exceeding 115 dBP. Compatibility conditions for areas on land west of Hooper Target would remain similar to the No Action Alternative (Section 3.6.3.1, Land Use, No Action Alternative, and Table 3.6-1).

Additionally, Alternative 1 would be consistent to the maximum extent practicable with the enforceable coastal zone management policies of Maryland and Virginia.

Outlying Field Webster Adjacent Land Use

Alternative 1 would not impact residential or commercial land uses surrounding OLF Webster. No areas off the installation would experience noise levels above 65 dB DNL.

Regional Land Use (Beneath the PRC Airspace)

Noise exposure would increase up to 1.8 dBA L_{dnmr} under PRC airspace areas (Table 3.1-17, Noise Levels Beneath PRC Airspace Areas Under Alternative 1). The resulting noise levels would remain under 55 dBA, which are below levels of concern for compatible land use.

Recreation and Protected Areas

Under Alternative 1, three off-base local parks are currently exposed to aircraft noise levels of 65 dBA to 70 dBA DNL at NAS Patuxent River. Lexington Manor Passive Park and John G. Lancaster Park would experience slight increases in noise exposure, but only John G. Lancaster Park would be newly exposed to levels of 70 to 75 dBA DNL and greater in portions of the park (Figure 3.6-5). The projected noise levels are considered compatible land uses under AICUZ guidelines, but some persons familiar with the parks may notice the slight increase in noise.

Parks underlying R-4005 would be exposed to about 54 dBA L_{dnmr} (an increase of 1.1 dBA L_{dnmr}) (Figure 3.1-8, Noise Levels (dBA L_{dnmr}) Beneath PRC Airspace Areas). This change would be minor and would not cause a noticeable change from current conditions. This increase would not displace or cause the land use of underlying areas to change. Peak noise levels experienced by civilian boaters from munitions firing would continue to potentially exceed 115 dBP (associated with a moderate risk of complaints) or even potentially 130 dBP (associated with a high risk of complaints). Recreational uses would experience minimal change from these operations.

Overall, conditions would remain similar to those described for the No Action Alternative and affected environment, and projected increases for Alternative 1 would not likely alter land use. It is anticipated that the installation would continue to work and coordinate with local jurisdictions to minimize conflicts and ensure that future development is compatible.

3.6.3.3 Land Use, Alternative 2 (Preferred Alternative) Potential Impacts

Under Alternative 2, the impacts of noise on land uses would be similar to those described for Alternative 1. Because the tempo of operations would increase under Alternative 2, analysis was conducted to estimate the increase in noise over both the No Action Alternative and Alternative 1.

NAS Patuxent River Adjacent Land Use

An increase in aircraft operations of approximately 29 percent under Alternative 2 (Table 2.3-1, Annual PRC Operational Tempo per Alternative: Activities and Assets) would involve a similar increase in airfield arrivals and departures. Alternative 2 would result in larger DNL noise contours, encompassing a greater land area than under the No Action Alternative (Figure 3.6-6). The amount of adjacent land areas exposed to 65 dBA DNL would expand. These areas would amount to about 1,370 acres under Alternative 2 (an additional 12,153 acres within the noise contour would be over water), compared with approximately 594 acres under the No Action Alternative (Table 3.6-2 and Table 3.1-18, Off-Installation Acres and Population Exposed to Elevated Noise Levels Under Alternative 2).

The increased land area exposed to 65 dBA DNL includes residential land to the south and southwest of the airfield, with an estimated 416 acres of residential area newly exposed to noise levels at or above 65 dBA DNL under Alternative 2. This change would almost triple the residential land exposed to incompatible noise off the installation. Some of this land is forested and not fully developed; however, areas experiencing incompatible noise exposure to the southwest would include all those identified for Alternative 1 plus dwellings at the west end of the Greens at Hilton Run apartments, homes to the south between Pine Hill Road and Long Lane east of Highway 712, and a larger area of the Riverbay Town Home development.

Noise impacts from the use of Hannibal and Hooper Target areas and the ATA would be similar to those of Alternative 1 and the No Action Alternative, with similar noise levels from non-explosive munitions and other MEM (see Section 3.1.7.3, Ambient Airborne Noise, Alternative 2 (Preferred Alternative) Potential Impacts, and Figure 3.1-12, Alternative 2 Sonic Boom and Munitions Noise Level (CDNL)). Because firing would be conducted at the same locations and with the same munitions, peak sound levels would be the same as shown in Figure 3.1-5 (Baseline Munitions Peak Noise Levels (dBP)). While natural attenuation reduces noise in surrounding areas, the installation would continue to manage the potential for mutual encroachment of incompatible activities (both military and nonmilitary) to achieve maximum flexibility in the future. Noise levels from non-explosive munitions and other MEM as well as sonic booms would remain below 40 dB CDNL on all land areas; sonic boom intensity would remain the same, and munitions noise would remain below 115 dBP (munitions peak noise level) on land (refer to Section 3.1, Ambient Airborne Noise, for more information).

Additionally, Alternative 2 would be consistent to the maximum extent practicable with the enforceable coastal zone management policies of Maryland and Virginia.

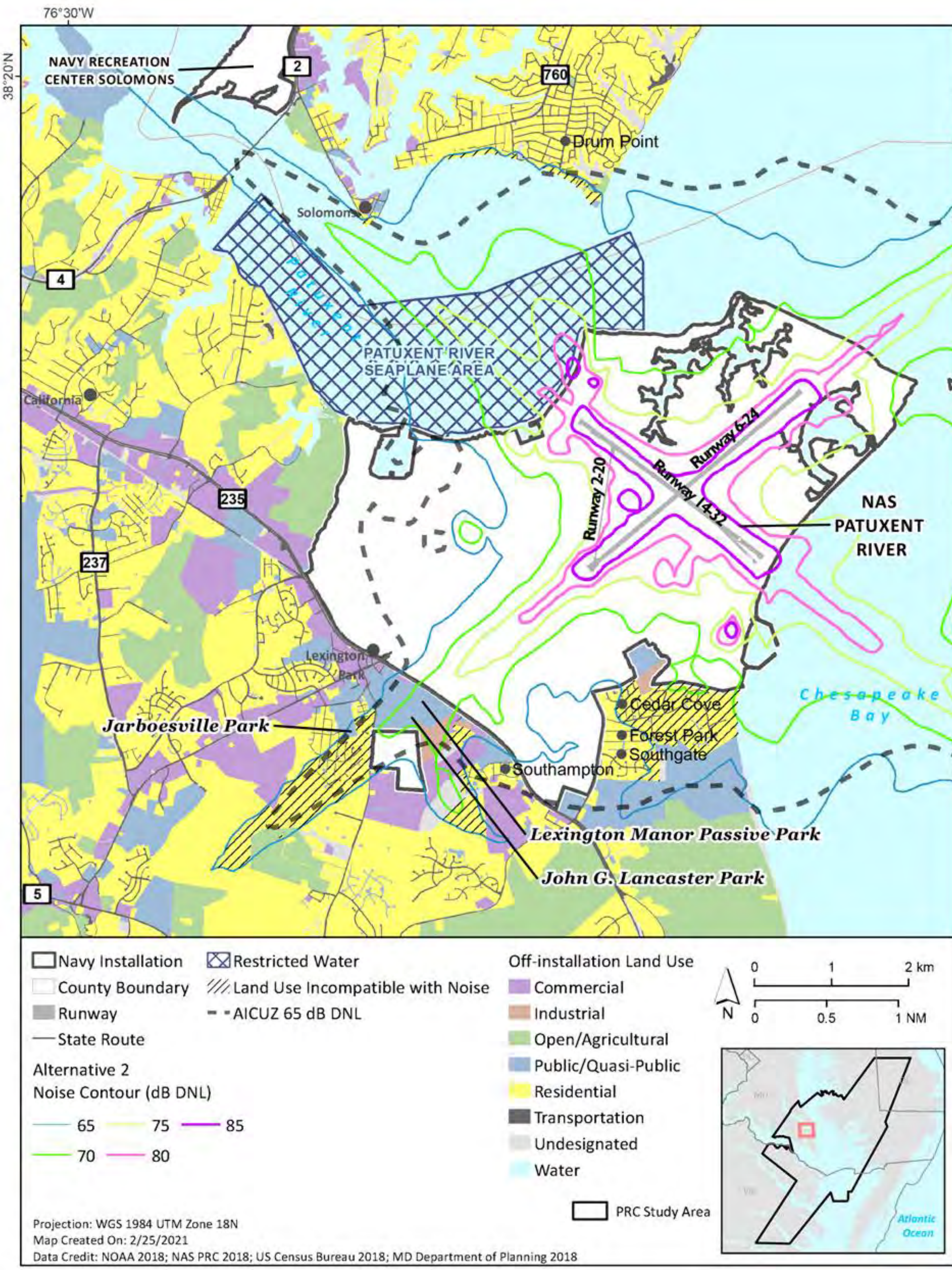

Figure 3.6-6 Alternative 2 Land Use for NAS Patuxent River

Outlying Field Webster Adjacent Land Use

Alternative 2 would be compatible with the past use of OLF Webster and would not impact residential or commercial land uses surrounding OLF Webster. No areas off the installation would experience noise levels above 65 dB DNL.

Regional Land Use (Beneath the PRC Airspace)

Noise exposure levels would increase by approximately 1.5 dBA L_{dnmr} under restricted airspace (R-4005 and R-4006) and by up to 2.3 dBA for West Helicopter Operating Area (Helo OPAREA), but levels would remain less than 55 dBA L_{dnmr} under all PRC airspace (Table 3.1-24, Noise Levels Beneath PRC Airspace Areas Under Alternative 2). Some residents in underlying areas may perceive these increases in noise in their local surroundings; however, the resulting noise levels would remain under 55 dBA, and well below levels of concern, for compatible residential land use. Conditions would remain similar to those described for the No Action Alternative and affected environment. Land areas would continue to be unaffected by noise exceeding 115 dBP.

Recreation and Protected Areas

Parks and protected wildlife management areas underlying R-4005 and R-4006 and Helo OPAREAs would be exposed to DNL increases of up to 2.3 dBA L_{dnmr} (Figure 3.1-8, Noise Levels (dBA L_{dnmr}) Beneath PRC Airspace Areas). The increase would not displace or cause underlying recreation or protected areas to change use from those reflected in current-use patterns.

In comparison with the No Action Alternative, only one off-base local park, John G. Lancaster Park, would be newly exposed to aircraft noise levels of 70 to 75 dBA DNL at NAS Patuxent River (Figure 3.6-6). Both Jarboesville Park and Lexington Manor Passive Park, currently exposed to noise levels of 65 to 70 dBA DNL, would remain in that exposure bracket, though there may be a slight increase in noise within these two parks. These noise levels are considered compatible with outdoor recreational use under AICUZ guidelines, but some persons familiar with the parks may notice slight increases in noise.

3.6.3.4 Alternatives Impact Summary

Summary of Impacts, Land Use

Acoustic:

Impacts with each alternative reflect existing noise mitigation measures identified in the 1998 PRC EIS and operating procedures designed with noise impact minimization in mind (Table 2.5-1, Standard Operating Procedures, and Table 3.10-1, Impact Avoidance and Minimization Measures).

<u>No Action Alternative</u>

- Under the No Action Alternative, there would be no changes to regional land use; however, a continuation of marginally incompatible noise exposure to a small area of residential land off the NAS Patuxent River installation would occur. Adjacent to the installation, approximately 9,800 acres would be exposed to noise levels of 65 dBA DNL or greater under the No Action Alternative, with 9,206 of these acres occurring over water. The remaining 594 acres exposed to noise levels of 65 dB DNL or greater would occur over land, including about 230 acres of residential land off the installation. Activities under the No Action Alternative would not expose any new surrounding areas to incompatible noise levels compared to the current AICUZ conditions. Land areas along the shoreline to the west of Hooper Target may continue to experience peak noise levels below 115 dBP but greater than 87 dBP; at these levels, land use compatibility guidelines recommend attenuation for structures for residential land uses. Effects of noise and overflights on recreational uses and protected areas under the No Action Alternative are essentially the same as described for the affected environment with noise levels below 55 dBA L_{dnmr}. These noise levels are generally considered compatible with any land uses underlying PRC airspace, including uses within protected areas. Jarboesville Park and John G. Lancaster Park occur within the baseline noise contour of 65 dBA DNL for aircraft noise at NAS Patuxent River. Lexington Manor Passive Park is within the 70 dBA DNL noise contour. Outdoor recreational use is generally considered compatible with these noise exposure levels under the AICUZ guidelines. Testing and training activities would not pose any new risks to surrounding land use.

Alternative 1

- Alternative 1 would result in a larger land area exposed to noise levels of 65 dBA DNL and greater, increasing from 594 acres under the No Action Alternative to about 1,158 acres (excluding 11,541 acres over water). Some areas would experience increased noise exposure at levels above recommended noise compatibility guidelines based on specific land uses. Under Alternative 1, three off-base local parks are currently exposed to aircraft noise levels of 65 dBA to 70 dBA DNL at NAS Patuxent River. Lexington Manor Passive Park and John G. Lancaster Park would experience slight increases in noise exposure, but only John G. Lancaster Park would be newly exposed to levels of 70 to 75 dBA DNL and greater in portions of the park. The projected noise levels are considered compatible land uses under AICUZ guidelines, but some persons familiar with the parks may notice the slight increase in noise.

Alternative 2 (Preferred Alternative)

- Alternative 2 would result in larger DNL noise contours and noise exposure, encompassing a larger land area than under the No Action Alternative, increasing from 594 acres to about 1,370 acres (excluding 12,153 acres over water). Some areas would experience increased noise exposure at levels above recommended noise compatibility guidelines based on specific land uses. The loudest aircraft noise levels would not change, but the frequency of noise events would increase. Under Alternative 2, three off-base local parks are currently exposed to aircraft noise levels of 65 dBA to 70 dBA DNL at NAS Patuxent River. Lexington Manor Passive Park and John G. Lancaster Park would experience slight increases in noise exposure, but only John G. Lancaster Park would be newly exposed to levels of 70 to 75 dBA DNL and greater in portions of the park. The projected noise levels are considered compatible land uses under AICUZ guidelines, but some persons familiar with the parks may notice the slight increase in noise.

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3.7 Socioeconomics

This section focuses on commercial and private air traffic within the PRC airspace, commercial and private vessel transportation, commercial and recreational fishing within the Chesapeake Bay Water Range, and other recreational activities throughout the Patuxent River Complex (PRC) Study Area. Commercial and private vessel transportation includes vessel movement in public waterways. Since the PRC Study Area waterways are in Maryland and Virginia, the discussion does not include commercial, private, and recreational activities in Delaware waters. Property values are discussed in Appendix B (Noise Primer, Section B.5.8, Property Values).

3.7.1 Socioeconomics, Regulatory Setting

Specific aviation and airspace management procedures and policies to be used by the Navy are provided by Office of the Chief of Naval Operations Instruction 3710.7, *Naval Aviation Training and Operating Procedures Standardization General Flight and Operating Instructions* (U.S. Department of the Navy, 2016c). In addition, Table 2.5-1 (Standard Operating Procedures) identifies procedures that reduce the potential for interactions with aircraft flight activities in the PRC Study Area. Specific instructions for conducting flight operations at Naval Air Station (NAS) Patuxent River, Outlying Field (OLF) Webster, and the different testing and training airspace areas are contained in NAS Patuxent River Instruction 3710.5X, *NAS Patuxent River Air Operations Manual* (U.S. Department of the Navy, 2017a). The following airspace and airfield discussions are based on the information provided in that manual. Other applicable regulations regarding special use airspace (SUA) management include specific Federal Aviation Administration (FAA) orders.

United States (U.S.) Army Corps of Engineers maintains federal navigation channels, including navigation channels in many of the tributaries to the Chesapeake Bay.

U.S. Coast Guard (USCG) Notices to Mariners. The USCG Notices to Mariners provide information to private and commercial vessels on temporary closures of water areas. Broadcast notices on maritime frequency radio, weekly publications by the USCG Navigation Center, and global positioning navigation charts distribute these navigational warnings. They provide information about the duration and location of closures due to activities that are potentially dangerous to surface vessels. Vessels are responsible for being aware of any Notices to Mariners that are in effect.

Magnuson-Stevens Fishery Conservation and Management Act. Fisheries management in the Chesapeake Bay is accomplished through a complex jurisdictional framework involving the Virginia Marine Resources Commission, the Pennsylvania Fish and Boat Commission, Maryland Department of Natural Resources, and the District of Columbia Fisheries and Wildlife Division. Virginia Marine Resources Commission and Maryland Department of Natural Resources manage the blue crab fishery, and commercial and recreational finfish and shellfish resources; the Atlantic States Marine Fisheries Commission and the Fisheries Management Councils, authorized by the Magnuson-Stevens Fishery Conservation and Management Act, manage coastal species. Regulation of commercial fishing activities varies by species, type of gear, and jurisdiction (e.g., coastal vs. estuarine species). Virginia regulations for tidal waters include seasonal closures; licensing; size, possession, and catch limits; harvest quotas; and gear restrictions (Virginia Marine Resources Commission, 2019). Maryland also has commercial and recreational fishing regulations for the Chesapeake Bay and tributaries, which can be found on the Maryland Department of Natural Resources website (Maryland Department of Natural Resources, 2020c).

3.7.2 Socioeconomics, Affected Environment

3.7.2.1 Commercial and Private Air Traffic

The Chesapeake Bay Water Range is overlain by 2,352 square miles of SUA. Range operations in this airspace typically involve multiple aircraft in high-speed and dynamic flight maneuvering. In order to maintain safe separation from all other air traffic, the FAA designates specific parcels of airspace (defined by lateral and vertical dimensions) as SUA for military use. This designation allows the military user to control and restrict the use of the designated airspace authorized for tests and related military flights. During periods that the PRC Study Area SUA is activated (normally between 7:00 a.m. and 11:00 p.m.), the Atlantic Test Ranges (ATR) maintain a military radar unit (Baywatch) that provides restricted area containment surveillance under the supervision of the NAS Patuxent River Air Traffic Control facility. When the restricted areas/SUA are not in use (normally after 11:00 p.m.), they are released back to FAA for command and control. The PRC Study Area also includes the Chessie Air Traffic Control Assigned Airspace (ATCAA) and Helicopter Operating Areas (Helo OPAREAs) as well as other airspace designations/classes that accommodate both military and civilian aircraft operations.

Special Use Airspace – Restricted Areas

The SUA restricted areas are shown in Figure 1.3-2 (PRC Airspace), with the average annual use for each area noted in Figure 3.0-2 (Sorties Conducted in PRC Restricted Airspace). Overall, these restricted areas are used an average of 16,080 hours annually, with the majority of those hours of use occurring in restricted area R-4006 and R-4008 (Table 3.0-14, Current and Proposed Annual Flight Hours by PRC Airspace). The *NAS Patuxent River Air Operations Manual* (U.S. Department of the Navy, 2017a) limits the combined total number of aircraft operating within R-4005, R-4006, and R-4008 to 10 at any one time to prevent saturation of this airspace. When used concurrently with other military components, this total number is not to exceed six aircraft, unless otherwise approved through prior coordination (U.S. Department of the Navy, 2017a).

Operational information provided by the ATR Sustainability Office notes that the restricted areas are used an average of 12 hours per weekday, with the daily peak use of 16 hours; the weekend average daily use is 1 hour, with a peak use of 3 hours. While nonparticipating air traffic must remain clear of restricted areas when active, weather conditions, higher-density holiday traffic periods, and other such circumstances may at times require the FAA to route their Instrument Flight Rules (IFR) traffic through one or more of these areas. In such cases, the FAA will coordinate with the Terminal Radar Approach Control (TRACON) to either clear this airspace or restrict flight altitudes to ensure this traffic is separated from any military aircraft. Visual Flight Rules (VFR) aircraft that need to operate within these PRC restricted areas, such as fish spotters, can obtain the active status of each area through Notices to Airmen and Air Traffic Control or Flight Service Station advisories (Debenedittis, 2019).

Helicopter Operating Areas

The three Helo OPAREAs (West, East, and South) are not depicted on aeronautical charts, as they are unrestricted, shared-airspace areas where other nonparticipating aircraft may operate while testing and training activities are being conducted (Figure 1.3-2, PRC Airspace). As with other unrestricted airspace classes, Air Traffic Control separates IFR aircraft and provides traffic advisories to VFR pilots as required, to maintain a safe flight environment for all concerned. The West Helo OPAREA includes designated federal airways and military training routes (discussed below) and the NAS Patuxent River instrument-approach course lines. The St. Mary's County Airport is also located in this area, which generates a high level of civilian aircraft transiting through this airspace. The South and East Helo OPAREAs underlie and/or are bounded by restricted airspace and contain instrument approach corridors. Procedures for operating to/from and within each of the three operating areas are governed by the *NAS Patuxent River Air Operations Manual*, which limits the maximum number of aircraft operating at one time in the East and South Helo OPAREAs to four aircraft, while the West Helo OPAREA is limited to five. Table 3.0-14 (Current and Proposed Annual Flight Hours by PRC Airspace) notes that the Helo OPAREAs are used an average of 4,020 hours annually.

Air Traffic Control Assigned Airspace

ATCAA is uncharted airspace where nonhazardous military flight-testing and training activities are conducted at 18,000 feet mean sea level and above. Per the *NAS Patuxent River Air Operations Manual*, flights within the Chessie A and B ATCAAs are limited to an FAA-assigned 3,000-foot altitude block between 27,000 and 41,000 feet, while Chessie C operations are limited to a 3,000-foot block between 18,000 and 50,000 feet. Only one altitude block may be activated at any one time within each subdivision. These restrictions and the infrequent ATCAA use, as noted in Section 3.0.2.3.4.1 (Air-Based Assets), avoid any impacts on the high-density IFR air traffic that transits through this ATCAA airspace at those higher altitudes (U.S. Department of the Navy, 2017a).

Military Training Routes

Four military training routes transit through the PRC Study Area but are not typically used by the Navy. However, their use by other military components does factor into the overall shared use of this airspace. These routes are low-altitude corridors along which military tactical fighter-type aircraft conduct low-altitude flight training (below 10,000 feet mean sea level) at airspeeds in excess of 250 knots within their published vertical/lateral boundaries. They are depicted on aeronautical charts for general aviation awareness with special operating procedures stipulating the altitude restrictions, avoidance areas, and other specific instructions military pilots must follow while flying these routes.

Navigation Routes

Federal airways, jet routes, and other similar navigational routes are published “highways” along which most IFR aircraft operate throughout the National Airspace System. Many of these routes transit through areas where SUA, ATCAAs, and other testing and training airspace areas are established, such as the PRC Study Area. In those cases, coordination between the scheduling and Air Traffic Control controlling agencies ensure civil IFR traffic is separated from the military flight activities when those areas are active.

Visual Flight Rules Corridors

VFR corridors are commonly established in those higher-density air traffic areas where they provide a means for separating VFR general aviation aircraft from other military and/or civilian flights operating in those areas. Such corridors have been established in the PRC Study Area for VFR aircraft flying to/from those civilian airports located beneath or near the overlying restricted areas to help separate these aircraft from the PRC flight operations. These VFR corridors can be used only in visual weather conditions and require prior approval from the Patuxent TRACON. Pilots must be in radio contact with this facility and follow “see-and-avoid” procedures while operating through these corridors.

Public/Private Airports

The PRC Study Area airspace is over several public/private airports. Most of these airports are privately owned, while the others are owned/operated by county or local governments for public use. The

Crisfield, Tangier, and Reedville airfields are under the portion of R-4006 beginning at 3,500 feet, where civilian aircraft can fly beneath that restricted area while operating to the Salisbury and other airfields within this area. Pilots operating at these different airfields may use the VFR corridors discussed above, avoid the different testing and training areas, or get traffic advisories as appropriate to remain clear of the Navy flight operations (Debenedittis, 2019).

3.7.2.2 Commercial and Recreational Vessel Transportation and Fishing

The Chesapeake Bay is the largest estuary in North America, and supports significant commercial and recreational fisheries (National Oceanic and Atmospheric Administration, 2018). Many of the fishing industries supported by the Chesapeake Bay have been adversely impacted by pollution runoff over the years, resulting in less diverse and productive industries (Chesapeake Bay Foundation, 2019). As an example, the once thriving oyster industry in the Chesapeake Bay has suffered decades of overharvesting and pollution; as a result, the oyster population is only a fraction of what it used to be (Chesapeake Bay Program, 2019b). Since oysters are natural filters, large-scale restoration efforts to recover oyster populations have been taking place in the Bay, as a means to maintain and eventually improve water quality. As part of the effort, in April 2019, Maryland’s General Assembly voted to override the governor’s veto of the oyster-sanctuary bill, a bill that permanently protects five oyster sanctuaries by prohibiting the catch of oysters in Harris Creek, the Little Choptank River, the Tred Avon River, the St. Mary’s River, and the Manokin River (Chesapeake Bay Magazine, 2019).

Recreational fishing occurs in the waters of the Chesapeake Bay Water Range and adjacent waters by boat, shoreline, and fishing piers such as Point Lookout and Solomons public fishing piers (Figure 3.7-1). There are public marinas and boat ramps throughout the PRC Study Area that allow water access to the Bay (Figure 3.7-1). There are also scattered shoreline beaches and parks along the Chesapeake Bay. Recreational boating in Maryland is an important economic contributor to the state of Maryland. The total annual economic benefit of recreational boating in the state is estimated at $2.41 billion (National Marine Manufacturers Association, n.d.). Recreational boating supports approximately 19,000 direct, indirect, and induced jobs and over 1,000 boating-related businesses in the state (National Marine Manufacturers Association, n.d.).

The total catch and the number of recreational angler trips, as well as the number of boat registrations throughout the states of Maryland and Virginia, have fluctuated slightly over the last several years with an overall decline since 2010 levels. Total catch and angler trips for inland marine waters (primarily comprised of the Chesapeake Bay) of Maryland and Virginia is available from the National Marine Fisheries Service *Marine Recreational Fisheries Statistics Survey* (National Marine Fisheries Service, 2019a; National Marine Fisheries Service, 2019b). Angler trips to inland waters of Maryland declined from approximately 9.3 million in 2010 to 6.3 million in 2018 (National Marine Fisheries Service, 2019a). Total catch in the state also declined during the same time from approximately 51.2 million fish to 27 million fish (National Marine Fisheries Service, 2019b). Similarly, the number of angler trip to inland waters of Virginia declined from approximately 7.7 million in 2010 to 5.4 million in 2018 (National Marine Fisheries Service, 2019a). Total catch in Virginia declined from approximately 53.3 million fish to 33 million fish during the same time (National Marine Fisheries Service, 2019b). The number of registered vessels in the nation has followed a similar pattern (Table 3.7-1).

A busy shipping channel runs the length of the Bay and is an important transit route for large commercial vessels entering or leaving the Port of Baltimore and Norfolk (Figure 3.7-2).

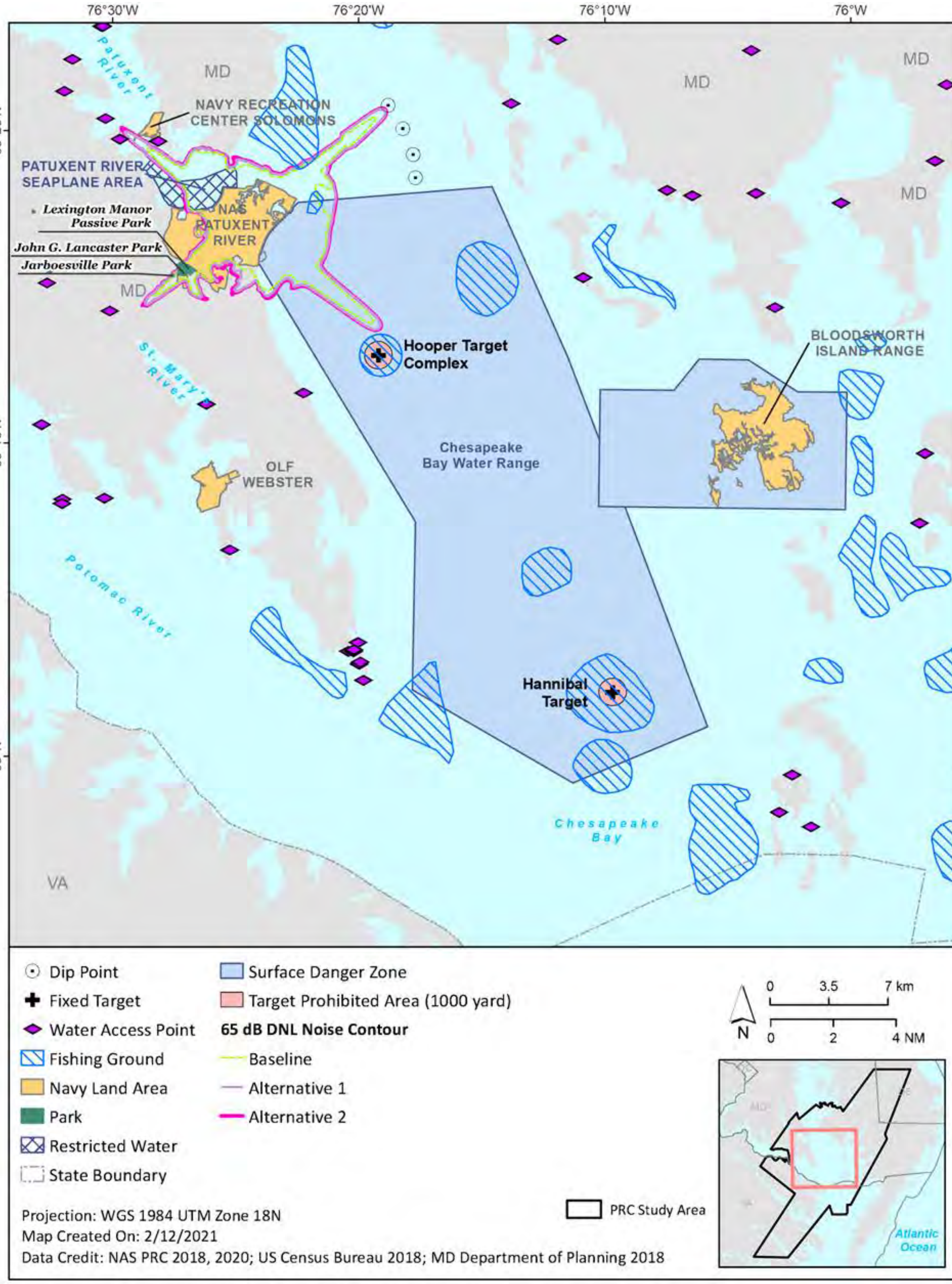

Figure 3.7-1 Water Recreation (Fishing) in the Patuxent River Complex Study Area

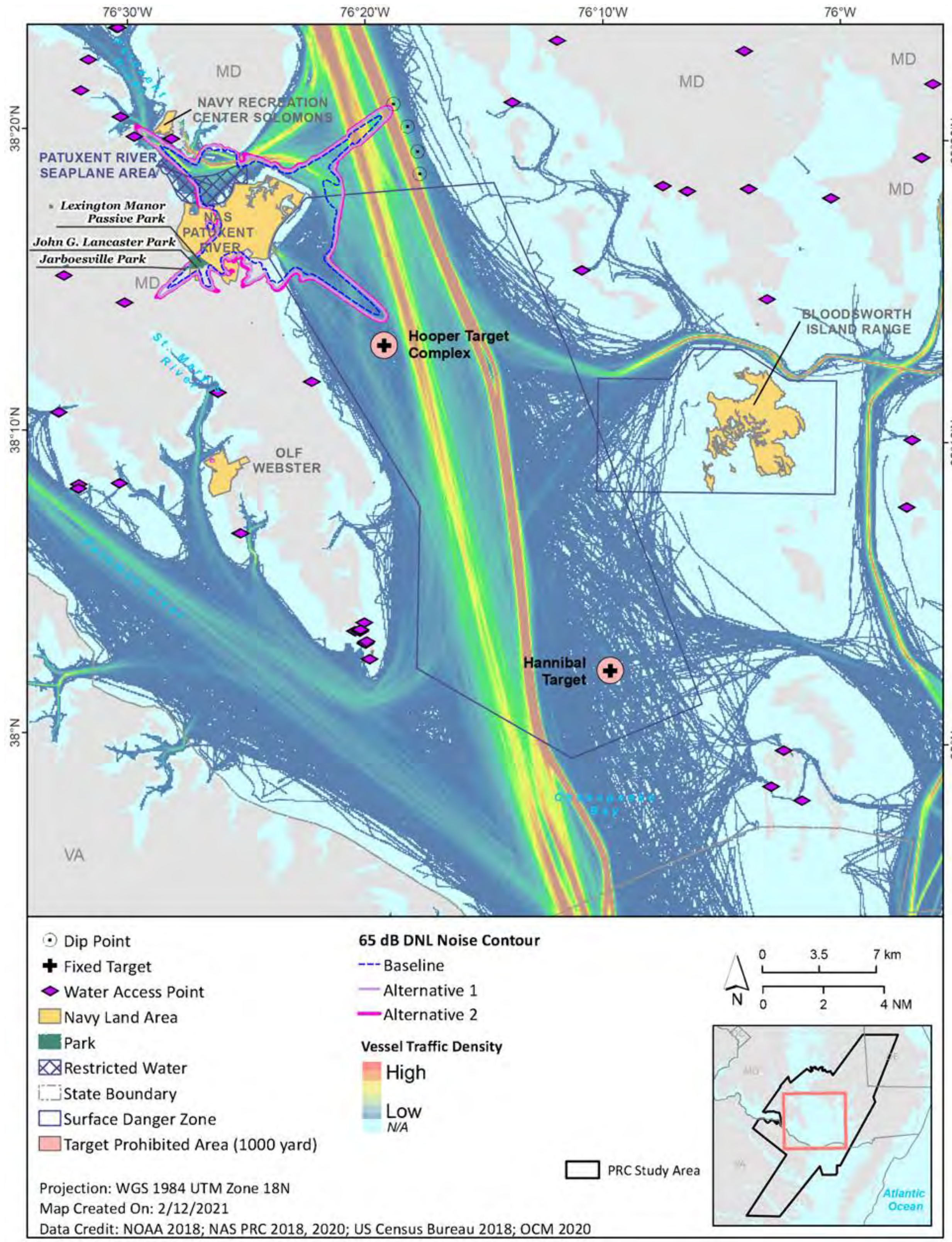

Figure 3.7-2 Vessel Traffic Density in the Chesapeake Bay Water Range

Table 3.7-1 Registered Vessels for Each Year from 2010 to 2018

Area	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*Percent Change (2010 to 2018)*
Maryland	193,259	188,623	185,626	181,544	178,573	178,798	176,207	172,304	170,365	-11.8
Virginia	242,473	245,940	239,878	237,551	236,521	234,052	233,236	224,031	225,732	-6.9
United States	12,438,926	12,173,935	12,191,936	11,993,067	11,804,002	11,867,049	11,861,811	11,961,568	11,852,969	-4.7

Sources: (U.S. Coast Guard, 2011; U.S. Coast Guard, 2013b; U.S. Coast Guard, 2015; U.S. Coast Guard, 2017b; U.S. Coast Guard, 2018)

Commercial landings for all species (in terms of pounds) in Maryland and Virginia have also fluctuated since 2010, but have experienced an overall decline from 2010 levels. Commercial landings are presented for the entire state, including ocean waters. Table 3.7-2 shows the total commercial landings for all species in Maryland and Virginia between 2010 and 2017, along with total dollar value.

Table 3.7-2 Annual Commercial Landings, 2010 to 2017

Year	*Maryland*		*Virginia*	
	Total Pounds	*Total Dollars*	*Total Pounds*	*Total Dollars*
2010	101,734,582	$103,821,193	510,458,726	$183,178,809
2011	78,162,738	$82,564,008	496,296,213	$193,958,274
2012	77,263,981	$84,305,146	462,442,708	$174,521,382
2013	47,200,010	$81,136,441	381,591,958	$163,016,097
2014	50,210,782	$92,121,473	398,947,543	$172,806,076
2015	54,030,595	$88,327,764	400,756,605	$197,004,465
2016	59,256,852	$91,025,619	361,024,603	$204,519,975
2017	51,350,340	$82,168,805	337,991,659	$187,755,628

Source: (National Marine Fisheries Service, 2019c)

Testing and training within the Chesapeake Bay Water Range may require clearance of commercial, fishing, and recreational boating within small portions of the Bay, especially around Hannibal and Hooper Targets. Table 3.7-3 shows the number of clearance events, number of hours cleared, and the number of watercraft cleared during the events.

Table 3.7-3 Annual Target Area Clearances, 2008 to 2017

Clearance Event Details	*FY2008*	*FY2009*	*FY2010*	*FY2011*	*FY2012*	*FY2013*	*FY2014*	*FY2015*	*FY2016*	*FY2017*
Number of Clearance Events	63	61	34	53	68	57	31	29	37	55
Hours Cleared	115	116	57	104	196	122	64	74	91	106
Watercraft Cleared	137	107	64	51	98	165	38	31	28	86

Key: FY = fiscal year.

3.7.2.3 Recreational Activities

Naval Air Station Patuxent River

NAS Patuxent River is located in St. Mary's County, Maryland. The 14,500-acre complex of NAS Patuxent River includes the Navy Recreation Center (NRC) Solomons, the main station in Lexington Park, OLF Webster, and Bloodsworth Island Range (U.S. Department of the Navy, 2019i). Many recreational activities are available throughout NAS Patuxent River and the surrounding area due to its location where the waters of the Patuxent River and the Chesapeake Bay meet. Recreational activities and facilities on the main station include saltwater and freshwater fishing, hunting and trapping, two campgrounds, a beach, and a marina. North of NAS Patuxent River is NRC Solomons located in Solomons, Maryland, in Calvert County. Recreational activities available at NRC Solomons are for military personnel and authorized users and include fishing or crabbing to patrons with a valid State of Maryland fishing permit and a NAS Patuxent River/NRC Solomons fishing permit. Point Patience Marina at NRC Solomons is a fully equipped facility located at the southern end of the complex. The Riverside Aquatics Complex is also at NRC Solomons and is located just south of Riverside Beach, which offers 400 feet of shoreline and beaches.

Bloodsworth Island Range is located in the Chesapeake Bay and consists of four islands including Bloodsworth, Pone, Adam, and Northeast (Figure 1.3-5, Bloodsworth Island Range). Due to the Navy's use of Bloodsworth Island Range as a shore bombardment and bombing range for firing and dropping live and non-explosive ordnance from ships and aircraft between 1942 and 1996, unexploded ordnance possibly exists on the range and in nearshore waters (U.S. Department of the Navy, 2006). The Navy has ceased impact operations at Bloodsworth Island Range, but it remains an active military range owned and managed by NAS Patuxent River and the Naval Air Warfare Center Aircraft Division. Due to the presence of unexploded ordnance, federal law prohibits trespassing in areas on Bloodsworth Island Range. These areas include all land, waters within 75 yards of land, and waters within a 0.5-mile radius circle on the west side of Bloodsworth and Pone Island (U.S. Department of the Navy, 2015c).

The surrounding waters of Bloodsworth Island Range are part of a restricted military area also called the Surface Danger Zone (SDZ). Fishing, crabbing, and boating are allowed within the SDZ but public access is restricted during military operations. Waterfowl hunting is authorized within designated water areas around the Bloodsworth Island Range but only with a permit from the Maryland Department of Natural Resources (U.S. Department of the Navy, 2015c). At all times, there is no public access on Bloodsworth Island Range land areas. The SDZ is approximately 3 miles east of the Chesapeake Bay's main shipping channel (Figure 3.7-2).

Outlying Field Webster

OLF Webster is located 3 miles south of St. Mary's City and bounded by the St. Mary's River to the west; St. Inigoes Creek and Molls Cove to the north; and farms, forests, and light residential development to the east and south. Since much of OLF Webster is undeveloped, it serves as a home to numerous wildlife and fish species, which support a number of hunting, fishing, and trapping opportunities (U.S. Department of the Navy, 2019j).

Surrounding Region

The PRC Study Area extends into land portions over three states (including Virginia, Maryland, and Delaware) and covers portions of the Chesapeake Bay, including the Chesapeake Bay Water Range. In addition to recreational transportation and fishing in the area, the PRC Study Area airspace overlies many other land and water recreational activities. The Chesapeake Bay is a main feature for tourists who visit Maryland and Virginia. Swimming, boating, kayaking, and sailing are just a few of the recreational activities supported by the Bay. Military and non-military wrecks are also common in the area and serve as popular dive sites.

Recreational activities near NAS Patuxent River and OLF Webster occur within Southern Maryland. Throughout the state, the Maryland Park Service manages 75 state parks on 140,671 acres of land (Maryland Department of Natural Resources, 2018). There are numerous parks and waterfront public landings throughout Southern Maryland offering a variety of recreational activities. For example, there are five state parks located in St. Mary's County (Maryland Department of Commerce, 2019). Recreational activities throughout Southern Maryland include hiking, biking, fishing, camping, amongst many other outdoor activities. In 2018, more than 13.4 million visitors participated in outdoor recreational activities in the entire state of Maryland (Maryland Department of Natural Resources, 2019d). A list of state parks and forests, park activities and amenities, outdoor education, and other programs are available online on the Maryland Department of Natural Resources website. Jarboesville Park, located at 46760 Thomas Drive, Lexington Park, St. Mary's County, is a 3-acre park with a baseball field, basketball court, and geocaching. John G. Lancaster (Lancaster) Park, located at 21550 Willows Road, Lexington Park, St. Mary's County, is a 46-acre park, owned by the Navy and leased to St. Mary's County until 2023. Lexington Manor Passive Park is the adjacent parcel at the Old Flat Tops and is approximately 80 acres. These parks are located less than 2 miles from the NAS Patuxent River boundary and are affected by aircraft noise levels of 65 A-weighted decibels (dBA) day-night average sound level (DNL) and greater, under existing conditions (Figure 3.7-1 and Figure 3.7-2).

3.7.3 Socioeconomics, Environmental Consequences

When the restricted areas are activated for Navy testing and training activities, civilian aviation is not able to access this airspace for other uses. Published times of use for the restricted areas, along with Air Traffic Control advisories, help inform these aviation interests when airspace is available. As noted in Section 3.0.2.2 (Resources and Issues Eliminated from Further Consideration), the Proposed Action and alternatives do not include changes to the PRC airspace or airfield use. Any higher daily/annual operating levels are safely accommodated through adherence to existing standard operating procedures (SOPs) (Table 2.5-1, Standard Operating Procedures) and FAA orders that clearly govern how flight activities must be conducted. Existing procedures for maintaining safe and efficient military, commercial, and private air traffic in the PRC airspace would continue for all alternatives. Coordination between Patuxent River TRACON, Baywatch, and the FAA would also continue in a proactive fashion to support public use of the area. Therefore, impacts to commercial and private air traffic are not anticipated nor further discussed.

Analysis of impacts to socioeconomics focuses on the effects of the alternatives on commercial and private vessel transportation, commercial and recreational fishing, and other water-based recreational activities in the PRC Study Area. Potential land-based impacts are discussed in Section 3.6 (Land Use). Vessels predominantly operate within the Chesapeake Bay Water Range; therefore, the region of influence for socioeconomic analyses for the No Action Alternative is defined as the Chesapeake Bay and its tributaries. Recreational areas within the noise contours for 65 dBA DNL and greater were considered for potential socioeconomic impacts under the acoustic stressor.

Acoustic stressors from testing and training activities in the PRC Study Area may impact fishing and other recreational activities. Noise from ground activities associated with testing and training is consistent with ambient noise associated with a military installation and, therefore, noise from vehicle movement and other similar ground activities does not impact commercial or recreational activities within the Southern Maryland region. Impacts associated with each alternative reflect existing noise mitigation measures identified in the 1998 *Environmental Impact Statement for Increased Flight and Related Operations in the Patuxent River Complex* (U.S. Department of the Navy, 1998) and operating procedures designed with noise impact minimization in mind (Table 2.5-1, Standard Operating Procedures, and Table 3.10-1, Impact Avoidance and Minimization Measures). For example, the restrictions on supersonic events and maintaining sonic boom monitoring as well as limiting of Open-Air Engine Test Cell operations, minimizes acoustic stressor impact to recreational users in the PRC Study Area.

Public interaction in common-use areas may also impact recreational activities. The Navy follows SOPs (see Table 2.5-1, Standard Operating Procedures), which require that vessel operators are alert at all times, travel at a safe speed for the prevailing conditions, observe no-wake zones, use state-of-the-art satellite navigational systems, and are trained to take proper action to avoid collisions (e.g., NAVAIRWARCENACDIVINST 3700.3, *Range Safety Policy*, NAVAIRWARCENACDIVINST 3710.1A, *Range Safety Manual*, U.S. Coast Guard Commandant Instruction M16114.5C, *Boat Crew Seamanship Manual*, U.S. Coast Guard Commandant Instructions M16130.2F, *National Search and Rescue Supplement*). In addition, the Navy provides Notice to Mariners, as appropriate, for testing and training activities. Continued implementation of these practices minimizes the potential for public interaction between Navy vessels and other vessels.

3.7.3.1 Socioeconomics, No Action Alternative

Under the No Action Alternative, the Navy would continue testing and training activities within the PRC Study Area as represented in Figure 1.3-1 (PRC Study Area), and socioeconomic resources would continue as they are under baseline conditions. Commercial and private transportation, commercial and recreational fishing, and other water-based recreational activities would continue to occur within the waters underlying the PRC airspace and the Chesapeake Bay Water Range.

Acoustic

Commercial and Recreational Transportation and Fishing

The majority of aircraft noise would be generated at NAS Patuxent River and OLF Webster during takeoffs and landings; therefore, recreational users in the vicinity may experience noise from aircraft during testing and training activities similar to those described for the ambient noise existing conditions (see Section 3.1, Ambient Airborne Noise).

Noise associated with small- and medium-caliber weapons firing and deployment of non-explosive munitions would primarily occur near the Chesapeake Bay Water Range fixed target areas and may be audible and disturbing to commercial and recreational boaters. Noise generated from munitions firing at the Armament Test Area could be audible and potentially disturbing to commercial and recreational boaters in nearby areas during gun firing and aerial target launch events.

As stated in Section 3.1.6.4 (Range Noise Environment), prior to non-explosive munitions firing events, Navy range personnel ensure that the open-water target areas and any areas exposed to hazards associated with the proposed munitions firing activities are clear of nonparticipating watercraft (e.g., watermen, recreational boaters). Noise levels experienced by watermen and recreational boaters on the Chesapeake Bay depend on the distance to the firing activity and the direction of fire. Noise levels experienced by these civilian boaters may sometimes exceed 115 dB peak (dBP) (associated with a moderate risk of complaints) or even 130 dBP (associated with a high risk of complaints). In compliance with safety precautions, aircraft would not fire non-explosive munitions from directly above boaters, but even if that were to occur, noise levels would not exceed 140 dBP, the regulatory threshold to protect against noise-induced permanent threshold shift (i.e., hearing loss). Potential acoustic stressors would not be anticipated to affect fishing catch since most invertebrate, fish, and reptile/amphibian species are relatively insensitive to distant sounds and unlikely to encounter more intense short-range sounds from primarily mobile/high-altitude sources (see Sections 3.4.3.1 and 3.4.3.2, Biological Resources, Environmental Consequences, Acoustics subsections for the No Action Alternative and Alternative 1, respectively).

Commercial and recreational boaters in the Mid-Bay region could experience annoyance and disturbance associated with testing and training activities. However, the Mid-Bay region is known for its large military presence, and the majority of local boaters have experienced these events for decades. Noise generated from Navy vessels is temporary and localized and is consistent with the ambient noise environment of the inshore waters of the Chesapeake Bay and within the PRC Study Area.

Recreational Activities

Potential noise impacts to recreational activities would be similar to that of noise impacts to commercial and recreational transportation and fishing, as described above. Under existing conditions, there are three parks within the 65 dBA DNL or greater noise contour associated with aircraft noise at NAS Patuxent River, which include Lancaster Park, Jarboesville Park, and Lexington Manor Passive Park.

As detailed in Section 3.6.3.1 (Land Use, No Action Alternative), 9,206 acres (over water) would be exposed to noise levels of 65 dBA DNL or greater under the No Action Alternative. Other non-aircraft noise stressors and potential impacts are discussed in Section 3.1.6.4 (Range Noise Environment). There would be no change to the number of acres exposed to noise and to the ambient airborne noise under this alternative, compared to baseline conditions. As noted above, the Mid-Bay region and Southern Maryland is known for its large military presence, and the majority of the public surrounding Navy locations that conduct testing and training have experienced these events for decades. Tourists and visitors that are unfamiliar with the Navy presence and the noise associated with Navy testing and training activities may experience annoyance and disturbance related to noise during recreational activities. However, these noise events would be infrequent and intermittent.

Public Interaction

Commercial and Recreational Transportation and Fishing

Under the No Action Alternative, there would be potential for interaction between Navy vessels, unmanned maritime systems (UMS), motorized targets, and the public (Table 2.3-1, Annual PRC Operational Tempo per Alternative: Activities and Assets) . However, these assets are primarily operated during activities requiring range clearance, and therefore, the potential for public interaction would not occur once the range is cleared. As stated previously in Section 3.0.2.3.3.2 (Vessels (and Other Water-Based Assets)), the number of vessels is dependent on customer requirements and can be highly variable. During activities, the public may not have access to certain areas. Restricted access would last as long as the testing or training activity (i.e., a few hours up to 12 hours per day), with an average of 2.9 hours per range closure event. Although the number of events, range cleared hours, and the number of watercraft cleared varies from year to year, a peak of 68 annual events associated with 196 hours range clearance time was chosen for the no action baseline (Table 3.7-3 and Table 3.0-15, Range Target Clearance Events). During times of target closures, commercial and recreational users may use other areas of the Bay during Navy operations and return to the cleared area after testing and training activities are completed.

Navy vessel movement within the Chesapeake Bay is consistent with other vessel movement in these waterways. As previously mentioned, the Chesapeake Bay experiences a high volume and diversity of vessel traffic. The Navy practices safe navigation, regardless of the conditions. SOPs require that vessel operators are alert at all times, travel at a safe speed for the prevailing conditions, observe no-wake zones, use state-of-the-art satellite navigational systems, and are trained to take proper action to avoid collisions. Continued implementation of these practices minimizes the potential for public interaction between Navy vessels and other vessels.

Favored fishing areas change over time with fluctuations in fish populations and communities, preferred target species, and fishing modes and styles. Popular fishing sites are characterized by relative ease of access, ability to anchor or secure the boat, and abundant presence of target fish. As shown in Figure 3.7-1, target areas have been identified in Bay charts as popular recreational fishing spots, which would create potential for impacts to commercial bottom trawlers or other anglers with gear that drags along the Bay floor. The 1,000-yard prohibited areas immediately surrounding the targets are closed to commercial fishing and other recreational activities, to minimize the potential for accidental interaction between the public and military expended material. The Navy strives to reduce interaction with the public by conducting testing and training activities in a manner that is compatible with commercial and recreational waterway users.

The main shipping channel transits through the length of the Chesapeake Bay Water Range (Figure 3.7-2). Commercial vessels (e.g., tankers) traversing the range are not required to halt or wait for the testing or training activities to be completed. As noted in 33 Code of Federal Regulations 334.210(b)(6), “this section shall not deny traverse of portions of the restricted area by commercial craft proceeding in established steamer lanes, but when firing is or will soon be in progress all such craft shall proceed on their normal course through the area with all practicable speed.” The ATR procedures for liquid natural gas tanker transit are identified in Range Safety SOP 3170.1 (U.S. Department of the Navy, 2003).

Recreational Activities

Public interaction impacts between the Navy and other recreational users (i.e., divers, swimmers, personal watercraft) of nearshore and shoreline areas would be similar to the impacts described under commercial and private transportation and commercial and recreational fishing. As noted above, the Navy implements strict SOPs, which minimize public interactions with recreational users during testing and training activities.

Stressors Combined

For commercial and recreational transportation and fishing as well as recreational activities in the PRC Study Area, the combined impacts from acoustic and public interaction stressors would primarily occur when the Chesapeake Bay Water Range is open. When the range is closed, Navy practices such as range clearance would minimize the potential for public interaction between the Navy and commercial or recreational users of the study area while also providing greater separation from acoustic sources. Regardless of range status, the Navy practices safe navigation and, therefore, the primary impact would be from acoustic stressors as summarized above.

3.7.3.2 Socioeconomics, Alternative 1 Potential Impacts

Potential impacts to socioeconomic resources from acoustic stressors and public interaction would be similar to, but more frequent, than under the No Action Alternative, due to the additional testing and training activities conducted under this alternative.

Acoustic

Commercial and Recreational Transportation and Fishing

Due to the increases in PRC operational tempos, noise would likely impact a greater number of commercial and recreational participants who may be present near the Chesapeake Bay Water Range (outside of any established range safety clearance areas). As stated in Section 3.0.2.3.1.4 (Non-explosive Munitions and Other Military Expended Materials), noise associated with the firing of directed energy weapons systems (i.e., high-energy lasers and high-power microwaves) would be localized noise generated by aircraft, surface vessels, or land-based assets carrying the weapon. These noise sources are discussed in Sections 3.0.2.3.1.1 (Aircraft and Aerial Targets (Air-Based Assets)), 3.0.2.3.1.2 (Vessels (and Other Water-Based Assets)), and 3.0.2.3.1.3 (Land-Based Assets). No further analysis is required regarding directed energy noise impacts on socioeconomic resources.

Recreational Activities

Potential noise impacts to recreational activities would be similar to that of noise impacts to commercial and private transportation and commercial and recreational fishing, as described above. In addition, the Southern Maryland and Mid-Bay region is known for its large military presence, and the majority of the public surrounding Navy locations that conduct testing and training have experienced these events for decades, with intensity varying from year to year. Tourists and visitors who are unfamiliar with the Navy presence and the noise associated with Navy testing and training activities may experience annoyance and disturbance related to noise during recreational activities. As under the No Action Alternative, Jarboesville Park, Lancaster Park, and Lexington Manor Passive Park are located in St. Mary's County, would be the only parks within the 65 dBA DNL to 69 dBA DNL contour, associated with aircraft noise at NAS Patuxent River.

As detailed in Section 3.6.3.2 (Land Use, Alternative 1 Potential Impacts), implementation of Alternative 1 would expand the number of acres (over water) exposed to noise levels of 65 dBA DNL or greater from 9,206 acres (under baseline conditions) to 11,541 acres, under this alternative. Other non-aircraft noise stressors and potential impacts to watermen and recreational boaters on the Bay are discussed in Section 3.1.7.2 (Ambient Airborne Noise, Alternative 1 Potential Impacts, Range Noise Environment). Noise events over water would be more frequent, would expand over a larger area of water, and could impact more commercial and recreational users under this alternative, compared to baseline conditions.

Public Interaction

Commercial and Recreational Transportation and Fishing

Potential public interaction impacts to commercial and recreational transportation and fishing under Alternative 1 would be similar in nature to those described under the No Action Alternative. Under this alternative, there is a slight increase in vessel, UMS, and motorized target deployments, when compared to the No Action Alternative (Table 2.3-1, Annual PRC Operational Tempo per Alternative: Activities and Assets) and, therefore, an increased potential for public interactions. Additionally, under this alternative, the number of events and cleared hours under Alternative 1 would be 250 annual clearance events associated with 750 hours of clearance time, compared to 68 events and 196 hours cleared under the No Action Alternative for the Chesapeake Bay Water Range (Table 3.7-4). During times of target closures, commercial and recreational users may use other areas of the Bay during Navy operations and return to the cleared area after testing and training activities are completed. Therefore, the increase in the clearance events and hours per year under Alternative 1 could impact commercial and recreational users more frequently under this alternative, compared to baseline conditions.

Table 3.7-4 Target Area Clearances Under Alternative 1

Alternative	*Number of Events Per Year*	*Hours Cleared Per Year*	*Average Number of Events Per Month*	*Average Number of Hours Cleared Per Event*
No Action	68	196	5.7	2.9
Alternative 1	250	750	20.8	3.0

Potential impacts for public interaction during the use of directed energy weapon systems under this alternative would not be likely. Activities would occur within range and/or installation boundaries and exclusive use airspace. Primary laser areas would include Hooper Center Main Target and Hannibal Target within the Chesapeake Bay Water Range or within NAS Patuxent River or OLF Webster boundaries on or near the runways. Testing and training within the Chesapeake Bay Water Range may require clearance of commercial and recreational participants within small portions of the Bay, especially around Hannibal and Hooper Targets. As noted above, the Navy implements range safety protocols and SOPs, which include ensuring that an area is clear of all nonparticipating vessels before testing or training activities take place. In addition, the Navy provides advance notification of testing or training activities to the public through Notice to Mariners and postings on Navy websites.

Recreational Activities

Public interaction impacts between the Navy and recreational users of nearshore and shoreline areas would be similar to the impacts described under commercial and private transportation and commercial and recreational fishing. As noted above, the Navy implements strict safety operations, which minimize public interactions with recreational users during testing and training activities.

Stressors Combined

For commercial and recreational transportation and fishing as well as recreational activities in the PRC Study Area, the combined impacts from acoustic and public interaction stressors under Alternative 1 would be the same as under the No Action Alternative.

3.7.3.3 Socioeconomics, Alternative 2 (Preferred Alternative) Potential Impacts

Potential impacts to socioeconomic resources from public interaction and acoustic stressors would be similar to, but more frequent, than under the No Action Alternative, due to the additional testing and training activities conducted under this alternative.

Acoustic

Commercial and Recreational Transportation and Fishing

Potential impacts to commercial recreational vessel transportation and fishing from noise associated with Navy testing and training would be similar to the No Action Alternative, but due to the increases in

PRC operational tempos, noise would likely impact a greater number of commercial and recreational participants who may be present near the Chesapeake Bay Water Range (outside of any established range safety clearance areas). Similar to the No Action Alternative, supersonic aircraft noise (sonic boom) levels exceeding land use compatibility thresholds occur only in open water areas far from shore. Sonic booms have the potential to startle people and are a common cause of complaints.

Noise levels associated with increased non-explosive munitions firing under Alternative 2 would continue to be conducted far from shore and land areas would continue to be affected by noise levels well below 62 dB C-weighted DNL (CDNL) (see Section 3.1.7.3, Ambient Airborne Noise, Alternative 2 (Preferred Alternative) Potential Impacts). Potential impacts to civilian boaters would continue as described under the No Action Alternative and would be limited to temporary disturbances for the people that happen to be on the open water and relatively close to the firing event at the time the firing event occurs. The increased frequency of munitions firing events may increase annoyance to commercial and recreational participants but would not be expected to result in other impacts. As stated in Section 3.0.2.3.1.4 (Non-explosive Munitions and Other Military Expended Materials), noise associated with the firing of directed energy weapons systems (i.e., high-energy lasers and high-power microwaves) would be localized noise generated by aircraft, surface vessels, or land-based assets carrying the weapon. These noise sources are discussed in Sections 3.0.2.3.1.1 (Aircraft and Aerial Targets (Air-Based Assets)), 3.0.2.3.1.2 (Vessels (and Other Water-Based Assets)), and 3.0.2.3.1.3 (Land-Based Assets). No further analysis is required regarding directed energy noise impacts on socioeconomic resources.

Recreational Activities

Potential noise impacts to recreational activities at PRC would be similar to that of noise impacts to commercial and recreational transportation and fishing, as described above. In addition, the Mid-Bay region is known for its large military presence, and the majority of the public surrounding Navy locations that conduct testing and training have experienced these events for decades, with intensity varying from year to year. Tourists and visitors who are unfamiliar with the Navy presence and the noise associated with Navy testing and training activities may experience annoyance and disturbance related to noise, during recreational activities. Similar to baseline conditions, under this alternative, there would be three parks within the 65 to 69 dBA DNL noise contours. Jarboesville Park, Lancaster Park, and Lexington Manor Passive Park would be exposed to noise levels of 65 to 69 dBA DNL associated with aircraft noise at NAS Patuxent River. As discussed in Section 3.1.3 (Noise Effects) and Appendix B (Noise Primer), people exposed to higher DNL are more likely to become highly annoyed by the noise, and at noise levels greater than 65 dBA DNL, the Department of Defense considers noise to be sufficiently intrusive that some noise-sensitive land uses are considered to be incompatible with the noise.

As detailed in Section 3.6.3.3 (Land Use, Alternative 2 (Preferred Alternative) Potential Impacts), implementation of Alternative 2 would expand the number of acres (over water) exposed to noise levels of 65 dBA DNL or greater from 9,206 acres (under baseline conditions) to 12,153 acres under this alternative. Other non-aircraft noise stressors and potential impacts to watermen and recreational boaters on the Bay are discussed in Section 3.1.7.3 (Ambient Airborne Noise, Alternative 2 (Preferred Alternative) Potential Impacts, Range Noise Environment). Noise events over water would be more frequent, would expand over a larger area of water, and could impact more commercial and recreational users under this alternative, compared to baseline conditions.

Public Interaction

Commercial and Recreational Transportation and Fishing

Potential public interaction impacts to commercial and private vessel transportation and commercial and recreational fishing under Alternative 2 would be similar to those described under the No Action Alternative. However, under this alternative, there is a slight increase in the vessel, UMS, and motorized target deployments, when compared to the No Action Alternative (Table 2.3-1, Annual PRC Operational Tempo per Alternative: Activities and Assets) and, therefore, an increased potential for public interactions. Additionally, the number of events and cleared hours under Alternative 2 would be 275 annual clearance events associated with 825 hours clearance time for the Chesapeake Bay Water Range (Table 3.7-5).

Table 3.7-5 Target Area Clearances Under Alternative 2

Alternative	*Number of Events*	*Hours Cleared*	*Average Number of Events Per Month*	*Average Number of Hours Cleared Per Event*
No Action	68	196	5.7	2.9
Alternative 2	275	825	22.9	3.0

Potential impacts for public interaction during the use of directed energy weapon systems under this alternative would not be likely. Activities would occur within range and/or installation boundaries and exclusive use airspace. Primary laser areas would include Hooper Center Main Target and Hannibal Target within the Chesapeake Bay Water Range or within NAS Patuxent River or OLF Webster boundaries on or near the runways. Testing and training within the Chesapeake Bay Water Range may require clearance of commercial and recreational participants within small portions of the Bay, especially around Hannibal and Hooper Targets. As noted above, the Navy implements range safety protocols and SOPs, which include ensuring that an area is clear of all nonparticipating vessels before testing or training activities take place. In addition, the Navy provides advance notification of testing or training activities to the public through Notice to Mariners and postings on Navy websites.

Recreational Activities

Potential impacts from public interaction between the Navy and the public would be similar to the impacts described under commercial and private transportation and commercial and recreational fishing. As noted above, the Navy implements range safety protocols and SOPs, including ensuring that an area is clear of all nonparticipating vessels before testing or training activities take place and providing advance notification of testing or training activities to the public through Notice to Mariners and posting on Navy websites, which minimize public interactions with recreational users during testing and training activities.

Stressors Combined

For commercial and recreational transportation and fishing as well as recreational activities in the PRC Study Area, the combined impacts from acoustic and public interaction stressors under Alternative 2 would be the same as under the No Action Alternative.

3.7.3.4 Alternative Impacts Summary

Summary of Impacts, Socioeconomics

Acoustic:

Noise levels associated with each alternative reflect existing noise mitigation measures identified in the 1998 *Environmental Impact Statement for Increased Flight and Related Operations in the Patuxent River Complex* (U.S. Department of the Navy, 1998) and operating procedures designed with noise impact minimization in mind (Table 2.5-1, Standard Operating Procedures, and Table 3.10-1, Impact Avoidance and Minimization Measures).

The Mid-Bay region is known for its large military presence, and the majority of local boaters have experienced these events for decades. Noise generated from Navy vessels is temporary and localized and is consistent with the ambient noise environment of the inshore waters of the Chesapeake Bay and within the PRC Study Area.

<u>No Action Alternative</u>

- Recreational users within the vicinity of NAS Patuxent River and OLF Webster may experience noise from aircraft during testing and training activities similar to those described for the ambient noise existing conditions (Section 3.1, Ambient Airborne Noise).
- Noise associated with small- and medium-caliber weapons firing and deployment of non-explosive munitions and other MEM would primarily occur in the Chesapeake Bay Water Range and may be audible and disturbing to commercial and recreational boaters.
- Noise generated from munitions firing and aerial target launching at the Armament Test Area could be audible and potentially disturbing to commercial and recreational boaters in nearby areas during firing events.
- Commercial and recreational boaters in the Mid-Bay region could experience annoyance and disturbance associated with testing and training activities.

<u>Alternative 1</u>

- Potential impacts from noise associated with Navy testing and training to commercial and private vessel transportation, commercial and recreational fishing participants and other recreational users (i.e. divers, swimmers, etc.) would be similar in nature to the No Action Alternative, but more frequent. Due to the increases in PRC operational tempos, noise would likely impact a greater number of commercial and recreational participants who may be present near the Chesapeake Bay Water Range (outside of any established range safety clearance areas).

<u>Alternative 2 (Preferred Alternative)</u>

- Potential impacts from noise associated with Navy testing and training to commercial and private vessel transportation, commercial and recreational fishing participants, and other recreational users (e.g., divers, swimmers) would be similar in nature to the No Action Alternative, but more frequent. Due to the increases in PRC operational tempos, noise would likely impact a greater number of commercial and recreational participants who may be present near the Chesapeake Bay Water Range (outside of any established range safety clearance areas).

Public Interaction:

The Navy follows SOPs (see Table 2.5-1), which require that vessel operators are alert at all times, travel at a safe speed for the prevailing conditions, observe no-wake zones, use state-of-the-art satellite navigational systems, and are trained to take proper action to avoid collisions. In addition, the Navy provides Notice to Mariners, as appropriate, for testing and training activities. Continued implementation of these practices minimizes the potential for public interaction between Navy vessels and other vessels.

Existing procedures for maintaining safe and efficient air traffic in the PRC airspace would continue. Coordination between Patuxent River TRACON, Baywatch, and the FAA would also continue in a proactive fashion to support public use of the area.

<u>No Action Alternative</u>

- Under the No Action Alternative, there would be potential for public interaction between commercial and private vessel transportation, commercial and recreational fishing vessels, and the Navy. However, Navy vessel movement is consistent with other vessel movements in waterways, and the Navy follows strict safety operations to reduce public interactions.
- The number of events and cleared hours under the No Action Alternative would be 68 events and 196 hours cleared for the Chesapeake Bay Water Range.

<u>Alternative 1</u>

- Potential impacts to socioeconomic resources from public interaction would be similar in nature but more frequent and, therefore, likely impact a greater number of people than under the No Action Alternative.
- Potential impacts for public interaction during the use of directed energy weapon systems (i.e., high-energy lasers and high-power microwaves) under this alternative would not be likely. Activities would occur within range and/or installation boundaries and exclusive use airspace. Primary laser areas would include Hooper Center Main Target and Hannibal Target within the Chesapeake Bay Water Range or within NAS Patuxent River or OLF Webster boundaries on or near the runways. Testing and training within the Chesapeake Bay Water Range may require clearance of commercial and recreational participants within small portions of the Bay, especially around Hannibal and Hooper Targets. As noted above, the Navy implements range safety protocols and SOPs, which include ensuring that an area is clear of all nonparticipating vessels before testing or training activities take place. In addition, the Navy provides advance notification of testing or training activities to the public through Notice to Mariners and postings on Navy websites.
- The number of events and cleared hours under Alternative 1 would be 250 annual clearance events associated with 750 hours of clearance time compared to 68 events and 196 hours cleared under the No Action Alternative for the Chesapeake Bay Water Range.

<u>Alternative 2 (Preferred Alternative)</u>

- Potential impacts to socioeconomic resources from public interaction would be similar in nature but more frequent and, therefore, likely impact a greater number of people than under the No Action Alternative.
- Potential impacts for public interaction during the use of directed energy weapon systems (i.e., high-energy lasers and high-power microwaves) under this alternative would not be likely.

Activities would occur within range and/or installation boundaries and exclusive use airspace. Primary laser areas would include Hooper Center Main Target and Hannibal Target within the Chesapeake Bay Water Range or within NAS Patuxent River or OLF Webster boundaries on or near the runways. Testing and training within the Chesapeake Bay Water Range may require clearance of commercial and recreational participants within small portions of the Bay, especially around Hannibal and Hooper Targets. As noted above, the Navy implements range safety protocols and SOPs, which include ensuring that an area is clear of all nonparticipating vessels before testing or training activities take place. In addition, the Navy provides advance notification of testing or training activities to the public through Notice to Mariners and postings on Navy websites.

- The number of events and cleared hours under Alternative 2 would be 275 annual clearance events associated with 825 hours of clearance time compared to 68 events and 196 hours cleared under the No Action Alternative for the Chesapeake Bay Water Range.

Combined Stressors:

- For commercial and private vessel transportation, commercial and recreational fishing, and other recreational activities in the PRC Study Area, the combined impacts from acoustic and public interaction stressors would primarily occur when the Chesapeake Bay Water Range is open. When the range is closed, Navy practices such as range clearance would minimize the potential for public interaction between the Navy and commercial or recreational users of the study area while also providing greater separation from acoustic sources. Regardless of range status, the Navy practices safe navigation and, therefore, the primary impact would be from acoustic stressors as described above.

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3.8 Environmental Justice

The United States (U.S.) Environmental Protection Agency (USEPA) defines environmental justice as, "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (U.S. Environmental Protection Agency, 2019d). Environmental justice analysis focuses on the minority and low-income population in the affected environment, defined as those areas off-installation that are exposed to noise levels at or above 65 A-weighted decibels (dBA) day-night average sound level (DNL) from noise sources associated with operations from Naval Air Station (NAS) Patuxent River and Outlying Field (OLF) Webster in the Patuxent River Complex (PRC) Study Area. As noted in Section 3.1.6.3 (Installation Noise Environment, Table 3.1-3, Baseline Off-Installation Acres and Population Exposed to Noise Greater than 65 dBA DNL), aircraft noise levels of 65 dBA DNL do not extend off-installation at locations on and near OLF Webster under baseline conditions and under each alternative (see Table 3.1-10, Off-Installation Acres and Population Exposed to Elevated Noise Levels Under Alternative 1). Therefore, OLF Webster is not discussed further in this section.

The environmental justice analysis also considers the public interaction stressor associated with the potential for disproportionately adverse and high impacts to minority and low-income populations from aircraft mishaps residing within the Accident Potential Zones (APZs).

3.8.1 Environmental Justice, Regulatory Setting

Consistent with Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (February 16, 1994), the Navy's policy is to identify and address any disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

3.8.2 Environmental Justice, Affected Environment

In order to assess the impacts to minority and low-income communities, the Navy first identified whether there were any areas of minority and low-income populations that may experience disproportionately high and adverse impacts from the Proposed Action. These environmental justice communities were determined by analyzing the demographic and economic characteristics of the affected area and comparing those to the characteristics of the larger community as a whole. This larger community is known as the community of comparison.

Potential environmental justice communities that may be impacted by the Navy's actions were identified using population and demographic data from the U.S. Census Bureau for potentially affected block groups. For the purposes of this Environmental Impact Statement, the environmental justice analysis concentrates on the communities that are most likely to be affected by actions under the Proposed Action and that have been identified as the communities of comparison. County-level data was selected as the community of comparison because it represents the smallest geographic unit that incorporates the affected population within the entire 65 dBA DNL or greater noise contours. Figure 3.8-1 shows the location of the affected block groups under baseline conditions of 65 dB DNL or greater noise contours for the PRC Study Area.

If the percentage of residents with incomes below the poverty level in the block group is greater than the percentage of residents in the community of comparison with incomes below the poverty level, then there is a low-income environmental justice community. Minority environmental justice communities are identified by comparing population characteristics from the block groups to the larger community as a whole and determining whether there is a "meaningfully greater" difference between the two areas. Following recommendations made in the March 2016 report, *Promising Practices for Environmental Justice Methodologies in NEPA Reviews* (U.S. Environmental Protection Agency, 2016), "the 'Meaningfully Greater' analysis requires use of a reasonable, subjective threshold (e.g., 10 percent to 20 percent greater than the reference community). What constitutes 'meaningfully greater' varies by agency, with some agencies considering any percentage in the selected geographic unit of analysis that is greater than the percentage in the appropriate reference community to qualify as being 'meaningfully greater.'"

For this analysis, "meaningfully greater" is defined as demographic statistics that represent an increase in the proportion of minority populations and that differ by more than 15 percent from those of the community of comparison (the county). The 15-percent difference is an appropriate threshold for determining the presence of environmental justice communities because this increase is large enough to take into account natural variations in demographic populations within a community.

Data from the U.S. Census Bureau's 2013–2017 American Community Survey were used to characterize minority populations in the area of impact and to define low-income populations throughout this section. Low-income populations in this analysis are defined using the percent of all individuals for whom poverty status has been determined, as defined by the U.S. Census Bureau, for each specific geographic area. The U.S. Census statistics were utilized in this analysis because of their ability to provide poverty estimates down to the block group level. In addition, utilizing U.S. Census Bureau data ensured that the demographic and poverty statistics used in the environmental justice analysis were consistent with the block group–level population data that were used in the noise analysis.

3.8.2.1 Environmental Justice Assessment

To assess the presence of environmental justice communities under baseline operations, the Navy looked at the off-installation populations in block groups within the baseline noise contours at 65 dBA DNL and above. As detailed in Table 3.8-1, there are six block groups located in Calvert County and St. Mary's County that are within the 65 dBA DNL and greater noise contours under baseline conditions. These block groups are shown in Figure 3.8-1.

Table 3.8-1 shows minority and low-income populations in the affected area (defined as the area within noise levels of 65 dBA DNL and greater) of the PRC Study Area and indicates block groups that contain environmental justice communities based on the indicated thresholds. All block groups that have a meaningfully greater percent of minority and/or higher low-income percentages than the community of comparison are identified as environmental justice communities and are located in St. Mary's County.

As displayed on Table 3.8-1, there are three block groups where the percentage of the minority population in the block group is greater than 50 percent and "meaningfully greater" than the county percentages (i.e., the community of comparison); therefore, these block groups are identified as minority environmental justice communities. Three of the block groups in the affected area have a higher percentage of residents identified as low-income compared to the community of comparison (St. Mary's County). The block groups in the affected area with environmental justice communities are summarized below and shown in Figure 3.8-2:

- Block group 240378759011 has a higher percent low-income population (10.7 percent) than St. Mary's County (8.2 percent).
- Block group 240378759013 has a meaningfully greater percent minority population (54.5 percent) than St. Mary's County (24.9 percent).

- Block group 240378759021 has a meaningfully greater percent minority population (53.0 percent) than St. Mary's County (24.9 percent) and a higher percent low-income population (13.2 percent) than St. Mary's County (8.2 percent).
- Block group 240378759023 has a meaningfully greater percent minority population (50.4 percent) than St. Mary's County (24.9 percent) and a higher percent low-income population (9.8 percent) than St. Mary's County (8.2 percent).

Two block groups within the affected area are located in Calvert County. The block groups in the affected area located in Calvert County do not have a "meaningfully greater" concentration of minority residents and do not have a greater concentration of low-income residents, compared to the community of comparison (Calvert County). Consequently, these areas are not considered minority or low-income environmental justice communities.

Table 3.8-1 Off-Installation Populations in Affected Block Groups in the PRC Study Area

Census Geographic Area	*Total Population*	*Number of Minority[2]*	*Percent Minority[1]*	*Population for Whom Poverty Status is Determined[3]*	*Number of Low-Income*	*Percent Low-Income[4]*
Calvert County (COC)	**90,824**	**19,242**	**21.2%**	**89,882**	**5,114**	**5.7%**
240098609003	1,319	111	8.4%	1,230	38	3.1%
240098610032	1,487	84	5.6%	1,487	4	0.3%
St. Mary's County (COC)	**110,979**	**27,639**	**24.9%**	**107,806**	**8,839**	**8.2%**
240378759011	2,168	538	24.8%	2,168	231	10.7%
240378759013	4,081	2,223	54.5%	3,998	306	7.7%
240378759021	3,256	1,727	53.0%	3,256	430	13.2%
240378759023	2,253	1,136	50.4%	2,134	209	9.8%

Sources: (U.S. Census Bureau, 2017b; U.S. Census Bureau, 2017c; U.S. Census Bureau, 2017d)
Key: PRC = Patuxent River Complex; COC = community of comparison.
Notes:
1. Blue shaded cells identify block groups with a "meaningfully greater" percentage of minority residents or block groups with a greater percentage of low-income residents than the community of comparison (i.e., the county within which the block group is located). For this analysis, "meaningfully greater" is defined as demographic statistics that differ by more than 15 percent from those of the community of comparison. The following formula (the percent difference between two percentages) was used to calculate whether these statistics differed by more than 15 percent: $\frac{|V_1 - V_2|}{(\frac{V_1+V_2}{2})}$ X 100.
2. Minority is defined as individuals who are members of the following population groups: American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, or Black or African American, as well as individuals who self-identify as Hispanic or Latino origin who are White. Individuals who self-identify as Hispanic or Latino from another race are already included in the analysis.
3. The number and percent of low-income is based upon the population for whom poverty status is determined. Population for whom poverty status is determined does not take into consideration people whose poverty status cannot be determined, including institutional group quarters, college dormitories, and military barracks; living situations without conventional housing; and unrelated individuals under age 15, etc., and therefore may differ from the total population (U.S. Census Bureau, 2019).
4. Percent low-income is defined as the percent of all residents identified as having incomes placing them below the U.S. Census-defined poverty level, according to data published by the U.S. Census Bureau in the *2013-2017 American Community Survey (5-Year Estimates)*.

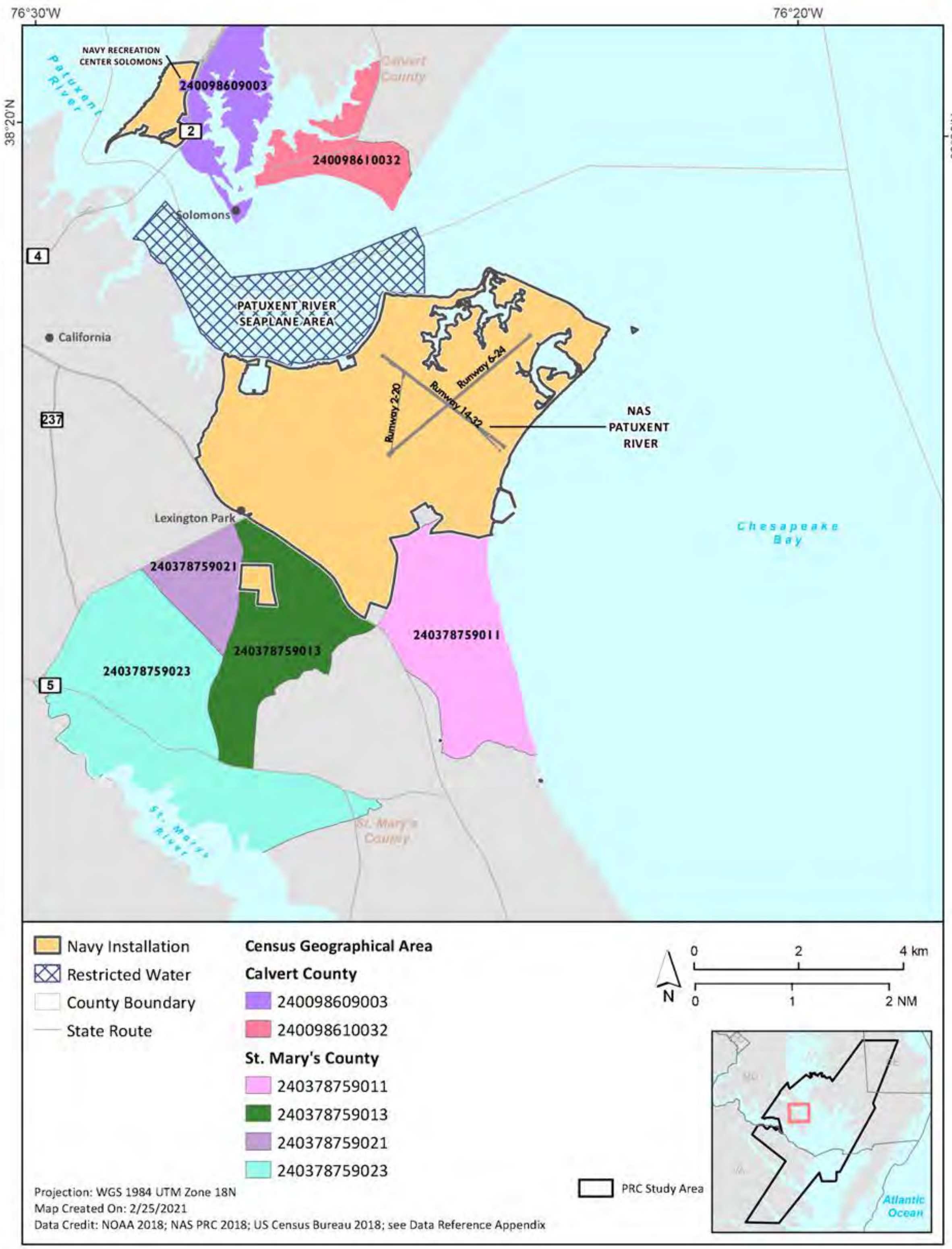

Figure 3.8-1 Block Groups Within the Affected Area (65 dBA DNL or Greater Noise Contours) Under Baseline Conditions

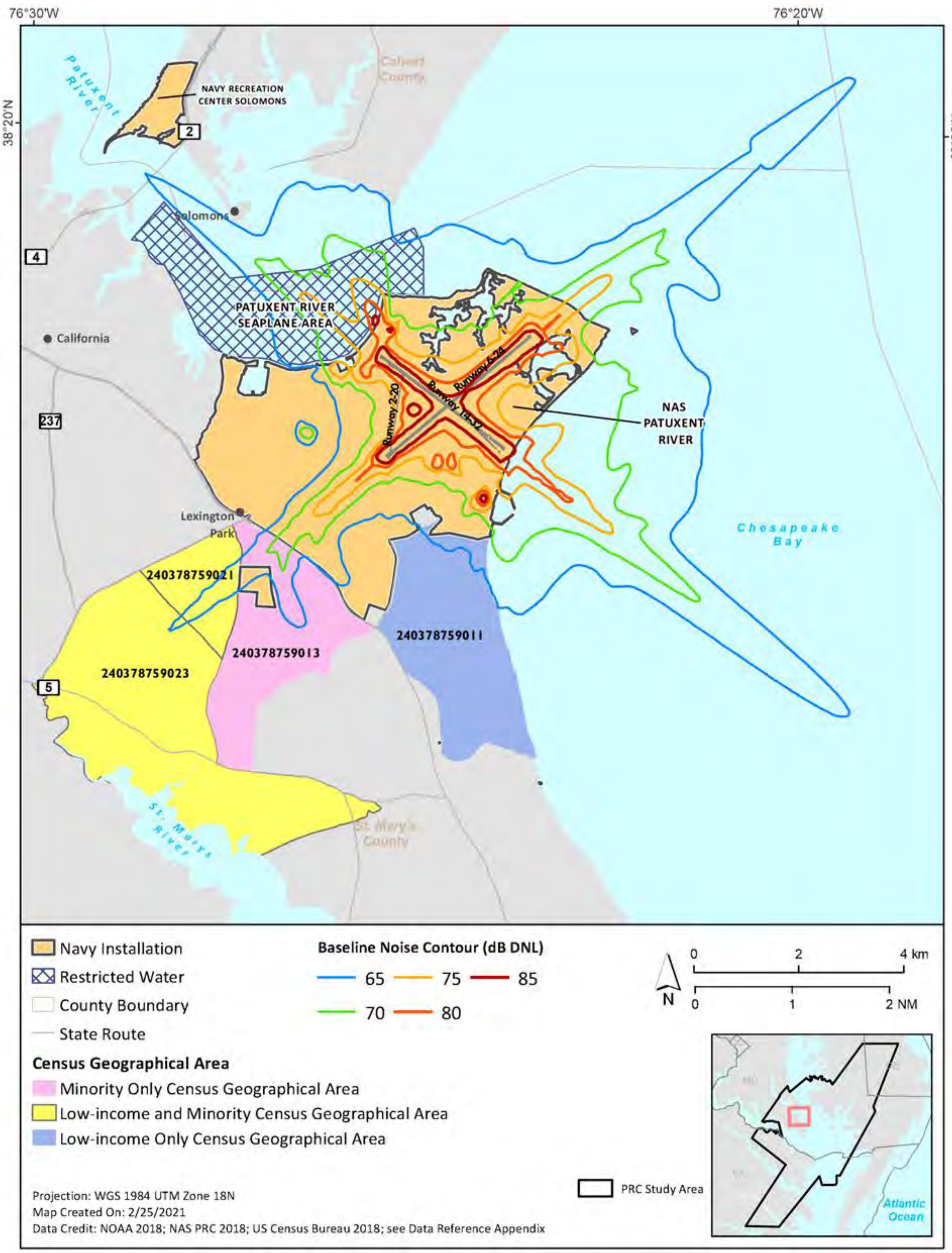

Figure 3.8-2 Affected Area Environmental Justice Populations and PRC Study Area Noise Contours Under Baseline Conditions

Table 3.8-2 shows the total off-installation populations in the affected area exposed to 65 dBA DNL and greater under baseline conditions. Under these conditions, there are approximately 1,290 people throughout the six block groups residing within the 65 dBA DNL and greater noise levels resulting from aircraft noise at PRC. Approximately 578 people of the total population affected are minority (44.8 percent) and 155 people are low-income (12.0 percent). Based on a comparison of the environmental justice communities within the affected area to the total population within the affected area, the Navy has determined that there are disproportionately high and adverse impacts to minority and low-income populations under baseline DNL conditions resulting from aircraft noise levels of 65 dBA DNL and above. Noise levels exceeding 70 dBA DNL associated with aircraft noise generated at PRC do not extend into residential areas under baseline conditions.

Table 3.8-2 Off-Installation Populations in Affected Areas Exposed to 65 dBA DNL or Greater Under Baseline Conditions

Census Geographical Area	*Total Population Affected (65 dBA DNL or greater)*	*Number of Minority*[1]	*Percent Minority*	*Number of Low-Income*	*Percent Low-Income*[2]
Calvert County (COC)	*-*	*-*	***21.2%***	*-*	***5.7%***
240098609003	0	0	8.4%	0	3.1%
240098610032	21	1	5.6%	0	0.3%
Total Affected Population in Calvert County	21	1	5.6%	0	0.3%
St. Mary's County (COC)	-	-	24.9%	-	8.2%
240378759011	343	85	24.8%	37	10.7%
240378759013	86	47	54.5%	7	7.7%
240378759021	824	437	53.0%	109	13.2%
240378759023	16	8	50.4%	2	9.8%
Total Affected Population in St. Mary's County	**1,269**	**577**	**45.5%**	**155**	**12.1%**
Total Affected Population in Calvert and St. Mary's County Combined	**1,290**	**578**	**44.8%**	**155**	**12.0%**

Key: COC = community of comparison; dB = decibels; DNL = day-night average sound level.

To assess the presence of environmental justice communities within the APZ under baseline conditions, the Navy looked at the off-installation populations in block groups within the APZs. There are no residential populations within the APZ 1. There are approximately 2,652 residents within the APZ 2 (Table 3.8-3). The APZ 2 overlies six block groups, three of which are also within the 65 dBA DNL to 69 dBA DNL noise contours (see Figure 3.8-3). Block groups within the 65 dBA DNL noise contour and within APZ 2 include 240378759011, 240378759013, and 240378759021 (see Table 3.8-3). Block groups 240378759012, 240378760012, and 240378762001 are within APZ 2 but are not within the 65 dBA DNL noise contours.

APZs are discussed in more detail in Section 3.5 (Public Health and Safety) and Section 3.6 (Land Use).

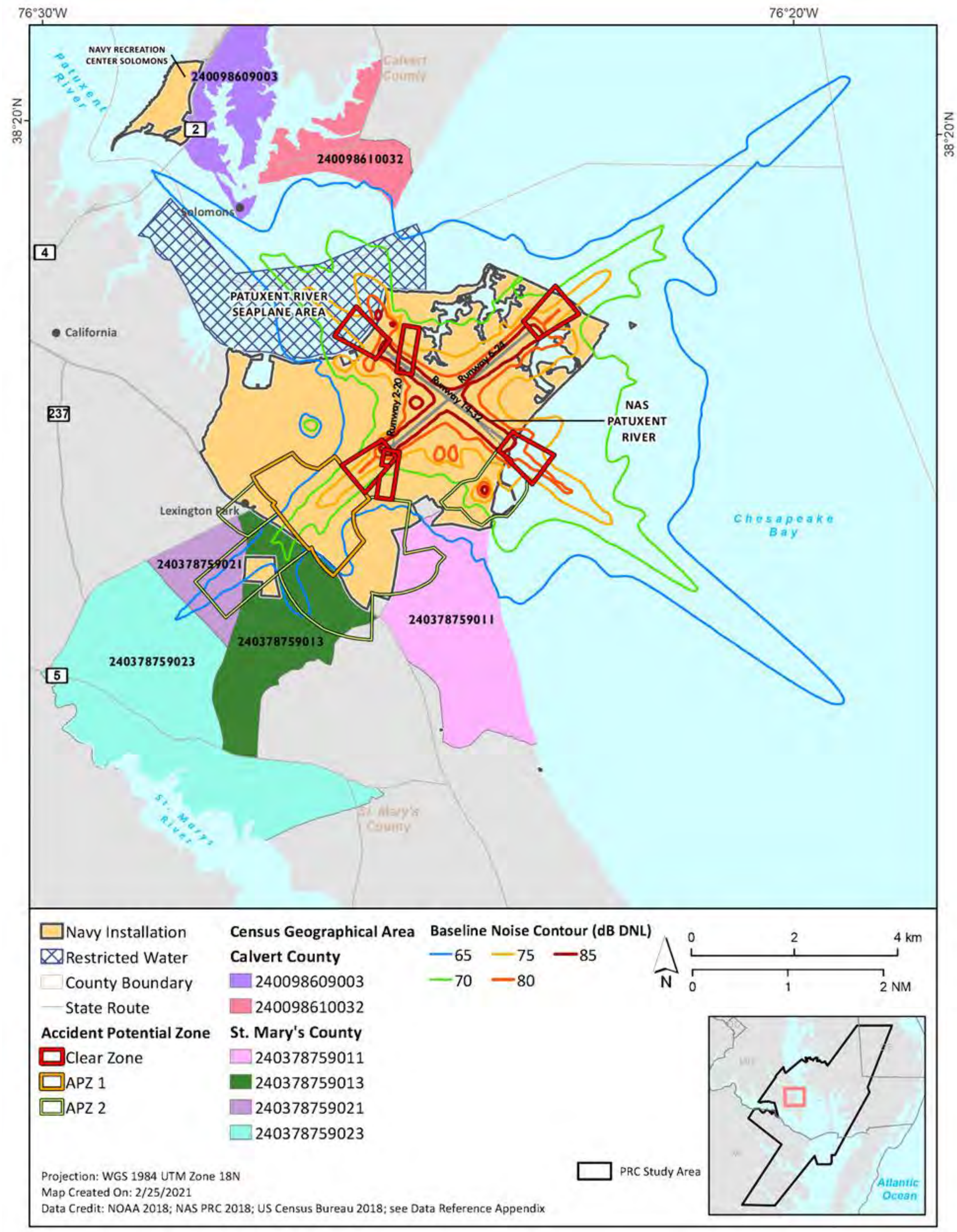

Figure 3.8-3 Affected Census Geographical Areas (Within the 65 dBA DNL to 69 dBA DNL) and Also Within the Accident Potential Zones

Table 3.8-3 Populations in the Accident Potential Zone 2 Under Baseline Conditions

Census Geographical Area	*Total Population*	*Total Population Within APZ 2*	*Number of Minority*	*Percent Minority*	*Number of Low-Income*	*Percent Low-Income*
St. Mary's County (Community of Comparison)-County Total				**24.9%**	**-**	**8.2%**
240378759011[1]	2,168	500	124	24.8%	53	10.7%
240378759012	848	34	16	47.9%	3	7.9%
240378759013[1]	4,081	633	345	54.5%	48	7.7%
240378759021[1]	3,256	1,407	746	53.0%	186	13.2%
240378760012	1,229	7	4	52.6%	2	28.1%
240378762001	959	71	4	6.3%	0	0.0%
Total	**12,541**	**2,652**	**1,240**	**46.7%**	**292**	**11.0%**

Key: APZ = Accident Potential Zone.
Note:
1. Block group within the 65 dBA DNL or greater noise contours

3.8.3 Environmental Justice, Environmental Consequences

This analysis focuses on the existence of environmental justice communities (i.e., minority or low-income populations) and the potential for a disproportionate and adverse exposure of specific off-installation population groups to the projected adverse consequences discussed in the previous sections of this chapter. The acoustic stressor is expected to be the primary adverse environmental and human health impact associated with the Proposed Action. Therefore, the affected area for the environmental justice analysis has been defined as the block groups that fully or partially fall beneath the modeled 65 dBA DNL or greater noise contours under each alternative.

In order to assess the impacts to minority and low-income communities, the Navy first identified whether there were any areas of minority and low-income populations that may experience disproportionately high and adverse impacts from the Proposed Action. These environmental justice communities were determined by analyzing the demographic and economic characteristics of the affected area and comparing those to the characteristics of the larger community as a whole. The larger community is known as the community of comparison and for this analysis is the county within which the block group is located. Under any alternative, the affected area (defined as the block groups wholly or partially within the 65 dBA DNL or greater noise contours) would remain with the block groups identified in Section 3.8.2 (Affected Environment). As such, the same block groups identified in Section 3.8.2 with environmental justice communities would be the same under each alternative.

Once the presence of environmental justice communities were identified, the Navy determined whether the environmental justice communities would be subject to disproportionately high and adverse impacts resulting from acoustic stressors generated at the PRC under each alternative. The Navy considered recommendations from the Council on Environmental Quality's Environmental Justice Guidance under the National Environmental Policy Act (U.S. Environmental Protection Agency, 1997) and the report from the Federal Interagency Working Group on Environmental Justice and National Environmental Policy Act (U.S. Environmental Protection Agency, 2016). The Council on Environmental Quality's guidance on environmental justice analysis requires that any disproportionately high and adverse human health or environmental effects on minority and low-income populations be identified and analyzed. A disproportionate effect is defined as an adverse effect that either is predominantly borne by a minority population and/or low-income population or is an effect that will be suffered by the minority and/or low-income population and is appreciably more severe or greater in magnitude than the adverse effects that will be suffered by the non-minority population and/or low-income population.

Based on the assessment of impacts from the Proposed Action, several impacts would be common under each alternative and would not result in disproportionately high and adverse human health or environmental effects on environmental justice communities. These impacts are briefly discussed in this section, with further discussions in respective sections. Block groups that exist solely over water do not include residential populations; therefore, they are excluded from this analysis.

The public interaction stressor was considered for the potential of the Proposed Action to result in disproportionately high and adverse impacts to minority and/or low-income populations within the APZ 2 due to changes in the risk of aircraft mishaps. Under the No Action Alternative, there would be no change to public health and safety related to flight safety or APZs or Clear Zones (Section 3.5.3.1, Public Health and Safety, No Action Alternative). Alternative 1 and 2 would be associated with increased aircraft operations tempo, which could increase the potential for aircraft mishaps within the APZ. The Navy recognizes that there are environmental justice communities present within APZ 2. The risk of an aircraft mishap under any alternative would be possible under the entire APZ (not only to areas where there would be minority and/or low-income populations) and, thus, the potential impacts would not be predominantly borne by a minority and/or low-income population nor would impacts be appreciably more severe or greater in magnitude than the adverse effects that would be suffered by the non-minority population and/or low-income population. Therefore, the Navy has determined that there would be no disproportionately high and adverse impacts to minority and/or low-income populations from the public interaction stressor, which is not analyzed further in this section. Current aircraft flight-safety policies and procedures (as described in Section 3.5.2.1, Flight Safety) would continue under any alternative.

Noise associated with the expenditure of non-explosive munitions over water would not result in acoustic stressor impacts to residential populations and is not analyzed further in this section. Sonic booms are associated with some noise complaints but munitions and sonic boom noise levels would remain below 40 dB C-weighted day-night average sound level (CDNL) on all land areas. Sonic boom intensity would remain the same, and munitions noise would remain below 115 decibels peak (dBP) on land (see Section 3.1.7, Ambient Airborne Noise, Environmental Consequences). Therefore, sonic boom and munition noise are not further analyzed in this section.

Noise from individual munition firing events and aerial target launches from the Armament Test Area (ATA) would be audible at the closest residential area outside of NAS Patuxent River boundaries. Individual munitions-firing noise events at the ATA would be associated with a moderate risk of complaints, and aerial target launches would be comparable to fighter aircraft overflights. However, since firing events and aerial-target launch events would be infrequent, land use compatibility thresholds would not be exceeded outside of installation boundaries; therefore, these events would not present disproportionately high and adverse impacts to environmental justice communities. Section 3.1 (Ambient Airborne Noise) provides additional details on noise impacts associated with firing events at the ATA.

Acoustic impacts on property values are discussed in Appendix B (A Noise Primer: Noise and Its Effect on the Environment, Section B.5.8, Property Values). As discussed in the Noise Primer, there is enough data available to conclude that aircraft noise has a real effect on property values. The actual value varies from location to location and is very often small compared to non-noise factors.

Acoustic impacts associated with each alternative reflect existing noise mitigation measures identified in the 1998 PRC EIS and operating procedures designed with noise impact minimization in mind such as limitations on supersonic flights and Open-Air Engine Test Cell facility operations (Table 2.5-1, Standard Operating Procedures, and Table 3.10-1, Impact Avoidance and Minimization Measures). The Southern Maryland region is known for its large military presence; the majority of the public surrounding Navy locations that conduct testing and training have experienced these events for decades, with intensity varying from year to year. Under each alternative, the Navy would continue its public outreach efforts to ensure that impacted environmental justice populations are kept informed and involved on Navy actions that may have potentially adverse noise impacts. For example, the Navy's noise abatement programs include establishing a real estate disclosure clause to notify prospective buyers of potential impacts from nearby military installations.

3.8.3.1 Environmental Justice, No Action Alternative

The affected area (i.e., block groups wholly or partially within the 65 dBA DNL or greater noise contours) under the No Action Alternative would be the same as described under baseline conditions (Section 3.8.2.1, Environmental Justice Assessment). Navy testing and training under this alternative would continue to result in disproportionately high and adverse impacts to those environmental justice communities identified in Section 3.8.2 (Environmental Justice, Affected Environment).

Under the No Action Alternative, no change in aircraft operations or tempo would occur compared to current baseline conditions. Therefore, no additional environmental or human health impacts would be associated with the implementation of the No Action Alternative.

3.8.3.2 Environmental Justice, Alternative 1 Potential Impacts

The affected area (i.e., block groups wholly or partially within the 65 dBA DNL or greater noise contours) under Alternative 1 would be the same as described under the No Action Alternative (Section 3.8.3.1, Environmental Justice, No Action Alternative) (Figure 3.8-4). While the block groups would be the same as under the No Action Alternative, the number of acres within the affected block groups exposed to 65 dBA DNL or greater would increase and therefore expose a greater number of residents to these noise levels under this alternative (Table 3.8-4). Under Alternative 1, the majority of the total affected off-installation population is within the 65 dBA DNL to 69 dBA DNL noise contours. However, under this alternative, noise levels of 70 dBA DNL to 74 dBA DNL would extend into residential land areas and affect approximately four people.

Under Alternative 1, there would be a total of approximately 2,640 people off the installation that reside within the affected area. Out of the total population estimated to reside within the 65 dBA DNL or greater noise levels (affected area), approximately 1,143 (43.3 percent) would be minority, which is meaningfully greater compared to St. Mary's County (24.9 percent) (i.e., greater than 15 percent difference). In addition, approximately 303 people (11.5 percent) would be low-income, which is higher compared to St. Mary's County (8.2 percent) and therefore considered disproportionate (see Table 3.8-5). Navy testing and training under this alternative would continue to result in disproportionately high and adverse impacts to those environmental justice communities identified in Section 3.8.2 (Environmental Justice, Affected Environment). Table 3.8-6 shows the change in the environmental justice populations within the affected area under Alternative 1 compared to the No Action Alternative.

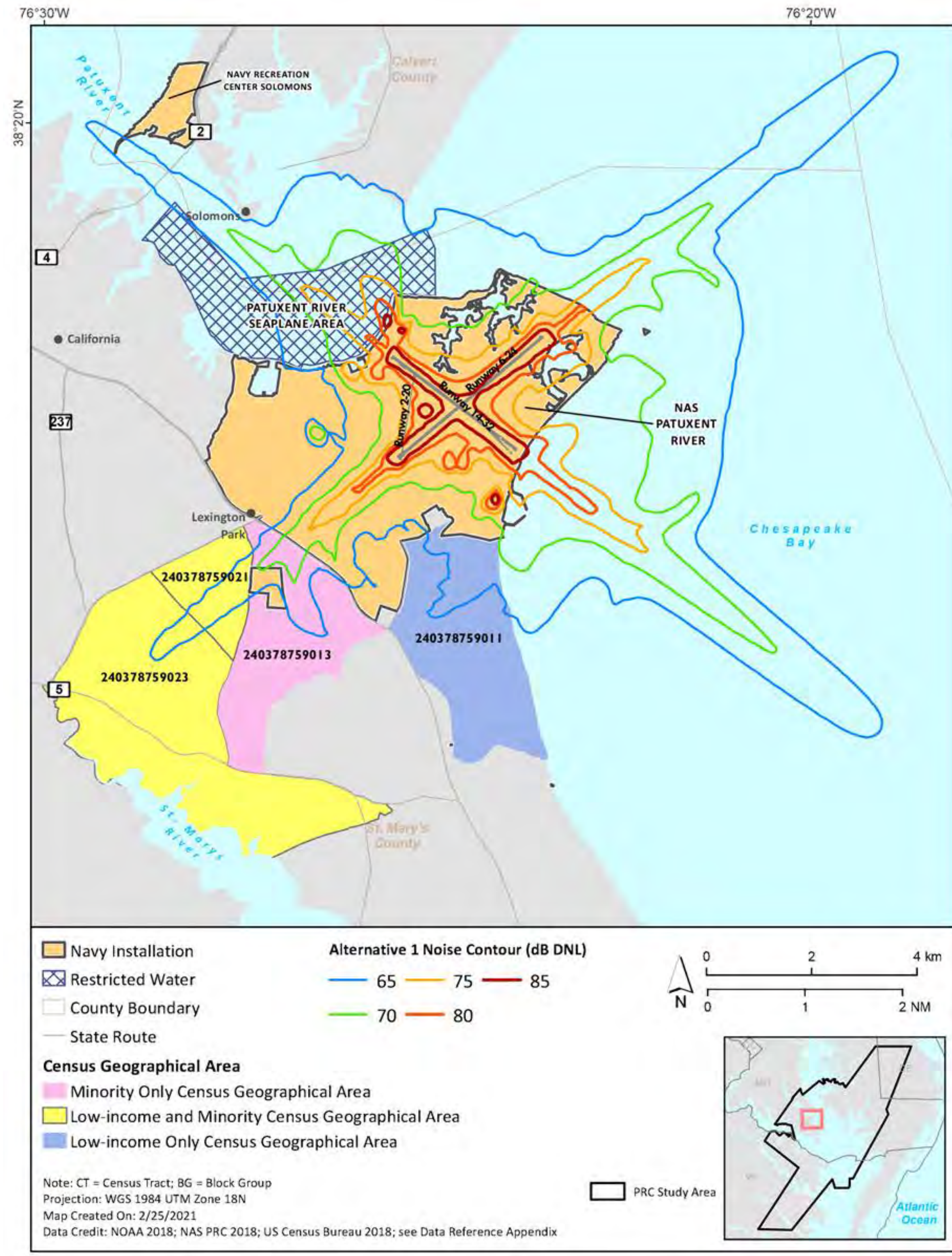

Figure 3.8-4 Affected Area Environmental Justice Populations and PRC Study Area Noise Contours Under Alternative 1

Table 3.8-4 Environmental Justice Populations Within Each Noise Contour Range Under Alternative 1

Average Noise Levels	*Total Affected Off-Installation Population*	*Number of Minority*[1]	*Percent Minority*	*Number of Low-Income*	*Percent Low-Income*[2]
St. Mary's County (Community of Comparison)			**24.9%**		**8.2%**
No Action Alternative					
65–69 dBA DNL	1,290	578	44.8%	155	12.0%
Total >65 dBA DNL[3]	**1,290**	**578**	**44.8%**	**155**	**12.0%**
Alternative 1					
65–69 dBA DNL	2,636	1,142	43.3%	303	11.5%
70–74 dBA DNL	4	1	25.0%	0	0.0%
Total >65 dBA DNL[3]	**2,640**	**1,143**	**43.3%**[5]	**303**	**11.5%**
Population Change from the No Action Alternative					
65–69 dBA DNL	1,346	564	41.9%[5]	148	11.0%
70–74 dBA DNL[4]	4	1	25.0%	0	0.0%
Population Change from No Action Alternative	**1,350**	**565**	**41.9%**[5]	**148**	**11.0%**

Key: > = greater than; dBA = A-weighted decibels; DNL = day-night average sound level.

Notes:

Numbers and percentages may be subject to rounding errors.

1. Minority is defined as individuals who are members of the following population groups: American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, or Black or African American, as well as individuals who self-identify as Hispanic or Latino origin who are White. Individuals who self-identify as Hispanic or Latino from another race are already included in the analysis.
2. Percent low-income is defined as the percent of all residents identified as having incomes placing them below the U.S. Census-defined poverty level, according to data published by the U.S. Census Bureau in the *2013-2017 American Community Survey (5-Year Estimates)*.
3. Noise levels of 70 dBA DNL or greater do not extend into residential land use under the No Action Alternative.
4. Noise levels of 75 dBA DNL or greater do not extend into residential land use under Alternative 1.
5. Indicate where environmental justice communities have been identified based upon the indicated thresholds identified in Section 3.8.2 (Environmental Justice, Affected Environment).

Table 3.8-5 Off-Installation Population Affected by 65 dBA DNL or Greater Under Alternative 1 by Block Group[1]

Census Geographical Area	*Total Population Affected (65 dBA DNL or greater)*	*Number of Minority*[3]	*Percent Minority*	*Number of Low-Income*	*Percent Low-Income*[2]
Calvert County (COC)	-	-	**21.2%**	-	**5.7%**
240098609003	7	1	8.4%	0	3.1%
240098610032	57	3	5.6%	0	0.3%
Total Affected Population in Calvert County	64	4	5.6%	0	0.3%
St. Mary's County (COC)			**24.9%**	-	**8.2%**
240378759011	809	201	24.8%	87	10.7%
240378759013	257	140	54.5%	20	7.7%
240378759021	1,400	742	53.0%	185	13.2%

Table 3.8-5 Off-Installation Population Affected by 65 dBA DNL or Greater Under Alternative 1 by Block Group, Continued

Census Geographical Area	*Total Population Affected (65 dBA DNL or greater)*	*Number of Minority[3]*	*Percent Minority*	*Number of Low-Income*	*Percent Low-Income[2]*
Calvert County (COC)	**-**	**-**	**21.2%**	**-**	**5.7%**
240378759023	110	56	50.4%	11	9.8%
Total Affected Population in St. Mary's County	**2,576**	**1,139**	**44.2%**	**303**	**11.8%**
Total Affected Population in Calvert and St. Mary's County Combined	**2,640**	**1,143**	**43.3%**	**303**	**11.5%**

Key: COC = community of comparison; dBA = A-weighted decibels; DNL = day-night average sound level.
Notes:
1. This table includes the total off-installation populations including those census geographical areas identified as having environmental justice communities (i.e., 240378759011, 240378759013, 240378759021, 240378759023) and census geographical areas that are not considered environmental justice communities (i.e., 240098609003 and 240098610032).
2. Low-income environmental justice community based on threshold identified in Section 3.8.2 (Environmental Justice, Affected Environment).
3. Minority environmental justice community based on threshold identified in Section 3.8.2.

Table 3.8-6 Off-Installation Populations in Potentially Affected Areas Exposed to 65 dBA DNL or Greater Under Alternative 1 Compared to the No Action Alternative

Census Geographical Area	*No Action Alternative*			*Alternative 1*			*Change from the No Action[2]*		
	Total Population Affected (65 dBA DNL or greater)	*Number of Minority[1]*	*Number of Low-Income*	*Total Population Affected (65 dBA DNL or greater)*	*Number of Minority[1]*	*Number of Low-Income*	*Total Population Affected (65 dBA DNL or greater)*	*Number of Minority[1]*	*Number of Low-Income*
240098609003	0	0	0	7	1	0	+7	+1	+0
240098610032	21	1	0	57	3	0	+36	+2	+0
240378759011[3]	343	85	37	809	201	87	+466	+116	+50
240378759013[4]	86	47	7	257	140	20	+171	+93	+13
240378759021[3,4]	824	437	109	1,400	742	185	+576	+305	+76
240378759023[3,4]	16	8	2	110	56	11	+94	+48	+9
TOTAL	1,290	578	155	2,640	1,143	303	+1,350	+565	+148

Key: dBA = A-weighted decibels; DNL = day-night average sound level.
Notes:
1. This table includes the total off-installation populations including those census geographical areas identified as having environmental justice communities and census geographical areas identified as non-environmental justice communities.
2. "+" = increase or additional change from the No Action Alternative.
3. Low-income environmental justice community based on threshold identified in Section 3.8.2 (Environmental Justice, Affected Environment).
4. Minority environmental justice community based on threshold identified in Section 3.8.2.
5. Corresponding percentages shown in Table 3.8-2 were applied to the total population to determine the number of minority and low-income population for each census geographical areas.

3.8.3.3 Environmental Justice, Alternative 2 (Preferred Alternative) Potential Impacts

The affected area (i.e., block groups wholly or partially within the 65 dBA DNL or greater noise contours) under Alternative 2 would be the same as described under the No Action (Section 3.8.3.1, Environmental Justice, No Action Alternative) (Figure 3.8-5). While the block groups would be the same as under the No Action Alternative, the number of acres within the affected block groups exposed to 65 dBA DNL or greater would increase, and therefore expose a greater number of residents to these noise levels under this alternative Table 3.8-7. Under Alternative 2, the majority of the total affected off-installation population is within the 65 dBA DNL to 69 dBA DNL noise contours. However, under this alternative, noise levels of 70 dBA DNL to 74 dBA DNL would extend into residential land areas and affect approximately 71 people.

Table 3.8-7 Environmental Justice Populations Within Each Noise Contour Range Under Alternative 2

Average Noise Levels[3]	*Total Affected Off-Installation Population*	*Number of Minority[1]*	*Percent Minority*	*Number of Low-Income*	*Percent Low-Income[2]*
St. Mary's County (Community of Comparison)			**24.9%**		**8.2%**
No Action Alternative					
65–69 dBA DNL	1,290	578	44.8%	155	12.0%
Total >65 dBA DNL	**1,290**	**578**	**44.8%**	**155**	**12.0%**
Alternative 2					
65–69 dBA DNL	3,001	1,280	42.7%	338	11.3%
70–74 dBA DNL	71	21	29.6%	7	9.9%
Total >65 dBA DNL	**3,072**	**1,301**	**42.4%**	**345**	**11.2%**
Population Change from the No Action Alternative					
65–69 dBA DNL	1,711	702	41.0%	183	10.7%
70–74 dBA DNL	71	21	29.6%	7	9.9%
Population Change from No Action Alternative	**1,782**	**723**	**40.6%**	**190**	**10.7%**

Key: > = greater than; dBA = A-weighted decibels; DNL = day-night average sound level.

Notes:

1. Minority is defined as individuals who are members of the following population groups: American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander, or Black or African American, as well as individuals who self-identify as Hispanic or Latino origin who are White. Individuals who self-identify as Hispanic or Latino from another race are already included in the analysis.
2. Percent low-income is defined as the percent of all residents identified as having incomes placing them below the U.S. Census-defined poverty level, according to data published by the U.S. Census Bureau in the *2013-2017 American Community Survey (5-Year Estimates)*.
3. Noise levels of 70 dBA DNL or greater do not extend into residential land use under the No Action Alternative.
4. Noise levels of 75 dBA DNL or greater do not extend into residential land use under Alternative 1.
5. Indicates where environmental justice communities have been identified based upon the indicated thresholds identified in Section 3.8.2 (Environmental Justice, Affected Environment).

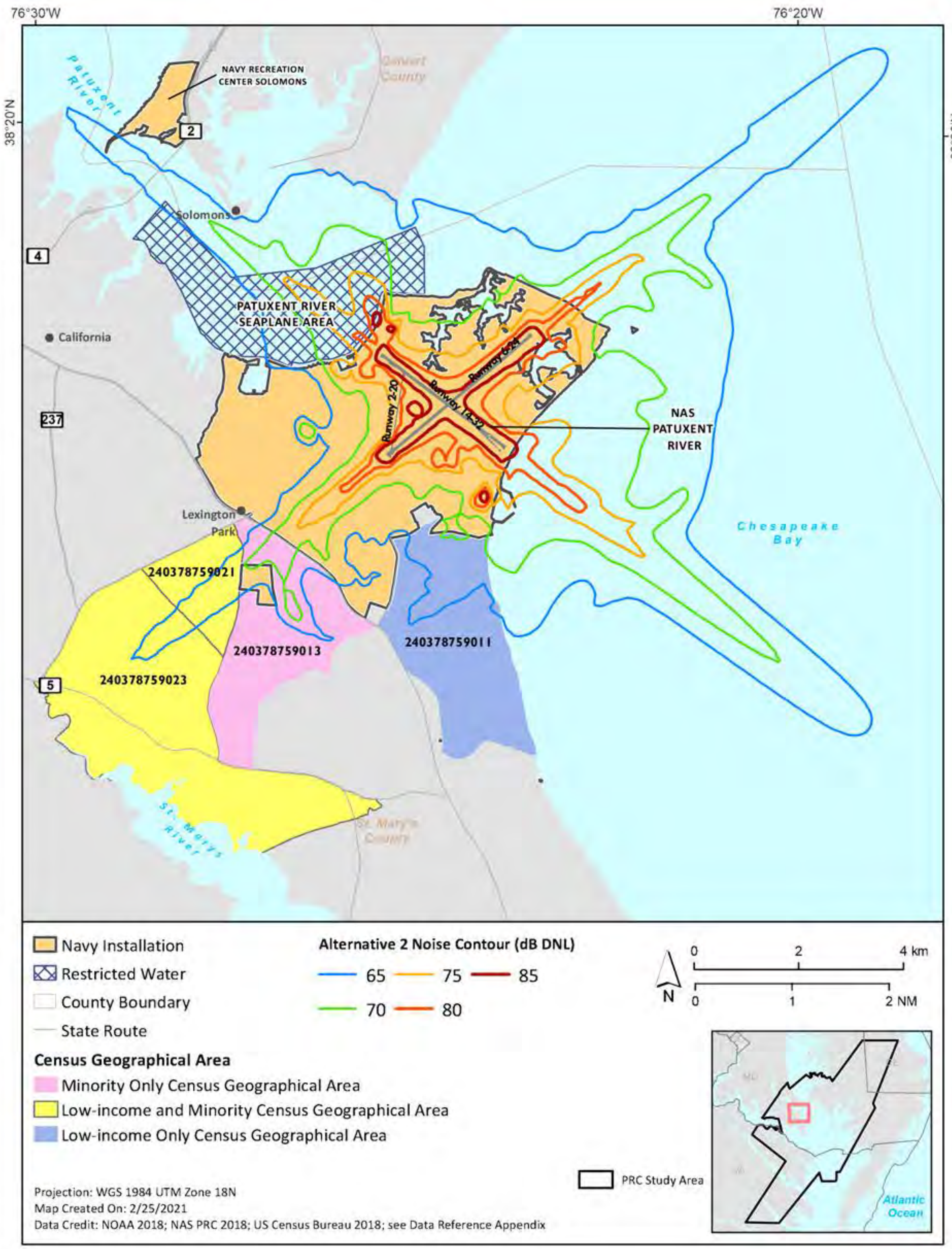

Figure 3.8-5 Affected Area Environmental Justice Populations and PRC Study Area Noise Contours Under Alternative 2

Under Alternative 2, there would be a total of approximately 3,072 people off the installation that reside within the affected area. Out of the total population estimated to reside within the 65 dBA DNL or greater noise levels (affected area), approximately 1,301 (42.4 percent) would be minority, which is meaningfully greater compared to St. Mary's County (24.9 percent) (i.e., greater than 15 percent difference). In addition, approximately 345 people (11.2 percent) would be low-income, which is higher compared to St. Mary's County (8.2 percent) and therefore considered disproportionate (see Table 3.8-8). Navy testing and training under this alternative would continue to result in disproportionately high and adverse impacts to those environmental justice communities identified in Section 3.8.2 (Environmental Justice, Affected Environment). Table 3.8-9 shows the change in the environmental justice populations within the affected area under Alternative 2 compared to the No Action Alternative.

Table 3.8-8 Off-Installation Population Affected by 65 dBA DNL or Greater Under Alternative 2 by Block Group[1]

Census Geographical Area	*Total Population Affected (65 dBA DNL or greater)*	*Number of Minority[3]*	*Percent Minority*	*Number of Low-Income*	*Percent Low-Income[2]*
Calvert County (COC)	**-**	**-**	**21.2%**	**-**	**5.7%**
240098609003	11	1	8.4%	0	3.1%
240098610032	83	5	5.6%	0	0.3%
Total Affected Population in Calvert County	94	6	5.6%	0	0.3%
St. Mary's County (COC)	-	-	**24.9%**	**-**	**8.2%**
240378759011	1,010	251	24.8%	108	10.7%
240378759013	314	171	54.5%	24	7.7%
240378759021	1,517	804	53.0%	200	13.2%
240378759023	137	69	50.4%	13	9.8%
Total Affected Population in St. Mary's County	**2,978**	**1,295**	**43.5%**	**345**	**11.6%**
Total Affected Population in Calvert and St. Mary's County Combined	**3,072**	**1,301**	**42.4%**	**345**	**11.2%**

Key: COC = community of comparison; dBA = A-weighted decibels; DNL = day-night average sound level.

Notes:

1. This table includes the total off-installation populations including those census geographical areas identified as having environmental justice communities (i.e., 240378759011, 240378759013, 240378759021, 240378759023) and census geographical areas that are not considered environmental justice communities (i.e., 240098609003 and 240098610032).
2. Low-income environmental justice community based on threshold identified in Section 3.8.2 (Environmental Justice, Affected Environment).
3. Minority environmental justice community based on threshold identified in Section 3.8.2.

Table 3.8-9 Off-Installation Populations in Potentially Affected Areas Exposed to 65 dBA DNL or Greater Under Alternative 2 Compared to the No Action Alternative

Census Geographical Area	*No Action Alternative*			*Alternative 2*			*Change from the No Action*[2]		
	Total Population Affected (65 dBA DNL or greater)	*Number of Minority*[1]	*Number of Low-Income*	*Total Population Affected (65 dBA DNL or greater)*	*Number of Minority*[1]	*Number of Low-Income*	*Total Population Affected (65 dBA DNL or greater)*	*Number of Minority*[1]	*Number of Low-Income*
240098609003	0	0	0	11	1	0	+11	+1	0
240098610032	21	1	0	83	5	0	+62	+4	0
240378759011[3]	343	85	37	1,010	251	108	+667	+166	+71
240378759013[4]	86	47	7	314	171	24	+228	+124	+17
240378759021[3,4]	824	437	109	1,517	804	200	+693	+367	+91
240378759023[3,4]	16	8	2	137	69	13	+121	+61	+11
TOTAL	**1,290**	**578**	**155**	**3,072**	**1,301**	**345**	**+1,782**	**+723**	**+190**

Key: dBA = A-weighted decibels; DNL = day-night average sound level.

Notes:

1. This table includes the total off-installation populations including those census geographical areas identified as having environmental justice communities and those census geographical areas identified as non-environmental justice communities.
2. "+" = increase or additional change from the No Action Alternative.
3. Low-income environmental justice community based on threshold identified in Section 3.8.2 (Environmental Justice, Affected Environment).
4. Minority environmental justice community based on threshold identified in Section 3.8.2.
5. Corresponding percentages shown in Table 3.8-2 were applied to the total population to determine the number of minority and low-income population for each census geographical areas.

3.8.3.4 Alternatives Impact Summary

Summary of Impacts, Environmental Justice

Acoustic:

Acoustic stressors associated with each alternative reflect existing noise mitigation measures identified in the 1998 PRC EIS and operating procedures designed with noise impact minimization in mind (Table 2.5-1, Standard Operating Procedures, and Table 3.10-1, Impact Avoidance and Minimization Measures).

No Action Alternative

- Under the No Action Alternative, there would be six block groups that are within the affected area defined as the area with 65 dBA DNL or greater noise levels. Of the six block groups within the affected area, four block groups have environmental justice communities present. These four block groups include the following:
    - Block group 240378759011 has a higher percent low-income population (10.7 percent) than St. Mary's County (8.2 percent).
    - Block group 240378759013 has a meaningfully greater percent minority population (54.5 percent) than St. Mary's County (24.9 percent).

- Block group 240378759021 has a meaningfully greater percent minority population (53.0 percent) than St. Mary's County (24.9 percent) and a higher percent low-income population (13.2 percent) than St. Mary's County.
- Block group 240378759023 has a meaningfully greater percent minority population (50.4 percent) than St. Mary's County (24.9 percent) and a higher percent low-income population (9.8 percent) than St. Mary's County (8.2 percent).

- Based on the environmental justice analysis, there would be potential for disproportionately high and adverse impacts to minority and low-income populations in the affected population under the No Action Alternative due to noise.
- Under the No Action Alternative, there would be a total of approximately 1,290 people off the installation that reside within the affected area. Out of the total population estimated to reside within the 65 dBA DNL or greater noise levels, approximately 578 (44.8 percent) would be minority, which is meaningfully greater compared to St. Mary's County (24.9 percent) and approximately 155 people (12 percent) would be low-income, which is higher compared to St. Mary's County (8.2 percent).

Alternative 1

- Under Alternative 1, the block groups previously identified in the No Action Alternative as the affected area would be the same block groups impacted under this alternative by noise levels of 65 dBA DNL or greater.
- Based on the environmental justice analysis, there would be potential for disproportionately high and adverse impacts to minority and low-income populations in the affected population under Alternative 1 due to noise.
- Under Alternative 1, there would be an increase in the frequency of aircraft operations that would expose a larger area, and therefore more residents (including minority and low-income populations) to noise levels of 65 dBA DNL or greater compared to the No Action Alternative. Under this alternative, there would be a total of approximately 2,640 people off the installation that reside within the affected area. Out of the total population estimated to reside within the 65 dBA DNL or greater noise levels, approximately 1,143 people (43.3 percent) would be minority, which is meaningfully greater compared to St. Mary's County (24.9 percent) and approximately 303 people (11.5 percent) would be low-income, which is higher compared to St. Mary's County (8.2 percent).

Alternative 2 (Preferred Alternative)

- Under Alternative 2, the block groups previously identified in the No Action Alternative as the affected area would be the same block groups impacted under this alternative by noise levels of 65 dBA DNL or greater.
- Based on the environmental justice analysis, there would be potential for disproportionately high and adverse impacts to minority and low-income populations in the affected population under Alternative 2 due to noise.
- Under Alternative 2, there would be an increase in the frequency of aircraft operations that would expose a larger area, and therefore more residents (including minority and low-income

populations) to noise levels of 65 dBA DNL or greater compared to the No Action Alternative. Under this alternative, there would be a total of approximately 3,072 people off the installation that reside within the affected area. Out of the total population estimated to reside within the 65 dBA DNL or greater noise levels, approximately 1,301 people (42.4 percent) would be minority, which is meaningfully greater compared to St. Mary's County (24.9 percent) and approximately 345 people (11.2 percent) would be low-income, which is higher compared to St. Mary's County (8.2 percent).

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3.9 Cultural Resources

This discussion of cultural resources includes prehistoric and historic archaeological sites; historic buildings, structures, and districts; and physical entities and human-made or natural features important to a culture, a subculture, or a community for traditional, religious, or other reasons. Cultural resources can be divided into three major categories:

- Archaeological resources (prehistoric and historic) are locations where human activity measurably altered the earth or left deposits of physical remains over 50 years ago.
- Architectural resources include standing buildings, structures, landscapes, and other built-environment resources of historic or aesthetic significance.
- Traditional cultural properties may include archaeological resources, structures, neighborhoods, prominent topographic features, habitat, plants, animals, and minerals that Native Americans or other groups consider essential for the preservation of traditional culture.

There are no traditional cultural properties or sacred sites identified at any of the installations under Naval Air Station (NAS) Patuxent River jurisdiction that are in the Area of Potential Effects (APE) of the Proposed Action (U.S. Department of the Navy, 2018d). Therefore, this category will not be carried forward for analysis.

3.9.1 Cultural Resources, Regulatory Setting

Cultural resources are governed by federal laws and regulations, including the National Historic Preservation Act (NHPA), Archeological and Historic Preservation Act, American Indian Religious Freedom Act, Archaeological Resources Protection Act of 1979, and the Native American Graves Protection and Repatriation Act of 1990. Cultural resources also may be covered by state, local, and territorial laws.

National Historic Preservation Act

Federal agencies' responsibility for protecting historic properties is defined primarily by Sections 106 and 110 of the NHPA. Section 106 requires federal agencies to take into account the effects of their undertakings on historic properties. Section 110 of the NHPA requires federal agencies to establish—in conjunction with the Secretary of the Interior—historic preservation programs for the identification, evaluation, and protection of historic properties.

3.9.2 Cultural Resources, Affected Environment

Cultural resources listed in the National Register of Historic Places (NRHP) or eligible for listing in the NRHP are "historic properties" as defined by the NHPA. The list was established under the NHPA and is administered by the National Park Service on behalf of the Secretary of the Interior. The NRHP includes properties on public and private land. Properties can be determined eligible for listing in the NRHP by the Secretary of the Interior or by a federal agency official with concurrence from the applicable State Historic Preservation Office (SHPO). An NRHP-eligible property has the same protections as a property listed in the NRHP. The historical properties include archaeological and architectural resources.

The Navy has conducted inventories of cultural resources at NAS Patuxent River and Outlying Field (OLF) Webster to identify historical properties that are listed or potentially eligible for listing in the NRHP.

The APE for cultural resources is the geographic area or areas within which an undertaking (project, activity, program or practice) may cause changes in the character or use of any historic properties present. The APE is influenced by the scale and nature of the undertaking and may be different for various kinds of effects caused by the undertaking. For this Proposed Action, the Navy determined that the APE for direct impacts (effects) is defined as the 65 A-weighted decibel (dBA) day-night average sound level (DNL) contour and the range areas where the testing and training activities are/would be conducted. The APE for indirect impacts (effects) is the area defined as the Patuxent River Complex (PRC) Study Area, as represented in Figure 1.3-1 (PRC Study Area).

Archaeological and historic architectural resources under airspace, which are unlikely to be affected by aircraft overflights, were identified using the records of the NRHP and National Historic Landmarks (NHL) (National Park Service, 2019).

3.9.2.1 National Historic Landmarks

NHL are places that "possess exceptional value or quality in illustrating and interpreting the heritage of the United States" and include battlefields, architectural or engineering masterpieces, ruins, and historic towns and communities. There are nine NHL beneath the boundaries of the PRC Study Area airspace (Table 3.9-1 and Figure 3.9-1), none of which are within the 65 dBA DNL contour (i.e., the APE for direct effects).

Table 3.9-1 National Historic Landmarks Within the PRC Study Area

Name of Landmark	*Location (City, County, State)*
J. C. Lore Oyster House	Solomons, Calvert, Maryland
WM. B. Tennison (Chesapeake Bay Bugeye)	Solomons, Calvert, Maryland
Sotterley	Hollywood, St. Mary's, Maryland
St. Mary's City Historic District	St. Mary's City, St. Mary's, Maryland
West St. Mary's Manor	Drayden, St. Mary's, Maryland
Holly Knoll	Capahosic, Gloucester, Virginia
Christ Church	Irvington, Lancaster, Virginia
Spence's Point	Westmoreland, Westmoreland, Virginia
Yeocomico Church	Tucker Hill, Westmoreland, Virginia

Source: (National Park Service, 2019)
Key: PRC = Patuxent River Complex.

3.9.2.2 National Register of Historic Places

There are 266 federally listed resources in the NRHP throughout 16 counties in Delaware (2), Maryland (6), and Virginia (8) underneath the PRC airspace (Table 3.9-2). Property types range from residences, churches, schools, and civic buildings to agricultural, archaeological, transportation, and commercial properties (Table 3.9-3). There is one NRHP-listed property (archaeological site 18ST390) within the 65 dBA DNL contour (APE for direct effects).

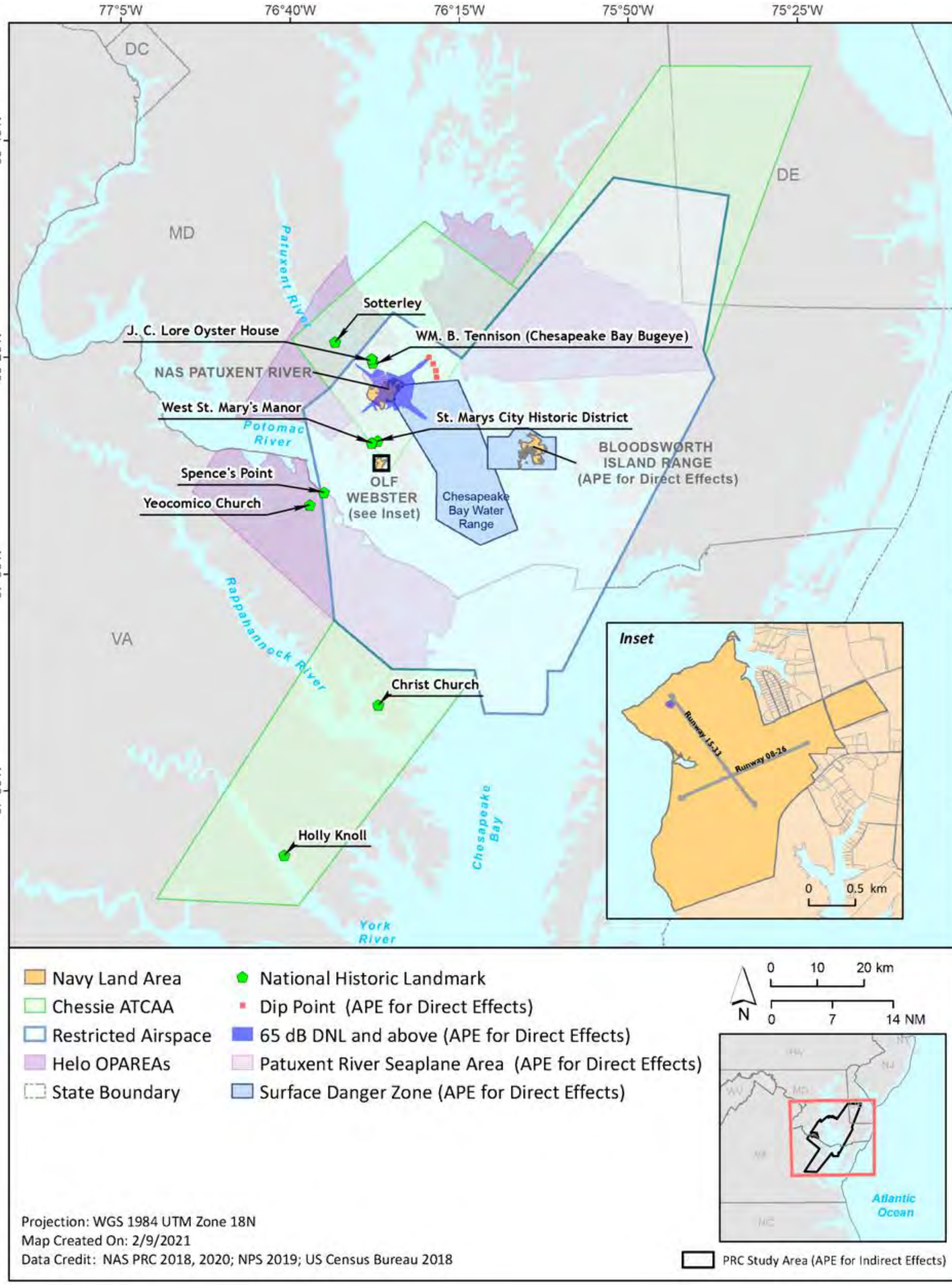

Figure 3.9-1 National Historic Landmarks Within the PRC Study Area

Table 3.9-2 Number of NRHP-Listed Properties Within the PRC Study Area by County and State

State and County	*Number of Properties*
Delaware	**61**
Kent	3
Sussex	58
Maryland	**117**
Calvert	8
Caroline	6
Dorchester	23
Somerset	47
St. Mary's	21
Wicomico	12
Virginia	**88**
Accomack	2
Gloucester	22
James City	7
King And Queen	3
Lancaster	12
Middlesex	14
Northumberland	18
Westmoreland	10
Grand Total	**266**

Source: (National Park Service, 2019)
Key: NRHP = National Register of Historic Places; PRC = Patuxent River Complex.

Table 3.9-3 NRHP-Listed Properties Within the PRC Study Area by Type and State

Property Type	*Delaware*	*Maryland*	*Virginia*	*Total*
Agricultural	12	7	0	19
Archaeological	3	5	10	18
Boat	0	2	0	2
Church	5	18	12	35
Club	0	2	1	3
Commercial	7	7	2	16
Courthouse	0	1	2	3
Fire Department	1	0	0	1
Historic District	6	14	12	32
Industrial	2	0	0	2
Library	1	0	0	1
Lighthouse	2	3	0	5
Military	0	2	0	2
Residence	17	51	25	93
School	2	5	6	13
Town	0	0	16	16
Transportation	3	0	2	5
Total	**61**	**117**	**88**	**266**

Source: (National Park Service, 2019)
Key: NRHP = National Register of Historic Places; PRC = Patuxent River Complex.

In addition to those properties possessing national significance and listed on the NRHP, the land area underlying the PRC airspace abounds with cultural resources considered historically significant at the state and local levels. Lists of these resources are available through the SHPO at the Delaware Division of Historical and Cultural Affairs, the Maryland Historical Trust, or the Virginia Department of Historic Resources.

3.9.2.3 Archaeological Resources

Naval Air Station Patuxent River

Since 1980, more than 50 archaeological surveys or archaeological site investigations have been conducted at NAS Patuxent River, and most of the main installation has been surveyed. A total of 145 archaeological sites have been identified at the main installation, although not all archaeological resources have been evaluated for NRHP eligibility. Archaeological site 18ST390 (Mattapany-Sewall Site) is listed in the NRHP, and 10 other archaeological sites have been determined eligible for listing in the NRHP (U.S. Department of the Navy, 2018d). Although much of the main installation is highly developed, it includes and retains great potential for significant archaeological resources.

Outlying Field Webster

Since the 1930s, more than 20 archaeological surveys or archaeological site investigations have been conducted at OLF Webster, and most of the main installation has been surveyed. A total of 59 archaeological sites have been identified, although not all archaeological resources have been evaluated for NRHP eligibility. Of the site inventory, 7 sites have been recommended as eligible for listing on the NRHP, 13 have no eligibility determinations, and 39 have been determined not eligible for NRHP listing (U.S. Department of the Navy, 2018d).

Chesapeake Bay Water Range (including Bloodsworth Island Range)

Since 1980, three archaeological surveys or archaeological site investigations have been conducted at Bloodsworth Island Range, which have covered the entire range. Seven archaeological sites have been identified; four of the sites have been recommended as eligible for listing on the NRHP as an archaeological district, and three have been determined not eligible for NRHP listing (U.S. Department of the Navy, 2018d).

3.9.2.4 Architectural Resources

Naval Air Station Patuxent River

All of the built resources on the main installation at NAS Patuxent River constructed before 1965 have been surveyed and evaluated for NRHP eligibility; some of the late Cold War-era resources also have been evaluated for NRHP eligibility. Nine resources on the installation are individually eligible for listing in the NRHP, include five hangars built during the 1940s, the 1943 Administration Building, St. Nicolas Church (constructed in 1915) and cemetery, Firehouse No. 2 (1944), and the Frank Knox School (1944) (see Table 3.9-4). Five of these resources are inside the 65 dBA DNL or greater contour (APE for direct effects) (see Table 3.9-4). In addition to the building surveys, a 2009 historic landscape study recommended several elements of the landscape as eligible for listing in the NRHP as contributing features of other NRHP-eligible resources. The flagpole and drill field contribute to the adjacent Administration Building and the St. Nicolas Cemetery contributes to St. Nicolas Church. The taxiways contribute to the Radio Test Landplane Concrete Hangar, the Electronics Test Shielded Hangar, and the two Naval Air Transport Service Seaplane Hangars. The West Patuxent Seaplane Basin contributes to the third Naval Air Transport Service Seaplane Hangar (U.S. Department of the Navy, 2018d).

Table 3.9-4 Architectural Resources at NAS Patuxent River Individually Eligible for Listing in the NRHP

Building Number	*Facility Name*	*Year Built*	*Associated NRHP-Eligible Landscape Features*	*Inside 65 dBA DNL or Greater Contour (Direct Effects APE)*
115	Radio Test Landplane Concrete Hangar	1944	Taxiways	Yes
144	Electronics Test Shielded Hangar	1949	Taxiways	Yes
301	NATS Seaplane Hangar	1943	West Patuxent Seaplane Basin (Building 1174)	No
305	NATS Seaplane Hangar	1943	Taxiways	Yes
306	NATS Seaplane Hangar	1943	Taxiways	Yes
409	Administration Building	1943	Flag Pole (Building 844) Drill Field (Building 2427)	Yes
428	St. Nicolas Church	1915	St. Nicolas Cemetery	No
443	Firehouse No. 2	1944	None	No
2189	Frank Knox School	1944	None	No

Source: (U.S. Department of the Navy, 2018d)
Key: NATS = Naval Air Transport Service; NRHP = National Register of Historic Places; PRC = Patuxent River Complex.

Three historic districts at NAS Patuxent River have been determined eligible for listing in the NRHP, all of which are inside the 65 dBA DNL or greater contour (APE for direct effects). The three districts include the Armament Test/Electronics Test/Weapons Test Historic District (originally named the Armament Test Historic District and updated in 2005), the Flight Test/Tactical Test/NAS Operations Historic District, and the Mattapany-Sewall Complex Historic District. The Mattapany-Sewall Complex Historic District, sited on the Patuxent River, roughly between the East Patuxent River Basin and the West Patuxent River Basin, includes a circa 1740 house, eight ancillary structures, and the surrounding landscape that contribute to the district. The Armament Test/Electronics Test/Weapons Test Historic District is significant "for its association with the primary mission of NAS Patuxent River during World War II and the early Cold War period" (1943–1965) and for its "resources whose design is specific to, and particularly illustrative of, the testing facilities that supported the activities of the Armament Test Division in these decades." This historic district includes a parcel on the Chesapeake Bay and the installation's runways and taxiways. The Flight Test/Tactical Test/NAS Operations Historic District, a divided NRHP-eligible district, is significant for its association with the primary mission of NAS Patuxent River during World War II and the early Cold War period (1943–1965). This district overlaps with the Armament Test/Electronics Test/Weapons Test Historic District (U.S. Department of the Navy, 2018d).

Outlying Field Webster

All of the built resources at OLF Webster constructed before 1965 have been surveyed and evaluated for NRHP eligibility. One historic district has been determined eligible for the NRHP at OLF Webster. The Webster Field Historic District includes resources that are associated with the two primary missions (ordnance testing and testing of the Naval Air Navigation Electronics Project) of OLF Webster during World War II and the early Cold War (Table 3.9-5) (U.S. Department of the Navy, 2018d). No individual buildings or structures at the installation have been determined eligible for the NRHP.

Table 3.9-5 Contributing Architectural Resources in the Webster Field Historic District

Building Number	*Facility Name*	*Year Built*	*MHT Concurrence*
8016	Electrical/Communication System Integration Lab	1953	6/27/05
8016A	Well	1953	6/27/05
8017	Satellite Communication Tower RDT&E	1956	6/27/05
8020	TACAN Antenna Range Building	1959	6/27/05
8031	Antenna Tracking Mount R-D	1962	6/27/05
8053	TACAN Flight Test Pad #1	1961	6/27/05
8062	Antenna Track Mount/B8020	1964	6/27/05
8063	Antenna Track Mount/B8020	1966	6/27/05
8069	Radar Tower/Top 8016	1953	6/27/05
8070	Radar Tower/Top 8016	1953	6/27/05

Source: (U.S. Department of the Navy, 2018d)

Key: MHT = Maryland Historical Trust; RDT&E = research, development, test and evaluation; TACAN = Tactical Air Navigation System.

3.9.2.5 Shipwrecks and Underwater Obstructions

Chesapeake Bay Water Range

As part of mission activities, NAS Patuxent River conducts limited actions in the waterways adjacent to installation areas and, in accordance with U.S. Department of the Navy policy (Office of the Chief of Naval Operations Instruction 5090.1E) and the NHPA, NAS Patuxent River is responsible for reviewing installation actions for potential impacts to submerged resources.

As codified in the Sunken Military Craft Act of 2004 (Title XIV of the Fiscal Year 2005 National Defense Authorization Act, Public Law Number 108-375), the U.S. Navy is the owner in perpetuity of wrecks of Navy warships, aircraft, and their cargoes. The U.S. Department of the Navy protects and manages these resources in compliance with U.S. historic preservation laws and U.S. Navy regulations, with oversight and permitting through the Underwater Archaeology Branch of the Naval Historical Center, located at the Washington Navy Yard. It should be noted that the State of Maryland has control of non-military submerged resources, as determined by the elevation of mean high tide, which is an important consideration for submerged archaeological resources that are not claimed by the U.S. Navy.

The waters of the lower Patuxent River and central Chesapeake Bay off NAS Patuxent River are considered sensitive for submerged archaeological resources, particularly for vessels from the War of 1812, the Civil War era, and the World War II/Cold War era. Literature on the underwater archaeology in the lower Patuxent and Potomac rivers and Chesapeake Bay includes the works of Shomette (Shomette, 1982; 1985; 1996; 2009). The Naval Historical Center began inventorying sunken Navy craft in 1993 and completed an inventory for Maryland in 1996. The Maryland inventory includes 105 known military shipwrecks spanning the entirety of U.S. history and includes 21 different vessel types (e.g., armed military barges, schooners, and submarines) (Shomette, 1997). Non-military wrecks are also common in the area, with documented losses numbering in the hundreds, including those of steamboats, watermen, and commercial vessels.

There are eight known underwater resources within the boundary of the Chesapeake Bay Water Range (Table 3.9-6 and Figure 3.9-2). These resources include one Navy aircraft wreck (Grumman XF8F-1 Bearcat from 1945); two Navy shipwrecks (Hannibal and American Mariner), which are the former and current direct-impact targets of the Hannibal Target in the Chesapeake Bay Water Range (Section 1.3.3, PRC Water Areas); two NAS Patuxent River Target wrecks; and three shipwrecks listed in the Maryland Historical Trust database (Maryland Historical Trust, 2019).

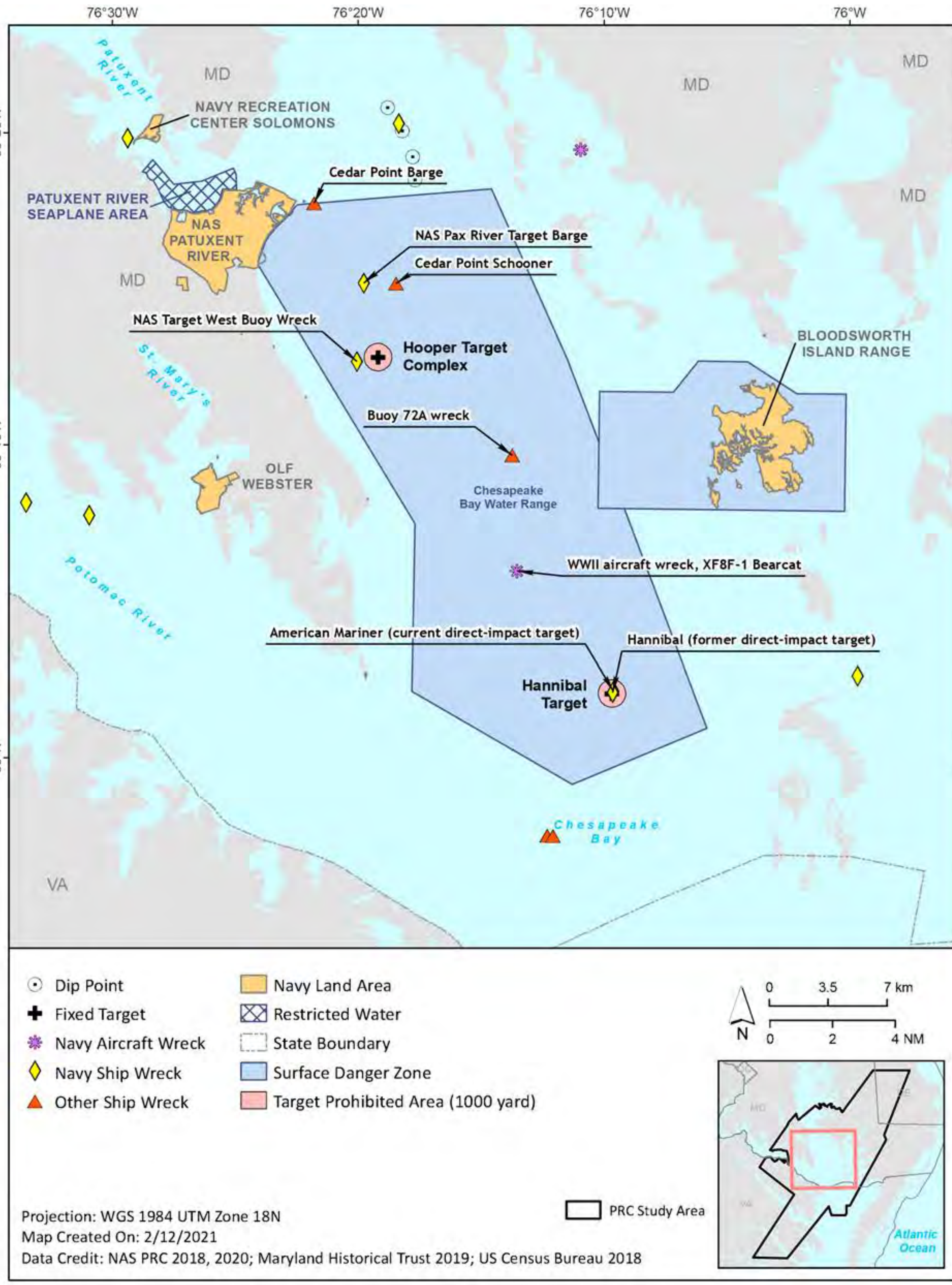

Figure 3.9-2 Underwater Cultural Resources Within the Chesapeake Bay Water Range

None of these wrecks are known to have been evaluated for NRHP eligibility and are thus considered potentially eligible. As such, they are treated in this analysis the same as NRHP-listed or -eligible resources. There are additional wrecks that may be present within the region that have not been inventoried, but standard Navy practice is to avoid known in-water "obstacles." There has been no systematic underwater archaeological survey (Phase I) in the range; therefore, all potentially eligible resources may not been have identified.

Table 3.9-6 Underwater Cultural Resources Within the Chesapeake Bay Water Range

Site Number	*Type*	*Description*	*NRHP Status*
18ST847	Aircraft Wreck	WWII aircraft wreck, XF8F-1 Bearcat (possible war grave)	Not Evaluated
N/A	Shipwreck	Hannibal (former direct-impact target)	Not Evaluated
N/A	Shipwreck	American Mariner (current direct-impact target)	Not Evaluated
18ST869	Shipwreck	NAS Patuxent River Target Barge	Not Evaluated
18ST870	Shipwreck	NAS Target West Buoy Wreck	Not Evaluated
18DO494	Shipwreck	Buoy 72A wreck	Not Evaluated
18ST892	Shipwreck	Cedar Point Schooner	Not Evaluated
18ST893	Shipwreck	Cedar Point Barge	Not Evaluated

Sources: (Maryland Historical Trust, 2019)
Key: N/A = not available; NAS = Naval Air Station; NRHP = National Register of Historic Places; WWII = World War II.

3.9.3 Cultural Resources, Environmental Consequences

Analysis of potential impacts to cultural resources considers impacts that may occur by the following:

- physically altering, damaging, or destroying all or part of a resource
- altering characteristics of the surrounding environment that contribute to the importance of the resource
- introducing visual, atmospheric, or audible elements that are out of character for the period the resource represents (thereby altering the setting)
- neglecting the resource to the extent that it deteriorates or is destroyed

Direct impacts can be assessed by identifying the types and locations of proposed activities and determining the location of cultural resources that could be affected. Indirect impacts occur later in time or farther from the Proposed Action.

There are two stressors associated with the Proposed Action that may impact cultural resources: (1) acoustic and (2) physical disturbance and strike. The acoustic stressor most likely to impact cultural resources is from aircraft overflight of land areas beneath the PRC. Since the underwater cultural resources in the Chesapeake Bay Water Range (see Table 3.9-6) are not sensitive to changes in exposed noise from aircraft overflight and from vessels and sonar, they would not be affected from the acoustic stressor. Physical disturbance and strike of cultural resources may occur within the Chesapeake Bay Water Range from anchor placement and/or expended munitions. However, the Navy would continue to employ established safety requirements and protocols, as discussed in Section 2.5 (Standard Operating Procedures Included in the Proposed Action) (see Table 2.5-1, Standard Operating Procedures), including avoiding navigational hazards that appear on nautical charts, such as submerged wrecks and obstructions. Testing and training activities that would not have the potential to impact cultural resources include the use of a form of directed energy (e.g., high-energy lasers/microwave) and deployment of certain non-explosive military expended materials (MEM), such as sonobuoys and marine markers. Sonobuoy deployment was analyzed in a 2013 EA (U.S. Department of the Navy, 2013a), which indicated that there would be no impacts to cultural resources and marine markers, which are consumed on the surface, would not impact the sea floor. Since no ground-disturbing activities would occur in areas not previously disturbed, land-based cultural resources would not be affected from physical disturbance and strike stressors.

3.9.3.1 Cultural Resources, No Action Alternative

Under the No Action Alternative, the Navy would continue testing and training activities within the PRC Study Area, as described in Section 2.3.1 (No Action Alternative). There would be no change to cultural resources under the No Action Alternative.

Acoustic

As described in Section 3.9.2 (Cultural Resources, Affected Environment), there are historic properties listed in, and eligible for listing in, the NRHP on NAS Patuxent River and OLF Webster, as well as outside the installations beneath the PRC Study Area airspace, which are subject to the noise and vibration of testing and training activities within the PRC Study Area.

There is a body of scientific literature on impacts from all types of noise and vibration, including construction, vehicle traffic, and aircraft overflight; and overpressure associated with sonic booms (Battis, 1983; Battis, 1988). Most scientific studies of the effects of vibration on historic properties have considered potential impacts on standing architecture; however, some studies of the effects of overflights—both subsonic and supersonic—on archaeological features and other types of sites have also been published. Two Air Force-sponsored studies have included research into potential effects of supersonic overflight on "nonstructural" archaeology and unconventional structures (Sutherland et al., 1990) (Battis, 1983). These studies have concluded that overpressures generated by supersonic overflight were well below established damage thresholds, and that subsonic operations would be even less likely to cause damage (see Appendix B, A Noise Primer: Noise and Its Effect on the Environment). The subsonic noise and sonic booms associated with continuation of existing testing and training activities would not be of sufficient magnitude to impact built or archeological historic properties under the airspace.

Physical Disturbance and Strike

Shipwrecks and Underwater Obstructions

The existing testing and training activities with the potential to cause adverse effects to underwater cultural resources within the PRC Study Area that contribute to the physical disturbance stressor include munitions deployment and vessel/target anchoring (Table 3.0-1, Testing and Training Activities, Assets, and Locations by Stressor). Non-explosive munitions are released in the Chesapeake Bay Water Range during testing and training, and fall to the bottom of the Chesapeake Bay. The highest concentrations of non-explosive munitions are released near the fixed targets, recovery areas, and/or aim points (Figure 2.1-3, Chesapeake Bay Water Range Munition Concentration Areas). Hooper and Hannibal Targets are the most heavily used stationary target sites. There are four non-target underwater cultural resources potentially eligible for the NRHP (World War II aircraft wreck, XF8F-1 Bearcat; Buoy 72A wreck; Cedar Point Schooner; and Cedar Point Barge; see Table 3.9-6) in the Chesapeake Bay Water Range where vessel/target anchoring would occur, and non-explosive munitions are released and fall to the bottom of the Chesapeake Bay. However, targets would not be placed in areas of intact in-water cultural resources, and therefore, continued use of the PRC Study Area would not affect underwater cultural resources that are potentially eligible for the NRHP. Should this standard procedure change in the future, the Navy would conduct the necessary National Environmental Policy Act analysis and Section 106 process to identify and evaluate historic properties in order to avoid adversely affecting them.

Stressors Combined

There would be no combination of stressors to any of the cultural resources within the APEs. As discussed above, cultural resources on land areas beneath the PRC would only be subject to the acoustic stressor from aircraft overflight but not the physical disturbance and strike stressor. In-water cultural resources within the PRC would only be subject to the physical disturbance and strike stressor, but not the acoustic stressor from aircraft overflight, vessels, and sonar.

3.9.3.2 Cultural Resources, Alternative 1 Potential Impacts

Under Alternative 1, the Navy would conduct the same types of testing and training operations within the same PRC Study Area as the No Action Alternative. However, Alternative 1 would have higher anticipated annual flight hours, fewer supersonic events, use of marine markers, testing of active sonobuoys at dip points and adjustments in anticipated aircraft mix, non-explosive munitions and other MEM, as described in Section 2.3.2 (Action Alternative 1). Alternative 1 also includes the introduction of a new technology to the PRC Study Area as a limited number of testing activities that use a form of directed energy (e.g., high-energy lasers/microwave), which would not have the potential to impact cultural resources. As described in Section 3.9.3 (Cultural Resources, Environmental Consequences), use of a form of directed energy (e.g., high-energy lasers/microwave) and deployment of certain non-explosive MEM, such as sonobuoys and marine markers have no potential to impact cultural resources.

Acoustic

Aircraft operations may result in an acoustic stressor with the potential to cause adverse effects to cultural resources on land within the PRC Study Area (Table 3.0-1, Testing and Training Activities, Assets, and Locations by Stressor).

National Historic Landmarks and NRHP-Listed Properties

As described in Section 3.1 (Ambient Airborne Noise), current baseline noise levels beneath the PRC Study Area airspace are between less than 35 dBA and 52.9 dBA. Under Alternative 1, subsonic noise levels would increase by between 0.5 dBA to 1.8 dBA, with the greatest increase in the West Helicopter Operating Area from 44.3 dBA to 46.1 dBA (Table 3.1-17, Noise Levels Beneath PRC Airspace Areas Under Alternative 1).

No direct impacts (i.e., physical damage) on the NRHP-listed or -eligible historic properties and NHL beneath the PRC Study Area airspace (see Table 3.9-1 and Table 3.9-3) are expected to result from the proposed increase in aircraft operations testing and training activities. Scientific studies of the effects of noise and vibration on historic properties have considered potential impacts on historic buildings, prehistoric structures, water tanks, archaeological cave/shelter sites, and rock art. These studies have concluded that overpressures generated by supersonic overflight were well below established damage thresholds and that subsonic operations would be even less likely to cause damage (see Appendix B, Noise Primer). As described in Table 2.3-1 (Annual PRC Operational Tempo per Alternative: Activities and Assets), there would be a decrease in supersonic events, and although there would be a slight increase in subsonic noise, it would not be of sufficient magnitude to impact historic properties under the airspace.

No indirect impacts on the NRHP-listed historic properties and NHL beneath the PRC Study Area airspace are expected to result from the proposed increase in testing and training activities. As explained in Section 3.1 (Ambient Airborne Noise), changes in A-weighted noise levels of less than 2 dBA would not be noticeable. The incremental increase in overflights of any individual historic resource would be infrequent and of short duration, and would not diminish the characteristics that make the sites eligible for the NRHP; the minor change to the historic setting would not change the character or use of the historic properties. The minimal increase in visual or audible elements introduced by the undertaking would not diminish the integrity of the properties' significant historic attributes and would not alter the characteristics that qualify them for inclusion in the NRHP. Therefore, the proposed increased use of the PRC Study Area would cause no adverse effect to the historic properties beneath the airspace.

Archaeological and Architectural Resources

Under Alternative 1, impacts to archaeological and architectural resources at the installations in the PRC Study Area from the acoustic stressor would be the same as those for NHL and NRHP-listed properties.

Physical Disturbance and Strike

Shipwrecks and Underwater Obstructions

The Alternative 1 testing and training activities with the potential to cause adverse effects to underwater cultural resources within the PRC Study Area that contribute to the physical disturbance/strike stressor include munitions deployment and vessel/target anchoring (Table 3.0-1, Testing and Training Activities, Assets, and Locations by Stressor). Non-explosive munitions are released in the Chesapeake Bay Water Range during testing and training and fall to the bottom of the Chesapeake Bay. There are four non-target underwater cultural resources potentially eligible for the NRHP (see Table 3.9-6) in the Chesapeake Bay Water Range where vessel/target anchoring would occur and non-explosive munitions are released (and fall to the bottom of the Chesapeake Bay). Although non-explosive MEM may potentially physically come in contact with in-water cultural resources such as shipwrecks, most non-explosive MEM are expended in the Chesapeake Bay Water Range and are focused around the munition concentration areas where there are no known cultural resources (Figure 2.1-3, Chesapeake Bay Water Range Munition Concentration Areas). However, targets would not be placed in areas of intact in-water cultural resources and, therefore, the proposed increased use of the PRC Study Area under Alternative 1 would not affect underwater historic properties in the Chesapeake Bay. Should this standard procedure change in the future, the Navy would conduct the necessary National Environmental Policy Act analysis and Section 106 process to identify and evaluate historic properties in order to avoid adversely affecting them.

Stressors Combined

As described for the No Action Alternative, there would be no combination of stressors to any of the cultural resources within the APEs under Alternative 1 because cultural resources on land would only be subject to the acoustic stressor and in-water cultural resources would only be subject to the physical disturbance and strike stressor.

3.9.3.3 Cultural Resources, Alternative 2 (Preferred Alternative) Potential Impacts

Under Alternative 2, the Navy would conduct the same types of testing and training activities within the PRC as Alternative 1 but with increased annual number of flight hours as well as adjustments to current aircraft mix, non-explosive munitions numbers, and systems to accommodate projected testing and training requirements identified by Navy subject matter experts for increased global conflict as described in Section 2.3.3 (Action Alternative 2 (Preferred Alternative)).

Acoustic

National Historic Landmarks and NRHP-Listed Properties

Under Alternative 2, aircraft flight activities would be incrementally higher than Alternative 1, and noise levels would increase over existing conditions by between 1 dBA to 2.3 dBA, with the greatest increase in the West Helicopter Operating Area from 44.3 dBA to 46.6 dBA (Table 3.1-24, Noise Levels Beneath PRC Airspace Areas Under Alternative 2). As with Alternative 1, no direct or indirect impacts on the NHL and NRHP-listed or -eligible historic properties beneath the PRC Study Area airspace are expected to result from the proposed increase in aircraft operations testing and training activities of Alternative 2. The minimal increase in visual or audible elements introduced by Alternative 2 would not diminish the integrity of the properties' significant historic attributes and would not alter the characteristics that qualify them for inclusion in the NRHP. Therefore, the proposed increased use of the PRC Study Area of Alternative 2 would cause no adverse effect to the historic properties beneath the airspace.

Archaeological and Architectural Resources

Under Alternative 2, impacts to archaeological and architectural resources at the installations in the PRC Study Area from the acoustic stressor would be the same as for NHL and NRHP-listed properties.

Physical Disturbance and Strike

Shipwrecks and Underwater Obstructions

Under Alternative 2, there would be an increase in the annual number of flight hours and other operational metrics over Alternative 1, which is also an increase over the No Action Alternative (see Section 2.3.2, Action Alternative 1), including the release of non-explosive munitions in the Chesapeake Bay Water Range. As with Alternative 1, the proposed increased use of the PRC Study Area under Alternative 2 would not affect underwater historic properties in the Chesapeake Bay and would be the same as discussed in the Alternative 1 discussion above.

Stressors Combined

As described for No Action Alternative, there would be no combination of stressors to any of the cultural resources within the APEs under Alternative 2 because cultural resources on land would only be subject to the acoustic stressor and in-water cultural resources would only be subject to the physical disturbance and strike stressor.

Consultation and Coordination

In compliance with Section 106 of the NHPA, the Navy has initiated consultation with the Virginia Department of Historic Resources (which acts as the Virginia SHPO), the Maryland Historical Trust (which acts as the Maryland SHPO), and the Division of Historical and Cultural Affairs (which acts as the Delaware SHPO), regarding its determination of effects for the proposed testing and training activities in the PRC Study Area. The Navy is committed to the Section 106 process and will strive to avoid adverse effects on historic properties. When appropriate, the Navy will develop management actions and mitigation measures in consultation with the above parties to mitigate any adverse effects prior to implementing the Proposed Action.

In accordance with Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, the Navy submitted notification letters to 22 tribes (14 federally recognized) during the scoping process. Only one tribe responded, indicating that no further information was required.

3.9.3.4 Alternatives Impact Summary

Summary of Impacts, Cultural Resources

The Navy would continue to employ established safety requirements and protocols, as discussed in Table 2.5-1 (Standard Operating Procedures), including avoiding navigational hazards that appear on nautical charts, such as submerged wrecks and obstructions.

Acoustic:

Note: In-water cultural resources are not affected.

No Action Alternative

- The subsonic noise and sonic booms associated with continuation of existing testing and training activities would not be of sufficient magnitude to impact historic properties under the airspace.

Alternative 1

- The incremental increase in overflights of any individual historic resource would be infrequent and of short duration, and would not diminish the characteristics that make the sites eligible for the NRHP; the minor change to the historic setting would not change the character or use of the historic properties. The minimal increase in visual or audible elements introduced by the undertaking would not diminish the integrity of the properties' significant historic attributes and would not alter the characteristics that qualify them for inclusion in the NRHP. Therefore, the proposed increased use of the PRC Study Area would cause no adverse effect to the historic properties beneath the airspace.

Alternative 2 (Preferred Alternative)

- Under Alternative 2, the incremental increase in overflights of any individual historic resource would be infrequent and of short duration and would not diminish the characteristics that make the sites eligible for the NRHP. The minimal increase in visual or audible elements introduced by Alternative 2 would not diminish the integrity of the properties' significant historic attributes and would not alter the characteristics that qualify them for inclusion in the NRHP. Therefore, the proposed increased use of the PRC Study Area of Alternative 2 would cause no adverse effect to the historic properties beneath the airspace.

Physical Disturbance and Strike:

Note: Land-based cultural resources are not affected.

No Action Alternative

- The continued use of the PRC Study Area would not affect underwater historic properties in the Chesapeake Bay.

Alternative 1

- The proposed increased use of the PRC Study Area under Alternative 1 would not affect underwater historic properties in the Chesapeake Bay.

Alternative 2 (Preferred Alternative)

- The proposed increased use of the PRC Study Area under Alternative 2 would not affect underwater historic properties in the Chesapeake Bay.

Combined Stressors:

No Action Alternative

- No combination of stressors would occur because cultural resources on land would only be subject to the acoustic stressor and in-water cultural resources would only be subject to the physical disturbance and strike stressor.

Alternative 1

- As described for No Action Alternative, there would be no combination of stressors to any of the cultural resources within the APEs.

Alternative 2 (Preferred Alternative)

- As described for No Action Alternative, there would be no combination of stressors to any of the cultural resources within the APEs.

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3.10 Summary of Potential Impacts to Resources and Impact Avoidance and Minimization

A summary of the potential environmental impacts to each resource area by alternative and their associated impact avoidance and minimization measures are presented in Table ES-1 (Summary of Potential Impacts to Resource Areas) and Table 3.10-1 (and Table ES-3), respectively. Table 3.10-1 provides a comprehensive list of all mitigation requirements associated with the Proposed Action.

The Navy has been mitigating the impacts from military readiness activities conducted throughout the Patuxent River Complex (PRC) for more than two decades in accordance with the 1998 PRC EIS and Environmental Assessments completed since that time. Current mitigations implemented by the Navy derive from these existing National Environmental Policy Act (NEPA) documents or are voluntary as noted in Table 3.10-1. No new mitigations have been identified since these existing NEPA documents. The Navy will continue to implement all current mitigations under the Proposed Action for all alternatives. The Navy will also apply the standard operating procedures incorporated into the Proposed Action discussed in Section 2.5 (Standard Operating Procedures Included in the Proposed Action). Standard operating procedures are designed to provide for safety and mission success, whereas mitigation measures are designed to avoid or reduce potential environmental impacts resulting from the Proposed Action. Should regulatory agencies or the public identify potential mitigation measures as part of the NEPA consultation and review process, they will be considered in the development of future versions of this EIS.

Table 3.10-1 Impact Avoidance and Minimization Measures

Environmental Resource	*Mitigation Measure*	*Anticipated Benefit / Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*
Ambient Airborne Noise	Maintain a noise disturbance reporting system.[1]	Facilitate communication between NAS Patuxent River and the surrounding community.	Provide a toll-free telephone number and email address for noise disturbance reporting. Maintain a database of noise disturbance reports. Monitor and track the number of annual noise disturbances and document trends in an annual noise report.	ATR Sustainability Office/NAS Patuxent River Air Operations
Ambient Airborne Noise	Provide noise awareness briefs.[1]	Avoid noise-sensitive areas and mitigate noise impacts to the surrounding community.	Educate aircrew on local aircraft operating procedures and noise sensitive receptors beneath the PRC airspace. Monitor and track the number of briefs given annually.	ATR Sustainability Office/NAS Patuxent River Tenant Squadrons
Ambient Airborne Noise	Follow supersonic event restrictions and maintain sonic boom monitoring system.[1]	Mitigate noise impacts generated by sonic booms to the surrounding community.	Restrict supersonic flights below 30,000 feet to weapons separation test flights. Restrict supersonic flights above 30,000 feet to mission-critical flights. Monitor and track annual numbers of supersonic events and document noise disturbance trends associated with supersonic events in an annual noise report. Maintain sonic boom monitoring system.	ATR Military Radar Unit (Baywatch)/NAS Patuxent River Air Operations/ATR Sustainability Office
Ambient Airborne Noise	Utilize expanded UAS routes.[1]	Mitigate low-level noise impacts due to UAS overflights to residents of the Northern Neck of Virginia.	Increase areas within the PRC available for UAS operations to reduce repetitive noise exposure over any one location. Monitor and track the number of annual UAS flight hours.	NAS Patuxent River Central Schedules/NAS Patuxent River Air Operations/UX-24/Maryland Army National Guard/ATR Sustainability Office
Ambient Airborne Noise	Limit Open-Air Engine Test Cell operations.[1]	Mitigate noise impacts due to jet engine open-air test cell events to residents of Solomons, Maryland.	Limit maintenance runs for jet (turbofan and turbojet) engines to mission-critical situations when enclosed test cell is unavailable for an extended period of time. Contact ATR Sustainability Office prior to testing to determine if event may be conducted based on favorable wind conditions. Monitor and track the number of annual events conducted in the jet engine testing instrumentation test cell.	Naval Air Warfare Center Aircraft Division Propulsion System Evaluation Department/ATR Sustainability Office

Table 3.10-1 Impact Avoidance and Minimization Measures, Continued

Environmental Resource	*Mitigation Measure*	*Anticipated Benefit / Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*
Biological Resources	Monitor for marine species prior to mid-frequency active sonar system event.[2]	Mitigate impacts to marine species due to mid-frequency active sonar transmissions.	Visually survey for marine mammals and sea turtles within a radius of 1 nautical mile centered on the dip point prior to a mid-frequency active sonar event. Halt or delay the event if a marine mammal or sea turtle is observed until the animal has moved outside the survey area.	HX-21 helicopter aircrew
Biological Resources	Maintain altitude restrictions over Bloodsworth Island Range.[3]	Mitigate impacts to waterfowl during migratory season.	Avoid overflight of Bloodsworth Island Range below 3,000 feet for fixed-wing aircraft and 1,000 feet for rotary-wing aircraft during migratory waterfowl season (typically November 15 to March 31).	NAS Patuxent River Central Schedules/ NAS Patuxent River Air Operations/NAS Patuxent River Tenant or Transient Aircraft
Biological Resources	Monitor for marine species prior to mine countermeasure testing events.[4]	Mitigate impacts to marine species due to in-water electromagnetic devices towed at high speed.	Visually survey for marine mammals and sea turtles within the test area. Halt or delay the event if a marine mammal or sea turtle is observed until the animal has moved outside the survey area.	Program Executive Office (Littoral Mine Warfare) and Naval Air Warfare Center Aircraft Division
All resources	Continue test plan environmental review process.[5]	Ensure all testing and training activities conducted within the PRC are adequately assessed under NEPA.	Review all project test plans for compliance with the PRC EIS and other NEPA documents as applicable.	ATR Sustainability Office
Ambient Airborne Noise, Land Use, and Environmental Justice	Employ sonic boom prediction tool.[5]	Mitigate potential noise disturbances and property damage due to sonic booms to populated areas within the surrounding community.	Generate a sonic boom footprint for all supersonic weapons separation tests to predict potential noise impacts. Postpone flights or adjust aircraft angle of approach as needed to avoid impacts to populated areas.	ATR Range Safety/Naval Test Wing Atlantic Squadrons
Biological Resources	Close one TERF area landing zone during northern diamondback	Protect northern diamondback terrapin nests within the TERF	Close and use only one of two beach landing zones during northern diamondback terrapin nesting and hatching season (May to September). Place fencing around the active landing zone to prevent terrapins	NAS Patuxent River Environmental Division (Natural Resources Department)

Table 3.10-1 Impact Avoidance and Minimization Measures, Continued

Environmental Resource	*Mitigation Measure*	*Anticipated Benefit / Evaluating Effectiveness*	*Implementing and Monitoring*	*Responsibility*
	terrapin nesting season.[5]	area helicopter landing zones.	from nesting in the area. Conduct terrapin nest surveys within landing zones each season.	
Biological Resources	Aircraft flight restrictions over the Hannibal Ttarget during the peregrine nesting season (February 15 – August 15).[5]	Avoid/reduce potential environmental impacts to nesting peregrine falcons.	Aircraft maintain 0.5 mile buffer from the Hannibal Target from February 15 through August to avoid disturbance of peregrine falcon nesting activities.	NAS Patuxent River Air Operations

Key: ATR = Atlantic Test Ranges; EIS = Environmental Impact Statement; NAS = Naval Air Station; NEPA = National Environmental Policy Act; PRC = Patuxent River Complex; TERF = terrain flight; UAS = unmanned aerial systems.

1. U.S. Department of the Navy, 1998
2. U.S. Department of the Navy, 2013a
3. U.S. Department of the Navy, 2006
4. U.S. Department of the Navy, 2005c
5. Voluntary mitigation

4 Cumulative Impacts

This section (1) defines cumulative impacts, (2) describes past, present, and reasonably foreseeable future actions relevant to cumulative impacts, (3) analyzes the incremental interaction the Proposed Action may have with other actions, and (4) evaluates cumulative impacts potentially resulting from these interactions.

4.1 Definition of Cumulative Impacts

The approach taken in the analysis of cumulative impacts follows the objectives of the National Environmental Policy Act (NEPA), Council on Environmental Quality (CEQ) regulations (Council on Environmental Quality, 1997), and CEQ guidance (Council on Environmental Quality, 2005). Cumulative impacts are defined in 40 Code of Federal Regulations section 1508.7 as "the impact on the environment that results from the incremental impact of the action when added to the other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

To determine the scope of environmental impact analyses, agencies shall consider cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact analysis document.

In addition, CEQ and the United States (U.S.) Environmental Protection Agency have published guidance addressing implementation of cumulative impact analyses—*Guidance on the Consideration of Past Actions in Cumulative Effects Analysis* (CEQ, 2005) and *Consideration of Cumulative Impacts in EPA Review of NEPA Documents* (U.S. Environmental Protection Agency, 1999). CEQ guidance entitled *Considering Cumulative Impacts Under NEPA* (1997) states that cumulative impact analyses should

"…determine the magnitude and significance of the environmental consequences of the proposed action in the context of the cumulative impacts of other past, present, and future actions...identify significant cumulative impacts…[and]…focus on truly meaningful impacts."

Cumulative impacts are most likely to arise when a relationship or synergism exists between a proposed action and other actions expected to occur in a similar location or during a similar time period. Actions overlapping with or close to the Proposed Action would be expected to have more potential for a relationship than those more geographically separated. Similarly, relatively concurrent actions would tend to offer a higher potential for cumulative impacts. To identify cumulative impacts, the analysis needs to address the following three fundamental questions.

- Does a relationship exist such that affected resource areas of the Proposed Action might interact with the affected resource areas of past, present, or reasonably foreseeable actions?
- If one or more of the affected resource areas of the Proposed Action and another action could be expected to interact, would the Proposed Action affect or be affected by impacts of the other action?
- If such a relationship exists, then does an assessment reveal any potentially significant impacts not identified when the Proposed Action is considered alone?

4.2 Scope of Cumulative Impacts Analysis

The scope of the cumulative impacts analysis involves both the geographic extent of the effects and the time frame in which the effects could be expected to occur. For this Environmental Impact Statement (EIS), the study area includes those areas previously identified in Chapter 3 (Affected Environment and Environmental Consequences) for the respective resource areas. The time frame for cumulative impacts centers on the timing of the Proposed Action. The implementation of the Proposed Action would occur when the U.S. Department of the Navy (hereinafter referred to as the Navy) signs a Record of Decision. Since the Proposed Action includes ongoing and future testing and training activities that are expected to continue into the future, the cumulative impacts analysis does not have a specific future time frame. The Navy will continue to evaluate testing and training activities, as needed, in an ongoing process, and environmental planning documents will cover any changes in testing and training activities, including updates to cumulative impacts analysis.

Another factor influencing the scope of cumulative impacts analysis involves identifying other actions to consider. Beyond determining that the geographic scope and time frame for the actions interrelate to the Proposed Action, the analysis employs the measure of "reasonably foreseeable" to include or exclude other actions. For the purposes of this analysis, public documents prepared by federal, state, and local government agencies form the primary sources of information regarding reasonably foreseeable actions. Documents used to identify other actions include notices of intent for EISs and Environmental Assessments (EAs), management plans, land use plans, and other planning-related studies.

To be included in the cumulative analysis, the impacts on each resource area were reviewed. If the analysis determined that no impacts would occur, the resource was not carried forward for cumulative impacts. As a result, commercial and private air traffic, environmental health risks and safety risks to children, and cultural resources are not discussed further in this section since the impacts analysis determined that no impacts would occur with implementation of the Proposed Action.

4.3 Past, Present, and Reasonably Foreseeable Future Actions

This section will focus on past, present, and reasonably foreseeable future projects at and near the Proposed Action locale. In determining which projects to include in the cumulative impacts analysis, a preliminary determination was made regarding the past, present, or reasonably foreseeable action. Specifically, using the first fundamental question included in Section 4.1 (Definition of Cumulative Impacts), it was determined if a relationship exists such that the affected resource areas of the Proposed Action (included in this EIS) might interact with the affected resource area of a past, present, or reasonably foreseeable future action. If no such potential relationship exists, the project was not carried forward into the cumulative impacts analysis. In accordance with CEQ guidance (CEQ, 2005), these actions considered but excluded from further cumulative effects analysis are not cataloged here as the intent is to focus the analysis on the meaningful actions relevant to informed decision-making. Projects in the region that posed temporary impacts only during construction but are now complete are listed in Table 4.3-1. In addition, the table includes projects scheduled for the near-term that would only pose temporary construction impacts but would not contribute to any permanent increase in impacts. None of these projects is carried forward for cumulative analysis because:

- no additional permanent impact would be expected to occur; or
- the project impacts are already incorporated into the affected environment described for each resource area.

Table 4.3-1 Cumulative Actions with Temporary Construction Impacts

Proponent	*Location*	*Action Name*	*Status*	*Description*
Past Actions that had Temporary Construction Impacts but are Now Complete				
Navy	NAS Patuxent River	P558 and P561 Aircraft Prototype Facility – Phase 1 and 2	EA/FONSI FONSI signed April 2007	• Constructed hangar, laboratory, and work space to consolidate and improve aircraft rapid prototyping and modification capacity for the Naval Air Warfare Center Aircraft Division and other DoD programs hosted by NAS Patuxent River
Navy	NAS Patuxent River	ILS Construction	CATEX signed June 2018	• Installed ILS navigational aids to enhance all weather activities for aircraft • Serves as the program test and development bed
Board of Public Works	Chesapeake Bay	ATR Bay Fiber Optic Crossing	Construction completed in 2015	• Installed 7.4 miles of fiber-optic cable to enable high-speed Internet access in rural areas • Between Dorchester County and Calvert and St. Mary's Counties
Navy	NAS Patuxent River	P975 Bachelor Enlisted Quarters	CATEX Signed September 2016	• Construct multi-story unaccompanied housing facility for E1-E4 permanent military personnel
Reasonably Foreseeable Future Actions that Would Pose Temporary Construction Impacts Only				
Navy	NAS Patuxent River	P265 RDT&E Facility and Hangar	CATEX signed February 2018, construction ongoing	• Construct UCLASS/Carrier Based Aerial Refueling System RDT&E facility and hangar • Located on the primary airfield and connected to Runway 06-24 by a short taxiway
Navy	NAS Patuxent River	P536 Advanced Installed System Integration Capability	CATEX expected	• Construct a facility with an anechoic chamber, aircraft apron, and vehicle parking • Relocates existing NERF Pad 535 feet to the north
Navy	NAS Patuxent River	P559 Aircraft Prototype Facility – Phase 3	CATEX signed August 2020, construction ongoing	• Construct hangar, laboratory, and work space to consolidate and improve aircraft rapid prototyping and modification capability for the Naval Air Warfare Center Aircraft Division and other DoD programs hosted by NAS Patuxent River
Navy	NAS Patuxent River	P691 E-6B Modernization of the Aircraft Systems Integration Lab	CATEX or EA/FONSI expected	• Construct a new headquarters, lab, and hangar complex for program planning and initiation of developing and testing integrated systems for new aircraft • Multiple phase construction

Key: ATR = Atlantic Test Ranges; CATEX = categorical exclusion; DoD = Department of Defense; EA = Environmental Assessment; FONSI = Finding of No Significant Impact; ILS = instrument landing system; NAS = Naval Air Station; NERF = Naval Electromagnetic Radiation Facility; RDT&E = research, development, test and evaluation; UCLASS = Unmanned Carrier-Launched Airborne Surveillance and Strike.

If the projects pose ongoing impacts (e.g., aircraft noise, air emissions, or vessel traffic) then they are included in the cumulative analysis. All projects included in this cumulative impacts analysis are listed in Table 4.3-2 and briefly described in the following subsections.

Table 4.3-2 Cumulative Action Evaluation

Action	***Agency***	***Level of NEPA Analysis Completed***	***Status***
Past Actions			
Cove Point LNG Terminal Expansion	FERC	EA/FONSI	April 2018 – in-service date
University of Maryland Unmanned Aircraft Systems Test Site at St. Mary's County Airport	UMD	NA	August 5, 2014 –Test Site opened
REPI County Parks at Shannon Farms and Snow Hill Farm	St. Mary's County	NA	Shannon Farm – purchased December 2015 Snow Hill – July 2017 open to public
Establishment of the Middle Chesapeake Sentinel Landscape	USDA	NA	Established 2015
Establishment of the Harriet Tubman RLA	MDNR	NA	Established in 2018
Designation of the Mallows Bay-Potomac River NMS	NOAA	EIS	Designated September 2019
Present Actions			
Expansion of the Mattapany and Nanticoke RLAs	MDNR	NA	January 2020 – MDNR recommended that Public Works approve the fiscal year 2020 grants for expansion
Chesapeake Bay Bridge Crossing	FHWA/MDTA	EIS	Final EIS/ROD Summer 2021
St. Mary's County Airport Expansion	FAA	EA/FONSI	June 2006; funding approved for road relocation in March 2019
Recreational and Commercial Vessel Use	NA	NA	Ongoing
Reasonably Foreseeable Future Actions			
Construction of a Second Span on the Thomas Johnson Bridge	MDOT/SHA	EA/FONSI	2015 FONSI but not constructed
Route 3 Northern Neck Corridor Improvement Study	VDOT	NA	2016 study; has not been funded

Key: EA = Environmental Assessment; EIS = Environmental Impact Statement; FAA = Federal Aviation Administration; FERC = Federal Energy Regulatory Commission; FHWA = Federal Highway Administration; FONSI = Finding of No Significant Impact; LNG = liquefied natural gas; MDNR = Maryland Department of Natural Resources; MDOT = Maryland Department of Transportation; MDTA = Maryland Transportation Authority; NA = not applicable; NEPA = National Environmental Policy Act; NMS = National Marine Sanctuary; NOAA = National Oceanic and Atmospheric Administration; REPI = Readiness and Environmental Protection Integration; ROD = Record of Decision; RLA = Rural Legacy Area; SHA = State Highway Administration; UMD = University of Maryland; USDA = United States Department of Agriculture; VDOT = Virginia Department of Transportation.

4.3.1 Past Actions

Cove Point LNG Terminal Expansion. Dominion Energy's Cove Point Terminal is located on the Chesapeake Bay in Lusby, Calvert County, Maryland. The facility previously received transport vessels, stored liquefied natural gas (LNG) onshore, and converted it back to gas, as needed, to meet demand (Dominion, 2019). The Cove Point Liquefaction Project allows Dominion Energy to liquefy natural gas onsite and transport it to tanker ships for export. This project was placed in service in April 2018 (Dominion, 2019). The Federal Energy Regulatory Commission prepared an EA for this action. This project has been constructed. Increased vessel traffic and associated air emissions are still occurring and were analyzed for potential cumulative impacts for air quality, water resources, biological resources, public health and safety, and socioeconomics.

University of Maryland Unmanned Aircraft Systems Test Site at St. Mary's County Airport. The University of Maryland, A. James Clark School of Engineering, established an Unmanned Aircraft Systems Test Site at the St. Mary's County Regional Airport in August 2014 (University of Maryland, 2014). The test site conducts research and addresses technology and policies. Testing is contained within Patuxent River Complex (PRC) Special Use Airspace, including restricted areas (R-4002, R-4005, R-4006, and R-6609); therefore, no Federal Aviation Administration (FAA) approval was required but range rules apply (Scassero, 2014). Certificate of Authorization was not required since no public operations would occur (Scassero, 2014). FAA defines public operations as not flying as part of the government, for a commercial purpose, or receiving compensation for flight operations (Federal Aviation Administration, 2020). A long-range airspace analysis is in progress (Scassero, 2014). This project was analyzed for potential cumulative impacts to noise, air quality, biological resources, land use, and public health and safety.

Readiness and Environmental Protection Integration (REPI) County Parks at Shannon Farms and Snow Hill Farm. Shannon Farm, a 212-acre property, was purchased by St. Mary's County in 2015 (St. Mary's County, 2016b). The site is now a public park for passive recreation including fishing, hiking, educational and cultural activities, wildlife observation, non-motorized boating (e.g., kayaking, canoeing, and sailing), and horseback riding. Snow Hill Park is 163 acres located in the northern Hollywood, Maryland, area (Cipolloni, 2017). The park opened to the public July 22, 2017. The Navy used the Department of Defense's REPI program in partnership with Maryland Department of Natural Resources and St. Mary's County to preserve compatible land uses around military installations. The property is owned by St. Mary's County and a sole easement was issued to the Navy to limit future development that would be incompatible with the Navy's use of airspace for testing and training (St. Mary's County, 2016b). The park provides water access and recreational opportunities including boating, swimming, hiking, fishing, and picnicking with future plans to include a motorized-boat launch and athletic fields (St. Mary's County, 2016b). This project preserves compatible land uses with the military mission and reduces the potential for further development. This project was analyzed for potential cumulative impacts to noise, air quality, biological resources, land use, and socioeconomics.

Establishment of the Middle Chesapeake Sentinel Landscape. The Sentinel Landscapes Partnership works with federal departments to align resources and implement compatible land uses to protect the military mission while benefiting partners and landowners (U.S. Department of Agriculture, 2016). The Middle Chesapeake Sentinel Landscape was established in 2015 and protects Naval Air Station (NAS) Patuxent River and the land and water ranges of the Atlantic Test Ranges. The Navy, U.S. Fish and Wildlife Service, U.S. Department of Agriculture, Natural Resources Conservation Service, Chesapeake Conservancy, and other state and conservation partners have worked together to conserve a wildlife corridor of approximately 1,385 acres along the Nanticoke River and under the Atlantic Test Ranges airspace (U.S. Department of Agriculture, 2016). This project was analyzed for potential cumulative impacts to noise, air quality, water quality, biological resources, public health and safety, land use, and socioeconomics.

Establishment of the Harriet Tubman Rural Legacy Area (RLA). The Harriet Tubman RLA was established in 2018 on the Eastern Shore of Maryland. This RLA is the center of the Harriet Tubman Historic Area, the Harriet Tubman Underground Railroad National Historical Park, and encompasses the Harriet Tubman Underground Railroad State Park and Visitor Center (Maryland Department of Natural Resources, 2019e). This area is located within and adjacent to the Blackwater National Wildlife Refuge. There are roughly 11,528 acres of agricultural land and 14,251 acres of forest (Maryland Department of Natural Resources, 2019e). These projects preserve compatible land uses with the military mission and reduces the potential for further development. These projects were analyzed for potential cumulative impacts to noise, air quality, biological resources, land use, and socioeconomics.

Designation of the Mallows Bay-Potomac River National Marine Sanctuary (NMS). The National Oceanic and Atmospheric Administration, the state of Maryland, and Charles County designated a new national marine sanctuary that took effect on September 3, 2019 (National Oceanic and Atmospheric Administration, 2020). This sanctuary is 18 square miles, located 40 miles south of Washington, D.C. (National Oceanic and Atmospheric Administration, 2019). The area is designated to protect and conserve shipwrecks and cultural heritage resources. Mallows Bay contains partially submerged wooden steamships that were built to respond to German U-boats that were sinking ships in the Atlantic during World War I. The fleet was not used in the war; however, ships were brought to the Potomac River to be salvaged for scrap metal (National Oceanic and Atmospheric Administration, 2019). This project was analyzed for potential cumulative impacts to noise, air quality, water resources, biological resources, public health and safety, land use, and socioeconomics.

4.3.2 Present Actions

Expansion of the Mattapany and Nanticoke RLAs. The RLA program was created in 1997 to protect large, contiguous tracts of cultural and natural resource lands in Maryland through grants to local applicants (Maryland Department of Natural Resources, 2019e). The Mattapany RLA is located in southern St. Mary's County. The area provides an open space buffer south of NAS Patuxent River. The area protects farmland, forests, wetlands, historic sites, and wildlife habitat. In addition, conservation provides water quality benefits to the Chesapeake Bay and the St. Mary's River watershed. The Nanticoke RLA is located in the Nanticoke watershed in Dorchester County. The RLA links the Fishing Bay Wildlife Management Area, the U.S. Fish and Wildlife Service Blackwater Refuge, Delaware's Nanticoke Wildlife Area, and the existing Agriculture Security Corridor–Marshyhope RLA (Maryland Department of Natural Resources, 2019e). This watershed contains over one-third of all the state's wetlands, plant and wildlife habitat, prime farmland, and large blocks of forests along 16 miles of shoreline of the Nanticoke River and Marshyhope Creek (Maryland Department of Natural Resources, 2019e). The RLA creates growth boundaries around Vienna, Maryland. In January 2020, the Maryland Department of Natural Resources recommended that Public Works approve the grant for expansion of both RLAs (Maryland Department of Natural Resources, 2020d). The grant application would be submitted in 2021, and the time from application to completion of the easement process is typically 18 to 24 months (The Lexington Park Leader, 2020).

Chesapeake Bay Bridge Crossing. The Maryland Transportation Authority is preparing an EIS with the Federal Highway Administration as the lead agency for providing additional capacity and access across the Chesapeake Bay. A two-tiered approach will be used to systematically evaluate potential transportation improvements. A regional analysis is undertaken during Tier 1 and involves evaluation of approximately 2-mile wide corridors using a broad-scale level of detail for engineering and environmental information (Maryland Transportation Authority, 2007). The Tier 1 EIS is expected to be complete in December 2020 and will result in selection of a corridor alternative that best meets the study's purpose and need (Maryland Transportation Authority, 2007). Next, a Tier 2 study identifies specific alignment alternatives within the corridor. The Final EIS and Record of Decision is expected in the summer of 2021. This project was analyzed for potential cumulative impacts to water resources, biological resources, public health and safety, and socioeconomics.

Expansion of the St. Mary's County Airport. St. Mary's County Regional Airport is located 4 miles northeast of Leonardtown. St. Mary's County Airport received a Department of Transportation grant in September 2018 to extend the existing runways and remove obstructions to allow for increased capacity for passengers and cargo (Southern Maryland News Net, 2018). FAA prepared an EA and Finding of No Significant Impact in 2006 for airport improvements and to remove obstructions for Runway 11/29 (Federal Aviation Administration, 2006). The Proposed Action, as described in the EA, would acquire 3 acres of fee-simple land and 54 acres of aviation easement. Runway modifications include extending and strengthening Runway 11/29 approximately 1,200 feet to the west and relocating parallel Taxiway A 240 feet to the south and extending to the east. An antenna and distance measuring equipment would be installed at the end of Runway 29 and the rotating beacon would be upgraded. New construction would include a west apron and connecting taxiway, hangars, vehicle parking, and apron. A perimeter security fence would be installed along with roadway improvements (e.g., relocate Hayden Road 700 feet to the west, realign Airport Drive 30-feet to the south, and construct Airport Access Road). Funding for the road relocation was obtained in 2019 (The Enterprise, 2019). This project was analyzed for potential cumulative impacts to noise, air quality, biological resources, land use, and socioeconomics.

Recreational and Commercial Vessel Traffic. The total recreational fishing catch and total recreational angler trips to inland waters of Virginia and Maryland have declined between 2010 and 2018. Additionally, the number of boat registrations in Maryland and Virginia (and the nation) have also declined during the same period. Declines may be attributed to more strict fishing regulations and people participating in other recreational activities. Pleasure boats up to 200 feet long can now navigate state waters without a licensed bay pilot, and that could result in an increase in the number of large recreational vessels in the Chesapeake Bay. This project was analyzed for potential cumulative impacts to water resources, biological resources, public health and safety, and socioeconomics.

4.3.3 Reasonably Foreseeable Future Actions

Construction of a Second Span on the Thomas Johnson Bridge. An EA was prepared and a Finding of No Significant Impact signed in 2015 for the Thomas Johnson Bridge Project improvements from Patuxent Point Parkway to Maryland Route (MD) 235 in Calvert and St. Mary's Counties. The Federal Highway Administration determined that the Maryland State Highway Administration's preferred alternative will have no significant impact on the human, natural, or cultural environment (Maryland Department of Transportation State Highway Administration, 2015). MD 4 provides access for commuters to points north, including Washington, D.C., and to points south, including NAS Patuxent River. The preferred alternative includes expanding MD 4 to four lanes from just north of the Thomas Johnson Memorial

Bridge in Calvert County to MD 235 in St. Mary's County; improving the intersection at MD 4 and MD 235; building a new Thomas Johnson Bridge with two lanes in each direction, shoulders, and a 10-foot-wide shared use (Maryland Department of Transportation State Highway Administration, 2018). The project will be undertaken in four phases, with completion in 2027 (Maryland Department of Transportation State Highway Administration, 2015). This project was analyzed for potential cumulative impacts to water resources, biological resources, public health and safety, land use, and socioeconomics.

Route 3 Northern Neck Corridor Improvement Study. Route 3 is one of the main highways in the Northern Neck of Virginia and the only highway that traverses the geographic region from one end to another. In late spring 2014, Virginia Department of Transportation staff met with the Northern Neck Planning District Commission staff, County Administrators and several supervisors, including King George County, to initiate a study of the Route 3 corridor. The purpose was to evaluate the facility and corridor to determine ways to increase efficiency for local, seasonal, and freight traffic. The Route 3 corridor has moderately low current and projected traffic volumes (Virginia Department of Transportation, 2016). As a result, only selected roadway sections warrant widening to four lanes, including two-lane segments near Kilmarnock and White Stone and Route 3 near Route 301 in King George County (Virginia Department of Transportation, 2016). The study concluded that adding passing lanes would be economical and would improve efficiency. In addition, five intersections would require turn lane improvements: two in King George County and three in Lancaster County. Multimodal improvements could include adding bicycle and pedestrian paths, commuter parking, or van pools (Virginia Department of Transportation, 2016). Projects in the corridor would be funded by state or federal dollars and would go through a prioritization process. Projects that score well within the statewide or district grant program and are selected by the Commonwealth Transportation Board to advance to the Six Year Improvement Plan for funding and construction (Virginia Department of Transportation, 2016). To date, the project has not been funded (Bateman, John, 2020). This project was analyzed for potential cumulative impacts to public health and safety.

Offshore Wind. There are two offshore wind development projects that are located outside of the PRC Study Area but could pose permanent mission impacts for Naval Air Systems Command. Task Force meetings were held early in the planning process with local, state, and federal agencies, including the Navy. As a result, proposed wind development would be located in areas that were already reviewed by the Navy to ensure that the turbines would not pose radar interference with aircraft and aircraft testing. Leases have been granted for offshore wind in Maryland and Delaware in the Atlantic Ocean. The Navy has already reviewed locations; therefore, these projects will not be carried forward in the cumulative impacts analysis.

4.4 Cumulative Impact Analysis

Where feasible, the cumulative impacts were assessed using quantifiable data; however, for many of the resources included for analysis, quantifiable data is not available and a qualitative analysis was undertaken. In addition, where an analysis of potential environmental effects for future actions has not been completed, assumptions were made regarding cumulative impacts related to this EIS where possible. The analytical methodology presented in Chapter 3 (Affected Environment and Environmental Consequences), which was used to determine potential impacts to the various resources analyzed in this document, was also used to determine cumulative impacts.

Tables are presented for each resource area indicating the past, present, and reasonably foreseeable future projects that were analyzed for potential cumulative impacts. Under the impacts column in the tables, the term *potential* indicates the possibility that the Proposed Action, when considered with the past, present, and foreseeable future actions, could pose cumulative impacts. *Beneficial* means that the past, present, and reasonably foreseeable future actions would pose beneficial impacts by protecting tracts of cultural and natural resource lands. As a result, these projects, when considered with the Proposed Action, could partially offset impacts associated with the Proposed Action.

4.4.1 Ambient Airborne Noise

4.4.1.1 Description of Geographic Study Area

The region of influence (ROI) for ambient airborne noise is the PRC Study Area. Portions of the PRC Study Area are gradually transitioning from a rural agricultural to a more urbanized landscape. This transition involves construction (e.g., residences, commercial properties, and infrastructure) and increased human activity, which are associated with increased noise levels.

4.4.1.2 Relevant Past, Present, and Future Actions

Table 4.4-1 identifies the past, present, or reasonably foreseeable future actions that might interact with the affected airborne noise of the Proposed Action.

Table 4.4-1 Actions That May Contribute to Airborne Noise Cumulative Impacts

Proponent	***Location***	***Action Name***	***Impacts***
Past Actions			
UMD	St. Mary's County	University of Maryland Unmanned Aircraft Systems Test Site at St. Mary's County Airport	Potential
St. Mary's County	St. Mary's County	REPI County Parks at Shannon Farms and Snow Hill Farm	Beneficial
USDA	1,385 acres along the Nanticoke River and broader Chesapeake Bay under the Atlantic Test Ranges	Establishment of the Middle Chesapeake Sentinel Landscape	Beneficial
MDNR	Dorchester County	Establishment of the Harriet Tubman RLA	Beneficial
NOAA	Charles County	Designation of the Mallows Bay-Potomac River NMS	Beneficial
Present Actions			
MDNR	St. Mary's and Dorchester Counties	Expansion of the Mattapany and Nanticoke RLAs	Beneficial
FAA	California, MD	St. Mary's County Airport Expansion	Potential

Key: FAA = Federal Aviation Administration; MD = Maryland; MDNR = Maryland Department of Natural Resources; NOAA = National Oceanic and Atmospheric Administration; NMS = National Marine Sanctuary; NOAA = National Oceanic and Atmospheric Administration; REPI = Readiness and Environmental Protection Integration; RLA = Rural Legacy Area; UMD = University of Maryland; USDA = United States Department of Agriculture.

4.4.1.3 Cumulative Impact Analysis

The main stressor related to ambient noise associated with the Proposed Action is acoustic. The projects in Table 4.4-1 could result in increases in time-averaged noise levels that would overlap spatially and temporally with the Proposed Action. Ongoing expansion of St. Mary's Regional Airport would generate noise during construction and flight activities associated with projected increases in the tempo of flights. Construction conducted as part of the ongoing expansion of St. Mary's Regional Airport would generate noise that is localized (i.e., typically audible only within airport boundaries) and temporary (i.e., lasting only for the duration of the project) and would not contribute to overall noise levels. An EA for expansion of St. Mary's Airport in 2006 analyzed noise impacts associated with an increase to 62,000 airfield activities per year (predicted for calendar year 2020) and found that the 65 A-weighted decibels (dBA) day-night average sound level (DNL) would be contained entirely within airport property (Federal Aviation Administration, 2006). The number of airfield activities recorded in the 12-month period ending in April 2019 was less than 35,000 (Airnav, 2019), and current noise levels at and near the airport can be presumed to be less than those analyzed in the 2006 EA (Airnav, 2019). Under the Proposed Action, military flying activities in the West Helicopter Operating Area (Helo OPAREA) would occur within a large area such that any given location is directly overflown infrequently. Time-averaged noise levels beneath the West Helo OPAREA would remain below 50 dBA onset-rate adjusted monthly DNL (L_{dnmr}) under all action alternatives (see Table 3.1-17, Noise Levels Beneath PRC Airspace Areas Under Alternative 1, and Table 3.1-24, Noise Levels Beneath PRC Airspace Areas Under Alternative 2, in Section 3.1, Ambient Airborne Noise). The combined noise level near the airport generated by construction, increased airfield tempo, and increased activities in the West Helo OPAREA would be below 65 dBA DNL because the DNL contribution of each of the sources is well below 65 dBA DNL. If the St. Mary's Regional Airport flight tempo reaches levels projected in the 2006 EA concurrent with construction activity on the airport property, and flight activities in the West Helo OPAREA reach the tempo proposed under Alternative 2, cumulative noise impacts would be limited to a minimal increase in the likelihood of annoyance for people living near the airport.

Past and ongoing Navy actions have been assessed for noise impacts, and the results have been reported in NEPA documents. Noise associated with these actions is reflected in calculated baseline noise level as described in Section 3.1.6 (Ambient Airborne Noise, Affected Environment). Past and ongoing non-Navy infrastructure development generates noise, which is temporary (e.g., construction projects) and also indirectly results in noise increases that are permanent (e.g., increased human activity levels). Construction noise intensity depends on the work and the equipment used. Examples of loud construction equipment include a dozer, which generates 82 dBA maximum sound level (L_{max}) at a reference distance of 50 feet and a dump truck, which generates 77 dBA L_{max} at the same distance (U.S. Department of Transportation, 2006). Aircraft overflights often generate similar L_{max} (see Table 3.1-2, Individual Overflight Noise Levels, and Table 3.1-8, Individual Overflight Noise Levels (dBA SEL_r and L_{max}) in the PRC Study Area), although aircraft and construction noise differ in characteristics other than maximum intensity. Overlaps between construction activities noise and increased noise levels associated with the Proposed Action could result in annoyance for people nearby. However, construction noise is temporary, lasting for the duration of the construction project, and therefore noise impacts are temporary as well. Increases in average noise levels associated with increased human activity are generally permanent. The National Park Service has conducted extensive measurements of noise levels in a variety of settings and concluded that the best predictor of ambient noise levels is the level of human activity. Average noise levels in urbanized areas are generally 55 dBA or higher while noise levels in geographically remote areas are as low as 35 dBA (National Park Service, 2016b). The precise locations and extent of development and increased human activity is not known, and no definitive statements about impacts can be made. However, because the population in PRC Study Area is generally increasing, increased noise levels associated with the Proposed Action can be expected to occur in a context of slightly increased background noise levels. Depending on their personal perspectives, individuals may perceive Navy-generated noise as less intrusive in a setting with higher ambient noise, or they may consider the combined noise level of Navy operations and day-to-day non-Navy activities to be unacceptably high.

Future Navy weapons systems test programs, including the Future Vertical Lift and Fighter/Attack program, could replace test programs currently underway. It is unknown whether the future test programs would generate less or more noise compared to than programs ongoing at this time. Noise levels generated by future test operations would depend on the noise level generated by the weapons system while it is in operation and how the weapons system is employed. In the future, a greater number of test operations may be conducted through simulation rather than actual flights. Neither the noise level nor employment of possible future weapons systems are known at this time, and therefore no definitive impacts analysis is possible.

Continuation of non-Navy infrastructure development (i.e., construction) and associated increase in human activity levels would be expected to further increase ambient noise levels in the future. Future development patterns are contingent on several factors that are not known, and therefore future ambient noise levels are also not known. Overlap of noise generated by non-Navy construction activities with Navy operations would be temporary, resulting in a temporary increase in potential for annoyance. The reactions of people to Navy noise in a future context of higher ambient noise levels may be more or less intense than their reactions to Navy noise in a lower ambient noise environment, depending on their personal perspectives.

4.4.2 Air Quality

4.4.2.1 Description of Geographic Study Area

For cumulative impacts, the ROI is defined as the PRC Study Area including the three air basins described in Section 3.2.2 (Air Quality, Affected Environment): Maryland, Delaware, and Virginia. For criteria pollutants, this includes NAS Patuxent River and the surrounding areas within the Southern Maryland Intrastate Air Quality Control Region as well as areas where overflights may occur below the 3,000-foot above ground level mixing layer. Aircraft and other activities occur in St. Mary's, Calvert, Dorchester, Somerset, and Wicomico Counties in Maryland. These counties are all in attainment for criteria pollutants except for Calvert County, which is classified as a nonattainment area. In Virginia, Lancaster, Northumberland, and Westmoreland Counties are all in attainment for criteria pollutants while Charles City, Gloucester, James City, and York Counties are maintenance areas. Kent County in Delaware is attainment maintenance area, while Sussex County is classified as a nonattainment area. Because greenhouse gases are not limited by the 3,000-foot above ground level mixing layer, they are emitted over a larger area that the criteria pollutants. As a result, aircraft emissions from high-altitude operations also impact Caroline and Talbot Counties in Maryland and Accomack, Charles City, Gloucester, James City, King and Queen, Mathews, Middlesex, New Kent, Richmond, Williamsburg, and York Counties in Virginia.

4.4.2.2 Relevant Past, Present, and Future Actions

Table 4.4-2 identifies the past, present, or reasonably foreseeable future actions that might interact with the affected air quality of the Proposed Action. Any activity in the area that involves the combustion of fossil fuels on a permanent basis and associated with infrastructure/facilities improvement or transportation activities (including government and commercial or private vehicles, vessels, or aircraft) would contribute to the air quality conditions in the region.

4.4.2.3 Cumulative Impact Analysis

The primary stressor associated with air quality is pollutants including criteria pollutants and greenhouse gases in the form of air emissions. Air quality impacts and emissions associated with the Navy's testing and training activities would result in a minor increase over current conditions. The Navy has conducted similar operations in this area for many years, and the increase in emissions would be minimal in the context of the annual emissions in the overall PRC Study Area.

Depending on the timing of infrastructure improvement and construction projects occurring in the PRC Study Area (which is the ROI for cumulative impacts), incremental increases in air emissions would result from construction. However, because these projects are temporary and emissions are typically minor, emissions from several, simultaneous projects would not likely result in temporary or long-term combined emissions that would exceed county significance criteria or negatively affect attainment status.

Table 4.4-2 Actions That May Contribute to Air Quality Cumulative Impacts

Proponent	*Location*	*Action Name*	*Impacts*
Past Actions			
FERC	Lusby, MD Chesapeake Bay	Cove Point LNG Terminal Expansion	Potential
UMD	California, MD	University of Maryland Unmanned Aircraft Systems Test Site at St. Mary's County Airport	Potential
St. Mary's County	St. Mary's County	REPI County Parks at Shannon Farms and Snow Hill Farm	Beneficial
USDA	1,385 acres along the Nanticoke River and broader Chesapeake Bay under the Atlantic Test Ranges	Establishment of the Middle Chesapeake Sentinel Landscape	Beneficial
MDNR	Dorchester County	Establishment of the Harriet Tubman RLA	Beneficial
NOAA	Charles County	Designation of the Mallows Bay-Potomac River NMS	Beneficial
Present Actions			
MDNR	St. Mary's and Dorchester Counties	Expansion of the Mattapany and Nanticoke RLAs	Beneficial
FHWA/MDTA	Chesapeake Bay	Chesapeake Bay Bridge Crossing	Potential
FAA	California, MD	St. Mary's County Airport Expansion	Potential
NA	Chesapeake Bay	Recreational and Commercial Vessel Use	Potential
Reasonably Foreseeable Future Actions			
MDOT/SHA	St. Mary's and Calvert Counties	Construction of a Second Span on the Thomas Johnson Bridge	Potential
VDOT	Northern Neck of Virginia	Route 3 Northern Neck Corridor Improvement Study	Potential

Key: FAA = Federal Aviation Administration; FERC = Federal Energy Regulatory Commission; FWHA = Federal Highway Administration; LNG = liquefied natural gas; MD = Maryland; MDNR = Maryland Department of Natural Resources; MDOT = Maryland Department of Transportation; MDTA = Maryland Transportation Authority; NA = not applicable; NMS = National Marine Sanctuary; NOAA = National Oceanic and Atmospheric Administration; REPI = Readiness and Environmental Protection Integration; RLA = Rural Legacy Area; SHA = State Highway Administration; UMD = University of Maryland; USDA = United States Department of Agriculture; VDOT = Virginia Department of Transportation.

Some projects such as the St. Mary's County airport expansion could increase flights and associated air pollutants when considered with the Proposed Action. In addition, an increase in vessel traffic associated with Cove Point LNG Terminal and recreational and commercial fishing could pose cumulative impacts on air quality. These projects could also contribute to long-term increased need for fossil fuels, but emissions from these projects would likely be minimal in the overall context of the regional air quality and would potentially be offset by other transportation improvements.

Cumulative air quality impacts from past, present, and future actions within the ROI would likely be short term during construction and minimal. Some infrastructure projects, once constructed, could result in improved traffic flow and resulting air quality. Emissions from the Proposed Action would be nominal in the context of the overall regional air quality, past, present, and future projects, and the ongoing and future government/municipal, commercial/industrial, and private/recreational construction, and transportation emissions. Fossil fuel combustion associated with infrastructure projects already completed, in progress, or expected in the foreseeable future would primarily cause temporary increases in air pollutant emissions, and thus cumulative impacts would be primarily short-term and localized. Further, projects such as the REPI parks, RLA expansions, and NMS establishment would likely provide a beneficial impact to air quality, thereby partially offsetting potential cumulative air emissions generated during aircraft activities.

4.4.3 Water Resources and Sediments

4.4.3.1 Description of Geographic Study Area

The ROI for water resources and sediments is the Chesapeake Bay Water Range and waters of the middle Chesapeake Bay watershed including waters adjacent to NAS Patuxent River and Outlying Field (OLF) Webster. Water and sediment quality within Chesapeake Bay have been and are being affected by watershed influences, including pollutant inputs from the runoff and tributaries that discharge to the Bay, as well as historical actions that resulted in legacy contamination of water and sediments.

4.4.3.2 Relevant Past, Present, and Future Actions

Past, present, or reasonably foreseeable future actions that might interact with water resources and sediments within the PRC Study Area for the Proposed Action are listed in Table 4.4-3.

Table 4.4-3 Actions That May Contribute to Water and Sediments Quality Cumulative Impacts

Proponent	*Location*	*Action Name*	*Impacts*
Past Actions			
FERC	Lusby, MD Chesapeake Bay	Cove Point LNG Terminal Expansion	Potential
USDA	1,385 acres along the Nanticoke River and broader Chesapeake Bay under the Atlantic Test Ranges	Establishment of the Middle Chesapeake Sentinel Landscape	Beneficial
NOAA	Charles County	Designation of the Mallows Bay-Potomac River NMS	Beneficial
Present Actions			
FHWA/MDTA	Chesapeake Bay	Chesapeake Bay Bridge Crossing	Potential
NA	Chesapeake Bay	Recreational and Commercial Vessel Use	Potential
Reasonably Foreseeable Future Actions			
MDOT/SHA	St. Mary's and Calvert Counties	Construction of a Second Span on the Thomas Johnson Bridge	Potential

Key: FERC= Federal Energy Regulatory Commission; FHWA = Federal Highway Administration; LNG = liquefied natural gas; MD = Maryland; MDOT = Maryland Department of Transportation; MDTA = Maryland Transportation Authority; NA = not applicable; NMS = National Marine Sanctuary; NOAA = National Oceanic and Atmospheric Administration; SHA = State Highway Administration; USDA = United States Department of Agriculture.

Section 3.3.2 (Water Resources and Sediments, Affected Environment) provides a discussion of impairments, pollutant stressors, and trends related to water resources. Large portions of the Chesapeake Bay and adjacent watersheds that drain into the Bay are considered impaired due to a variety of historical and ongoing input sources within the watershed. A number of these impairments have been addressed by Total Maximum Daily Load Plans (TMDLs) that have been implemented or are planned for implementation. In particular, a region-wide TMDL addressing nutrients and sediments, which are considered primary contributors to the impairments, was implemented by the U.S. Environmental Protection Agency in 2010. Along with the TMDLs, cooperative, interagency programs to develop Watershed implementation Plans designed to achieve TMDL goals (https://www.chesapeakeprogress.com/?/clean-water#water-quality) (Chesapeake Progress, 2017) have been initiated, best management practices have been developed and implemented, and monitoring is being conducted to evaluate progress.

According to Chesapeake Progress (2017), an estimated 42 percent of the Chesapeake Bay and its tidal tributaries met water quality standards during the 2015 to 2017 assessment period, which was the highest estimate of water quality standards attainment since 1985. This 5-percent increase from the previous assessment period was due in large part to improvements in water clarity, improvements in chlorophyll *a* (a measure of algae growth) and improvements in dissolved oxygen in the open waters of the bay. In contrast, Versar (2016b) reported negative trend in benthic community health attributed to hypoxia. Success in the future with respect to meeting water quality standards will depend on tighter controls of watershed-based inputs.

4.4.3.3 Cumulative Impact Analysis

The Proposed Action would not include any in-water construction, but use of vessels and military expended materials would increase. The primary stressors to water resources associated with the Proposed Action are physical disturbance and pollutants. Other present and foreseeable future actions in the ROI also potentially involve physical disturbance and pollutants associated with in-water construction and vessel use. Construction projects in the Chesapeake Bay, including the two bridge projects, could result in localized physical disturbance of sediments, resulting in temporary water quality and sediment impacts. Cumulative water quality and sediment impacts could occur if construction and use of Navy military expended materials were to occur simultaneously in the same area. Construction of the Cove Point LNG Terminal Expansion project has already occurred. Therefore, there is no temporal overlap between the construction phase of this project and the Proposed Action and no potential for cumulative impacts from physical disturbance. However, the Cove Point LNG Terminal Expansion project contributes to increased commercial vessel traffic, which is a potential source of pollutants to the PRC Study Area. In contrast, numbers of recreational boating and commercial vessel traffic fluctuate over time due to a variety of economic (e.g., tariffs on global trade) and social (e.g., recreational boat registration) factors. As a result, slight changes in vessel traffic associated with present and reasonably foreseeable future actions likely have minimal effects on pollutant stressors within the PRC Study Area. Projects including the Middle Chesapeake Sentinel Landscape and the Mallows Bay-Potomac NMS would provide beneficial impacts to water quality and preservation and partially offset potential cumulative impacts to water quality and sediment.

None of the past, present, and future actions listed in Table 4.4-3 would contribute appreciably, either adversely or beneficially, to water resources within the ROI because they would not alter the watershed loadings of nutrients or sediments that are largely responsible for current impairments within the Chesapeake Bay and tributaries. Similarly, the Proposed Action would not contribute to loadings for nutrients or sediments. Contributions from the Proposed Action to metal loadings would be negligible, and metals are not a stressor contributing to water quality or sediment impairments in Chesapeake Bay.

4.4.4 Biological Resources

4.4.4.1 Description of Geographic Study Area

The ROI for biological resources impacts is the estuarine and terrestrial/freshwater habitat present in the PRC Study Area. As described in Section 3.4.3.1 (Biological Resources, No Action Alternative, Generic Background for Analysis), the natural environment overlapping the Proposed Action ROI has declined due to human-encroachment into natural habitats. This has resulted in habitat loss, habitat fragmentation, habitat degradation, and the introduction of invasive species as the main threats to biological resources.

4.4.4.2 Relevant Past, Present, and Future Actions

Table 4.4-4 and Section 4.3 (Past, Present, and Reasonably Foreseeable Future Actions) describe the relevant past, present, and future (human) actions that may add cumulatively to the overall impact of the Proposed Action on biological resources.

Table 4.4-4 Actions That May Contribute to Biological Resources Cumulative Impacts

Proponent	*Location*	*Action Name*	*Impacts*
Past Actions			
FERC	Lusby, MD Chesapeake Bay	Cove Point LNG Terminal Expansion	Potential
UMD	California, MD	University of Maryland Unmanned Aircraft Systems Test Site at St. Mary's County Airport	Potential
St. Mary's County	St. Mary's County	REPI County Parks at Shannon Farms and Snow Hill Farm	Beneficial
USDA	1,385 acres along the Nanticoke River and broader Chesapeake Bay under the Atlantic Test Ranges	Establishment of the Middle Chesapeake Sentinel Landscape	Beneficial
MDNR	Dorchester County	Establishment of the Harriet Tubman RLA	Beneficial
NOAA	Charles County	Designation of the Mallows Bay-Potomac River NMS	Beneficial
Present Actions			
MDNR	St. Mary's and Dorchester Counties	Expansion of the Mattapany and Nanticoke RLAs	Beneficial
FHWA/MDTA	Chesapeake Bay	Chesapeake Bay Bridge Crossing	Potential
FAA	California, MD	St. Mary's County Airport Expansion	Potential
NA	Chesapeake Bay	Recreational and Commercial Vessel Use	Potential
Reasonably Foreseeable Future Actions			
MDOT/SHA	St. Mary's and Calvert County	Construction of a Second Span on the Thomas Johnson Bridge	Potential

Key: FAA = Federal Aviation Administration; FERC = Federal Energy Regulatory Commission; FHWA = Federal Highway Administration; LNG = liquefied natural gas; MD = Maryland; MDNR = Maryland Department of Natural Resources; MDOT = Maryland Department of Transportation; MDTA = Maryland Transportation Authority; NA = not applicable; NOAA = National Oceanic and Atmospheric Administration; NMS = National Marine Sanctuary; REPI = Readiness and Environmental Protection Integration; RLA = Rural Legacy Area; SHA = State Highway Administration; UMD = University of Maryland; USDA = United States Department of Agriculture.

4.4.4.3 Cumulative Impact Analysis

The overall effect of past, present, and foreseeable future human activities in the ROI are difficult to both determine and control but represents a critical frontier in managing environmental impacts.

Because the typical level of activity included in the Proposed Action is virtually identical to what has been occurring for over 20 years, the cumulative impact of that level of activity is currently factored into the environmental baseline in the ROI. It should be noted that the Proposed Action does not depend on any present or foreseeable future actions in the ROI.

The present and foreseeable future actions in the ROI represent a mixture of stressors including both habitat loss/degradation and stressor mitigations (e.g., establishment of conservation lands). However, the Proposed Action would not contribute to any habitat loss in previously undisturbed natural areas (e.g., wetland areas, low-elevation uplands, etc.). The primary stressors generated by the Proposed Action (e.g., acoustic, physical disturbance, and strike) either do not add cumulatively to the major threats to biological resources (e.g., acoustic, energy) or they represent a miniscule contribution to habitat degradation (e.g., physical disturbance and strike) that is responsible for the most significant cumulative impacts on biological resources. The Cove Point LNG Terminal Expansion project increased the number of large ships moving through the Chesapeake Bay Water Range and would increase the overall potential for a water-based asset striking an uncommon animal, such as a sea turtle or sturgeon. The cumulative effect would be most pronounced during years when the proposed peak of activity occurred. However, a typical year of proposed activity would be no more than what has been happening for many years.

Ongoing testing and training activities that have resulted in consistent human presence within the ROI may cause displacement of some plants and animals. The additional activities associated with the action alternatives would result in increased frequency of human presence within the ROI during atypical peaks of activity; however, any impact to plants and animals would be expected to generate only short-term and minimal impacts to mostly common/generalist species inhabiting previously disturbed areas. The chance of cumulatively impacting an uncommon/specialist species (e.g., threatened or endangered species) would be elevated during times of peak activity, but these species are most concentrated in natural areas far removed from the airfield environment or Chesapeake Bay Water Range where most of the proposed activity is occurring. Cumulative impacts are further reduced by various protective measures established for the safety of pilots and animals by moving animals away from the airfield environment (e.g., the Bird/Animal Aircraft Strike Hazard program) or avoiding impacts to visible marine/estuarine mammals, sea turtles, and concentrations of birds activity (Section 2.5, Standard Operating Procedures Included in the Proposed Action, and Section 3.10, Summary of Potential Impacts to Resources and Impact Avoidance and Minimization, respectively). Furthermore, implementation and continuous refinement of Integrated Natural Resources Management Plans for PRC installations and the water range serves to integrate conservation, restoration, and enhancement strategies for biological resources into the military mission, operation, and security requirements. Worldwide, areas reserved for military training (and testing) have increased the global protected area network by at least 25 percent and play an important complementary role in global conservation efforts (Zentelis & Lindenmayer, 2015).

No long-term permanent impacts on biological resources would be expected, either as a result of the Proposed Action or cumulatively when combined with other past, present, and reasonably foreseeable future actions. Note that this conclusion is contingent on a thorough analysis of the other actions that is beyond the scope of this EIS.

4.4.5 Public Health and Safety

4.4.5.1 Description of Geographic Study Area

The ROI for public health and safety cumulative impacts associated with the Proposed Action when considered with past, present, and future projects is the PRC Study Area, including the Chesapeake Bay Water Range and adjacent and surrounding waterways and airspace.

4.4.5.2 Relevant Past, Present, and Future Actions

Table 4.4-5 identifies the past, present, or reasonably foreseeable future actions that might interact with public health and safety. These actions described in Section 4.3 (Past, Present, and Reasonably Foreseeable Future Actions), including airfield/runway development, unmanned aerial system testing, and vessel activities, could have some individual or cumulative effect on public health and safety.

Table 4.4-5 Actions That May Contribute to Public Health and Safety Cumulative Impacts

Proponent	*Location*	*Action Name*	*Impacts*
Past Actions			
FERC	Lusby, MD Chesapeake Bay	Cove Point LNG Terminal Expansion	Potential
UMD	California, MD	University of Maryland Unmanned Aircraft Systems Test Site at St. Mary's County Airport	Potential
USDA	1,385 acres along the Nanticoke River and broader Chesapeake Bay under the Atlantic Test Ranges	Establishment of the Middle Chesapeake Sentinel Landscape	Beneficial
MDNR	Dorchester County	Establishment of the Harriet Tubman RLA	Beneficial
NOAA	Charles County	Designation of the Mallows Bay-Potomac River NMS	Beneficial
Present Actions			
FHWA/MDTA	Chesapeake Bay	Chesapeake Bay Bridge Crossing	Potential
FAA	California, MD	St. Mary's County Airport Expansion	Potential
NA	Chesapeake Bay	Recreational and Commercial Vessel Use	Potential
Reasonably Foreseeable Future Actions			
MDOT/SHA	St. Mary's and Calvert Counties	Construction of a Second Span on the Thomas Johnson Bridge	Potential
VDOT	Northern Neck of Virginia	Route 3 Northern Neck Corridor Improvement Study	Potential

Key: FAA = Federal Aviation Administration; FERC = Federal Energy Regulatory Commission; FHWA = Federal Highway Administration; LNG = liquefied natural gas; MD = Maryland; MDNR = Maryland Department of Natural Resources; MDOT= Maryland Department of Transportation; MDTA = Maryland Transportation Authority; NA = not applicable; NMS = National Marine Sanctuary; NOAA = National Oceanic and Atmospheric Administration; RLA = Rural Legacy Area; SHA = State Highway Administration; UMD = University of Maryland; USDA = United States Department of Agriculture; VDOT = Virginia Department of Transportation.

4.4.5.3 Cumulative Impact Analysis

Stressors that may potentially impact public health and safety are acoustic, physical disturbance/strike, and public interaction. The Proposed Action would increase overall air and vessel activities within the PRC Study Area. Projects that increase aircraft activities that could pose a cumulative impact include the University of Maryland Unmanned Aircraft Systems Test Site at St. Mary's Airport and expansion of St. Mary's Airport. Current airspace safety procedures, maintenance, training, and inspections would continue to be implemented, and airfield flight operations would adhere to established safety procedures

(Section 2.5, Standard Operating Procedures Included in the Proposed Action). Potential aircraft mishaps are the primary safety concern with military testing and training flights. The Navy maintains detailed emergency and mishap response plans to react to an aircraft accident, should one occur. These plans assign agency responsibilities and prescribe functional activities necessary to react to mishaps, whether on or off the installation. While there is no proposed change planned to existing flight procedures, there would be an increase in aircraft activities. The existing Accident Potential Zones or Clear Zones that indicate where an aircraft mishap would likely occur, if one were to occur, would not change. Therefore, there would be no cumulative public health and safety impacts. Impacts from bird/animal aircraft strike hazard risk would be minimized through continued implementation of the standard procedures and protocols of the Bird/Animal Aircraft Strike Hazard Plan. Increased vessel traffic associated with the Proposed Action, the Cove Point LNG Terminal Expansion project, bridge projects, and recreational boating and commercial vessel traffic could pose a public interaction hazard. The LNG terminal is currently operational, with a slight increase in vessel traffic. Recreational and vessel traffic tend to fluctuate over time based on economic factors. As a result, slight changes in vessel traffic associated with present and reasonably foreseeable future actions likely would have minimal effects on public interactions within the PRC Study Area given the vessel safety measures employed by the Navy and the Cove Point LNG Terminal. The conservation and recreational areas provide some safety buffers for public recreation. These projects could partially offset cumulative safety impacts associated with the Proposed Action and other projects that increase vessel use.

4.4.6 Land Use

4.4.6.1 Description of Geographic Study Area

The ROI for land use impacts associated with the Proposed Action and considering past, present, and future projects includes adjacent properties and areas beneath the PRC Study Area airspace.

4.4.6.2 Relevant Past, Present, and Future Actions

Table 4.4-6 presents the past, present, or reasonably foreseeable future actions that might interact with the affected land use areas of the Proposed Action and cumulatively impact land use compatibility in the area beneath the PRC Study Area airspace.

Table 4.4-6 Actions That May Contribute to Land Use Cumulative Impacts

Proponent	***Location***	***Action Name***	***Impacts***
Past Actions			
UMD	California, MD	University of Maryland Unmanned Aircraft Systems Test Site at St. Mary's County Airport	Potential
St. Mary's County	St. Mary's County	REPI County Parks at Shannon Farms and Snow Hill Farm	Beneficial
USDA	1,385 acres along the Nanticoke River and broader Chesapeake Bay under the Atlantic Test Ranges	Establishment of the Middle Chesapeake Sentinel Landscape	Beneficial
MDNR	Dorchester County	Establishment of the Harriet Tubman RLA	Beneficial
NOAA	Charles County	Designation of the Mallows Bay-Potomac River NMS	Beneficial
Present Actions			
MDRN	St. Mary's and Dorchester Counties	Expansion of the Mattapany RLA and Nanticoke RLAs	Beneficial
FAA	California, MD	St. Mary's County Airport Expansion	Potential

Table 4.4-6 Actions That May Contribute to Land Use Cumulative Impacts, Continued

Proponent	*Location*	*Action Name*	*Impacts*
Reasonable Foreseeable Future Actions			
MDOT/SHA	St. Mary's and Calvert Counties	Construction of a Second Span on the Thomas Johnson Bridge	Potential
VDOT	Northern Neck of VA	Route 3 Northern Neck Corridor Improvement Study	Potential

Key: FAA = Federal Aviation Administration; MD = Maryland; MDNR = Maryland Department of Natural Resources; MDOT = Maryland Department of Transportation; NOAA = National Oceanic and Atmospheric Administration; NMS = National Marine Sanctuary; REPI = Readiness and Environmental Protection Integration; RLA = Rural Legacy Area; SHA = State Highway Administration; UMD = University of Maryland; USDA = United States Department of Agriculture.

4.4.6.3 Cumulative Impact Analysis

Cumulative land use impacts from past, present, and future actions that would occur with implementation of the Proposed Action includes those projects that would introduce additional acoustic stressors (i.e., increased noise impacts) or additional risks associated with incompatible land uses in the PRC Study Area. Land use compatibility surrounding NAS Patuxent River would be impacted under the Proposed Action by exposure to increased noise levels (Section 3.6.3, Land Use, Environmental Consequences) or development in Accident Potential Zones around the airfields. Increased noise would impact some recreational facilities and could reduce the enjoyment of those facilities for some persons.

Many of the projects in the region involve construction and transportation improvement projects. These projects would add noise temporarily during construction and may add noise around the new infrastructure facilities (i.e., bridges, road improvements, and St. Mary's County Regional Airport). The additive noise would contribute to the overall urbanizing noise environment to a small degree. These dispersed noise sources would increase overall noise exposure that is associated with continued urbanization and infill in the region.

The Navy would continue to work and coordinate with local jurisdictions to minimize conflicts and to ensure that future development would be compatible with testing and training activities.

The Shannon Farms, Snow Hill Farm, Middle Chesapeake Sentinel Landscape, Harriet Tubman RLA, Mallows Bay-Potomac NMS, Mattapany RLA, and Nanticoke RLA, all would provide open space, protect natural and cultural resources, and provide land use buffers. These projects would result in beneficial impacts for land use while protecting the military mission. As a result, these projects could partially offset land use compatibility impacts associated with the Proposed Action.

4.4.7 Socioeconomics

4.4.7.1 Description of Geographic Study Area

The ROI for socioeconomics impacts associated with the Proposed Action and past, present, and future activities include the land areas of NAS Patuxent River and OLF Webster and associated noise zones and accident potential zones and the Chesapeake Bay Water Range and adjacent and surrounding waterways in the PRC Study Area.

4.4.7.2 Relevant Past, Present, and Future Actions

Table 4.4-7 identifies the past, present, or reasonably foreseeable future actions that might interact with the affected socioeconomics areas of the Proposed Action.

Table 4.4-7 Actions That May Contribute to Socioeconomics Cumulative Impacts

Proponent	*Location*	*Action Name*	*Impacts*
Past Actions			
FERC	Lusby, MD Chesapeake Bay	Cove Point LNG Terminal Expansion	Potential
St. Mary's County	St. Mary's County	REPI County Parks at Shannon Farms and Snow Hill Farm	Beneficial
USDA	1,385 acres along the Nanticoke River and broader Chesapeake Bay under the Atlantic Test Ranges	Establishment of the Middle Chesapeake Sentinel Landscape	Beneficial
MDNR	Dorchester County	Establishment of the Harriet Tubman RLA	Beneficial
NOAA	Charles County	Designation of the Mallows Bay-Potomac River NMS	Beneficial
Present Actions			
MDNR	St. Mary's and Dorchester Counties	Expansion of the Mattapany and Nanticoke RLAs	Beneficial
FHWA/MDTA	Chesapeake Bay	Chesapeake Bay Bridge Crossing	Potential
NA	Chesapeake Bay	Recreational and Commercial Vessel Use	Potential
Reasonably Foreseeable Future Actions			
MDOT/SHA	St. Mary's and Calvert County	Construction of a Second Span on the Thomas Johnson Bridge	Potential

Key: FERC = Federal Energy Regulatory Commission; FHWA = Federal Highway Administration; LNG = liquefied natural gas; MD = Maryland; MDNR = Maryland Department of Natural Resources; MDOT= Maryland Department of Transportation; MDTA = Maryland Transportation Authority; NA = not applicable; NOAA = National Oceanic and Atmospheric Administration; NMS = National Marine Sanctuary; REPI = Readiness and Environmental Protection Integration; RLA = Rural Legacy Area; SHA = State Highway Administration; USDA = United States Department of Agriculture.

4.4.7.3 Cumulative Impact Analysis

The primary stressors to socioeconomic resources associated with the Proposed Action are acoustic and public interaction. Other present and foreseeable future actions in the ROI that would also potentially involve acoustic and public interaction include those projects that involve in-water construction and continued or increased vessel traffic. The Cove Point LNG Terminal Expansion project is operating and deploys approximately one ship every four days. Both the Navy and the Cove Point LNG Terminal practice safe navigation. Navy vessel operation would continue to implement safe vessel practices to minimize the potential for public interaction between Navy and other vessels, including LNG ships, in the region. In addition, the Navy has been conducting testing and training in the PRC Study Area for decades, and therefore certain noise and traffic associated with the military's past and present activities are familiar to commercial and recreational users. Any additional increases in public interaction with the Navy and noise effects associated with the Proposed Action would be similar to the existing environment. The presence of bridge construction vessels, Navy vessels, and increased testing and training would result in increased potential for public interaction. Declines in boat registrations, commercial landing data, and recreational angler trips and catch suggest that public participation in commercial and recreational fishing and boating, while still an important component of the economy, might be slightly declining and offset some of the potential for Navy interaction. Tighter regulations on size and fish limits may be a contributing factor to the decline in commercial and recreational fishing and boating and continue to hinder participation, while other legislation aimed at improving shellfish landings, water quality, and larger commercial and recreational vessels in the Chesapeake Bay could result in an increase in boating and fishing participation in the area.

Past actions including the REPI County Parks at Shannon Farms and expansion of the Mattapany RLA, both located in St. Mary's County provide benefits to the region by offering additional recreational areas to the public outside of the Chesapeake Bay.

Increased testing and training events and the resulting noise exposure under the Proposed Action may have a negative impact on visitor experience at certain recreational areas within the greater than 65 dBA DNL contours. Implementation of the Proposed Action could potentially reduce participation rates from reaching the levels that would have occurred without the Proposed Action. Continued management and coordination between the Navy and others working or recreating within the Chesapeake Bay and parks would minimize the potential for cumulative public interaction and acoustic impacts on commercial and recreational fishing and boating and other recreational activities.

4.4.8 Environmental Justice

4.4.8.1 Description of Geographic Area

The ROI for environmental justice associated with the Proposed Action and past, present, and future activities includes the land areas within the noise contours for 65 dBA DNL and above, as well as accident potential zones.

4.4.8.2 Relevant Past, Present, and Future Actions

Table 4.4-8 identifies the past, present, or reasonably foreseeable future actions that might interact with the affected environmental justice communities in the Proposed Action area.

Table 4.4-8 Actions That May Contribute to Environmental Justice Cumulative Impacts

Proponent	*Location*	*Action Name*	*Impacts*
Past Actions			
UMD	St. Mary's County	University of Maryland Unmanned Aircraft Systems Test Site at St. Mary's County Airport	Potential
St. Mary's County	St. Mary's County	REPI County Parks at Shannon Farms and Snow Hill Farm	Beneficial
Present Actions			
MDNR	St. Mary's County	Expansion of the Mattapany RLA	Beneficial
FAA	California, MD	St. Mary's County Airport Expansion	Potential

Key: FAA = Federal Aviation Administration; MD = Maryland; MDNR = Maryland Department of Natural Resources; REPI = Readiness and Environmental Protection Integration; RLA = Rural Legacy Area; UMD = University of Maryland.

4.4.8.3 Cumulative Impact Analysis

The primary stressor to environmental justice communities associated with the Proposed Action is acoustic. Other past and present actions were identified in the ROI that would increase noise levels within the four block groups located in St. Mary's County with meaningful greater minority and/or low-income communities compared to St. Mary's County (240378759011, 240378759013, 240378759021, and 240378759023). Two past and present actions that would generate aircraft noise are both located at the St. Mary's County Airport (the University of Maryland Unmanned Aircraft Systems Test Site and the St. Mary's County Airport expansion). Both projects are located outside of the four block groups and, therefore, would not pose cumulative disproportionately high and adverse effects to environmental justice communities. Past and present actions, including the REPI County Park at Snow Hill Farm, located south of NAS Patuxent River, and the expansion of the Mattapany RLA, with parcels located both south of NAS Patuxent River and OLF Webster, provide benefits to the community by maintaining the rural land use character and minimizing future conflicts between development and military activities. Both projects would help to prevent future incompatible residential development in aircraft noise contours and serve to protect the military mission.

4.5 Summary of Cumulative Impacts

The Proposed Action would contribute incremental effects to airborne noise, air quality, water quality and sediment, biological resources, public health and safety, land use, socioeconomics, and environmental justice. When considering other past, present, and reasonably foreseeable future projects, there could be an overlap spatially and temporally with the Proposed Action resulting in potential cumulative impacts. Several of the proposed projects in the region involve transportation improvements. These projects could add temporary noise, air quality, water quality, and biological impacts during construction. The St. Mary's County Airport Expansion could result in a minimal increase in the likelihood of annoyance for people living near the airport and potential cumulative impacts with the Proposed Action. The Cove Point LNG Terminal Expansion is operational and contributes to a slight increase in vessel traffic. In contrast, overall numbers of recreational and commercial vessels tend to fluctuate based on economic conditions. Projects such as the REPI parks, Sentinel Landscape, RLA expansions, and NMS establishment would likely provide beneficial impacts such as maintaining open space, protecting natural and cultural resources, and providing land use buffers while protecting the military mission. As a result, these projects could partially offset potential cumulative impacts.

Each air-, land-, and water-based activity and asset associated with the Proposed Action has the potential to generate one or more stressors that may consequently impact a resource area. Table 4.5-1 shows the stressors by resource area used to further assess potential cumulative impacts. As shown, acoustic, physical disturbance/strike, pollutants, and public interactions could pose cumulative effects. The PRC Study Area is already experiencing and absorbing a variety of stressors. Implementing the Proposed Action would not be expected to result in a meaningful contribution to the ongoing stress or cause significant impact on any resource, but it could contribute minute impacts on resources that are already experiencing various degrees of interference and degradation. The measures described in Section 2.5 (Standard Operating Procedures Included in the Proposed Action) and Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) would limit the likelihood of overlap of Navy stressors in time and space with non-Navy stressors to reduce the risk of direct impacts of the Proposed Action.

Table 4.5-1 Potential Cumulative Stressor Impacts by Resource Area

Resource	***Stressor***						
	Acoustic	***Physical Disturbance/ Strike***	***Pollutants***	***Public Interaction***	***Energy***	***Entanglement***	***Ingestion***
Airborne Noise	√						
Air Quality			√				
Water and Sediments		√	√				
Biological Resources	√	√					
Public Health and Safety	√	√		√			
Land Use	√						
Socioeconomics	√			√			
Environmental Justice	√						

5 Other Considerations Required by NEPA

5.1 Consistency with Other Federal, State, and Local Laws, Plans, Policies, and Regulations

In accordance with 40 Code of Federal Regulations section 1502.16(c), analysis of environmental consequences shall include discussion of possible conflicts between the Proposed Action and the objectives of federal, regional, state, and local land use plans, policies, and controls. Table 5.1-1 identifies the principal federal and state laws and regulations that are applicable to the Proposed Action, and describes briefly how compliance with these laws and regulations would be accomplished.

Table 5.1-1 Principal Federal and State Laws Applicable to the Proposed Action

Federal, State, Local, and Regional Land Use Plans, Policies, and Controls	***Status of Compliance***	***EIS Section***
National Environmental Policy Act (NEPA); Council on Environmental Quality's NEPA implementing regulations; Navy procedures for Implementing NEPA	This Environmental Impact Statement (EIS) has been prepared in accordance with NEPA, Council on Environmental Quality regulations implementing NEPA, and Navy NEPA procedures. Public participation and review are conducted in compliance with NEPA.	Entire EIS
Clean Air Act	The air quality analysis in the EIS concludes that proposed emissions contribute to regional emission totals. All but two counties in the Patuxent River Complex (PRC) Study Area are in attainment for all criteria pollutants; Calvert County, Maryland, and Sussex County, Delaware, are in marginal nonattainment for the 8-hour ozone standard. However, no low-level flight operations occur in the Sussex County portion of the study area, so there are not any criteria pollutants emitted in the Sussex County nonattainment area. Therefore, a General Conformity determination is only required for the Proposed Action in Calvert County; however, the Proposed Action is exempt from the General Conformity Rule requirements because emissions are below the *de minimis* threshold for ozone precursors. A Record of Non-Applicability is included in Appendix D (Air Quality Calculations).	3.2 Air Quality
Clean Water Act	The Proposed Action is compliant to the extent practicable with the Clean Water Act.	3.3 Water Resources and Sediments
Coastal Zone Management Act	Coastal Consistency Determinations were prepared and will be submitted to the Maryland Department of Natural Resources and the Virginia Department of Environmental Quality. A Negative Determination was prepared and will be submitted to the Delaware Department of Natural Resources and Environmental Control. See Appendix F, Coastal Consistency Determination.	3.6 Land Use
Appropriation or Use of Waters, Reservoirs, and Dams, Annotated Code of Maryland, Environment Article, Section 5-501, et seq.	The Proposed Action is compliant to the extent practicable with the State of Maryland regulation.	3.3 Water Resources and Sediments

Table 5.1-1 Principal Federal and State Laws Applicable to the Proposed Action, Continued

Federal, State, Local, and Regional Land Use Plans, Policies, and Controls	***Status of Compliance***	***EIS Section***
Water Pollution Control, Annotated Code of Maryland, Environmental Article, Sections 9-313 through 9-323	The Proposed Action is compliant to the extent practicable with the State of Maryland regulation.	3.3 Water Resources and Sediments
Endangered Species Act	National Marine Fisheries Service Jurisdiction: All Endangered Species Act (ESA)-listed sea turtle and sturgeon that may occur in the PRC Study Area may be affected by the Preferred Alternative (Alternative 2), and some sturgeon are likely to be adversely affected by physical disturbance and strike and entanglement from water-based assets or military expended materials. Sea turtles are likely to be adversely impacted by only physical disturbance and strike. Formal consultation is required and has been initiated concurrent with the Draft EIS release (Appendix H, Endangered Species Act Documentation). U.S. Fish and Wildlife Service: All but one ESA-listed species (northern long-eared bat) that may occur in the PRC Study Area may be affected by the Preferred Alternative (Alternative 2), though they are not likely to be adversely affected. The affected species include eastern black rail, northeastern beach tiger beetle, puritan tiger beetle, red knot, and West Indian manatee. Informal consultation is required and has been initiated concurrent with the Draft EIS release.	3.4 Biological Resources
Magnuson-Stevens Fishery Conservation and Management Reauthorization Act	National Marine Fisheries Service Jurisdiction: Action Alternative 2 (Preferred Alternative) may adversely affect mostly water column, abiotic substrate, and biotic features of Essential Fish Habitat, though the impact would be minimal and mostly temporary to mostly resilient soft bottom habitats in deeper waters of the Chesapeake Bay Water Range. Informal consultation is required and has been initiated concurrent with the Draft EIS release (Appendix I, Essential Fish Habitat Documentation).	3.4 Biological Resources and 3.7 Socioeconomics
Marine Mammal Protection Act	National Marine Fisheries Service Jurisdiction: For the five marine mammals that may occur in the PRC Study Area (bottlenose dolphins, harbor porpoise, harbor seal, humpback whale, and West Indian manatee), the Proposed Action (Preferred Alternative, Alternative 2) would not result in the reasonably foreseeable "take" of any marine mammals. The ability to mitigate to zero takes is based on the surface visibility and seasonal absence of the species, rarity of stressor activities for which mitigation measures apply, and platform heights used to observe for species. No take authorization is required.	3.4 Biological Resources
Migratory Bird Treaty Act	U.S. Fish and Wildlife Service Jurisdiction: The Navy has determined that the Proposed Action may result in the "take" of migratory birds. The Proposed Action, however, is a military readiness activity; therefore, "take" is in compliance with the Migratory Bird Treaty Act in the absence of any population-level effects on native bird species. No consultation is required.	3.4 Biological Resources

Table 5.1-1 Principal Federal and State Laws Applicable to the Proposed Action, Continued

Federal, State, Local, and Regional Land Use Plans, Policies, and Controls	*Status of Compliance*	*EIS Section*
Bald and Golden Eagle Protection Act	U.S. Fish and Wildlife Service Jurisdiction: Pursuant to the Bald and Golden Eagle Protection Act and implementing guidance, prohibited take of an eagle is unlikely due to the measures taken to avoid impacts to nesting habitat. No Bald and Golden Eagle Protection Act permit is required. See Appendix M, Bald and Golden Eagle Protection Act Documentation.	3.4 Biological Resources
Fish and Wildlife Conservation Act	The U.S. Fish and Wildlife Service has identified Birds of Conservation Concern, which are species, subspecies, and populations of migratory non-game birds that, without additional conservation actions, are likely to become candidates for listing under the ESA. This EIS considers all impacts on species protected under this Act though specific analysis determinations are not required.	3.4 Biological Resources
Executive Order 13186, Responsibilities of the Federal Agencies to Protect Migratory Birds	This EIS considers all impacts on migratory birds. The Navy has a current Memorandum of Understanding with the U.S. Fish and Wildlife Service with respect to this Executive Order.	3.4 Biological Resources
Federal Aviation Administration Regulations Part 91, *General Operating and Flight Rules*	Military aircraft testing and training operations are conducted in accordance with this regulation, which governs aspects such as operating near other aircraft, right-of-way rules, and aircraft speed.	3.5 Public Health and Safety
Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks	The Proposed Action would not result in any significant disproportionate environmental health or safety risks to children.	3.5 Public Health and Safety
Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations	The Navy has determined that there would continue to be potential for disproportionately high and adverse impacts to minority and low-income populations in the affected population due to noise.	3.8 Environmental Justice
National Historic Preservation Act	The Navy determined an overall finding of no adverse effect to historic properties. Coordination will occur with the State Historic Preservation Officer at the Maryland Historical Trust, Virginia Department of Historical Resources, and Delaware Division of Historical and Cultural Affairs (Appendix J, National Historic Preservation Act Documentation).	3.9 Cultural Resources
Native American Graves Protection and Repatriation Act of 1990	As part of this action, no artifacts or remains attribute to tribes located with the PRC Study Area are anticipated to be impacted.	3.9 Cultural Resources
Executive Order 13175, Consultation and Coordination with Indian Tribal Governments	The Navy submitted notification letters to 22 tribes (14 federally recognized) during the scoping process. Only one tribe responded, indicating that no further information was required (Appendix K, Tribal Government to Government Documentation).	3.9 Cultural Resources

5.2 Irreversible or Irretrievable Commitments of Resources

Resources that are irreversibly or irretrievably committed to a project are those that are used on a long-term or permanent basis. This includes the use of non-renewable resources such as metal and fuel, and natural or cultural resources. These resources are irretrievable in that they would be used for this project when they could have been used for other purposes. Human labor is also considered an irretrievable resource.

Implementation of the Proposed Action would involve human labor and the consumption of fuel, oil, and lubricants for operation of aircraft, vessels, and vehicles. Implementing the Proposed Action would not result in significant irreversible or irretrievable commitment of resources.

5.3 Unavoidable Adverse Impacts

Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization) identifies the mitigation measures the Navy will continue to implement under the Proposed Action for all alternatives. Avoidance and minimization of adverse impacts were integrated into the development of the alternatives and existing Navy policy to the greatest extent practicable and were successful in many resource areas where there are impacts to the resource, but with compliance with applicable regulations and/or existing Navy management strategies, these impacts were minimized or not determined to be significant. All impacts from the implementation of the alternatives are described in detail in Chapter 3 (Affected Environment and Environmental Consequences).

5.4 Relationship between Short-Term Use of the Environment and Long-Term Productivity

The National Environmental Policy Act (NEPA) requires an analysis of the relationship between a project's short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This refers to the possibility that choosing one development site reduces future flexibility in pursuing other options, or that using a parcel of land or other resources often eliminates the possibility of other uses at that site.

Navy testing and training activities have been ongoing for decades in the study area, and the proposed increase in activities would occur over several years while continuing to vary in intensity from year to year. In the long-term, depending on their location, humans and animals would experience increased levels of noise during testing and training operations. Wildlife, including small mammals, reptiles and amphibians, breeding birds, and marine species are not expected to see changes in long-term productivity from the implementation of the Proposed Action because local wildlife are already exposed to a high level of long-term air operations and other human-made disturbances such as vessel movement. The wildlife has presumably habituated to the very high level of noise and visual disturbance associated with testing and training operations. The Proposed Action would not result in any impacts that would significantly reduce environmental productivity or permanently narrow the range of beneficial uses of the environment.

6 Public Involvement and Distribution

This chapter describes the efforts to involve the public in preparing the Patuxent River Complex (PRC) Environmental Impact Statement (EIS). Regulations from the Council on Environmental Quality direct agencies to involve the public in preparing and implementing their National Environmental Policy Act (NEPA) procedures. Public outreach was conducted in accordance with the NEPA and the United States (U.S.) Department of the Navy (Navy) Policy (Office of the Chief of Naval Operations Instruction [OPNAVINST] 5090.1E).

The Navy will consult with the National Marine Fisheries Service Greater Atlantic Region and U.S. Fish and Wildlife Service Chesapeake Bay Field Office in accordance with section 7 of the Endangered Species Act. The Navy will consult with the Mid-Atlantic Field Office Supervisor and Essential Fish Habitat Coordinator, Greater Atlantic Regional Fisheries Office in accordance with the Magnuson-Stevens Fishery Conservation and Management Act. A Coastal Consistency Determination will be prepared and submitted to the Maryland Department of Natural Resources and Virginia Department of Environmental Quality. A Coastal Consistency Negative Determination will be submitted to the Delaware Department of Natural Resources and Environmental Control. The Navy will also coordinate with the State Historic Preservation Officer at the Maryland Historical Trust, Virginia Department of Historical Resources, and Delaware Division of Historical and Cultural Affairs regarding the Proposed Action.

6.1 Early Engagement

The Navy conducted an early outreach engagement process prior to the publication in the Federal Register of the Notice of Intent (NOI) to prepare an EIS for PRC (Federal Register, February 16, 2019) (Appendix G, Public Involvement). The purpose was to provide public awareness of the upcoming EIS for existing and future testing and training in the PRC. A one-page pre-NOI website became active on February 6, 2019, and a trifold brochure was developed to provide stakeholders, including federal, state, and local elected officials, federally recognized tribal governments, government agencies, and the public, with general information. The Atlantic Test Ranges (ATR) Sustainability Office also made phone calls to several stakeholders, predominantly county administrators, to discuss the EIS and identify stakeholder concerns. Potential concerns identified were noise, land use, and economic impacts to watermen due to range closures; however, most noted that there were no major issues.

6.2 Project Website

A project website was established to provide the public with project information and to accept comments electronically. The full project website, www.PRCEIS.com, was made available to the public on February 15, 2019. The website address was included in the *Notice of Intent to Prepare an Environmental Impact Statement for Patuxent River Complex Testing and Training and to Announce Public Scoping Meetings*. It was also included in newspaper advertisements, agency letters, and NOI postcards. The project notifications; scoping fact sheet booklet; posters; maps; scoping meeting locations, dates, times, and directions; historical documents; and various other materials are available on the project website and will be updated throughout the course of the project.

6.3 Information Hotline

A dedicated EIS phone line was established to facilitate project inquiries and was activated on February 15, 2019. Callers were informed on how to make official comments, and inquiries were documented in contact reports included in the *Final Public Scoping Summary Report for the Patuxent River Complex*

Testing and Training Environmental Impact Statement (U.S. Department of the Navy, 2019l). Post-scoping, a recorded voice message informs callers that the public scoping period has ended. The message will be updated at major project phases as additional information becomes available.

6.4 Scoping Period

The purpose of the project scoping public involvement effort was to notify and inform stakeholders and the public about the scope of analysis, the alternatives, and resources to be considered during the Draft EIS development. The public scoping period began with the publication of the NOI to prepare an EIS for PRC and to announce public scoping meetings in the Federal Register on February 15, 2019. The scoping period ran from February 15, 2019, through April 1, 2019 (46 calendar days). Comments on the scope of the analysis were received at four public scoping meetings held in Maryland and Virginia, on March 4 through March 7, 2019; by mail; and through the project website. Comments received during the scoping period were considered in preparing the Draft EIS.

6.4.1 Public Scoping Notification

The Navy made significant efforts to notify the public to ensure maximum public participation during the scoping process. A summary of these efforts follows.

6.4.1.1 Notification Letters

Stakeholder letters were mailed first-class on February 15, 2019, to tribal contacts; federal, state, and local elected officials; and government agencies. The ATR Sustainability Office coordinated with the Naval Air Systems Command Congressional Liaison Office to mail and fax letters to Congressional representatives within the PRC Study Area. A total of 118 entities received the scoping notification letter (Appendix G, Public Involvement).

6.4.1.2 Postcard Mailers

A postcard mailer, providing information on the public scoping meetings, the Proposed Action, and how to submit comments, was mailed via first-class U.S. postal service to 237 individuals; nongovernmental organizations; tribal, community, and business groups; fishing, aviation, and recreation groups; and private companies on February 15, 2019 (Appendix G, Public Involvement).

6.4.1.3 Newspaper Advertisements

To announce the scoping period and scoping meetings, notices were published in local and regional newspapers to advertise the public's opportunity to comment on the scope of the analysis. A set of advertisements were published concurrently with the NOI Federal Register publication, and subsequent notices were published to coincide with the public meetings for each respective meeting location. The notices included a description of the Proposed Action, location of the scoping meetings, project website, comment period duration, and information on how to provide comments (Appendix G, Public Involvement).

6.4.1.4 Press Release

The Naval Air Station (NAS) Patuxent River Public Affairs Office distributed a press release to media outlets, county representatives, and homeowner associations on March 1, 2019, with information on the Proposed Action, public meeting details, project website, the duration of the public comment period, and ways to provide comments (Appendix G, Public Involvement). Information on the public scoping meetings was also posted to the NAS Patuxent River Facebook page.

6.4.1.5 Brochure and Comment Guide

The pre-NOI trifold brochure was revised after the NOI was published. The revised brochure (Appendix G, Public Involvement) described the project and timeline, requested comments from the public, and advertised public meeting dates and locations. The brochure was provided as a handout to groups and was available at several community libraries within the PRC Study Area that served as information repositories (Table 6.4-1). In addition, a *Guide to Providing Comments* was also provided.

Table 6.4-1 Locations of Information Repositories

Library	*Address*
Central Rappahannock Regional Library Montross Branch	56 Polk St., Montross, VA 22520
Central Rappahannock Regional Library Newton Branch	22 Coles Point Rd., Hague, VA 22469
Essex Public Library	117 N. Church Rd., Tappahannock, VA 22560
Richmond County Public Library	52 Campus Dr., Warsaw, VA 22572
Lancaster Community Library	16 Town Centre Dr., Kilmarnock, VA 22482
Northumberland Public Library	7204 Northumberland Hwy, Heathsville, VA 22473
Caroline County Public Library	123 Morris Ave., Federalsburg, MD 21632
Dorchester County Central Library	303 Gay St., Cambridge, MD 21613
Dorchester County Library, Hurlock Branch	222 S. Main St., Hurlock, MD 21643
Somerset County Library, Princess Anne Branch	11767 Beechwood St., Princess Anne, MD 21853
Somerset County Library, Crisfield Branch	100 Collins St., Crisfield, MD 21817
St. Mary's County Library, Charlotte Hall Branch	37600 New Market Rd., Charlotte Hall, MD 20622
St. Mary's County Library, Leonardtown Branch	232580 Hollywood Rd., Leonardtown, MD 20650
St. Mary's County Library, Lexington Park Branch	21677 FDR Blvd., Lexington Park, MD 20653

Key: MD = Maryland; VA = Virginia.

6.4.2 Public Scoping Meetings

The Navy held four open house public scoping meetings from March 4 through March 7, 2019, at the locations listed in Table 6.4-2. The meeting sites included the Northern Neck of Virginia, St. Mary's County, Maryland (near the location of NAS Patuxent River), and two locations on the Eastern Shore of Maryland where airspace activities take place.

Table 6.4-2 Public Scoping Meetings Locations, Dates, and Addresses

Location	*Date*	*Address*
Light of Christ Anglican Church, Parish Hall Heathsville, VA	Monday, March 4, 2019	9500 Northumberland Hwy Heathsville, VA 22473
Southern Maryland Higher Education Center Multi-Purpose Room Hollywood, MD	Tuesday, March 5, 2019	44219 Airport Rd Building 1 California, MD 20619
University of Maryland, Eastern Shore Richard A. Henson Center Ballroom Princess Anne, MD	Wednesday, March 6, 2019	University Blvd S Princess Anne, MD 21853
St. Paul's United Methodist Church. Parish Hall Cambridge, MD	Thursday, March 7, 2019	205 Maryland Ave Cambridge, MD 21613

Key: MD = Maryland; VA = Virginia.

Each scoping meeting included informational poster stations staffed by Navy representatives to answer questions and provide project information. Members of the public could arrive at any time during the event, and each meeting was three hours in duration. Staff at the welcome station greeted guests and encouraged meeting attendees to sign in and be added to the project mailing list. A 20-page fact sheet booklet (Appendix G, Public Involvement), designed to provide more detailed information on the poster topics, brochure, and *Guide to Providing Comments*, was distributed to attendees, along with verbal direction on the general flow of the poster stations and commenting methods. A video display showing the types of activities conducted within the PRC was also available for viewing to convey why testing and training is important for Sailors and Marines.

A comment station and staff were available to facilitate the public completing and submitting written comments. A recorder was made available in the event someone wanted to provide oral comments. No attendees used this recorder. Individuals could submit completed comment forms at the meeting or mail them to the address provided on the comment form. Meeting attendees were also informed that they could submit comments via the project website.

Media kits containing the brochure, scoping fact sheet booklet, and 11 x 17-inch copies of the posters were prepared and distributed to the media. A Public Affairs Officer accompanied all media representatives to the poster stations.

6.4.2.1 Meeting Attendance and Feedback

Table 6.4-3 shows the attendance at each public scoping meeting. Meeting feedback forms were available at the comment table. In addition, staff asked selected participants to provide feedback. Three meeting feedback forms were submitted that provided positive comments regarding the meeting format and discussions with Navy subject matter experts.

Table 6.4-3 Meeting Attendance

Meeting	*Attendance Number*
Heathsville, VA	9
California, MD	26
Princess Anne, MD	22
Cambridge, MD	13
TOTAL	**70**

Key: MD = Maryland; VA = Virginia.

6.4.2.2 Public Scoping Comments

The public scoping period was from February 15 to April 1, 2019. Comments were submitted via the project website's electronic comment form, in writing at the scoping meetings, and postal mail and email. Phone calls were received from nine people. Formal comments were not accepted by phone; however, these callers were advised on how to provide comments. Comments received during the scoping period were considered in preparing the Draft EIS. A summary of comments can be found in Appendix G (Public Involvement).

6.4.3 Community Presentations

ATR Sustainability Office representatives also offered presentations to community officials and groups upon request. These were outside of the official scoping period and for informational purposes. Three presentations were given at Solomons Civic Association on April 8, 2019, the Commissioners of St.

Mary's County on April 9, 2019, and Wicomico County Council on April 16, 2019. Audience questions focused on operations in general with the primary question related to the EIS effort about potential changes in noise levels.

6.5 Distribution and Notification of Availability of the Draft EIS

6.5.1 Distribution of the Draft EIS

The Draft EIS will be made available on the project website (www.PRCEIS.com) and at the information repositories listed in Table 6.4-1.

6.5.1.1 Federal Agencies

The U.S. Environmental Protection Agency (USEPA) Headquarters will receive an electronic copy of the Draft EIS. The regional office of the USEPA will also receive an electronic version of the Draft EIS.

6.5.2 Notification of the Draft EIS and Public Meetings

The USEPA's Draft EIS public review and comment period will begin with the publication of the Notice of Availability (NOA) of the Draft EIS for PRC and the publication of the Navy's Notice of Public Meetings in the Federal Register. The Federal Register notices will include the NOA of the Draft EIS and a Notice of Public Meetings with an overview of the Proposed Action and its purpose and need; public commenting information; where to access the Draft EIS; and the dates and times of the virtual public meetings. The purpose of the public meetings is to inform the public about the Proposed Action and environmental analysis and to solicit public comments on the environmental issues addressed and analyzed in the Draft EIS. Comments will be accepted by mail, through the project website at www.PRCEIS.com, and at the public meetings.

The Navy will make significant efforts to facilitate maximum public participation during the Draft EIS public review and comment period. A summary of these efforts follows.

6.5.2.1 Notification Letters

Notification letters will be distributed before the release of the Draft EIS to tribal contacts; federal, state, and local elected officials and government agencies; and persons expressing an interest in the Proposed Action and the environmental impact analysis.

6.5.2.2 Postcard Mailers

Postcards will be mailed to recipients on the project mailing list, including individuals; nongovernmental organizations; tribal, community, and business groups; fishing, aviation, and recreation groups; and private companies. The postcards will include the dates and times of the public meetings, as well as the website address, commenting information, and a brief summary of the Proposed Action.

6.5.2.3 Press Release

Press releases to announce the availability of the Draft EIS and public meetings will be distributed to local and regional media. Press releases will provide a description of the Proposed Action, project website, duration of the comment period and commenting methods, information repositories, and dates and times of the public meetings. The press releases will also provide information on the availability of the Navy to meet with the media in advance of the meetings.

6.5.2.4 Newspaper Advertisements

To announce the availability of the Draft EIS and public meetings, advertisements will be placed in the same area newspapers where the scoping meetings were advertised. The advertisements will include a description of the Proposed Action, the project website, the duration of the comment period, and information on how to provide comments.

6.5.3 Public Meetings

The Navy will hold virtual public meetings to inform the public about the Proposed Action and environmental analysis and to solicit public comments on the Draft EIS. Written comments can be submitted during the meetings.

6.6 Distribution and Notification of Availability of the Final EIS

6.6.1 Distribution of the Final EIS

The Final EIS will be made available on the project website (www.PRCEIS.com) for all stakeholders and at the information repositories listed in Table 6.4-1.

6.6.1.1 Federal Agencies

USEPA Headquarters and regional USEPA offices will receive the Final EIS.

6.6.2 Notification of the Final Environmental Impact Statement

The Final EIS public review and 30-day wait period will begin with the publication of the USEPA's NOA of the Final EIS for PRC in the Federal Register. The intent of public involvement efforts during the Final EIS phase of the NEPA process is to notify stakeholders and the public of the availability of the document, the 30-day wait period, and the next steps in the NEPA process. New substantive comments received during the wait period will be considered and addressed in the Record of Decision (ROD).

6.6.2.1 Notification Letters

Notification letters will be distributed before the release of the Final EIS to tribal contacts; federal, state, and local elected officials and government agencies; and persons expressing an interest in the Proposed Action and the environmental impact analysis.

6.6.2.2 Postcard Mailers

Postcards will be mailed to recipients on the project mailing list, including individuals; nongovernmental organizations; tribal, community, and business groups; fishing, aviation, and recreation groups; and private companies.

6.6.2.3 Press Release

A press release to announce the availability of the Final EIS will be distributed to local and regional media.

6.6.2.4 Newspaper Advertisements

To announce the availability of the Final EIS, advertisements will be placed in the same area newspapers that advertise the availability of the Draft EIS.

6.7 Notification of Availability the Record of Decision

The ROD phase of the NEPA process follows the Final EIS 30-day waiting period and includes selection of an alternative and signature of the ROD by the Office of the Assistant Secretary of the Navy (Energy, Installations, and Environment).

6.7.1 Notification of the Record of Decision

Following the 30-day waiting period, a ROD will be prepared. The ROD will state the decision, identify alternatives considered (including the Preferred Alternative), address substantive comments received on the Final EIS that were not previously addressed, discuss other considerations that influenced the final decision, and address mitigation, if needed. Following signing of the ROD, the Navy will publish a NOA of the ROD in the Federal Register. The intent of public involvement efforts during this phase of the NEPA process is to notify stakeholders and the public of the availability of the ROD and where it can be accessed and the Navy's decision to implement or not implement one of the alternatives.

6.7.1.1 Postcard Mailers

Postcards will be mailed to recipients on the project mailing list, including individuals; nongovernmental organizations; tribal, community, and business groups; fishing, aviation, and recreation groups; and private companies.

6.7.1.2 Press Release

A press release to announce the availability of the ROD will be distributed to local and regional media.

6.7.1.3 Newspaper Advertisements

To announce the availability of the ROD, advertisements will be placed in the same area newspapers that announced the availability of the Draft and Final EISs.

6.8 Distribution of the Record of Decision

The ROD will be made available on the project website (www.PRCEIS.com) and at the information repositories listed in Table 6.4-1.

6.8.1 Federal Agencies

USEPA Headquarters will receive the ROD. Regional offices of the USEPA will receive electronic versions of the ROD.

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Appendix A
PATUXENT RIVER COMPLEX ACTIVITY AND ASSET DESCRIPTIONS

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Abbreviations and Acronyms

Acronym	***Definition***
ALMDS	airborne laser mine detection system
AMNS	airborne mine neutralization system
ASW	anti-submarine warfare
ATMO	Atlantic Targets and Marine Operations
DICASS	Directional Command-Activated Sonobuoy
E^3	electromagnetic environmental effects
EA	electronic attack
COBRA	coastal battlefield reconnaissance and analysis
EIS	Environmental Impact Statement
EP	electronic protection
ES	electronic warfare support
EW	electronic warfare
IED	improvised explosive devices
IPOE	intelligence preparation of the operational environment
IR	infrared
ISR	Intelligence, Surveillance, and Reconnaissance
JDAM	Joint Direct Attack Munition
LOS	line of sight
MCM	mine countermeasure
MEM	military expended materials
MIW	mine warfare
MOP	magnetic orange pipe
N/A	not applicable
NAS	Naval Air Station
NAWCAD	Naval Air Warfare Center Aircraft Division
NTWL	Naval Test Wing Atlantic
OASIS	organic airborne and surface influence sweep
OPAREA	Operating Area
PRC	Patuxent River Complex
R-	restricted area
RCS	radar cross section
RDT&E	research, development, test and evaluation
RF	radio frequency
ROV	remotely operated vehicles
SAR	search and rescue
SEPTAR	Seaborne Powered Target
TUMS	towed unmanned submersible
UAS	unmanned aerial systems
UGS	unmanned ground systems
UMS	unmanned maritime systems
USNTPS	United States Naval Test Pilot School
USV	unmanned surface vehicles
UUV	unmanned underwater vehicles

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A.1 Patuxent River Complex Users

Primary users of the Patuxent River Complex (PRC) include Naval Test Wing Atlantic (NTWL) and other tenant squadrons home-based at Naval Air Station (NAS) Patuxent River. NTWL accounts for over 80 percent of the annual flight hours within the PRC. Transient aircraft, not stationed at NAS Patuxent River, also perform training and testing within the complex. These primary PRC users are responsible for generating the flight hours being analyzed in this Environmental Impact Statement (EIS). Each squadron is briefly described in Table A-1.

Table A-1: Primary Patuxent River Complex Users

Squadron Name		***Description***
Naval Test Wing Atlantic Squadrons		
Air Test and Evaluation Squadron	Two Zero (VX-20)	Supports RDT&E of fixed-wing battleforce support, strategic, and training aircraft. Current platforms include E-2C/D, C-12M, C-2A, C/KC-130J/T, E-6B, MQ-4C, P-8A, C-38, and T-6A.
	Two One (HX-21)	Supports RDT&E of rotary-wing and tilt-rotor aircraft and maintains NAS Patuxent River SAR assets. Current platforms include AH-1, UH-1, CH-53K, MH-53E, MH-60R/S, V-22, and Executive Transport Helicopters.
	Two Three (VX-23)	Supports RDT&E of fixed-wing tactical aircraft and is the largest flight test organization within Naval Air Systems Command. Current platforms include F/A-18A-F, EA-18G, and T-45A/C, as well as on-going contractor demonstration efforts for the F-35B/C and MQ-25A.
	Two Four (UX-24)	Supports RDT&E of UAS headquartered at Outlying Field Webster. Current platforms include RQ-12 Wasp, RQ-11 Raven, RQ-20 Puma, RQ-21 Blackjack, and MQ-8 Fire Scout. Aerostar UAS provide customers range clearance support and a platform to test payloads.
U.S. Naval Test Pilot School		Trains test pilots, flight officers, engineers, industry, and foreign partners in test and evaluation of aircraft and aircraft systems. Only U.S. test pilot school with a formal rotary-wing syllabus and only in the world offering an airborne systems curriculum. Navy's most diverse aircraft fleet (currently 46 aircraft of 14 different platforms) exposes students to a broad spectrum of performance, flying qualities, and weapon system capabilities.
Other NAS Patuxent River Squadrons		
Air Operations SAR		Provides SAR helicopter services in support of testing, training, and non-military events. Primary platform is the MH-60S.
Fleet Air Reconnaissance Squadron Four (VQ-4)		Maintains NAS Patuxent River Take Charge and Move Out Atlantic alert site. Provides launch and maintenance of E-6B aircraft in support of the squadron's strategic communications mission. Flight operations typically occur outside of the PRC.
Air Test and Evaluation Squadron One (VX-1)		Serves as the Navy's evaluator of airborne anti-submarine warfare and maritime anti-surface warfare weapon systems in an operational environment. Current platforms include P-8A, E-2D, and MH-60R/S and provides support for E-6B, KC-130J, MQ-8B, and MQ-4C.

Table A-1: Primary Patuxent River Complex Users, Continued

Squadron Name	*Description*
Scientific Development Squadron One (VXS-1)	Provides airborne research platforms for the Naval Research Laboratory, U.S. Navy, U.S. Government and its contracting agencies. Current platforms include two uniquely configured NP-3C, a RC-12, a UV-18, and numerous small UAS.
Maryland Army National Guard	Serves as the RQ-7 Shadow Tactical UAS Platoon operating out of Outlying Field Webster. Occasionally hosts similar National Guard units from other states such as Virginia and Pennsylvania.
Non-NAS Patuxent River Transients	
Transients	Transient aircraft, not stationed at NAS Patuxent River, that use range complex airspace for training or testing or the airfield as an airport. Primarily F-16 from Andrews Air Force Base, Maryland and Atlantic City International Airport, New Jersey; F-22 and T-38 from 1st Fighter Wing Langley, Virginia; and A-10 Reservists from Maryland and Pennsylvania. Also includes: federal and state agency small propeller research and/or surveying aircraft; commercial customer aircraft; and aircraft from Navy deployed Virginia Capes carriers.

Key: NAS = Naval Air Station; RDT&E = research, development, test and evaluation; SAR = search and rescue; UAS = unmanned aerial systems; U.S. = United States

A.2 Patuxent River Complex Activities

Testing and training activities analyzed in the 1998 PRC EIS included aircraft flight activities, ground-based activities, and surface vessel activities. These, as well as several activities assessed in various Environmental Assessments since 1998, are discussed within this appendix. They include surface and subsurface testing and training and a variety of mine countermeasure (MCM) systems, anti-submarine warfare (ASW) systems, and unmanned air, ground, and maritime systems activities. The definitions of laser classes are also provided.

A.2.1 Aircraft Flight Activities

Aircraft flight activities include test flights, training flights, and other flights.

A.2.1.1 Test Flights

Test flights are categorized into four main areas that encapsulate the unique Naval Air Warfare Center Aircraft Division (NAWCAD) research, development, test and evaluation (RDT&E) mission. They include air vehicle, carrier and shipboard suitability, mission systems, and electronic warfare (EW) tests. Each area is divided into subareas that further define specific test types. A small amount of test flights are also conducted by VX-1 in carrying out its operational test (versus developmental test) mission. Table A-2 provides a description of PRC test flight activities.

Table A-2: Test Flights

Activity Name	*Activity Description*
1.0 Air Vehicle	The air vehicle mission area includes four subcategories of tests that are conducted throughout the flight envelope to expose the airframe and aircrew to the full operational limits of altitude, speed, load factor, gross weight, environmental conditions, and operational situations experienced during Fleet operations. They include aeromechanics, air vehicle subsystems, structural tests, and crew systems. These tests may contain both flight and ground elements although the majority are conducted in flight. Tests are performed on manned and unmanned fixed- and rotary-wing aircraft and may involve the release of non-explosive munitions or other expendables.
1.1 Aeromechanics	Aeromechanics tests include aircraft aero propulsion, flying qualities/stability and control, performance, weapons compatibility, and weapons separation and jettison.
1.1.1 Aero Propulsion	Aero propulsion tests evaluate the in-flight operating characteristics and performance of the aircraft propulsion system. These tests include in-flight thrust measurement, engine stall and recovery characteristics, air starts, water and steam ingestion, gun and missile gas ingestion, engine control system response, engine/inlet compatibility, propeller and gearbox performance, engine monitor system functionality, and other similar types of tests. Aero propulsion tests may occasionally require the firing of guns, rockets, or missiles to conduct gun/missile gas ingestion tests.
1.1.2 Flying Qualities/Stability and Control	Flying qualities/stability control tests evaluate aircraft handling characteristics, stall characteristics, pilot-induced oscillations, spin and spin recovery controllability, and similar tests to determine compliance with detailed specifications. On rare occasions, tests may include intentional fuel dumping to achieve test weight objectives.
1.1.3 Performance	Performance tests evaluate aircraft performance characteristics such as take-off distance, climb rate, turn rate, sustained g-force, level acceleration, specific fuel consumption, and similar tests to determine compliance with detailed specifications. On rare occasions, tests may include intentional fuel dumping to achieve test weight objectives.
1.1.4 Weapons Compatibility	Weapons compatibility tests evaluate the compatibility between aircraft and expendable weapons. Ground tests evaluate form, fit, and function of the weapons stations and weapons management system. Flight tests include captive-carry of various weapons loadings to verify airframe compatibility, in-flight load and vibration measurement, and specification compliance.
1.1.5 Weapons Separation and Jettison	Weapons separation and jettison tests evaluate weapon separation characteristics and establish safe release envelopes for all expendable weapons. Tests involve the intentional release of weapons or any other expendables released during normal operations or jettisoned for emergencies. Tests include in-flight separation (drop) of non-explosive munitions, firing of gun ammunition with non-explosive rounds, or firing of missiles or rockets with live motors and non-explosive warheads. This category also includes weapons delivery accuracy testing.
1.2 Air Vehicle Subsystems	The air vehicle subsystems category involves the testing of aircraft cargo handling, environmental controls, fire detection/protection, hydraulics and fuel systems, landing systems, and reliability and maintainability.
1.2.1 Cargo Handling	Cargo handling tests evaluate the utility, functionality, durability, and specification compliance of cargo handling systems such as slings, hoists, and air drop stabilization and deceleration devices. These tests typically involve rotary-wing aircraft, but may occasionally be conducted for fixed-wing. Cargo handling tests may also include the intentional release of cargo (or mass equivalents) to test jettison and emergency release characteristics.
1.2.2 Environmental Controls	Environmental controls tests evaluate the functionality, control, operational suitability, and specification compliance of environmental control systems that are designed to cool the cockpit, passenger/cargo area, avionics and equipment bays, and other temperature sensitive areas of an aircraft.
1.2.3 Fire Detection / Protection	Fire detection/protection tests evaluate the functionality, durability, and specification compliance of fire protection, detection, and suppression systems of an aircraft. These tests may include the intentional release of fire suppression chemicals that have the potential to mix with air and water.

Table A-2: Test Flights, Continued

Activity Name	***Activity Description***
1.2.4 Hydraulics and Fuel Systems	Hydraulics and fuel systems tests evaluate the functionality, durability, and specification compliance of hydraulic pumps, lines, control valves, connectors, fuel management systems, internal and external fuel tanks, refueling devices, and related equipment. These tests include aerial refueling and may also include the intentional release of fuel to evaluate emergency fuel-dumping capabilities.
1.2.5 Landing Systems	Landing systems tests evaluate the functionality, durability, and specification compliance of landing gear systems including controls, tires, brakes, struts, wheels, anti-skid under wet and dry runway conditions, and other associated tests.
1.2.6 Reliability and Maintainability	Reliability and maintainability tests evaluate the reliability and maintainability of an aircraft and its related support systems. These tests may involve the intentional release of non-explosive munitions or other expendables onto a padded surface.
1.3 Structural Tests	The structural tests category involves the testing of dynamic and static airframe loads, flutter, launch and recover loads, and rotor dynamic loads.
1.3.1 Dynamic and Static Airframe Loads	Dynamic and static airframe load tests are conducted to measure static and dynamic loads under a broad range of flight conditions and to determine specification compliance.
1.3.2 Flutter	Flutter tests determine which airspeed and flight conditions may lead to potentially undesirable flutter conditions on aircraft surfaces. These tests primarily involve fixed-wing aircraft, but may occasionally be conducted for rotary-wing.
1.3.3 Launch and Recover Loads	Launch and recover load tests measure flight loads at various parts of the aircraft during catapult launch and recovery and shipboard operations. These tests primarily involve fixed-wing aircraft and may be conducted at shore-based facilities or on various ship platforms.
1.3.4 Rotor Dynamic Loads	Rotor dynamic load tests are conducted to measure loads of rotor system dynamic components under a broad range of flight conditions and to determine specification compliance.
1.4 Crew Systems	The crew systems category involves the testing of aircraft emergency egress, life support and personnel protection, and night combat equipment.
1.4.1 Emergency Egress	Emergency egress tests evaluate the operational characteristics and levels of protection for aircraft emergency egress and escape systems. These ground tests are accomplished in special facilities such as the Vertical and Horizontal Accelerators at the Atlantic Test Ranges.
1.4.2 Life Support and Personnel Protection	Life support and personnel protection tests evaluate the suitability and functional utility of aircrew life support systems and personnel protection equipment and how these items interface with the diverse technologies found in modern aircraft. Preliminary tests are performed in laboratory environments, followed by flight testing.
1.4.3 Night Combat Equipment	Night combat equipment tests evaluate the suitability of night vision systems and their compatibility with various cockpit configurations. Ground tests are accomplished in the Night Combat Test Laboratory. Flight tests are conducted during late night or near sunrise hours to emulate realistic test environments.
2.0 Carrier and Shipboard Suitability	The carrier and shipboard suitability mission area includes three subcategories of tests that are conducted in a shipboard environment or special ground-based facilities designed to simulate a shipboard environment (e.g., TC-7 steam catapult, MK-7 arresting gear, and short takeoff vertical landing facility). They include fixed-wing tests, rotary-wing tests, and ships air traffic control and landing systems certification tests. These tests are performed on manned and unmanned conventional and vertical takeoff and landing/short takeoff vertical landing aircraft and aircraft systems for all classes of aircraft carriers, amphibious ships, and from expeditionary airfields. Tests focus on the major aircraft design considerations driven by the requirement to operate on a ship and the unique adverse operating environments associated with a ship such as ship motion, air wake, confined operating areas, corrosive hazards, acoustic and electromagnetic hazards, ground crew safety, and other naval aviation challenges. Land based catapults and arrested landings are usually combined into a single test block. Carrier and shipboard suitability tests do not involve the release of non-explosive munitions or other expendables.
2.1 Fixed-Wing	Fixed-wing tests conducted at NAS Patuxent River include catapult and arrested landing structural demonstrations and minimum approach speed tests. Shipboard catapult launch, arrested landing, and ground handling tests are typically conducted offshore.

Table A-2: Test Flights, Continued

Activity Name	*Activity Description*
2.1.1 Catapult and Arrested Landing Structural Demonstrations	Catapult and arrested landing structural demonstrations include a series of structural demonstrations conducted at a shore-based facility prior to flying a new or modified aircraft off a carrier. These tests are designed to expose the aircraft and all of its subsystems to the extreme g-loads and impact shock loads associated with Naval aviation. High sink rate landings, off-center arrestments, in-flight engagement of the arresting wire, maximum catapult acceleration, max gross weight catapult and arrested landings, and tail hook dynamic load measurements are typical of this type of test. Steam ingestion catapult tests are also conducted to demonstrate the ability of the engine to operate stall free while ingesting steam leaked by the catapult piston.
2.1.2 Minimum Approach Speeds and Associated Flying Qualities	Minimum approach speeds and associated flying qualities tests involve shore-based testing to define the minimum acceptable approach airspeed and the associated flying qualities.
3.1.3 Shipboard Catapult Launch Tests	Shipboard catapult launch tests involve carrier-based testing to determine aircraft performance under various catapult speeds, crosswind and wind-over-deck conditions, low energy launches, and trim requirements for symmetric and asymmetric store configurations. Minimum catapult end airspeed tests define the slowest safe speed for catapult flyaway.
3.1.4 Shipboard Arrested Landing Tests	Shipboard arrested landing tests involve carrier-based testing to determine aircraft crosswind limits, bolter and wave-off performance, and handling qualities at high wind-over-deck conditions.
3.1.5 Shipboard Ground Handling Tests	Shipboard ground handling tests involve carrier deck-based testing to evaluate aircraft compatibility with shipboard facilities and support equipment such as heavy weather tie-down, canopy opening under high wind conditions, dynamic tip back following arrested landing, and hangar bay spotting and towing.
2.2 Rotary-Wing	Rotary-wing tests conducted at NAS Patuxent River include structural and functional integrity tests and aircraft handling and performance characteristics. Shipboard interface and ground tests are typically conducted offshore.
2.2.1 Structural and Functional Integrity Tests	Structural and functional integrity tests define the structural and functional integrity of an aircraft and its subsystems. Tests may involve water, sand, or ice ingestion; high sink rate landing; high wind conditions; cargo hoist handling; high gross weight take offs; and similar tests that stress an aircraft to its operational limits.
2.2.2 Aircraft Handling and Performance Characteristics	Aircraft handling and performance characteristics tests evaluate aircraft handling and performance during takeoff, approach, and recovery operations. These tests are sometimes referred to as dynamic interface testing.
3.2.3 Shipboard Interface Tests	Shipboard interface tests are conducted on many different types and classes of Navy and Coast Guard ships. These tests establish wind-over-deck limits under normal and emergency conditions, evaluate deck lighting and marking under day and night conditions, and determine compatibility with visual landing aids and mechanical aids such as the Recovery Assist, Securing, and Traversing system.
3.2.4 Shipboard Ground Tests	Shipboard ground tests evaluate aircraft deck handling, servicing, storage, and support operations. Test results are used to define operating envelopes, limits, and interoperability recommendations.
2.3 Ships Air Traffic Control and Landing Systems Certification	Ships air traffic control and landing systems certification includes the testing of Precision Approach Landing Systems for nuclear aircraft carrier landings and of precision approach radar for general purpose amphibious assault ship landings or helicopter dock amphibious assault ship landings.
2.3.1 Precision Approach Landing Systems Tests	Precision approach landing systems tests are conducted on fixed-wing aircraft both ashore and in carrier-based environments offshore. These tests evaluate and certify the electronic, electro-optical, satellite, and visual air traffic control and landing systems for carrier-based aviation. Primary landing systems include the AN/SPN-46 Automatic Carrier Landing System and the AN/SPN-41 Instrument Carrier Landing System.

Table A-2: Test Flights, Continued

Activity Name	*Activity Description*
2.3.2 Precision Approach Radar Systems Tests	Precision approach radar systems tests are conducted on rotary-wing aircraft both ashore and onboard Navy ships that are capable of supporting rotary-wing operations. These tests evaluate and certify the electronic, electro-optical, satellite, and visual air traffic control and landing systems. Primary systems include the AN/SPN-35 Precision Approach Radar and the AN/SPN-41 Instrument Carrier Landing System.
3.0 Mission Systems	Mission systems tests evaluate the performance and operability of subsystems that are integrated into the cockpit displays and fire control systems of modern military aircraft (and ships). These subsystems are commonly referred to as black boxes, avionics, or aircraft electronics. Both the operational functionality of the system (or subsystem) and interoperability with the aircraft and its systems are verified. Tests include communication (including laser), navigation, information warfare systems, central computer/mission computer systems, armament control systems, sensor integration, sensors, electromagnetic environmental effects (E^3), laser rangefinders and designators, and ship-based and shore-based systems. Mission systems tests may include both flight and ground elements and do not typically but may involve the release of non-explosive munitions or other expendables.
3.1 Communication	Communication tests evaluate the clear/secure internal and external voice communications and components that provide the transmission and receipt of digital data required by information warfare systems. System components include radios, data links, intercoms, anti-jam/low probability of intercept appliqués, antennas, data modems, and communications security equipment. This category also includes antennae pattern testing.
3.2 Navigation	Navigation tests evaluate the navigation systems and components that enable safe aircraft transit and provide position and course data to mission systems. This category also includes testing of tactical communications.
3.3 Information Warfare Systems	Information warfare systems tests evaluate the systems and devices for tactical information management, mission planning, data transfer/retrieval and recording, tactical decision-making, intelligence analysis, mission data recording systems, and Identification Friend or Foe systems.
3.4 Central Computer / Mission Computer Systems	Central computer/mission computer systems tests develop, document, integrate, and support the airborne central computer/mission computer systems and their respective operational flight programs.
3.5 Armament Control System	Armament control system tests develop, document, integrate, and support the airborne armament control systems and their respective operational flight programs.
3.6 Sensor Integration	Sensor integration tests develop, document, integrate, and support the integration of avionics and weapons into the aircraft weapons system.
3.7 Sensors	Sensors tests design, develop, and integrate the broad range of sensors used in aircraft and other weapons systems. Types of sensors include acoustic, radio frequency (RF), electro-optical, chemical, and other sensors under development.
3.8 Electromagnetic Environmental Effects (E^3)	E^3 tests are conducted using specialized ground-based equipment/facilities to determine the electromagnetic vulnerability of electronic systems embedded in aircraft and other weapons systems. These tests are performed to identify and correct safety hazards, equipment failures, operability limitations, and specification compliance related to E^3.
3.9 Ship- and Shore-Based Systems	Ship- and shore-based systems tests analyze a wide spectrum of ship- and shore-based electronics such as air traffic controls, surface-based aircraft identification systems, shipboard exterior communications, special communication systems for special and joint operations, shipboard data links, and emerging information technology systems.

Table A-2: Test Flights, Continued

Activity Name	*Activity Description*
4.0 Electronic Warfare (EW)	The EW mission area involves the test and evaluation of U.S. military electronic combat systems against a wide variety of threat simulations, surrogates, and actual systems that represent real-world threat scenarios. Types of tests include electronic attack (EA), tactics development and foreign materials exploitation that would support electronic protection (EP), electronic warfare support (ES) measures, and radar cross section (RCS) and infrared (IR) signature measurement. Systems under test may involve software and/or hardware that range from experimental, pre-production equipment, to fully developed systems that are installed in Fleet aircraft. EW tests may include both flight and ground elements and may involve the release of non-explosive munitions or other expendables related to electronic countermeasures.
4.1 Electronic Attack (EA)	EA involves the use of electromagnetic energy, directed energy, or anti-radiation weapons to attack personnel, facilities, or equipment with the intent of degrading, neutralizing, or destroying enemy combat capability. Examples include anti-radiation missiles, flares, active decoys, and directed energy. EA testing is the verification, or measurement of performance of EA software, hardware, or systems by providing simulated or actual threat signatures to stimulate EA systems and quantifying the received response of a jamming system, anti-radiation missile, or other attack system. This area also includes cyberwarfare testing.
4.1.1 Jammer Testing	Jammer testing includes frequency accuracy, effective radiated power, pointing accuracy, jammer response time and jamming-to-signal ratio, and testing of techniques, such as Range Gate Pull-Off, Velocity Gate Pull-Off, and others. These tests may involve the transmission of high power RF energy.
4.1.2 Expendables (Chaff & Flares)	Expendables are used by aircraft to create a false radar target (chaff) or false IR target (flares). These tests may involve the transmission of high power RF energy and/or the release of chaff, IR decoy flares, RF decoys, or similar non-explosive expendables.
4.1.3 Anti-Radiation and Directed-Energy Weapons	Anti-radiation missile seeker/avionics tests evaluate the seekers and avionics that control and guide anti-radiation missiles. Directed-energy weapons testing involves a high-energy laser or high-power microwave system. High-energy laser weapons are intended to damage or destroy enemy systems. High-power microwave systems are designed to produce effects on electronic systems and can also provide non-lethal anti-personnel capabilities.
4.2 Electronic Protect (EP)	EP involves actions taken to protect personnel, facilities, and equipment from any effects of friendly or enemy use of the electromagnetic spectrum that degrade, neutralize, or destroy friendly combat capability. These tests are conducted in a simulated threat environment to evaluate the effectiveness of EP software, hardware, and integrated systems.
4.3 Electronic Warfare Support (ES) Measures	ES measures involve actions taken to search for, intercept, identify, and locate sources of intentional and unintentional radiated electromagnetic energy for the purpose of immediate threat recognition, targeting, planning, conduct of future operations, and other tactical actions such as threat avoidance and homing. ES testing is the verification of software, hardware, and integrated systems used to passively detect, record, identify, and catalog enemy threat signatures. This is accomplished by providing realistic threat scenarios in order to stimulate sensors and systems under test. These tests involve transmissions of high power RF in all frequency ranges of interest (High Frequency to Ka band).
4.3.1 Electronic Warfare Tactics Developments	EW tactics developments tests develop defensive and offensive tactics against enemy weapon systems. These tests require an extensive array of realistic threat replication or simulation devices to ensure realistic results and may involve the transmission of high power RF energy and/or the release of chaff, IR decoy flares, RF decoys, or similar non-explosive expendables.
4.3.2 Foreign Materials Exploitation	Foreign materials exploitation tests evaluate foreign electronic weapons systems with the intent of identifying vulnerabilities and developing techniques to exploit them. These tests may involve the transmission of high power RF energy, and/or the release of chaff, IR decoy flares, RF decoys, or similar non-explosive expendables.
4.3.3 Intelligence Surveillance, and Reconnaissance (ISR)	ISR involves actions taken to collect/intercept, identify, locate, and analyze electromagnetic transmissions to inform the EW community of current and future threats for purposes of targeting, planning, conduct of future operations, and other tactical actions such as threat avoidance and homing. Information gathered through ISR is also used for EW reprogramming efforts.

Table A-2: Test Flights, Continued

Activity Name	*Activity Description*
4.3.4 Radar Warning Receivers	Radar warning receiver tests evaluate the effectiveness of warning receivers that are designed to detect threats such as incoming missiles, targeting radar, jamming, and other offensive threats. These tests may involve the transmission of high power RF energy.
4.4 Radar Cross Section and Infrared Signature Measurement	RCS and IR measurement tests involve flight and static ground tests to measure aircraft RCS and IR signatures. These tests are designed to document the vulnerability of an aircraft to detection and targeting by enemy weapon systems. Test articles may include full-scale aircraft, aircraft models, or various subsystems that are installed on aircraft. RCS measurement is a typical test associated with EP. The RCS measurement facility conducts ground-to-air RCS, jamming-to-signal ratio, and chaff measurements relative to aircraft, towed targets, and decoys. The Patuxent River IR Signature Measurement facility conducts surface-to-air and surface-to-surface IR signature measurement of aircraft, missiles, engines, and boats. Both RCS and IR signature tests may involve the transmission of high power RF energy.
5.0 Operational Tests	VX-1 operational aircraft test and evaluate airborne anti-submarine warfare and maritime anti-surface warfare weapon systems, airborne strategic weapons systems, as well as support systems, equipment, and materials.

Key: E^3 = electromagnetic environmental effects; EA = electronic attack; EP = electronic protection; ES = electronic warfare support; EW = electronic warfare; NAS = Naval Air Station; IR = infrared; ISR = intelligence, surveillance, and reconnaissance; RCS = radar cross section

A.2.1.2 Training Flights

Training flights primarily support tenant squadron training (including United States Navy Test Pilot School [USNTPS] test pilot training) as well as unit level training by transient aircraft. These activities are described in Table A-3. Intermediate and advance level training events conducted offshore are also supported by NAWCAD; however, only a small amount of these activities actually occur within the PRC. This support may include target presentation, instrumentations, range surveillance and clearance, telemetry relay, BQM aerial target launch, transient flight authorization, refueling services, and aircraft parking.

Table A-3: Training Flights

Activity Name	*Activity Description*
Tenant Training	
Aircrew Proficiency Flights*	Aircrew proficiency flights are performed by pilots and aircrew to: familiarize aircrew with new aircraft; complete Naval Aviation Training and Operating Procedures Standardization check flights; demonstrate ability to navigate; conduct instrumented approaches; fly with night vision and other devices; refresh test techniques; practice air combat maneuvering; train enlisted aircrew; maintain search and rescue helicopter skills; rehearse low-level flying; practice helicopter landings in sloped areas or confined landing zones; perform formation flying and tanker practice; and maintain aircrew proficiency in other critical areas.
Field Carrier Landing Practice*	Field Carrier Landing Practice flights are performed on a runway equipped to simulate an aircraft carrier flight deck to familiarize pilots with carrier landings. Flights must be conducted under both daytime and nighttime conditions and may support testing or training events. These flights are performed in close proximity to the airfield and below 3,000 feet.
Tenant Training	
USNTPS Flights	USNTPS flights train experienced U.S. and foreign military pilots, flight test engineers, and flight officers in the processes and techniques of aircraft and systems test and evaluation. The school graduates two classes annually (11 months each) with a syllabus divided into three parts including fixed-wing, rotary-wing, and airborne systems. The syllabus requires students to become familiar with flying a wide variety of aircraft, with a fleet of approximately 46 aircraft of 14 different platform types within the squadron. The school also offers condensed two-week short courses for the developmental flight test community. Flights include: all those for the technical training syllabus; practice of flight test techniques; demonstration of flight characteristics; student familiarization and qualification; USNTPS short courses; developmental test training; and all other USNTPS training flights.

Table A-3: Training Flights, Continued

Activity Name	Activity Description
Transient Training	
Transient Training flights	Transient aircrew train in unit level skills such as aircrew proficiency, field carrier landing practice, EW, weapons integration and separation (e.g., bomb drops or missile/gun/rocket firings), simulated air-to-air combat, and other tactical training tasks. May involve the release of non-explosive munitions or other military expended materials.

Key: * = May also be performed by transients; USNTPS = United States Naval Test Pilot School

A.2.1.3 Other Flights

Other flights are described in Table A-4 and include those conducted by tenant squadrons that have a support or operational function. A large portion of cross-country, mission of state, and strategic communications flights are flown outside of the PRC. However, the portions of flight hours within the PRC are included to capture all tenant squadron activity and ensure comprehensive analysis.

Table A-4: Other Flights

Activity Name	Activity Description
Support Flights	NTWL aircraft provide support needed to successfully accomplish a testing or training event. Flights include in-flight refueling, safety/photo chase, logistics, cooperative target and threat simulation, range surveillance, or other unique services.
Cross-Country Flights	Flown to transport equipment, material, and/or personnel to and from NAS Patuxent River in support of testing, training, or basekeeping operations. Enable pilots to achieve flight hours required to maintain qualifications. Examples include aircraft repositioning; detachment support flights; logistics flights; cross-country training flights; personnel shuttle flights; and aircraft ferry flights.
Functional Check Flights	Conducted to determine whether the airframe, propulsion, accessories, and equipment are functioning in accordance with predetermined standards when subjected to the intended operating environment. Performed after certain phase inspections; engine system installation or reinstallation; flight control surface component replacement; altitude system component adjustment/replacement; and any time the aircraft has not flown for 30 days or more regardless of the reason.
Mission of State Flights	Unmanned aerial systems (e.g., MQ-4C Triton) perform post hurricane surveillance involving high-altitude and meteorological surveys in support of post-disaster relief efforts.
Search and Rescue Flights	Search and rescue helicopters (MH-60) locate and recover military or civilian personnel injured or lost during a testing, training, or non-military event. May involve the release of marine markers as surface reference points to locate/mark survivors.
Strategic Communications Flights	VQ-4 aircraft (E-6B) conduct operational patrols to provide airborne command posts and strategic communications relays.
Scientific Development Flights	VXS-1 aircraft execute airborne science and technology projects such as bathymetry, electronic countermeasures, gravity mapping, and radar development.

A.2.2 Ground-Based Activities

Ground-based activities include those related to aircraft flights or conducted in ground test facilities and laboratories. Ground-based activities related to aircraft flights are described in Chapter 2 (Proposed Action and Alternatives). Ground test facility and laboratory tests include non-flight research and development, aircraft and weapons systems component testing, and modeling and simulation activities. Primary research and development and product areas include: materials, fuels, and lubricants; aircraft weapons certification; electromagnetic effects; EW systems; static engine runs; human-aircraft interface (i.e., human factors); communications systems; and computer-based simulations (U.S. Department of the Navy, 1998). Although most tests occur indoors, some ground test facilities and laboratories have outdoor test environments. These include the representative types (organized by test function) described in Table A-5. Although non-flight or laboratory-based testing can serve as a major supplement to a flight test program, it cannot replace actual flight testing (U.S. Department of the Navy, 1998).

Table A-5: Ground Test Facility and Laboratory Testing

Ground Test Facility/ Laboratory Name	*Description*
Propulsion Facilities	
Open-Air Engine Test Cell Facility*	Primarily developed for testing jet engine test cell instrumentation and control systems. Contains nine test cells including one T-26, one Turboprop Test Instrument, two shaft engine test instrumentation, two T-36 jet engine test instrumentation, and three T-24 test cells. Tests evaluate the functionality and suitability of portable engine test cells, sound suppression devices, or other related engine maintenance hardware, and determine if engines meet the standards for issue and installation into aircraft. Jet engine maintenance runs are limited to mission-critical situations when the primary enclosed maintenance test cell facility (T-10) at NAS Patuxent River is unavailable for extended periods of time.
Aircraft Subsystem and Weapons Certification Facilities	
Armament Test Area*	An operational range area where weapons systems ground testing has been conducted since 1943. Consists of 30 acres of restricted land and 75 yards of prohibited waters extending from the NAS Patuxent River shoreline. Facilities include a gun-firing tunnel, rocket test stand, two munition drop test pits, helicopter missile launch pad, and an aerial target launch area. Test activities include aircraft gun-firing; munition drop tests; aerial target launching; weapons compatibility and certification testing (bombs, missiles, rockets, chaff, flare, and cartridge and propellant actuated devices); and occasional use of a cockpit escape system test rig. Gun ammunitions are fired into the gun-firing tunnel from a test stand or fastened aircraft. Aerial targets, rockets, and missiles are launched into the Chesapeake Bay Water Range. An example weapons compatibility test may evaluate the release or launch mechanisms of new bomb racks or rocket launchers to be integrated with aircraft.
Aircraft Systems Integration Facilities	
Air Combat Environmental Test and Evaluation Facility**	A complex with a variety of facilities and laboratories that, when networked, can simulate virtually all aspects of aircraft operations and actual combat conditions through use of state-of-the-art simulation and stimulation techniques. Facilities and laboratories include: Manned Flight Simulator; Shielded Hanger; Warfare Simulation Laboratory; Threat Air Defense Laboratory; EW Integration Systems Test Laboratory; Communication, Navigation, and Identification Laboratory; Modern Communications Lab; Radar Lab; Advanced Systems Integration Laboratory; Aircraft Anechoic Test Facility; Electro Optical/Infrared Lab; Unmanned Air Systems Integration Lab; Warfare Simulation Lab; and Electromagnetic Effects Environmental Facilities.
Communications and Navigation Systems Facilities	
Communications Test and Evaluation Facility**	Performs fixed- and rotary-wing aircraft evaluation of high frequency, electronic counter-countermeasures communications and antenna systems. Also supports joint interoperability tests with U.S. Air Force and Army electronic counter-countermeasures communication systems. Has an unobstructed, over-the-water test environment that is only limited by line-of-sight propagation conditions.
Radar Facilities	
Facilities for Antenna and Radar Cross Section Measurement**	Consists of two anechoic chambers, three outdoor test ranges, and a rain erosion/impact measurement laboratory. Provides research and development engineering support for antenna technology from the concept phase through system integration. Exploratory and advanced research programs and antenna design, fabrication, and measurements are also conducted.

Table A-5: Ground Test Facility and Laboratory Testing, Continued

Ground Test Facility/ Laboratory Name	*Description*
Electromagnetic Radiation Facilities	
Electromagnetic Pulse Test Facilities**	Simulates the effects of nuclear electromagnetic pulse to conduct active and passive tests on avionics equipment and weapon systems electronics. Tests determine the survivability and electromagnetic pulse vulnerability of aircraft systems and subsystems.
Naval Electromagnetic Radiation Facility**	Simulates worldwide and Fleet operational electromagnetic environments to evaluate their effects on aircraft vehicle systems, critical functions, and mission systems. Supports military and commercial aircraft, ground support equipment, and air-launched munition systems testing.
Electromagnetic Interference Laboratory**	An outdoor, mobile, radiated susceptibility site that identifies potential electromagnetic environmental effect problems at the platform level. Provides Fleet support in areas of electromagnetic compatibility engineering analysis, component troubleshooting and correction, electromagnetic interference consultation, and correlation of specifications and limits to changing electromagnetic environmental effect environments.
Electromagnetic Effects Environmental Facilities**	Part of the Air Combat Environmental Test and Evaluation Facility. Performs electromagnetic compatibility and P-static testing on aircraft, weapons systems, and components. Uses high voltage and high amperage generators to test the effects of and protection from lightning strikes. Capabilities include: Military Standard 461/464 testing; electromagnetic interference detection; mobile electromagnetic compatibility; electromagnetic vulnerability; electromagnetic pulse; hazards of electromagnetic radiation to ordnance; directed energy weapons testing; and safety-of-flight testing.

Key: * = Conducts Open-Air Testing; ** = Emits Electromagnetic Radiation

A.2.3 Surface and Subsurface Activities

Surface and subsurface activities include support activities performed by NAWCAD Atlantic Targets and Marine Operations (ATMO) range support boats, as well as surface and subsurface testing and training conducted by non-NAWCAD combatant and patrol craft and unmanned maritime systems (UMS). Range support boat activities are described in Chapter 2 (Proposed Action and Alternatives). Table A-6 further describes surface and subsurface testing and training.

Table A-6: Surface and Subsurface Testing and Training

Activity Name	*Activity Description*
Testing Activities	
Surface Vessel Tests	Evaluate the performance and handling characteristics of prototype boats (e.g., hovercraft), combatant craft, amphibious vehicles, or scale models with advanced hull designs. May also include high-speed vessel test demonstrations.
Subsurface Vehicle Tests	Evaluate the performance and handling characteristics of unmanned underwater vehicles, their ability to operate autonomously, or their integration and interoperability with other manned or unmanned systems. Tests do not normally focus on the subsurface vehicle itself, but rather on various sonar and sensor packages integrated into the platform for a specific function.
Watercraft Detection and Disabling Tests	Assess methods for detecting and disabling small watercraft that could be used by hostile forces. Tests evaluate maritime technologies and products (e.g., electronics, radio and communication devices, personal safety equipment, and surveillance tools), signature measurements, watercraft identification and disabling devices, warning shot effectiveness, and weapon systems firing. Tests may involve the release of non-explosive munitions (e.g., gun ammunitions and missiles) or other military expended materials.
Training Activities	
Small Boat Training	Provides opportunities for crewmembers to test combat weapon systems, maintain proficiency, and train in realistic environments. Small boat crews train in unit level skills such as surface navigation, evasive tactics, or surface-to-surface gunfire; and therefore, may involve the release of gun ammunitions.

A.2.4 Mine Countermeasure Systems Testing

MCM systems testing demonstrates the capability and effectiveness of integrating and deploying mine detection and neutralization systems into and from manned and unmanned air, surface, and subsurface platforms. MCM systems fall into two broad categories including mine detection and mine neutralization.

A.2.4.1 Mine Detection Systems

Mine detection systems are used to locate, classify, and map mine shape targets on the surface, in the water column, or on the seafloor. Systems may be airborne, towed, or hull-mounted devices, or an unmanned underwater vehicles (UUV) or remotely operated vehicles (ROV) with acoustic, optical, laser and/or radar sensors. Representative mine detection systems include the airborne laser mine detection system (ALMDS), coastal battlefield reconnaissance and analysis (COBRA) system, and towed unmanned submersible (TUMS) system. Dipping sonar systems and sonobuoys may also be used for mine detection.

Airborne Laser Mine Detection System. The AN/AES-1 ALMDS is a mine hunting system designed to detect, classify, and localize floating and near-surface, moored sea mines using a low energy laser (i.e., streak tube imaging light detection and ranging). The system is integrated with a helicopter, such as the MH-60, to provide rapid, wide-area reconnaissance and assessment of mine threats. ALMDS also provides mine geo-location to follow-on neutralization systems. Figure A-1 illustrates an ALMDS testing scenario.

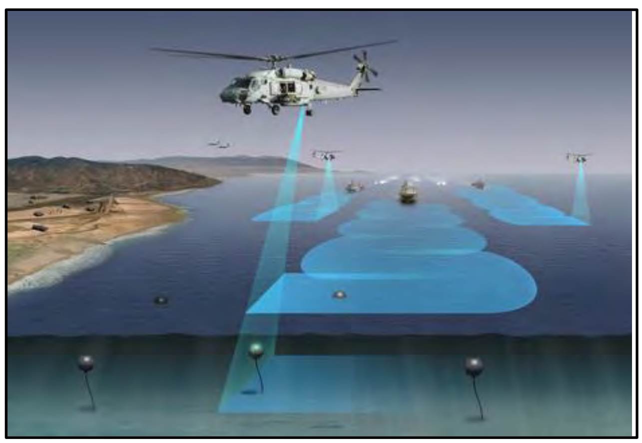


Figure A-1: Airborne Laser Mine Detection System

Coastal Battlefield Reconnaissance and Analysis System. The AN/DVS-1 COBRA system conducts unmanned aerial tactical reconnaissance in the littoral environment using optical sensors to detect and localize mines and obstacles in the surf zone and beach zone. The system is typically carried on the MQ-8 Fire Scout. Figure A-2 illustrates a COBRA testing scenario.

Figure A-2: Coastal Battlefield Reconnaissance and Analysis System

Towed Unmanned Submersible System. The TUMS system is a unique unmanned deep-sea submersible vehicle capable of operating in depths beyond the reach of conventional diving systems or ship sensors. The system performs a wide range of search, identification, classification, and recovery operations at full ocean depths using optic, acoustic, and magnetic sensors as well as a manipulator arm.

A.2.4.2 Mine Neutralization Systems

Mine neutralization systems are used to disrupt or disable mine targets. Systems include towed devices or UUV that may: deploy neutralizing vehicles with armor-piercing munitions to neutralize targets; generate acoustic or magnetic ship signatures to trigger or disable targets; or employ mechanical systems (e.g., cable cutters) to detach moored mine targets so they float to the surface for dispatch. Representative mine neutralization systems include the airborne mine neutralization system (AMNS) and in-water electromagnetic systems including the organic airborne and surface influence sweep (OASIS) system and magnetic orange pipe (MOP).

Airborne Mine Neutralization System. The AN/ASQ-235 AMNS deploys up to four UUV from a launch and handling system supported from the MH-60S helicopter. UUV are equipped with sonar, video camera, light, and non-explosive neutralizers to locate and neutralize moored and bottom mines. The fiber optic cables connecting the UUV to the handling system are typically expended during testing. Figure A-3 illustrates an AMNS testing scenario.

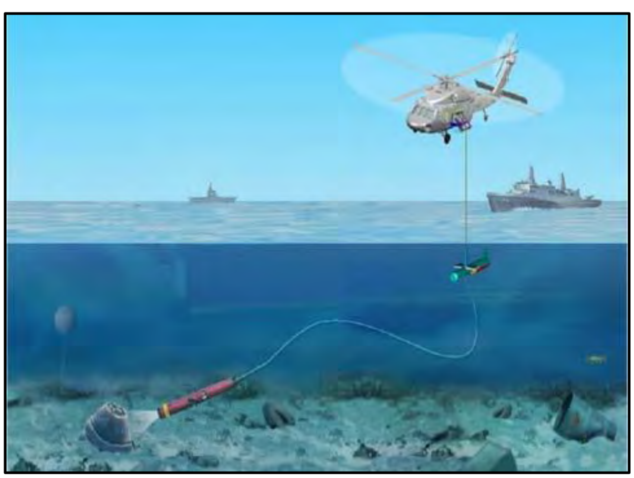


Figure A-3: Airborne Mine Neutralization System

Organic Airborne and Surface Influence Sweep. The OASIS system (Figure A-4) is a high-speed, magnetic and acoustic influence sweep system that is towed by a surface vessel or UUV to neutralize sea mine threats in areas where mine hunting is not possible due to mine burial or high bottom clutter. Sweeps are conducted over test areas containing tethered and/or totally buried mine-shapes to demonstrate the system's effectiveness to influence or trigger the magnetic mine targets.

OASIS emits an electromagnetic field equivalent to 2,300 microteslas (a measure of magnetic intensity). Forward and aft electrodes generate the magnetic signature, which is engaged after deployment and disengaged prior to recovery and captive carriage. A water-driven acoustic generator creates the acoustic energy that mimics a ship's signature. Historically, all MCM systems tests in the PRC Study Area have been non-magnetized events.

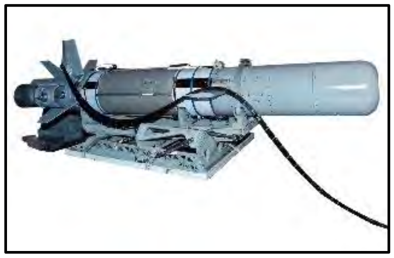


Figure A-4: Organic Airborne and Surface Influence System

Magnetic Orange Pipe. The MOP (Figure A-5) is a 30-foot, 1,000 pound, 10 3/4-inch diameter orange pipe filled with polystyrene foam. The pipe is given a magnetic charge before each sweep mission and if desired can be coupled with a mechanical acoustic generating device (i.e., MK-2(g) Rattle Bars) capable of actuating acoustic mines.

Figure A-5: Magnetic Orange Pipe

A.2.5 Anti-Submarine Warfare Systems Testing and Training

ASW warfare testing within the PRC evaluates the integration, deployment, and operation of helicopter dipping sonar systems. Tests assess sonar system software and hardware upgrades as well as weapons that operate in concert with the system (e.g., sonobuoys). Aircrew also conduct proficiency training on the sonar operation and practice helicopter hovering while the sonar transducer is deployed, maintained at depth, and recovered. A photograph of helicopter dipping sonar is shown in Figure A-6.

Figure A-6: Helicopter Dipping Sonar

Dipping sonar and sonobuoys may be active (sound emitting) or passive (listening only) to allow for short- and long-range target detection during an event. All sounds, including sonar, are categorized by frequency. When active, sonars emit a ping and then rapidly scan or listen to the sound waves in the surrounding area. This provides both distance to the targets as well as directional information. Sonar pings occur at intervals, referred to as duty cycles; the signals themselves are very short. For example, a sonar emitting a 1 second ping every 10 seconds has a 10 percent duty cycle. Consequently, active sonar is rarely used continuously throughout a testing or training event.

Representative types of ASW systems include the AN/AQS-22 dipping sonar and Directional Command-Activated Sonobuoy (DICASS). When active, both systems operate in the mid-frequency range of 1–10 kilohertz.

The AN/AQS-22 sonar is the Navy's latest mid-frequency active dipping sonar and one of the primary systems needed to perform the ASW mission. The AN/AQS-22 sonar has improved detection capabilities over previous dipping sonar systems and more readily counters the current and emerging ASW threat posed by submarines in the littoral (shallow water) environment.

The DICASS operates under direct command from a helicopter or ASW fixed-wing aircraft and can be deployed to various depths within the water column. Once deployed, DICASS determines the range and bearing of a subsurface target relative to the sonobuoy's position. After water entry, the sonobuoy transmits sonar pulses (continuous waveform or linear frequency modulation) upon command from the aircraft. The echoes from the active sonar signal are processed in the buoy and transmitted to the receiving station onboard the launching aircraft.

A.2.6 Unmanned Systems Testing and Training

Tests unique to unmanned systems are described in Table A-7. Types of unmanned air, maritime, and ground systems are discussed in Sections A.3.1.1, A.3.2.2, and A.3.3.1 respectively.

Table A-7: Unique Unmanned Systems Tests

Activity Name	*Activity Description*
Integration and Interoperability Tests	Ensure different types of unmanned systems, when deployed together, can collaborate and operate in synergy to execute tasks and achieve a common mission. Tests focus on the interoperability between system controls, automation, communications, data products, and data links. Demonstrate interoperability among platforms built by different manufacturers and operated by United States military services, foreign allies, and other United States agencies.

Table A-7: Unique Unmanned Systems Tests, Continued

Activity Name	*Activity Description*
Teaming Tests	Develop and demonstrate the ability of manned and unmanned systems to cooperatively execute and achieve common mission objectives such as anti-submarine warfare, strike, and intelligence, surveillance, and reconnaissance. Manned-unmanned systems teams work together to collect, process, exploit, and disseminate data.
Autonomy Tests	Asses the ability of an unmanned system to operate effectively with limited or no human intervention. Tests range from human delegated, to human supervised, to fully autonomous levels. Fully autonomous systems do not require outside control, but rather are governed by embedded logic that directs their behavior. Tests evaluate the full range of behaviors that might emerge in simulated and real world environments.
Counter-UAS	Determine the effectiveness of counter-UAS technologies designed to detect, track, identify, and mitigate potential UAS threats. Threats are detected by employing sensors (electro-optical, IR, acoustic, or radio frequency) or radar systems individually or in combination. Once detected, UAS may be engaged or disabled using EW jamming devices to interfere with the communications link to its operator. Other electronic strikes are intended to seize operational control of the UAS. UAS can also be destroyed or neutralized using traditional air defense systems, gun ammunitions, physical deterrents or barriers, or directed energy weapons.

Key: IR = Infrared; UAS = unmanned aerial systems

A.2.7 Lasers Systems

Laser classes 1-4 are used within the PRC. Definitions for each class are provided in Table A-8.

Table A-8: Laser Classes

Laser Class	*Class Description*	*Energy Emitted*	*Safety Issues*	*Examples*
Class 1*	Low powered devices considered safe from all potential hazards	N/A	No injury, regardless of exposure time, to eyes or skin. No safety measures necessary.	Laser printers, toys, compact disc players, compact disc read-only memory devices, laboratory analytical equipment
Class 2*	Low power, visible light lasers that could possibly cause damage to a person's eyes	< 1 milliwatt (mW)	Usually safe. Eye protection normally afforded by the aversion response (turning away from a bright light source or closing or blinking eyes). If directly viewed for long periods of time with no blinking, damage to eyes could result.	Pointers used in presentations, toys, range finding equipment, aiming devices
Class 3**	Medium Power	< 500 mW	May be hazardous to eyes under direct and specular reflection (almost perfect reflection such as a mirror) viewing conditions, but is normally not hazardous.	Laser scanners, military hand-held laser rangefinders, entertainment light shows, target illuminators

Table A-8: Laser Classes, Continued

Laser Class	*Class Description*	*Energy Emitted*	*Safety Issues*	*Examples*
Class 4	High Power	> 500 mW	Direct beam or specular reflection is hazardous to eyes and skin. May pose a diffuse reflection hazard (reflected off an imperfect reflective surface) or fire hazard. May produce air pollutants.	Medical surgery, research, drilling, cutting, welding, aircraft target designator used for guided weapons, military laser weapons

Source: American National Standards Institute (2007)
KEY: mW = milliwatt; N/A = not applicable.
* Class 1M and 2M categories also exist, which have the same parameters as above, except that direct viewing with an optical instrument such as a telescope could be potentially hazardous.
**Two subcategories exist under Class 3: Class 3R lasers are potentially hazardous if the eye is appropriately focused and stable, but probability of injury is low; energy emitted is < 5 mW. Class 3B may be hazardous under direct and specular reflection viewing conditions; energy emitted is < 500 mW.

A.3 Testing and Training Assets

Testing and training activities conducted within the PRC may use a variety of air-, water-, and land-based assets as well as non-explosive munitions and other expendables.

A.3.1 Air-Based Assets

Air-based assets include types of aircraft and aerial targets.

A.3.1.1 Aircraft

Aircraft are categorized according to their design and operational characteristics as fixed-wing jet, fixed-wing propeller, rotary-wing (including tiltrotor), or unmanned aerial systems (UAS). Example platforms for each category are shown in Table A-9. This table is not all-inclusive but represents the primary platforms flown by tenant squadrons and transients that generated the majority of flight hours being analyzed in this EIS. Future platforms projected to be tested within the PRC are also indicated. Although aircraft models, series, and variants may change, the four broad category types remain the same. Therefore, for the purpose of analysis, the F/A-18E/F, C-12, UH-60A, and T-34 (UAS surrogate) have been chosen as representative platforms for each aircraft category respectively.

Table A-9: Example Aircraft Types and Platforms

Aircraft Type	*Aircraft Platform*	
Manned Systems		
Fixed-Wing Jet	A-10 Thunderbolt[+]	F-16 Fighting Falcon[+]
	BAC-111 Jet Airliner[+]	F-22 Raptor[+]
	C-21 Learjet	F-35 Lightning II Joint Strike Fighter
	C-38 Courier	F/A-XX*
	CRJ-700 Bombardier[+]	P-8 Poseidon
	E-6 Mercury	Sabreliner[+]
	E/A-18 Growler	T-38 Talon
	F/A-18 Hornet/Super Hornet	T-45 Goshawk

Table A-9: Example Aircraft Types and Platforms, Continued

<table>
<tr><th>Aircraft Type</th><th colspan="5">Aircraft Platform</th></tr>
<tr><td>Fixed-Wing Propeller</td><td colspan="5">C-12 Huron
C-26 Metroliner
C-130 Hercules
Cessna+
E-2 Hawkeye/Advanced Hawkeye
KC-130 Super Hercules
NP-3C Modified Orion
RC-12 Guardrail
T-6 Texan
U-6 Beaver</td></tr>
<tr><td>Rotary-Wing</td><td colspan="5">Future Vertical Lift*
H-1 Super Cobra/Iroquois
H-53 King Stallion/Sea Dragon
H-58 Kiowa
H-60 Seahawk/Blackhawk
H-72 Lakota
TH-57 Sea Ranger
VH-92 Presidential Helicopter
V-22 Osprey (Tiltrotor)</td></tr>
<tr><td colspan="6">Unmanned Systems</td></tr>
<tr><td>Unmanned Aerial Systems</td><td><u>Group 1</u>
RQ-11 Raven
RQ-12 Wasp
RQ-20 Puma
XM-8 Quadcopter</td><td><u>Group 2</u>
Scan Eagle</td><td><u>Group 3</u>
RQ-7 Shadow
RQ-21 Blackjack
RQ-26 Aerostar</td><td><u>Group 4</u>
MQ-1 Grey Eagle
MQ-8 Fire Scout</td><td><u>Group 5</u>
MQ-4Triton
MQ-25 Stingray*</td></tr>
</table>

Key: + =Transient Aircraft Only; * = Future Projected Aircraft

UAS are categorized into five groups based on weight, operating altitude, and speed (Table A-10). These attributes allow categorization without respect to UAS mission, propulsion type, or payload. Example UAS types for each group size are provided in Table A-11.

UAS may be air- or ground-launched using conventional (i.e., launched under their own power) or unconventional means (i.e., requires assisted take off). UAS Groups 1 and 2 are typically launched on-range or use unconventional take-off systems such as catapults, slingshots, or by hand. In addition, these UAS may be launched from platforms such as aircraft, surface and subsurface vessels and platforms, vehicles, or tethering towers. Recovery methods may include conventional landing, vertical/short takeoff and landing, net, wire, arresting gear, dirt strip, or intentional crash. UAS Groups 3 through 5 typically use established airfields and runways for take-off and landing; some Group 4 and 5 UAS flights may require chase aircraft.

In addition, lighter-than-air systems, such as airships and aerostats, are a subset of UAS that have been historically used for military surveillance and anti-submarine warfare. Unlike fixed- or rotary-wing aircraft, aerostats and airships typically use helium to stay aloft and therefore, the classifications provided in Table A-10 do not apply. Airships use engines to fly whereas aerostats are tethered to the ground by a cable that also provides power.

Table A-10: UAS Groups

<table>
<tr><th>UAS Group</th><th>Maximum Gross Takeoff Weight (lbs.)</th><th>Normal Operating Altitude (feet)</th><th>Speed</th></tr>
<tr><td>Group 1</td><td>0-20</td><td>< 1,200 AGL</td><td>< 100 knots</td></tr>
<tr><td>Group 2</td><td>21-55</td><td>< 3,500 AGL</td><td rowspan="2">< 250 knots</td></tr>
<tr><td>Group 3</td><td>< 1,320</td><td rowspan="2">< 18,000 MSL</td></tr>
<tr><td>Group 4</td><td rowspan="2">> 1,320</td><td rowspan="2">Any Airspeed</td></tr>
<tr><td>Group 5</td><td>> 18,000 MSL</td></tr>
</table>

Source: Joint Unmanned Aircraft Systems Center of Excellence (JUAS COE) CONOPS, Joint Concept of Operations for Unmanned
Aircraft Systems, Version 1.5.
Key: *AGL = Above Ground Level *MSL = Mean Sea Level

Table A-11: Example UAS Types

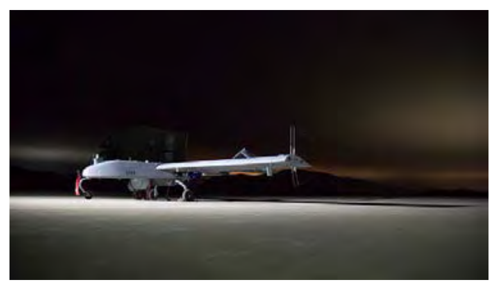
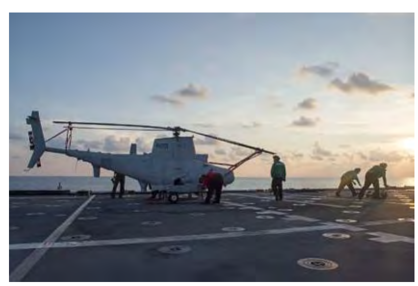
UAS Group	*Example Platform*	
UAS Group 1	 **RQ-20 Puma**	 **RQ-11 Raven**
Group 2	 **Scan Eagle**	 **Silver Fox**
Group 3	 **RQ-21A Blackjack**	 **RQ-7B Shadow**
Group 4	 **RQ-1 Predator**	 **MQ-8B Fire Scout**

Table A-11: Example UAS Types, Continued

UAS Group	*Example Platform*	
Group 5	 **MQ-4C Triton**	 **MQ-25 Stingray**

A.3.1.2 Aerial Targets

Aerial targets include towed banners and unmanned air platforms ranging from small hand-launched UAS, to aerial target drones, to full-scale aircraft. Targets may be augmented with various components (e.g., radio frequency, IR, or other electromagnetic or visual features) to meet testing or training requirements. Larger aerial targets, such as full-scale aircraft, serve as visual and radar targets only. Representative types of aerial targets are depicted in Table A-12. The BQM-74E is being replaced by the BQM-177A as the Navy's next generation subsonic aerial target drone. BQM targets require jet-assisted takeoff bottles for launch.

Table A-12: Example Aerial Target Types

Aerial Target	*Description*	*Photo*
BQM-74E	– A subscale, subsonic aerial target designed to simulate tactical threats by enemy aircraft and missiles – 13 feet long, 6 feet wingspan – Speed of 240-540 knots – 240 pounds, 749 pounds at launch – Williams J400-WR-404 Jet Engine	
BQM-177A	– A high-subsonic, sea-skimming anti-ship cruise missile threat target – 20 feet long, 10.5 feet wingspan – Capable of speeds in excess of 0.95 Mach – Sea-skimming altitude as low as 10 feet – Carries a suite of payloads to meet mission requirements	

Table A-12: Example Aerial Target Types, Continued

Aerial Target	*Description*	*Photo*
Potensic T25 Quadcopter	– A small remotely operated aerial system used as a target – Body measures 10.6 x 10.6 x 4.7 inches across the 3 axes – 4 pounds (including the attached camera) – 4 spinning rotors to generate lift – 984 feet signal range for drone control – 394 feet maximum flying height – Maximum speed of 15.5 miles per hour – Flight time up to 10 minutes per battery	

A.3.2 Water-Based Assets

Water-based assets include types of vessels, UMS, and surface and subsurface targets.

A.3.2.1 Vessels

Vessels include range support boats, operated by the NAWCAD ATMO Division, and combatant and patrol craft, operated by non-NAWCAD organizations such as the Naval Sea Systems Command and U.S. Coast Guard. Vessels are categorized by size as small (less than 50 feet), medium (50-100 feet), or large (greater than 100 feet but not usually exceeding 400 feet).

Table A-13 provides the operational characteristics of the current ATMO fleet. ATMO may also periodically contract or procure other boat types of similar size and performance. Representatives are noted for each size category and were chosen for analysis based on highest historical use. Table A-14 provides representative types of combatant and patrol craft for each size category. Types of amphibious vehicles are also included; however, they are not frequently used and do not operate on land within the PRC.

Table A-13: ATMO Range Support Boats

Range Support Boat	*Description*	*Photo*
	SMALL (Less than 50 feet)	
Fountain Boat*	– Length: 38 feet – Speed: 57+ knots – Weight: 10,600 pounds – Propulsion: Three Mercury 300 gasoline engines; 300 Horsepower each – Manned only – Used as a range support boat or mobile target	

Table A-13: ATMO Range Support Boats, Continued

Range Support Boat	*Description*	*Photo*
Rigid Hull Inflatable Boat	– Length: 28 feet – Speed: Max of 45 knots – Weight: 4,000 pounds – Propulsion: Two Mercury outboard gasoline engines; 200 Horsepower each – Manned and remote controlled – Used as a range support boat, mobile target, or to tow targets	
	MEDIUM (50 to 100 feet)	
Patrol Boat-777*	– Length: 65 feet – Speed: Max of 30 knots – Weight: 32 tons – Propulsion: Three GM 8V92 diesel engines; 650 Horsepower each – Manned only – Used as a range support boat or mobile target	
Prince	– Length: 53 feet – Speed: Max of 17 knots – Propulsion: Four 496 8.1 liter diesel engines; 370 Horsepower each – Manned only – Used as a range support boat or mobile target	
QST-35A SEPTAR	– Length: 56 feet – Speed: Max of 25 knots – Propulsion: Four Mercruiser gasoline engines; 370 HP each – Fiberglass, reinforced plastic hull – Manned and remote controlled – Used as a range support boat, mobile target, or to tow targets	

Table A-13: ATMO Range Support Boats, Continued

Range Support Boat	***Description***	***Photo***
QST-35B SEPTAR	– Length: 58 feet – Speed: Max of 30 knots – Propulsion: Two Detroit MTU series 60 diesel engines; 750 Horsepower each – Fiberglass, reinforced plastic hull – Manned and remote controlled – Used as a range support boat, mobile target, or to tow targets	
LARGE (Greater than 100 feet)		
Navy Relentless*	– Length: 145 feet – Speed: 10 knots – Propulsion: Two Caterpillar 3508B diesel engines; 805 Horsepower each – Manned only – Used as a range support boat	

Key: SEPTAR = Seaborne Powered Target
* = Representative for Size Class

Table A-14: Example Combatant and Patrol Craft

Combatant and Patrol Craft	***Description***	***Photo***
SMALL (Less than 50 feet)		
Rigid Inflatable Boat*	– Length: 35 feet, 11 inches – Speed: 40+ knots – Weight: 17,400 pounds Propulsion: Two Cummings Engines; 400 Horsepower each	

Table A-14: Example Combatant and Patrol Craft, Continued

Combatant and Patrol Craft	***Description***	***Photo***
Amphibious Combat Vehicle	– Length: 29 feet – Speed: 7-25 knots – Weight: 67,500-7,280 pounds (depending on load) – Propulsion: Single engine; 690 Horsepower – Replacing the Advanced Amphibious Assault Vehicles	
***MEDIUM (50 to 100 feet*)**		
Mark V Patrol Boat*	– Length: 82 feet – Speed: 65 knots – Weight: 57+ tons - Propulsion: Two MTU 16V2000M94 Engines; 2,660 Horsepower each	
Landing Craft Air Cushion	– Length: 92 feet – Speed: 40+ knots with full load – Weight:105-195 tons (depending on load) – Propulsion: 4-Allied-Signal TF-40 gas turbines (2 propulsion, 2 lift); 16,000 Horsepower sustained	
LARGE (Greater than 100 feet)		
Cyclone-Class Patrol Ship*	– Length: 179 feet – Speed: 35 knots – Weight: 331 tons Propulsion: Four 2,250 HP Paxman Engines	

*Representative for size class

A.3.2.2 Unmanned Maritime Systems

UMS can be defined as unmanned vehicles that displace water at rest and include unmanned surface vehicles (USV) and UUV. Both may be equipped with various sonar or sensor packages depending on test requirements. When operated remotely, mobile surface and subsurface targets may be considered a USV or UUV respectively.

USV operate with near-continuous contact with the surface of the water and fall within four size-based classes (Table A-15). Examples of USV are shown in Table A-16. UUV operate without necessary contact with the water surface but may need to be near the surface for communication purposes. Descriptions of UUV class are provided in Table A-17 and examples are shown in Table A-18. UUV also include ROV and bottom crawlers, which are boxed-shaped underwater robots versus typical torpedo-shaped UUV. ROV are unmanned but connected to a surface vessel or platform by cables and may include cameras, lights, sonar systems, and/or articulating arms for accomplishing mission tasks. Bottom crawlers are fully autonomous vehicles used in areas, such as shallow waters, where torpedo-shaped UUVs cannot effectively operate.

Table A-15: USV Classes

Vehicle Class	*Size*	*Description*
Class 1	**Very Small** (Length ≤7m)	Very Small USV, such as the Greenough Advanced Rescue Craft, focus on ISR, armed escort, and communications relay capabilities.
Class 2	**Small** (Length >7m and ≤12m)	Small USV, such as the Mine Countermeasures USV, focus on mine hunting, mine sweeping, mine neutralization, ISR, ASW, counter piracy, and communications relay capabilities.
Class 3	**Medium** (Length >12m and ≤ 50m)	Medium USV, such as the Sea Hunter, focus on ISR, armed escort, surface warfare, ASW, counter swarm, EW, mine countermeasures, and mining capabilities.
Class 4	**Large** (Length >50m)	Large USV, such as the Overlord, are being developed under the under the Ghost Fleet Program and focus on EW, ISR and targeting, anti-surface warfare, ASW, logistics, and payload carrying capabilities. Large USV will be fully autonomous and capable of conducting coordinated operations.

Source: Briefing by Captain Pete Small, Program Manager, Unmanned Maritime Systems (PMS 406), entitled "Unmanned Maritime Systems Update," January 15, 2019

Key: ASW = anti-submarine warfare; EW = Electronic Warfare; ISR = intelligence, surveillance, and reconnaissance; USV = unmanned surface vehicle

Table A-16: Example USV Types

USV Class (Example Platform)	
 **Class 1 Very Small USV (Greenough Advanced Rescue Craft)**	 **Class 2 Small USV (Mine Countermeasures USV)**

Table A-16: Example USV Types, Continued

USV Class (Example Platform)	
 **Class 3 Medium USV (Sea Hunter)**	 **Class 4 Large USV (Overlord)**

Key: USV = unmanned surface vehicle

Table A-17: UUV Classes

Vehicle Class	*Diameter (inches)*	*Launch Method*	*Description*
Small	>3 and < 10	Surface or Submarine	Small UUV, such as the Sandshark, are man-portable and focus on MIW, IPOE, and battle space awareness capabilities.
Medium	>10 and < 21	Surface or Submarine	Medium UUV, such as the Razorback, focus on MIW, IPOE, battle space awareness, and mine hunting capabilities.
Large	>21 and < 84	Surface or Submarine	Large UUV, such as the Snakehead, focus on IPOE, ISR, extended range IPOE and ISR, EW, anti-surface warfare, anti-submarine warfare, and payload carrying capabilities.
Extra Large	> 84	Pier	Extra Large UUV, such as the Orca, may be autonomous and focus on ISR, EW, anti-surface warfare, anti-submarine warfare, MIW, mine countermeasures, payload carrying, and strike capabilities.

Source: Briefing by Captain Pete Small, Program Manager, Unmanned Maritime Systems (PMS 406), entitled “Unmanned Maritime Systems Update,” January 15, 2019

Key: EW = electronic warfare; MIW = mine warfare; IPOE = intelligence preparation of the operational environment; ISR = intelligence, surveillance, and reconnaissance; UUV = unmanned underwater vehicle

Table A-18: Example UUV Types

UUV Class (Example Platform)	
 **Small UUV (Sandshark)**	 **Medium UUV (Razorback)**
 **Large UUV (Snakehead)**	 **Extra Large UUV (Orca)**

Key: UUV = unmanned underwater vehicle

A.3.2.3 Surface Targets

Surface targets are categorized as mobile (manned and unmanned), free floating or towed, or stationary (anchored). Table A-19 depicts example types for each target category and indicates representatives chosen for analysis based on highest historical use.

Mobile surface targets are propeller or impeller driven and range in size from 10 feet to 60 feet in length. When remote controlled, mobile surface targets are essentially types of USV. Mobile surface targets may be used to tow another target or be augmented with a sensor or emitter for detection or threat simulation. Mobile targets that also serve as range support boats are not expendable. Free floating or towed targets can be augmented with billboards or other items for weapons impact but are not used frequently within the PRC. These surface targets may be engaged with sensors, gun ammunitions, rockets, or other weapons systems.

Stationary surface targets are anchored to the seafloor or other objects to be visible at the water's surface. Examples include spar buoy, mine shapes, and moored rafts. Targets, such as the spar buoy, may be augmented with a radar reflector or other sensors. Moored rafts may be used for activities such as weapons delivery accuracy tests. Scenarios showing mine shape targets at the water surface and in the surf zone are depicted in Figures A-1 and A-2 respectively.

Table A-19: Example Surface Targets

Surface Target	***Description***	***Photo***
	Motorized Propeller	
High Speed Maneuverable Surface Target *	– Length: 29 feet – Speed: 40+ knots – Propulsion: Twin gas outboard engines, 200 Horsepower each – Rigid aluminum hull – Manned and remote controlled – Used as a mobile target (to simulate high speed enemy patrol boat) or to tow targets – Also used as a range support boat	
Fast Attack Craft Target	– Length: 50ft – Speed: 50+kts – Manned and remote controlled – Used as a mobile target – Also used as a support boat	
QST-35A (SEPTAR)	– Length: 56 feet – Speed: Max of 25 knots – Propulsion: Four Mercruiser gasoline engines; 370 Horsepower each – Fiberglass, reinforced plastic hull – Manned and remote controlled – Used as a mobile target or to tow targets – Also used as a range support boat	
QST-35B* (SEPTAR)	– Length: 58 feet – Speed: Max of 30 knots – Two Detroit MTU series 60 diesel engines; 750 Horsepower each – Fiberglass, reinforced plastic hull – Manned and remote controlled – Used as a mobile target or to tow targets – Also used as a range support boat	

Table A-19: Example Surface Targets, Continued

Surface Target	***Description***	***Photo***
	Motorized Impeller	
Ship Deployable Surface Target*	– Length: 10ft 10inches – Speed: 40+ knots – Propulsion: 4 stroke, 3 cylinder 155HP engine – Manned and remote controlled – Used as a medium to high speed target or to tow targets	
	Free Floating or Towed	
Catamaran Surface Towed Target (Super Cat)	– Length: 15 feet – Towed or free floating – Used for surface-to-surface and air-to-surface training in support of bombing, gunnery, and laser operations	
Improved Surface Towed Target	– Length: 29 feet – Fiberglass hull; mountable target augmentation systems – Towed or free floating target – Can be used for direct fire scenarios	
Inflatable Banana Target	– Length: 17 feet long, 2 feet diameter – Commercial ocean rider – Towed or free floating	
Low Cost Modular Target*	– Pontoon target – Size can me modified by removing and inserting pontoon sections	

Table A-19: Example Surface Targets, Continued

Surface Target	***Description***	***Photo***
Low Cost Towed Target	– Length: 15 feet – Weight: 750lbs – Fiberglass hull; mountable target augmentation systems – Towed or free floating	
PAX Pontoon Target	– Length: 16 feet – Low cost target – Towed or free floating	
Polyethylene Towed Target	– Length: 15 feet – Weight: 400lbs (base), 800lbs (with ballast) – Towable target at high speeds	
Squid	– Length: 135 inches – Wight: 350lbs (base), 500lbs (with ballast) – Unsinkable towed target – Easy to take apart and repair	
Stationary/Anchored		
Spar Buoy*	– Bottom anchored static target on which a radar reflector can be placed	

Key: * = Representative for surface target category; SEPTAR = Seaborne Powered Target.

A.3.2.4 Subsurface Targets

Subsurface targets include mine shapes and UUV that are used as targets. Mine shapes may be anchored at various depths below the water's surface or on the seafloor bottom. Example scenarios using subsurface mine shape targets are shown in Figures A-1 and A-3. UUV targets may be stationary, self-propelled, or towed and serve as a visual, radar, or acoustic target. A representative example is shown in Table A-20.

Table A-20: Example Subsurface Target

Subsurface Target	*Description*	*Photo*
	Mobile	
Autonomous Mobile Periscope System	– UUV with target acoustic system and expendable mobile acoustic training target signaling capability – Designed to simulate submarine activity in a littoral environment – Equipped with a periscope that can be raised close to the surface or lowered to allow visual or acoustic detection	

A.3.3 Land-Based Assets

Unmanned ground systems (UGS) and land targets are types of land-based assets. Other land-based assets include ground test facilities and laboratories and other types of ground vehicles described in Section A.2.2 (Ground-Based Activities) and Section 2.1.3.3 (Land-Based Assets), respectively.

A.3.3.1 Unmanned Ground Systems

UGS are robotic platforms that are used as an extension of human capability. These robots are capable of operating indoors or outdoors and over a wide variety of terrain. UGS include both wheeled and tracked vehicles and are commonly used to complete tasks by functioning in place of humans. UGS are generally defined based on size (i.e., transportability) and mode of operation. The four types of UGS based on transportability are shown in Table A-21. These systems can range from a few pounds up to 700 pounds. UGS modes of operation are described in Table A-22.

Table A-21: UGS Types

UGS Type	*Description*
Soldier Transportable	Systems small enough to be transported by a single person.
Vehicle Transportable	Systems too heavy to be transported by a person, or too slow to keep up with formation.
Self-Transportable	Systems too heavy to be transported by a person, but fast enough to keep up with formation.
Appliqué	Systems that are optionally manned due to a "kit" applied to the system allowing it to operate without a driver in the seat.

Sources: Army 2011 and Army 2012

Table A-22: UGS Modes of Operation

UGS Type	*Description*
Tethered	A mode of control wherein the human operator controls the UGS through a direct, wired connection. An example of such connection would be a fiber optic cable. Typically line of sight (LOS) must be maintained under tethered operation; however, under certain circumstances, a LOS is not necessary (i.e., operation in tunnel, around corners, etc.).
Remote Controlled	A mode of control wherein the human operator must dedicate 100 percent of their attention to system operation without benefit of sensory feedback from the vehicle. A LOS must be maintained with the vehicle under remote control operation.
Teleoperated	A mode of control wherein the human operator has control of the UGS through cues provided by video, audio and digital feedback. The human operator controls the UGS through a wireless connection transmitted over radio frequencies. The human operator must dedicate 100 percent of their time to operating the UGS. A LOS does not necessarily need to be maintained under teleoperation.
Autonomous	A mode of control wherein the UGS is self-sufficient. The human operator can program a mission for the UGS, but the UGS would execute the mission without any human interaction. There are varying levels of autonomy in regards to the level of human interaction with the UGS.
Semi-autonomous	A UGS that has multiple modes of control occurring simultaneously to include at least one autonomously controlled function. The level of semi-autonomy can vary greatly between UGS systems.

Key: LOS = line of sight; UGS = unmanned ground system

A.3.3.2 Land Targets

Land targets may be stationary or mobile and consist of fixed target arrays, full-scale three-dimensional targets, and manned or remote-controlled vehicles. These targets are primarily used for visual targeting, laser designating, sensor testing, or tracking. No munitions are released on land targets.

Stationary land targets generally include instrumented target boards, mock tanks and military vehicles, anti-radiation or radar reflecting posts, and other land targets. Examples of stationary land targets are shown in Table A-23. Mobile land targets can be UGS or manned vehicles such as pick-up trucks, vans, Jeeps, and High Mobility Multipurpose Wheeled Vehicles. Land targets may also include natural or man-made land features that can be used as a target or reference point (e.g., Bloodsworth Island Range [BIR], airfields, runways, roads). These are typically used to test sensors with unique detection capabilities. Other land targets are designed to meet specialized test requirements, such as mine shapes placed to simulate a beach zone minefield (as seen in Figure A-2), or practice improvised explosive devices (IED) placed or buried to simulate explosive, biological, or chemical IED threats (Navy, 2019). Practice IEDs would contain no hazardous materials. Unique tests involving these types of targets occur only on occasion (once every several years), such as testing a new MCM system or demonstrating IED sensors at a science and technology event. Some land targets are semi-permanent features (e.g., radar reflecting posts), whereas others are temporarily placed and removed following events.

Table A-23: Example Stationary Land Targets

Land Target Description	*Photo*
– Full-scale, three demensional target – Low-cost, plastic armored vehicle – Can be augmented to include RF and IR systems and camouflage paint themes	
– Radar Reflectors on Posts	

Key: IR = infrared; RF = radio frequency

A.4 Non-Explosive Munitions and Other Military Expended Materials

The typical types of non-explosive munitions and other military expended materials (MEM) expended within the PRC include: bombs, mines, missiles, rockets, torpedoes, and gun ammunitions (small and medium caliber), as well as decoys (chaff and flares). A general description of each is provided below. Other MEM includes: marine markers, signal cartridges/spotting charges, sonobuoys, launchers/dispensers/pods, search and rescue rafts and recovery kits, AMNS munitions, cartridge and propellant actuated devices, and other miscellaneous items such as fuel tanks and mass equivalents (e.g., I-Beams, sleds, or concrete blocks used for heavy lift testing). These materials are less common and intermittently used within the PRC. Accessories, such as parachutes, endcaps, pistons, and wires, associated with munitions and other MEM, are listed in Appendix E (Military Expended Materials and Physical Disturbance and Strike Analysis).

Bombs. Bombs are unpowered munitions dropped from aircraft on Chesapeake Bay Water Range targets. Bombs fall into four categories including cluster bombs, general purpose bombs, guided bombs, and practice bombs.

- **Cluster Bombs:** A cluster bomb is delivered in the same manner as a conventional practice bomb. After release from the aircraft and during free-fall, a strip of small shaped charges (similar to a firecracker) fire and opens the bomb canister releasing about 245 non-explosive bomblets.

- **General Purpose Bombs:** General purpose bombs (MK-80 Series) used in the PRC are composed of a steel case containing concrete. These bombs are available with or without a guidance system. Those with guidance systems, also referred to as "smart bombs," detect a target illuminated by a laser beam.

  The MK-80 Series general purpose bombs also can be modified by the addition of a Joint Direct Attack Munition (JDAM) guidance kit. Conversion of a general purpose bomb involves replacing the tail section with the JDAM guidance kit. This guidance kit contains a global positioning system/inertial guidance system unit to improve the accuracy of bomb delivery in adverse weather conditions.

Some of the general purpose bombs used in the PRC may be equipped with laser guidance systems and/or JDAM kits and may be equipped with battery-powered telemetry units. The bombs may be instrumented with a telemetry unit if the potential exists for it to exhibit poor separation characteristics and thus be likely to contact the aircraft or another munition.

- **Guided Bombs:** Guided bombs are designed to use electronic systems (laser or television) to improve the accuracy of delivery from an attack aircraft to a surface target. Typical guided bombs tested in the PRC include, but are not limited to GBU-24 and AGM-154 Joint Standoff Weapon. Guided bombs expended in the Chesapeake Bay Water Range have their guidance systems deactivated prior to being expended.

- **Practice Bombs:** Practice bombs are manufactured as either solid cast-metal bodies or thin sheet-metal containers that can be filled with wet sand or water to meet desired weight requirements. Practice bombs used for separation purposes in the PRC include but are not limited to: MK-76, MK-106, BDU-48/B, and the Laser Guided Test Round.

  To assist in visual observation in weapon-target impact, a practice bomb signal cartridge (i.e., spotting charge) that emits smoke or flames for impact marking can be used. A spotting charge is similar in explosive strength to a firecracker. Three different signal cartridges are used with practice bombs (MK-4, CXU-3, and CXU-4). The MK-4 cartridge contains about 65 g (2.3 oz) of red phosphorus. The red phosphorus ignites on impact and produces a bright flash and white smoke. The bright flash is important for night training. The CXU-3 and CXU-4 cartridges contain about 1 fluid oz and 2 fluid oz, respectively, of titanium tetrachloride. When exposed to air or moisture, titanium tetrachloride produces white smoke. While spotting charges are not used in support of testing activities in the PRC, they are commonly used in military training activities.

Mines. Mines are used as a subsurface anti-ship or anti-submarine weapon. The MK-56 mine has been in use since its development in 1966. More advanced mines include the MK-60 Captor (or “encapsulated torpedo”), the MK-62, MK-63, and MK-65 (Quickstrike), and the MK-67 (Submarine Launched Mobile Mine - SLMM). Most mines are delivered to the target by aircraft.

Missiles. Inert missile shapes (some with parachutes and telemetry units) are used for weapons separation testing from aircraft in the PRC. These shapes, mass-ballasted to account for the absence of the warhead and solid fuel rocket motor, are usually jettisoned or dropped in the Chesapeake Bay Water Range. The missile shapes used in weapons separation testing in the complex may represent the following types of missiles:

- **Air-to-Air Missiles:** Sidewinder (AIM-9), Sparrow (AIM-7), and Advanced Medium-Range Air-to-Air Missile, AIM-120). These shapes are not recovered.

- **Air-to-Surface Missiles: -** Shrike (AGM-45), Maverick (AGM-65), Harpoon Block II+ (AGM-84), (Stand-Off Land Attack Missile - AGM-84E), (Stand-Off Land Attack Missile Enhanced Range – AGM-84H/K), (High-Speed Anti-Radiation Missile - AGM-88), (Advanced Anti-Radiation Guided Missile Extended Range – AGM-88E), Joint Standoff Weapon (AGM-154), (Long Range Anti-Ship Missile – AGM-158), Griffin (AGM-176), (Joint Air-to-Ground Missile – AGM-179), Hellfire (AGM 114), and Switchblade. These missile shapes are usually recovered.

Recovery of air-to-surface missiles that have been dropped or jettisoned (including the parachute and telemetry package) occurs at an in-shore sandbar in the vicinity of Hooper target. The use of the parachute allows the jettisoned/dropped missiles to slow down as they enter the water and significantly minimizes the potential for breakup of the missile and/or the telemetry unit.

Rockets. Within the PRC, rockets may be launched from flying aircraft or from the rocket test stand at the Armament Test Area. From aircraft, single firings of rockets are allowed at Hooper Target and rockets can be dropped or fired at Hannibal Target (all rockets contain non-explosive warheads). More accurate than free-falling bombs, rockets are driven forward by the discharge of rapidly expanding gases from the nozzle of a motor. These gases are produced from the burning of a solid propellant that consists of a fuel and an oxidizer. Rocket sizes are most commonly 2.5 inches and 5 inches in diameter. Some rockets may contain flechette warheads that release up to 2,200 pointed steel projectiles, similar to a cluster bomb.

Gun Ammunition.

Gun ammunition is fired from aircraft, surface vessels, and occasionally personnel (from surface vessels or the Armament Test Area shoreline) into the Chesapeake Bay Water Range. Gun ammunition is also expended from a fastened aircraft or test stand into the Armament Test Area gun-firing tunnel. Gun ammunition is fired in support of weapons separation tests, other types of tests (such as counter-UAS), or military training activities.

Types of gun ammunition expended within the PRC include 5.56 mm, 7.62 mm, .50 caliber, 20 mm, 25 mm, 30 mm, and 40 mm. The projectiles for 5.56 mm and 7.62 mm gun ammunition have lead cores. The amount of lead in each of these projectiles has been estimated at 0.14 oz and 0.34 oz, respectively (Buxton, 1998). Projectiles for .50 caliber, 20 mm, 25 mm, 30 mm, and 40 mm gun ammunition are mostly steel with minor constituents of aluminum, copper, and lead. While cartridge cases are retained within aircraft or vessels after firing, the projectile (bullet) is deposited into the Chesapeake Bay. Ammunition fired into the firing tunnel is collected and expended bullets are properly disposed.

Decoys. Decoys are forms of EW countermeasures that allow an aircraft to foil or disable an adversary's offensive or defensive detection devices (e.g., communications and radar systems). The types of decoys tested in the PRC include chaff and flares. All decoys are expelled from an aircraft by the electronic firing of an impulse cartridge (known as a cartridge actuated detonator or CAD). The CAD contains 0.007 to 0.009 oz of propellant inside a steel body.

- **Chaff.** Chaff is the collective term for fiberglass fibers (or dipoles) coated with aluminum and biodegradable stearic acid and are released by an aircraft or ship to thwart radar and radar-controlled weapons. Chaff fibers are about the thickness of fine human hair, typically about (0.6 inch long, 0.01 inch wide, and 0.001 inch in diameter. Millions of these fibers are compressed into small packages or canisters. Only 1.6 oz of chaff are needed to cause an echo equal in size to a large bomber (US Naval Academy, December 1996). Each chaff package dropped independently can simulate additional aircraft.

  Chaff drops very slowly and can take many hours to reach the ground. Chaff settles at an estimated fall rate of 50 ft per minute or less. Initial chaff concentrations are about 120 micrograms per cubic meter (mg/m^3), but dissipate quickly because of its light weight and the effects of wind and air currents (US Air Force, November 1993). This causes the chaff to be widely dispersed, although clumps of chaff can be found occasionally.

- **Flares.** Flares are released by an aircraft to attract heat-seeking or IR-homing weapons targeted on that aircraft. When activated, an electrical firing mechanism ignites the flare and expels it from the aircraft. The flare begins burning immediately, reaching its highest temperature, 2,000EF, by the time it passes the tail of the aircraft (US Air Force, November 1993). The flare pellet is designed to provide a brief, high intensity heat source for up to ten seconds upon ejection (NAWCAD, January 1977). Normally, flares are completely consumed during this time (with the exception of small pieces of foil, felt, and plastic).

  Flares are composed of powdered or pelleted magnesium imbedded in a matrix such as polytetrafluoroethylene (teflon). Fluoroelastomer (viton, fluorel, or hytemp) may also be a constituent of the flare.

A.5 Patuxent River Complex Operational Tempo

Tables A-24 and A-25 are expanded versions of Chapter 2 (Proposed Action and Alternatives) Table 2.3-1 (Annual PRC Operational Tempo per Alternative: Activities and Assets) and Table 2.3-2 (Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems). These tables provide the quantitative numbers used for the analysis of alternatives for all activities, assets, munitions, other MEM, and directed energy weapons systems proposed for this EIS.

The No Action Alternative reflects the 10-year average of the 2008–2017 fiscal year baseline, as well as the highest individual (or peak) year within the 10-year period. Both averages and peaks were used by Navy subject matter experts to project activity levels needed to meet current and future military readiness requirements. Although averages reflect more typical levels of annual operational activity, peaks were analyzed to ensure the capacity to test and train at maximum levels required to meet military readiness in times of global conflict, and thereby meet the purpose and need in any given year.

Table A-24: Annual PRC Operational Tempo Per Alternative: Activities and Assets

Activity Name	No Action Alternative		Alternative 1		Alternative 2	Location(s)	Recovery Rate
	Annual Average	Annual Peak	Annual Average	Annual Peak	Annual Peak		
AIR-BASED ACTIVITIES							
Aircraft Flight Activities (# of Flight Hours)	**20,100**		**23,400**		**26,000**	Restricted Areas (80%) Helo OPAREAs (20%)	N/A
Below 3,000 ft AGL							
Fixed-Wing Jet	1,990		2,510		2,790	Restricted Areas	
Fixed-Wing Propeller	1,970		1,770		1,960	Restricted Areas & Helo OPAREAs	
Rotary-Wing	4,000		6,930		7,710	Restricted Areas & Helo OPAREAs	
Unmanned Aerial Systems	300		780		860	Restricted Areas	
Supersonic Activities (# of Supersonic Events)	180	247	175	180	198	Restricted Areas (98% in R-4008 above 30,000 feet; >2% below 30,000 feet [down to 10,000 feet] for supersonic weapons separation testing only); Chessie Air Traffic Control Assigned Airspace (1-3 events per year)	
AIR-BASED ASSETS							
Aerial (BQM) Targets (# of Targets)	<1	3	3	5	6	Launched from the Armament Test Area	100%
Unmanned Aerial System Targets (# of Targets)*	20	50	55	136	150	Restricted Areas (65% over land areas; 35% over water areas [25% Chesapeake Bay Water Range and 10% Bloodsworth Island Range Surface Danger Zone])	100% from land areas; 40% from water areas
LAND-BASED ACTIVITIES							
Aircraft Ground-Based Activities (Maintenance Runs, Taxis, Turns) (# of Hours)	**3,693**	**3,693**	**4,299**	**4,299**	**4,729**	PRC Installation airfields flight line, taxiways, tarmacs, and hanger aprons.	N/A
Outdoor Static Engine Runs (# of Events/Hours)	**61**	**92**	**61**	**92**	**101**	Open-Air Engine Test Cell Facility	

Table A-24: Annual PRC Operational Tempo Per Alternative: Activities and Assets, Continued

Activity Name	No Action Alternative		Alternative 1		Alternative 2	Location(s)	Recovery Rate
	Annual Average	Annual Peak	Annual Average	Annual Peak	Annual Peak		
Jet Engine Test Instrument (T-36)	21	31	21	31	34	Open-Air Engine Test Cell Facility	N/A
Turboprop Test Instrument	31	46	31	46	51		
Shaft Engine Test Instrument	8	12	8	12	13		
T-24	1	2	1	2	2		
T-26	< 1	1	< 1	1	1		
Armament Test Area (# of Events)	**10**	**25**	**10**	**27**	**30**	Armament Test Area	N/A
Gun Fire Test	5	11	5	12	13		
Weapons Compatibility Tests	5	14	5	15	17		
LAND-BASED ASSETS							
Ground Support Equipment (# of Hours)	**47,894**		**54,646**		**58,763**	On and around PRC Installation airfields	N/A
Aircraft Tow Tractor	9,918		11,316		12,169		
Mobile Electric Power Plant (Generator)	13,050		14,890		16,012		
Mobile Aircraft Start Unit	10,962		12,508		13,450		
Heavy Duty Land-based Tow Tractor	7,830		8,934		9,607		
Test Stand (Hydraulic Portable)	2,271		2,591		2,786		
Truck (Ammunition Loading, Transport)	1,566		1,787		1,921		
Air-Launched Weapons Loader	1,253		1,429		1,537		
Truck (Aerial Stores Lift)	1,044		1,191		1,281		

Table A-24: Annual PRC Operational Tempo Per Alternative: Activities and Assets, Continued

Activity Name	No Action Alternative		Alternative 1		Alternative 2	Location(s)	Recovery Rate
	Annual Average	Annual Peak	Annual Average	Annual Peak	Annual Peak		
Unmanned Ground Systems (# of Unmanned Ground Systems [Hours])	**2** ***(4 Hours)***	**2** ***(4 Hours)***	**40** ***(80 Hours)***	**40** ***(80 Hours)***	**44** ***(88 Hours)***	PRC installations (primarily Outlying Field Webster); previously disturbed approved areas	
WATER-BASED ACTIVITIES							
Anti-Submarine Warfare Systems (# of Events [Hours])	**17** ***(0.2)***	**34** ***(0.4)***	**34** ***(2)***	**68** ***(4)***	**74** ***(4.3)***	Sonar Dip Points	N/A
Active Dipping Sonar	2 *(0.2)*	4 *(0.4)*	18 *(2)*	36 *(4)*	39 *(4.3)*		
Passive Dipping Sonar	15	30	16	32	35		
Mine Countermeasure Systems (# of Events [Hours])	**21** ***(40.2 Hours)***	**22** ***(40.4 Hours)***	**22** ***(40.4 Hours)***	**24** ***(40.8 Hours)***	**26** ***(43 Hours)***	Chesapeake Bay Water Range and Installation surrounding waters (Airborne Mine Neutralization System only in the Water Range)	N/A
Airborne Mine Neutralization System	1 *(0.2 Hours)*	2 *(0.4 Hours)*	2 *(0.4 Hours)*	4 *(0.8 Hours)*	5 *(1 Hour)*		
Organic Airborne and Surface Influence Sweep	2 *(4 Hours)*	2 *(4 Hours)*	2 *(4 Hours)*	2 *(4 Hours)*	2 *(4 Hours)*		
Magnetic Orange Pipe	18 *(36 Hours)*	18 *(36 Hours)*	18 *(36 Hours)*	18 *(36 Hours)*	19 *(38 Hours)*		
WATER-BASED ASSETS							
Vessels (# of Vessels [Hours])	**208** ***(834 Hours)***	**593** ***(2,364 Hours)***	**601** ***(2,435 Hours)***	**605** ***(2,473 Hours)***	**666** ***(2,720 Hours)***	Chesapeake Bay Water Range (85-90%); Outside the Water Range but still within the PRC Study Area (10-15%)	N/A
Range Support Boats (Subtotals)	**202** ***(786 Hours)***	**570** ***(2,180 Hours)***	**570** ***(2,180 Hours)***	**570** ***(2,180 Hours)***	**627** ***(2,398 Hours)***		
Small Vessels (< 50 Feet)	80 *(287 Hours)*	228 *(856 Hours)*	228 *(856 Hours)*	228 *(856 Hours)*	251 *(942 Hours)*		
Medium Vessel (50 to 100 Feet)	85 *(290)*	232 *(629 Hours)*	232 *(629 Hours)*	232 *(629 Hours)*	255 *(692 Hours)*		
Large Vessel (> 100 Feet)	37 *(209 Hours)*	110 *(695 Hours)*	110 *(695 Hours)*	110 *(695 Hours)*	121 *(765 Hours)*		

Table A-24: Annual PRC Operational Tempo Per Alternative: Activities and Assets, Continued

Activity Name	No Action Alternative		Alternative 1		Alternative 2	Location(s)	Recovery Rate
	Annual Average	Annual Peak	Annual Average	Annual Peak	Annual Peak		
Combatant and Patrol Craft (Subtotals)	**6** ***(48 Hours)***	**23** ***(184 Hours)***	**31** ***(255 Hours)***	**35** ***(293 Hours)***	**39** ***(322 Hours)***	Chesapeake Bay Water Range (85-90%); Outside the Water Range but still within the PRC Study Area (10-15%)	N/A
Small Vessels (< 50 Feet)	4 *(32 Hours)*	13 *(104 Hours)*	22 *(173 Hours)*	26 *(211 Hours)*	29 *(232 Hours)*		
Medium Vessel (50 to 90 Feet)	1 *(8 Hours)*	2 *(16 Hours)*	6 *(50 Hours)*	6 *(50 Hours)*	7 *(55 Hours)*		
Large Vessel (> 100 Feet)	1 *(8 Hours)*	8 *(64 Hours)*	3 *(32 Hours)*	3 *(32 Hours)*	3 *(35 Hours)*		
Amphibious Vehicles (#s included in Combatant and Patrol Craft numbers)	1	1	1	1	2	Surface Water Operations only; Chesapeake Bay Water Range (85-90%); Outside the Water Range but still within the PRC Study Area (10-15%)	
Unmanned Maritime Systems (# of Unmanned Maritime Systems [Hours])	**51** ***(153 Hours)***	**51** ***(153 Hours)***	**160** ***(480 Hours)***	**160** ***(480 Hours)***	**176** ***(528 Hours)***	Primarily installation surrounding waters but also within the Chesapeake Bay Water Range. Bottom crawlers may also operate on land along Installation surf zone or beaches.	N/A
Unmanned Surface Vehicles	5 *(15 Hours)*	5 *(15 Hours)*	40 *(120 Hours)*	40 *(120 Hours)*	44 *(132 Hours)*		
Unmanned Underwater Vehicles	46 *(138 Hours)*	46 *(138 Hours)*	120 *(360 Hours)*	120 *(360 Hours)*	132 *(396 Hours)*		
Bottom Crawlers (#s included in UUV numbers)	< 1 *(< 1 Hour)*	< 1 *(< 1 Hour)*	1 *(2 Hours)*	1 *(2 Hours)*	2 *(4 Hours)*		
Surface Targets (# of Targets [Hours])	**242** **(954 Hours)**	**476** ***(2,447 Hours)***	**487** ***(2,492 Hours)***	**489** ***(2,492 Hours)***	**539** ***(2,749 Hours)***	Chesapeake Bay Water Range (85-90%); Outside the Water Range but still within the PRC Study Area (10-15%)	Mobile and Stationary Targets = 100% Free Floating or Towed Targets = 95%
Mobile Surface Targets (Subtotals)	238 *(954 Hours)*	472 *(2,447 Hours)*	481 *(2,492 Hours)*	481 *(2,492 Hours)*	530 *(2,749 Hours)*		
Small Motorized Propeller	51 *(275 Hours)*	140 *(904 Hours)*	140 *(904 Hours)*	140 *(904 Hours)*	154 *(994 Hours)*		
Medium Motorized Propeller	182 *(654 Hours)*	326 *(1,513 Hours)*	326 *(1,513 Hours)*	326 *(1,513 Hours)*	359 *(1,664 Hours)*		

Table A-24: Annual PRC Operational Tempo Per Alternative: Activities and Assets, Continued

Activity Name	No Action Alternative		Alternative 1		Alternative 2	Location(s)	Recovery Rate
	Annual Average	Annual Peak	Annual Average	Annual Peak	Annual Peak		
Motorized Impeller	3 *(15 Hours)*	3 *(15 Hours)*	5 *(25 Hours)*	5 *(25 Hours)*	6 *(36 Hours)*	Chesapeake Bay Water Range (85-90%); Outside the Water Range but still within the PRC Study Area (10-15%)	Mobile and Stationary Targets = 100% Free Floating or Towed Targets = 95%
Free Floating or Towed	2 *(10 Hours)*	3 *(15 Hours)*	10 *(50 Hours)*	10 *(50 Hours)*	11 *(55 Hours)*		
Stationary Surface Targets	4	4	6	8	9		
Subsurface Targets (# of Targets [Hours])	**4 *(2 Hours)***	**5 *(3 Hours)***	**11 *(7 Hours)***	**16 *(12 Hours)***	**18 *(13 Hours)***		
Mobile Subsurface Targets	2 *(2 Hours)*	3 *(3 Hours)*	7 *(7 Hours)*	12 *(12 Hours)*	13 *(13 Hours)*	Chesapeake Bay Water Range and Installation surrounding waters	100%
Stationary Subsurface Targets	2	2	4	4	5	Chesapeake Bay Water Range and Installation surrounding waters	100%

Key: AGL = above ground level; ft = feet; N/A = not applicable; OPAREAs = operating areas; R- = restricted area
* = Associated aircraft flight hours are included in flight hour totals

Table A-25: Annual PRC Operational Tempo Per Alternative: Number of Munitions, Other MEM, and Directed Energy

Type	No Action Alternative		Action Alternative 1		Action Alternative 2	Activity	Location(s)	Recovery Rate
	Annual Average	Annual Peak	Annual Average	Annual Peak	Annual Peak			
NON-EXPLOSIVE MUNITIONS (Number Expended)								
Bombs	36	196	120	273	300	Test & Training Flights	Chesapeake Bay Water Range	0%
Mines (Mine Laying)	5	16	159	184	202	Test Flights	Chesapeake Bay Water Range	0%
Missiles	1	4	42	42	46	Test Flights	Chesapeake Bay Water Range	55%
Rockets*	110	385	405	534	587	Test Flights	Chesapeake Bay Water Range	0%
Rockets (Flechette Warhead)	10	33	35	46	51	Test Flights	Chesapeake Bay Water Range	0%
Torpedoes	8	37	37	37	41	Test Flights	Chesapeake Bay Water Range	80%
Small Caliber Gun Ammunition*	13,708	36,100	24,420	53,420	58,762	Test & Training Flights; Surface & Subsurface Testing & Training	Chesapeake Bay Water Range	0%
Medium Caliber Gun Ammunition*	3,049	8,961	5,100	17,150	18,865	Test Flights; Surface & Subsurface Testing & Training	Chesapeake Bay Water Range	0%
Rockets*	2	18	2	19	21	Weapons Compatibility Tests	Armament Test Area launch into Chesapeake Bay Water Range	0%
Small Caliber Gun Ammunition*	8,328	19,977	8,744	20,976	23,074	Gun Fire Tests	Armament Test Area (Gun Firing Tunnel)	Expended into Gun Firing Tunnel
Medium Caliber Gun Ammunition*	862	2,430	905	2,552	2,807	Gun Fire Tests	Armament Test Area (Gun Firing Tunnel)	Expended into Gun Firing Tunnel
OTHER MILITARY EXPENDED MATERIALS (Number Expended)								
Airborne Mine Neutralization System Munitions	1	2	2	4	5	Mine Countermeasure Systems Tests	Chesapeake Bay Water Range	0%
Chaff (Canisters [pounds])	19 (85)	121 (543)	246 (1,107)	246 (1,107)	271 (1,220)	Test & Training Flights	Chesapeake Bay Water Range	0%
Dye Markers	8	37	37	37	41	Test Flights	Chesapeake Bay Water Range	0%
Flares (Decoys)	85	320	255	255	281	Test Flights	Chesapeake Bay Water Range	0%

Table A-25: Annual PRC Operational Tempo Per Alternative: Number of Munitions, Other MEM, and Directed Energy, Continued

Type	No Action Alternative		Action Alternative 1		Action Alternative 2	Activity	Location(s)	Recovery Rate
	Annual Average	Annual Peak	Annual Average	Annual Peak	Annual Peak			
Flares (Illumination)	14	51	40	40	44	Test & Training Flights	Chesapeake Bay Water Range	0%
Launchers/Pods	3	7	9	14	15	Test Flights	Chesapeake Bay Water Range	0%
Miscellaneous Items (e.g., Mass Equivalents, Fuel Tanks)	<1	1	1	1	1	Test Flights	Chesapeake Bay Water Range	0%
Marine Markers	3	22	9	34	37	Other Flights	Chesapeake Bay Water Range (Alt 1&2 - 50% Patuxent River Seaplane Area)	0%
Search and Rescue Rafts and Kits	1	2	15	15	17	Test Flights	Chesapeake Bay Water Range	100%
Signal Cartridges/Spotting Charges	1	12	12	12	13	Test Flights	Chesapeake Bay Water Range	0%
Passive Sonobuoys	32	122	21	122	134	Test Flights	Chesapeake Bay Water Range	0%
Active Sonobuoys	0	0	6	24	26	Anti-Submarine Warfare Tests	Dip Points	0% - Scuttled Following Events
Cartridge Actuated Devices & Propellant Actuated Devices	176	513	185	539	593	Weapons Compatibility Tests	Armament Test Area	100%
Chaff (Pounds)	81	81	85	85	94	Weapons Compatibility Tests	Armament Test Area	Chaff swept following events
Jet-Assisted Takeoff Bottles	2	6	6	10	12	Aerial (BQM) Target Launches	Armament Test Area launch into Chesapeake Bay Water Range	0%
DIRECTED ENERGY (Number of Events)								
High-Energy Laser (Events)	0	0	0	50	50	Directed Energy Weapons Tests	PRC Airspace, Land Areas, and Water Areas where the hazard pattern can be contained within the range and/or Installation boundary and exclusive use airspace can be provided.	N/A
High-Power Microwave (Events)	0	0	0	120	120	Directed Energy Weapons Tests	PRC Airspace, Land Areas, and Water Areas where the hazard pattern can be contained within the range and/or Installation boundary and exclusive use airspace can be provided.	N/A

* = Denotes Live-Fired Munition

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Appendix B
A Noise Primer: Noise and Its Effect on the Environment

Acknowledgements

This appendix reflects a consolidation of information retained by the Navy for clarification of noise analysis terminology.

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Acronyms and Abbreviations

Acronym	*Definition*
µPa	micropascal
$µPa^2$-s	micropascal squared per second
AAD	Annual Average Daily
AGL	Above Ground Level
ANSI	American National Standards Institute
ASHLA	American Speech-Language-Hearing Association
CHABA	Committee on Hearing, Bioacoustics, and Biomechanics
CNEL	Community Noise Equivalent Level
$CNEL_{mr}$	Onset-Rate Adjusted Monthly Community Noise Equivalent Level
dB	decibels
dB re 20 µPa	decibels referenced to 20 micropascals
dBA	A-Weighted Decibels
dB(A)	A-Weighted Decibels
DLR	German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt e.V.)
DNL	Day-Night Average Sound Level
DOD	Department of Defense
FAA	Federal Aviation Administration (US)
FICAN	Federal Interagency Committee on Aviation Noise
FICON	Federal Interagency Committee on Noise
HA	Highly Annoyed
HYENA	Hypertension and Exposure to Noise near Airports
Hz	Hertz
ISO	International Organization for Standardization
kHz	kilohertz
km	kilometer
kyd	kiloyard
L	Sound Level
L_{dn}	Day-Night Average Sound Level
L_{dnmr}	Onset-Rate Adjusted Monthly Day-Night Average Sound Level
L_{eq}	Equivalent Sound Level
$L_{eq(16)}$	Equivalent Sound Level over 16 hours
$L_{eq(24)}$	Equivalent Sound Level over 24 hours
$L_{eq(30min)}$	Equivalent Sound Level over 30 minutes
$L_{eq(8)}$	Equivalent Sound Level over 8 hours
$L_{eq(h)}$	Hourly Equivalent Sound Level
L_{max}	Maximum Sound Level
L_{pk}	Peak Sound Level
mmHg	millimeters of mercury
MOA	Military Operations Area
MTR	Military Training Route
NA	Number of Events At or Above a Selected Threshold
NATO	North Atlantic Treaty Organization
NDI	Noise Depreciation Index
NIPTS	Noise-induced Permanent Threshold Shift
NSDI	Noise Sensitivity Depreciation Index
OR	Odd Ratio
POI	Point of Interest
PTS	Permanent Threshold Shift
RANCH	Road Traffic and Aircraft Noise Exposure and Children's Cognition and Health
SEL	Sound Exposure Level
SIL	Speech Interference Level
SPL	sound pressure level
SUA	Special Use Airspace
TA	Time Above
TTS	Temporary Threshold Shift
U.S.	United States
UKDFES	United Kingdom Department for Education and Skills
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
WHO	World Health Organization

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This appendix discusses sound and noise and their potential effects on the human and natural environment. Section B.1 provides an overview of the basics of sound and noise. Section B.2 defines and describes the different metrics used to describe noise. The largest section, Section B.5, reviews the potential effects of noise, focusing on effects on humans but also addressing effects on property values, terrain, structures, and animals. Section B.6 contains the list of references cited.

B.1 Basics of Sound

Section B.1.1 describes sound waves and decibels. Section B.1.3 reviews sounds levels and types of sounds.

B.1.1 Sound Waves and Decibels

Sound consists of minute vibrations in the air that travel through the air and are sensed by the human ear. Figure B-1 is a sketch of sound waves from a tuning fork. The waves move outward as a series of crests where the air is compressed and troughs where the air is expanded. The height of the crests and the depth of the troughs are the amplitude or sound pressure of the wave. The pressure determines its energy or intensity. The number of crests or troughs that pass a given point each second is called the frequency of the sound wave.

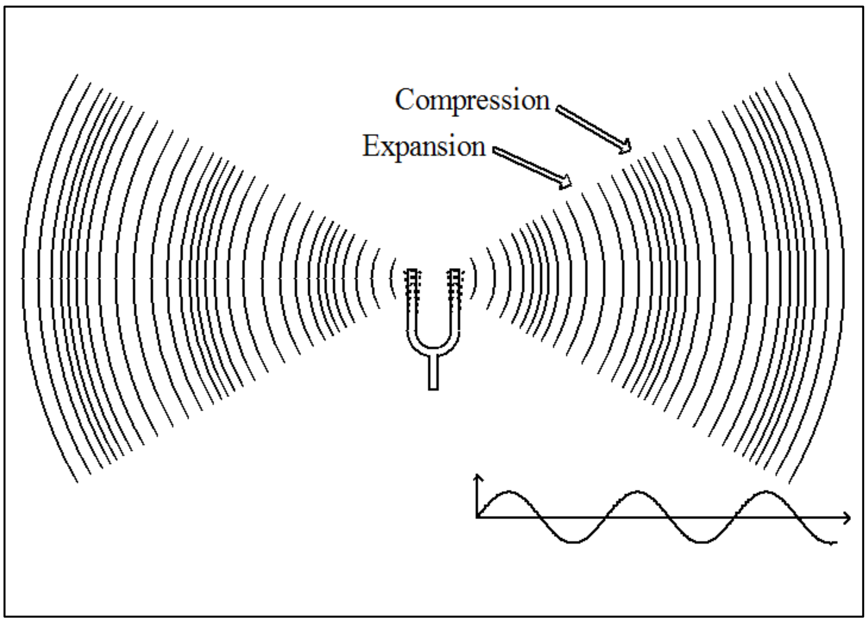


Figure B-1 Sound Waves from a Vibrating Tuning Fork

The measurement and human perception of sound involves three basic physical characteristics: intensity, frequency, and duration

- **Intensity** is a measure of the acoustic energy of the sound and is related to sound pressure. The greater the sound pressure, the more energy carried by the sound and the louder the perception of that sound.
- **Frequency** is the physical attribute most closely associated with the subjective attribute "pitch"— the higher the frequency, the higher the pitch. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or

screeches. Frequency is defined by the number of oscillations in the sound pressure or particle motion per second.

- **Duration** is the length of time the sound can be detected. Duty cycle describes the portion of time that a sound source actually generates sound. It is defined as the percentage of time during which a sound is generated over a total operational time period. For example, if a sonar source produces a one-second ping every 10 seconds, the duty cycle is 10 percent. Duty cycles vary among different acoustic sources; in general, a low-duty cycle could be considered 20 percent or less and a high-duty cycle 80 percent or higher.

The loudest sounds that can be comfortably heard by the human ear have intensities a trillion times higher than those of sounds barely heard. Because of this vast range, it is unwieldy to use a linear scale to represent the intensity of sound. Furthermore, the perceived relative loudness of two sounds relates to the ratio of the sound pressure level (SPL) rather than to the difference in the sound pressure's absolute values. Use of the logarithmic decibel (dB) unit of measure both compresses the wide range of sound pressure levels into a more useful scale and reflects the relative way in which different sound pressure levels are perceived. Decibel values are the logarithm of the ratio of the sound pressure being described to a reference pressure. By convention, sound levels in air are stated for a reference pressure of 20 micropascals (µPa), and sound levels in water are stated for a reference pressure of 1 µPa. Because of the differences in reference units, the same sound pressure would result in different decibel values in air and in water, and sound pressure levels in air and in water should never be directly compared. Sounds that do not have a reference level stated can be assumed to be referenced to 20 µPa, while sounds in water are typically specifically denoted as being referenced to 1 µPa.

An in-air sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are felt as pain (Berglund and Lindvall 1995).

As shown in Figure B-2, the sound from a tuning fork spreads out uniformly as it travels from the source. The spreading causes the sound's intensity to decrease with increasing distance from the source. For a source such as an aircraft in flight, the sound level will decrease by about 6 dB for every doubling of the distance. For a busy highway, the sound level will decrease by 3-4.5 dB for every doubling of distance.

As sound travels from the source, it also gets absorbed by the air. The amount of absorption depends on the frequency composition of the sound, the temperature, and the humidity conditions. Sound with high-frequency content gets absorbed by the air more than sound with low-frequency content. More sound is absorbed in colder and drier conditions than in hot and wet conditions. Sound is also affected by wind and temperature gradients, terrain (elevation and ground cover) and structures.

Because of the logarithmic nature of the decibel unit, sound levels cannot simply be added or subtracted and are somewhat cumbersome to handle mathematically. However, some simple rules are useful in dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example:

$$60 \text{ dB} + 60 \text{ dB} = 63 \text{ dB, and}$$

$$80 \text{ dB} + 80 \text{ dB} = 83 \text{ dB.}$$

Second, the total sound level produced by two sounds of different levels is usually only slightly more than the higher of the two. For example:

60.0 dB + 70.0 dB = 70.4 dB.

Because the addition of sound levels is different than that of ordinary numbers, this process is often referred to as "decibel addition."

The minimum change in the sound level of individual events that an average human ear can detect is about 3 dB. On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of the sound's loudness. This relation holds true for loud and quiet sounds. A decrease in sound level of 10 dB actually represents a 90% decrease in sound intensity but only a 50% decrease in perceived loudness because the human ear does not respond linearly.

Sound frequency is measured in terms of cycles per second or hertz (Hz). The normal ear of a young person can detect sounds that range in frequency from about 20 Hz to 20,000 Hz. As we get older, we lose the ability to hear high frequency sounds. Not all sounds in this wide range of frequencies are heard equally. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 Hz range. The notes on a piano range from just over 27 Hz to 4,186 Hz, with middle C equal to 261.6 Hz. Most sounds (including a single note on a piano) are not simple pure tones like the tuning fork in Figure B-1, but contain a mix, or spectrum, of many frequencies.

In this document, sounds are generally described as either low- (less than 1 kilohertz [kHz]), mid- (1 kHz–10 kHz), high- (10 kHz–100 kHz), or very high- (greater than 100 kHz) frequency. Hearing ranges of marine animals (e.g., fish, birds, sea turtles, and marine mammals) are quite varied and are species-dependent. For example, some fish can hear sounds below 100 Hz and some species of marine mammals have hearing capabilities that extend above 100 kHz. Acoustic impact analysis must, therefore, focus not only on the sound amplitude (i.e., pressure or particle motion), but on the sound frequency and the hearing capabilities of the species being considered.

The wavelength of a sound is the distance between wave peaks. Wavelength decreases as frequency increases. The frequency multiplied by the wavelength equals the speed of sound in a medium, as shown in this equation:

Frequency (s^{-1}) x wavelength (m) = sound speed (m/s)

The approximate speed of sound in sea water is 1,500 meters per second and in air is 340 meters per second, although speed varies depending on environmental conditions (e.g., pressure, temperature, and in the case of sea water, salinity).

Sounds with different spectra are perceived differently even if the sound levels are the same. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. A-weighting and C-weighting are the two most common weightings. These two curves, shown in Figure B-2, are adequate to quantify most environmental noises. A-weighting puts emphasis on the 1,000 to 4,000 Hz range.

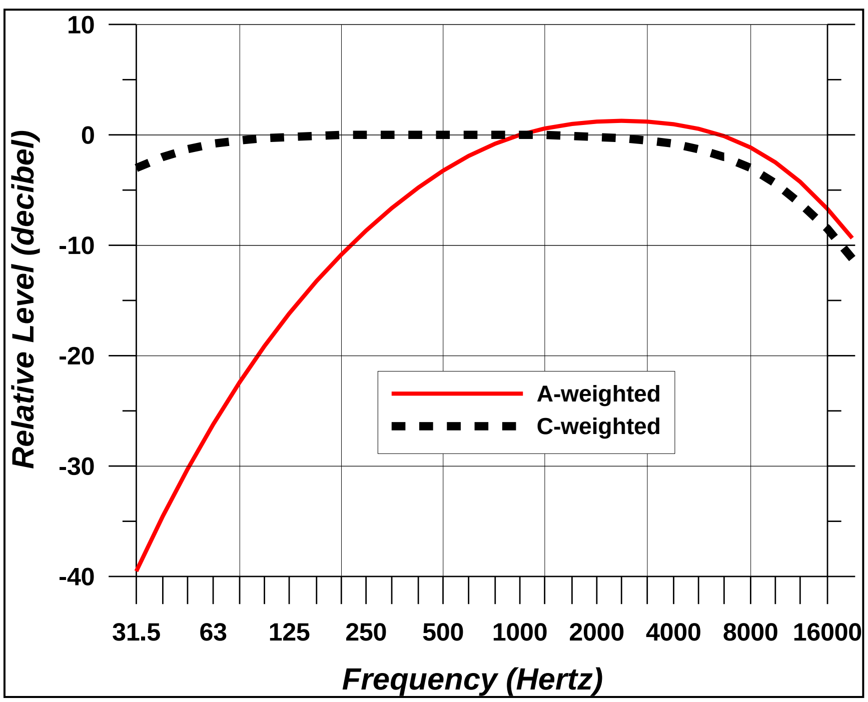
Very loud or impulsive sounds, such as explosions or sonic booms, can sometimes be felt, and can cause secondary effects, such as shaking of a structure or rattling of windows. These types of sounds can add to annoyance, and are best measured by C-weighted sound levels, denoted dBC. C-weighting is nearly flat throughout the audible frequency range, and includes low frequencies that may not be heard but cause shaking or rattling. C-weighting approximates the human ear's sensitivity to higher intensity sounds.

B.1.2 Acoustic Impedance

Acoustic impedance is a property of the propagation medium (air, water, or tissue) that can be simply described as the opposition to flow of a pressure wave. Acoustic impedance is a function of the density and speed of sound in a medium. Sound transmits more readily through materials of similar acoustic impedance, such as water and animal tissue. When sound waves encounter a medium with different acoustic impedance (e.g., an air-water interface), they reflect and refract, creating more complex propagation conditions. For example, sound traveling in air (low impedance) encountering the water surface (high impedance) will be largely reflected, preventing most sound energy in the air from being transmitted into the water.

B.1.3 Sound Levels and Types of Sounds

Most environmental sounds are measured using A-weighting. They are called A-weighted decibel sound levels, and sometimes use the unit dBA or dB(A) rather than dB. An example of the weighting would be if the unweighted received level of a 500 Hz tone at a human receiver was 90 dB referenced to 20 µPa, the A-weighted sound level would be 87 dBA, because the A-weighting function amplitude at 500 Hz is -3dB (Figure B-2). When the use of A-weighting is understood, the term "A-weighted" is often omitted and the unit dB is used. Unless otherwise stated, dB units refer to A-weighted sound levels.



Source: ANSI S1.4A -1985 "Specification of Sound Level Meters"

Figure B-2 Frequency Characteristics of A- and C-Weighting

When sound is purposely created to convey information, communicate, or obtain information about the environment, it is often referred to as a signal. Examples of sounds that could be considered signals are sonar pings, marine mammal vocalizations and echolocation clicks, and tones used in hearing experiments.

Sound becomes noise when it is unwelcome and interferes with normal activities, such as sleep or conversation. Noise is unwanted sound. Sounds produced by naval aircraft and vessel propulsion are considered noise because they represent possible inefficiencies and increased detectability. Noise can become an issue when its level exceeds the ambient or background sound level. Whether a sound is perceived as noise often depends on the receiver (i.e., the animal or system that detects the sound). For example, sonar used to generate sounds that can locate an enemy submarine produce signals that are useful to sailors engaged in anti-submarine warfare, but are assumed to be noise when detected by marine mammals.

The combination of all sounds at a particular location, whether these sources are located near or far, is ambient noise (American National Standards Institute, 1994). Ambient noise includes natural sources, such as sound from crashing waves, rain, and animals and anthropogenic sources, such as seismic surveys and vessel noise. Ambient noise in urban areas typically varies from 60 to 70 dB, but can be as high as 80 dB in the center of a large city. Quiet suburban neighborhoods experience ambient noise levels around 45-50 dB (U.S. Environmental Protection Agency (USEPA) 1978).

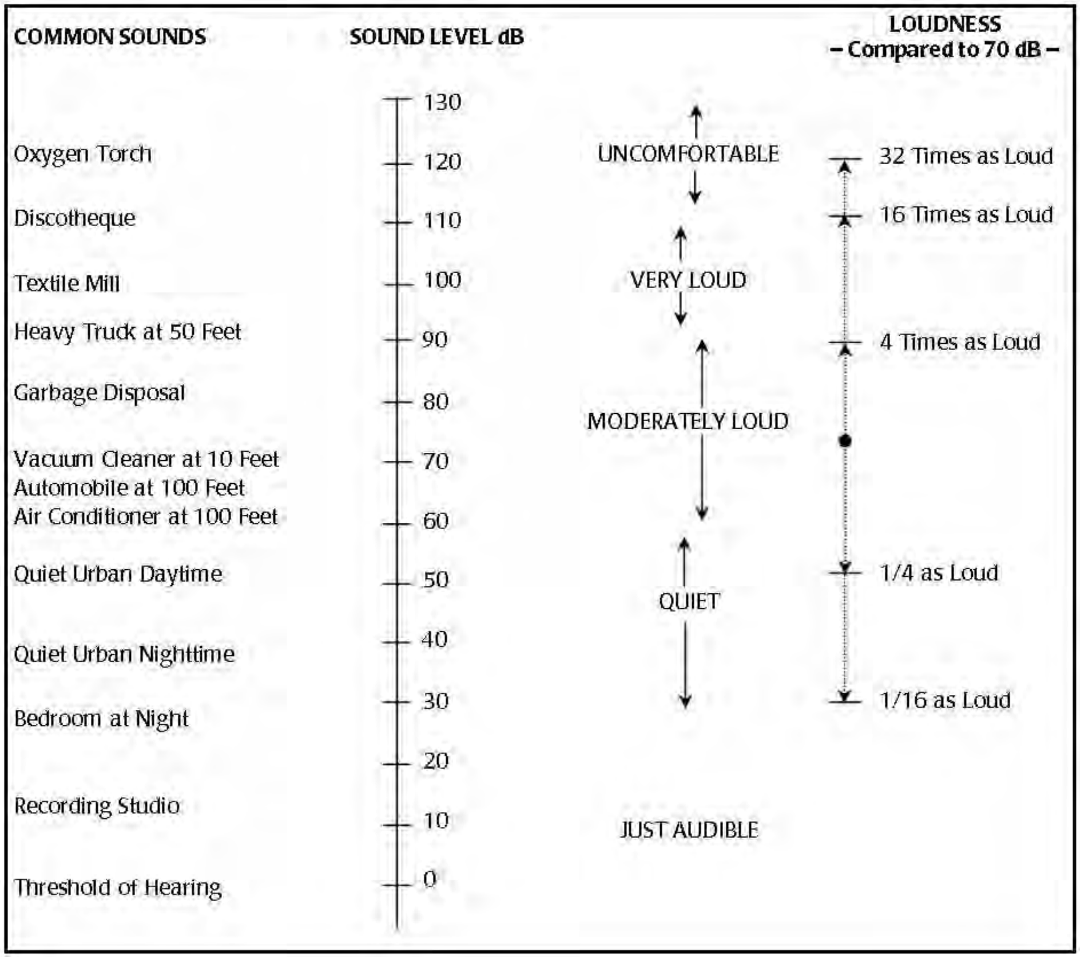
Figure B-3 is a chart of A-weighted sound levels from common sources. Some sources, like the air conditioner and vacuum cleaner, are continuous sounds whose levels are constant for some time. Some sources, like the automobile and heavy truck, are the maximum sound during an intermittent event like a vehicle pass-by. Some sources like “urban daytime” and “urban nighttime” are averages over extended periods. A variety of noise metrics have been developed to describe noise over different time periods. These are discussed in detail in Section B.2.

Aircraft noise consists of two major types of sound events: flight (including takeoffs, landings and flyovers), and stationary, such as engine maintenance run-ups. The former are intermittent and the latter primarily continuous. Noise from aircraft overflights typically occurs beneath main approach and departure paths, in local air traffic patterns around the airfield, and in areas near aircraft parking ramps and staging areas. As aircraft climb, the noise received on the ground drops to lower levels, eventually fading into the background or ambient levels.

Impulsive noises are generally short, loud events. Their single-event duration is usually less than 1 second. Examples of impulsive noises are small-arms gunfire, hammering, pile driving, metal impacts during rail-yard shunting operations, and riveting. Examples of high-energy impulsive sounds are quarry/mining explosions, sonic booms, demolition, and industrial processes that use high explosives, military ordnance (e.g., armor, artillery and mortar fire, and bombs), explosive ignition of rockets and missiles, and any other explosive source where the equivalent mass of dynamite exceeds 25 grams (American National Standards Institute [ANSI] 1996).

B.2 Noise Metrics

Noise metrics quantify sounds so they can be compared with each other, and with their effects, in a standard way. The simplest metric is the A-weighted level, which is appropriate by itself for constant noise such as an air conditioner. Aircraft noise varies with time. During an aircraft overflight, noise starts at the background level, rises to a maximum level as the aircraft flies close to the observer, then returns to the background as the aircraft recedes into the distance. This is sketched in Figure B-4, which also indicates two metrics (maximum sound level [L_{max}] and sound exposure level [SEL]) that are described in Sections B.2.1 and B.2.3 below. Over time there can be a number of events, not all the same.



Sources: Harris 1979.

Figure B-3 Typical A-weighted Sound Levels of Common Sounds

There are a number of metrics that can be used to describe a range of situations, from a particular individual event to the cumulative effect of all noise events over a long time. This section describes the metrics relevant to environmental noise analysis.

B.2.1 Single-events

Maximum Sound Level (L_{max})

The highest A-weighted sound level measured during a single event in which the sound changes with time is called the maximum A-weighted sound level or Maximum Sound Level and is abbreviated L_{max}. The L_{max} is depicted for a sample event in Figure B-4.

L_{max} is the maximum level that occurs over a fraction of a second. For aircraft noise, the “fraction of a second” is one-eighth of a second, denoted as “fast” response on a sound level measuring meter (ANSI 1988). Slowly varying or steady sounds are generally measured over 1 second, denoted “slow” response. L_{max} is important in judging if a noise event will interfere with conversation, TV or radio listening, or other common activities. Although it provides some measure of the event, it does not fully describe the noise, because it does not account for how long the sound is heard.

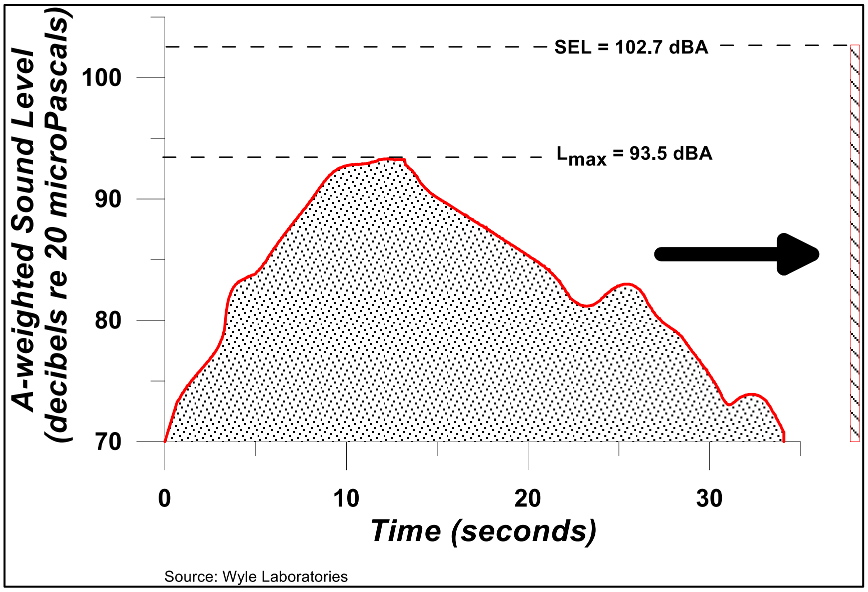


Figure B-4 Example Time History of Aircraft Noise Flyover

Peak Sound Pressure Level (L_{pk})

The Peak Sound Pressure Level is the highest instantaneous level measured by a sound level measurement meter. L_{pk} is typically measured every 20 microseconds, and usually based on unweighted or linear response of the meter. It is used to describe individual impulsive events such as blast noise. Because blast noise varies from shot to shot and varies with meteorological (weather) conditions, the U.S. Department of Defense (DOD) usually characterizes L_{pk} by the metric PK 15(met), which is the L_{pk} exceeded 15% of the time. The "met" notation refers to the metric accounting for varied meteorological or weather conditions.

Sound Exposure Level (SEL)

Sound Exposure Level combines both the intensity of a sound (sound pressure level) and its duration. For an aircraft flyover, SEL includes the maximum and all lower noise levels produced as part of the overflight, together with how long each part lasts. It represents the total sound energy in the event. In addition, SEL can be provided for a single exposure such as a single sonar ping, or for an entire acoustic event such as multiple sonar pings. Figure B-4 indicates the SEL for an example event, representing it as if all the sound energy were contained within 1 second.

Because aircraft noise events last more than a few seconds, the SEL value is larger than L_{max}. It does not directly represent the sound level heard at any given time, but rather the entire event.

SEL is determined by calculating the dB level of the cumulative sum-of-squared pressures over the duration of a sound, with units of dB referenced to 1 micropascal squared per second (μPa^2-s) for sounds in water and dB referenced to 20 μPa^2-s for sounds in air. Some rules of thumb for SEL are as follows:

- The numeric value of SEL is equal to the sound pressure level of a 1-second sound that has the same total energy as the exposure event. If the sound duration is 1 second, sound pressure level and SEL have the same numeric value (but not the same reference quantities). For example, a 1-second sound with a sound pressure level of 100 µPa has an SEL of 100 dB referenced to 1 μPa^2-s.
- If the sound duration is constant but the sound pressure level changes, SEL will change by the same number of dBs as the sound pressure level.
- If the sound pressure level is held constant and the duration changes, SEL will change as a function of 10 $\log_{10}$(duration):
    - 10 $\log_{10}(10) = 10$, so increasing duration by a factor of 10 raises SEL by 10 dB.
    - 10 $\log_{10}(0.1) = -10$, so decreasing duration by a factor of 10 lowers SEL by 10 dB.
    - 10 $\log_{10}(2) = 3$, so doubling the duration increases SEL by 3 dB.
    - 10 $\log_{10}(1/2) = -3$, so halving the duration lowers SEL by 3 dB.

B.2.2 Cumulative Events

Equivalent Sound Level (L_{eq})

Equivalent Sound Level is a "cumulative" metric that combines a series of noise events over a period of time. L_{eq} is the sound level that represents the decibel average SEL of all sounds in the time period. Just as SEL has proven to be a good measure of a single event, L_{eq} has proven to be a good measure of series of events during a given time period.

The time period of an L_{eq} measurement is usually related to some activity, and is given along with the value. The time period is often shown in parenthesis (e.g., $L_{eq(24)}$ for 24 hours). The L_{eq} from 7 a.m. to 3 p.m. may give exposure of noise for a school day.

Figure B-5 gives an example of $L_{eq(24)}$ using notional hourly average noise levels ($L_{eq(h)}$) for each hour of the day as an example. The $L_{eq(24)}$ for this example is 61 dB.

Day-Night Average Sound Level (DNL or L_{dn}) and Community Noise Equivalent Level (CNEL)

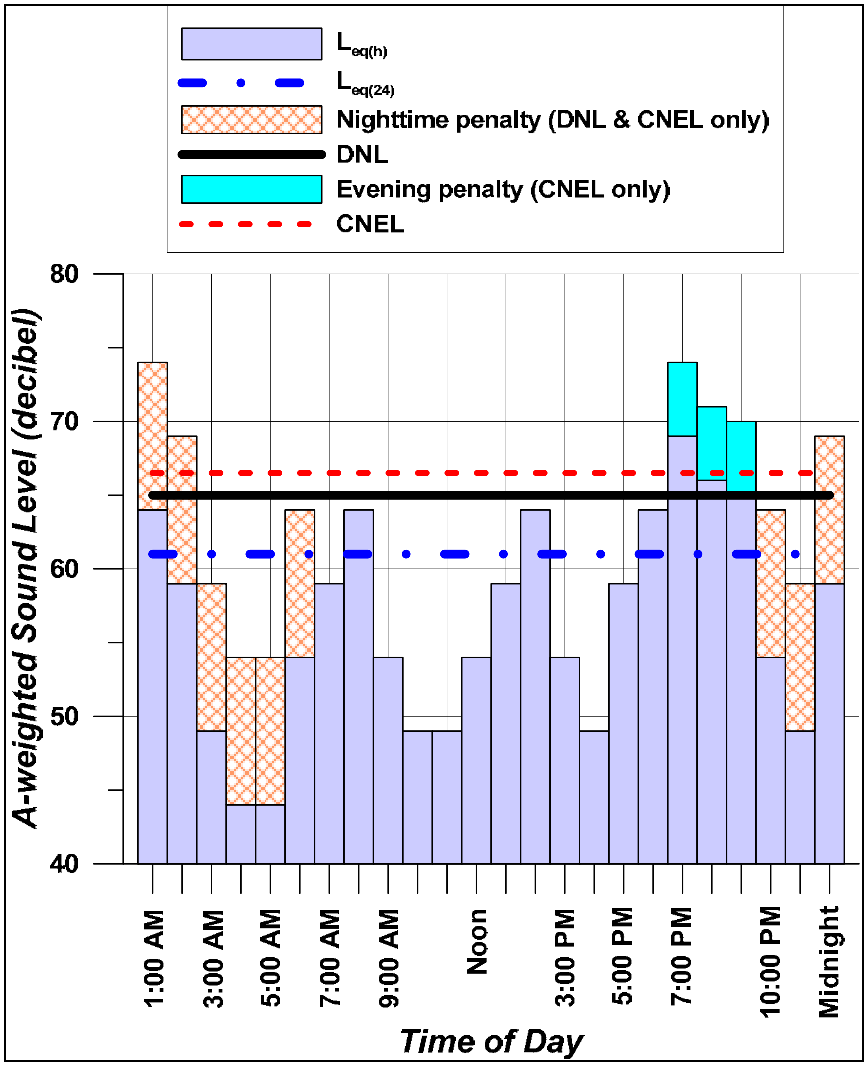
Day-Night Average Sound Level is a cumulative metric that accounts for all noise events in a 24-hour period. However, unlike $L_{eq(24)}$, DNL contains a nighttime noise penalty. To account for our increased sensitivity to noise at night, DNL applies a 10 dB penalty to events during the nighttime period, defined as 10:00 p.m. to 7:00 a.m. The notations DNL and L_{dn} are both used for Day-Night Average Sound Level and are equivalent.

CNEL is a variation of DNL specified by law in California (California Code of Regulations Title 21, *Public Works*) (Wyle Laboratories 1970). CNEL has the 10 dB nighttime penalty for events between 10:00 p.m. and 7:00 a.m. but also includes a 4.8 dB penalty for events during the evening period of 7:00 p.m. to 10:00 p.m. The evening penalty in CNEL accounts for the added intrusiveness of sounds during that period.

For airports and military airfields, DNL and CNEL represent the average sound level for annual average daily aircraft events.

Figure B-5 gives an example of DNL and CNEL using notional hourly average noise levels ($L_{eq(h)}$) for each hour of the day as an example. Note the $L_{eq(h)}$ for the hours between 10 p.m. and 7 a.m. have a 10 dB penalty assigned. For CNEL the hours between 7p.m. and 10 p.m. have a 4.8 dB penalty assigned. The DNL for this example is 65 dB. The CNEL for this example is 66 dB.

Figure B-6 shows the ranges of DNL or CNEL that occur in various types of communities. Under a flight path at a major airport the DNL may exceed 80 dB, while rural areas may experience DNL less than 45 dB.



Source: Wyle Laboratories

Figure B-5 Example of $L_{eq(24)}$, DNL and CNEL Computed from Hourly Equivalent Sound Levels

The decibel summation nature of these metrics causes the noise levels of the loudest events to control the 24-hour average. As a simple example, consider a case in which only one aircraft overflight occurs during the daytime over a 24-hour period, creating a sound level of 100 dB for 30 seconds. During the remaining 23 hours, 59 minutes, and 30 seconds of the day, the ambient sound level is 50 dB. The DNL for this 24-hour period is 65.9 dB. Assume, as a second example that 10 such 30-second overflights occur during daytime hours during the next 24-hour period, with the same ambient sound level of 50 dB during the remaining 23 hours and 55 minutes of the day. The DNL for this 24-hour period is 75.5 dB. Clearly, the averaging of noise over a 24-hour period does not ignore the louder single events and tends to emphasize both the sound levels and number of those events.

A feature of the DNL metric is that a given DNL value could result from a very few noisy events or a large number of quieter events. For example, 1 overflight at 90 dB creates the same DNL as 10 overflights at 80 dB.

DNL or CNEL do not represent a level heard at any given time, but represent long term exposure. Scientific studies have found good correlation between the percentages of groups of people highly annoyed and the level of average noise exposure measured in DNL (Schultz 1978; USEPA 1978).

Onset-Rate Adjusted Monthly Day-Night Average Sound Level (L_{dnmr}) and Onset-Rate Adjusted Monthly Community Noise Equivalent Level ($CNEL_{mr}$)

Military aircraft utilizing Special Use Airspace (SUA) such as Military Training Routes (MTRs), Military Operations Areas (MOAs), and Restricted Areas/Ranges generate a noise environment that is somewhat different from that around airfields. Rather than regularly occurring operations like at airfields, activity in SUAs is highly sporadic. It is often seasonal, ranging from 10 per hour to less than 1 per week. Individual military overflight events also differ from typical community noise events in that noise from a low-altitude, high-airspeed flyover can have a rather sudden onset, with rates of up to 150 dB per second.

The cumulative daily noise metric devised to account for the "surprise" effect of the sudden onset of aircraft noise events on humans and the sporadic nature of SUA activity is the Onset-Rate Adjusted Monthly Day-Night Average Sound Level (L_{dnmr}). Onset rates between 15 and 150 dB per second require an adjustment of 0 to 11 dB to the event's SEL, while onset rates below 15 dB per second require no adjustment to the event's SEL (Stusnick et al. 1992). The term "monthly" in L_{dnmr} refers to the noise assessment being conducted for the month with the most operations or sorties -- the so-called busiest month.

In California, a variant of the L_{dnmr} includes a penalty for evening operations (7 p.m. to 10 p.m.) and is denoted $CNEL_{mr}$.

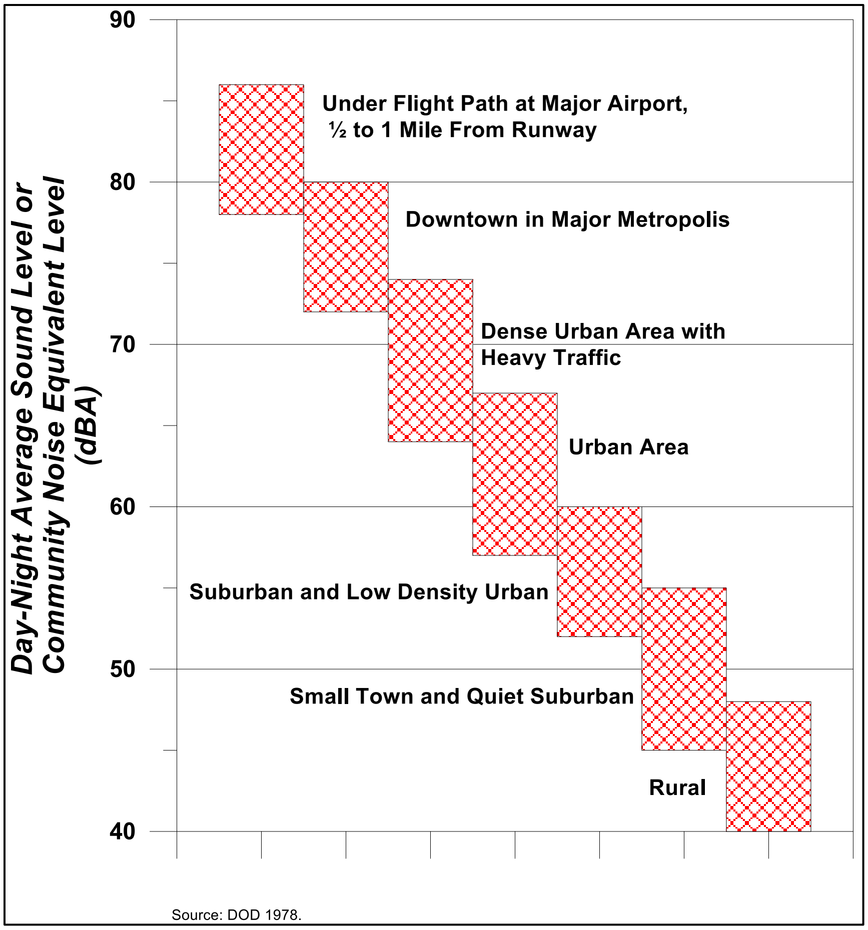


Figure B-6 Typical DNL or CNEL Ranges in Various Types of Communities

B.2.3 Supplemental Metrics

Number-of-Events Above (NA) a Threshold Level (L)

The Number-of-Events Above (NA) metric gives the total number of events that exceed a noise level threshold (L) during a specified period of time. Combined with the selected threshold, the metric is denoted NAL. The threshold can be either SEL or L_{max}, and it is important that this selection is shown in the nomenclature. When labeling a contour line or point of interest (POI), NAL is followed by the number of events in parentheses. For example, where 10 events exceed an SEL of 90 dB over a given period of time, the nomenclature would be NA90SEL(10). Similarly, for L_{max} it would be NA90L_{max}(10). The period of time can be an average 24-hour day, daytime, nighttime, school day, or any other time period appropriate to the nature and application of the analysis.

NA is a supplemental metric. It is not supported by the amount of science behind DNL/CNEL, but it is valuable in helping to describe noise to the community. A threshold level and metric are selected that best meet the need for each situation. An L_{max} threshold is normally selected to analyze speech interference, while an SEL threshold is normally selected for analysis of sleep disturbance.

The NA metric is the only supplemental metric that combines single-event noise levels with the number of aircraft operations. In essence, it answers the question of how many aircraft (or range of aircraft) fly over a given location or area at or above a selected threshold noise level.

Time Above (TA) a Specified Level (L)

The Time Above (TA) metric is the total time, in minutes, that the A-weighted noise level is at or above a threshold. Combined with the threshold level (L), it is denoted TAL. TA can be calculated over a full 24-hour annual average day, the 15-hour daytime and 9-hour nighttime periods, a school day, or any other time period of interest, provided there is operational data for that time.

TA is a supplemental metric, used to help understand noise exposure. It is useful for describing the noise environment in schools, particularly when assessing classroom or other noise sensitive areas for various scenarios. TA can be shown as contours on a map similar to the way DNL contours are drawn.

TA helps describe the noise exposure of an individual event or many events occurring over a given time period. When computed for a full day, the TA can be compared alongside the DNL in order to determine the sound levels and total duration of events that contribute to the DNL. TA analysis is usually conducted along with NA analysis so the results show not only how many events occur, but also the total duration of those events above the threshold.

B.3 Predicting How Sound Travels

While the concept of a sound wave traveling from its source to a receptor is relatively simple, sound propagation is quite complex because of the simultaneous presence of numerous sound waves of different frequencies and source levels, and other phenomena such as reflections of sound waves and subsequent constructive (additive) or destructive (cancelling) interferences between reflected and incident waves. Other factors such as refraction, diffraction, bottom types, and surface conditions also affect sound propagation. While simple examples are provided here for illustration, the Navy Acoustic Effects Model used to quantify acoustic exposures to marine mammals and sea turtles, takes into account the influence of multiple factors to predict acoustic propagation. Refer to the technical report entitled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (Navy, 2018).

B.3.1 Speed of Sound

The speed of sound is not affected by the SPL or frequency of the sound, but rather depends wholly on characteristics of the medium through which it is passing (e.g., the density and the compressibility). Sound travels faster through a medium that is harder to compress. For example, water is more difficult to compress than air, and sound travels approximately 340 meters per second in air and 1,500 meters per second in seawater.

The speed of sound in air is primarily influenced by temperature, relative humidity, and pressure, because these factors affect the density and compressibility of air. Generally, the speed of sound in air increases as air temperature increases.

The speed of sound in seawater also increases with increasing temperature and, to a lesser degree, with increasing hydrostatic pressure and salinity. In seawater, temperature has the most important effect on sound speed for depths less than approximately 300 meters. Below 1,500 meters, the increasing hydrostatic pressure is the dominant factor because the water temperature is relatively constant. The variation of sound speed with depth in the ocean is called a sound velocity profile.

B.3.2 Source Directivity

Most active acoustic sources do not radiate sound in all directions. Rather, they emit sounds over a limited range of angles, in order to focus sound energy on a specific area or object of interest. The specific angles are sometimes given as horizontal or vertical beam width. Some sources can be described qualitatively as “forward-looking,” when sound energy is radiated in a limited direction in front of the source, or “downward-looking,” when sound energy is directed toward the bottom.

B.3.3 Sound Attenuation

As a sound wave passes through a medium, the sound level decreases with distance from the sound source. This phenomenon is known as attenuation, which is described in terms of transmission loss (TL). The transmission loss is used to relate the source **sound pressure level** (SL), defined as the **sound pressure level** produced by a sound source at a distance of one meter, and the received **sound pressure level** (RL) at a particular location, as follows:

RL = SL – TL

The main contributors to sound attenuation are as follows (Urick, 1983):

- geometric spreading of the sound wave as it propagates away from the source
- sound absorption (conversion of sound energy into heat)
- scattering, diffraction, multipath interference, and boundary effects

B.3.3.1 Geometric Spreading Loss

Spreading loss is a geometric effect representing regular weakening of a sound wave as it spreads out from a source. Spreading describes the reduction in sound pressure caused by the increase in surface area as the distance from a sound source increases. Spherical and cylindrical spreading are common types of spreading loss.

In the simple case of sound propagating from a point source without obstruction or reflection, the sound waves take on the shape of an expanding sphere. An example of spherical spreading loss is shown in Figure B-7. As spherical propagation continues, the sound energy is distributed over an ever-larger area following the inverse square law: the pressure of a sound wave decreases inversely with the square of the distance between the source and the receptor. For example, doubling the distance between the receptor and a sound source results in a reduction in the pressure of the sound to one-fourth of its initial value, tripling the distance results in one-ninth of the original pressure, and so on. Since the surface area of a sphere is 4πr2, where r is the sphere radius, the change in SPL with distance *r* from the source is proportional to the radius squared. This relationship is known as the spherical spreading law. The transmission loss for spherical spreading between two locations is:

TL = 20 $\log_{10}$ (r2/r1),

where r1 and r2 are distances from the source. Spherical spreading results in a 6 dB reduction in SPL for each doubling of distance from the sound source. For example, calculated transmission loss for spherical spreading is 40 dB at 100 meters and 46 dB at 200 meters.

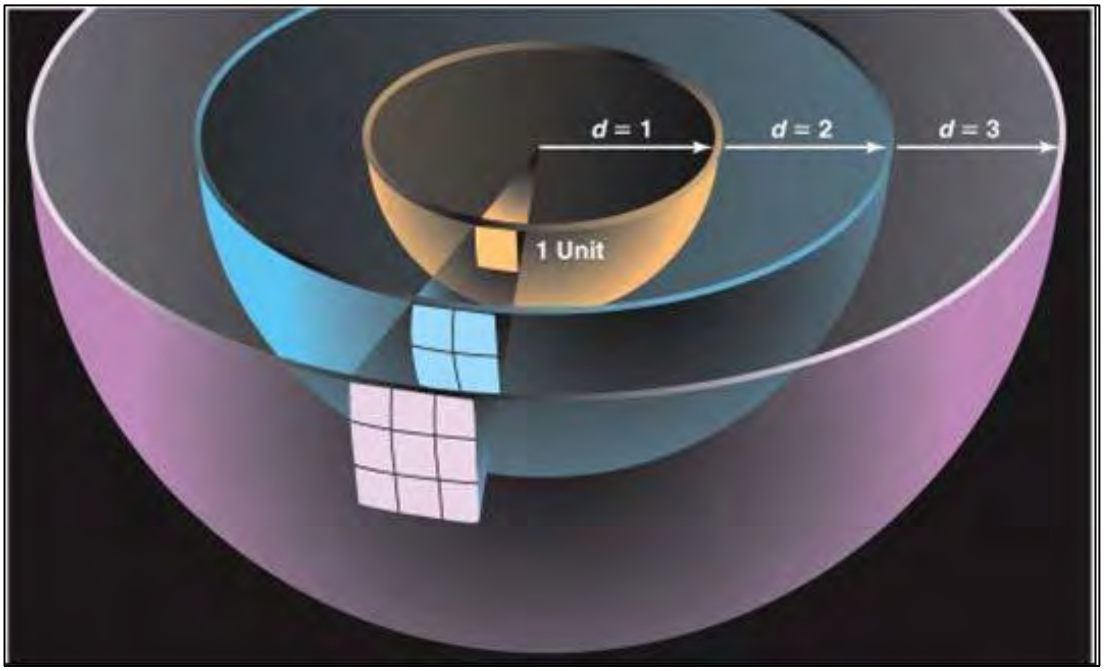


Figure B-7 Graphical Representation of the Inverse Square Relationship in Spherical Spreading

In cylindrical spreading, spherical waves expanding from the source are constrained by the water surface and the sea floor and take on a cylindrical shape. In this case, the sound wave expands in the shape of a cylinder rather than a sphere, and the transmission loss is:

$TL = 10 \log_{10} (r2/r1)$

Cylindrical spreading is an approximation of sound propagation in a water-filled channel with horizontal dimensions much larger than the depth. Cylindrical spreading predicts a 3-dB reduction in SPL for each doubling of distance from the source. For example, calculated transmission loss for cylindrical spreading is 30 dB at 1,000 meters and 33 dB at 2,000 meters.

The cylindrical and spherical spreading equations above represent two simple hypothetical cases. In reality, geometric spreading loss is more spherical near a source and more cylindrical with distance, and is better predicted using more complex models that account for environmental variables, such as the Navy Acoustic Effects Model. Refer to the technical report entitled *Quantifying Acoustic Impacts on Marine Mammals and Sea Turtles: Methods and Analytical Approach for Phase III Training and Testing* (Navy, 2018).

However, when conducting simple spreading loss calculations in near-shore environments, “practical spreading loss” can be applied, where:

$TL = 15 \log_{10}(r2/r1)$

Practical spreading loss accounts for other realistic losses in the environment, such as absorption and scattering, which are not accounted for in geometrical spreading.

B.3.3.2 Absorption

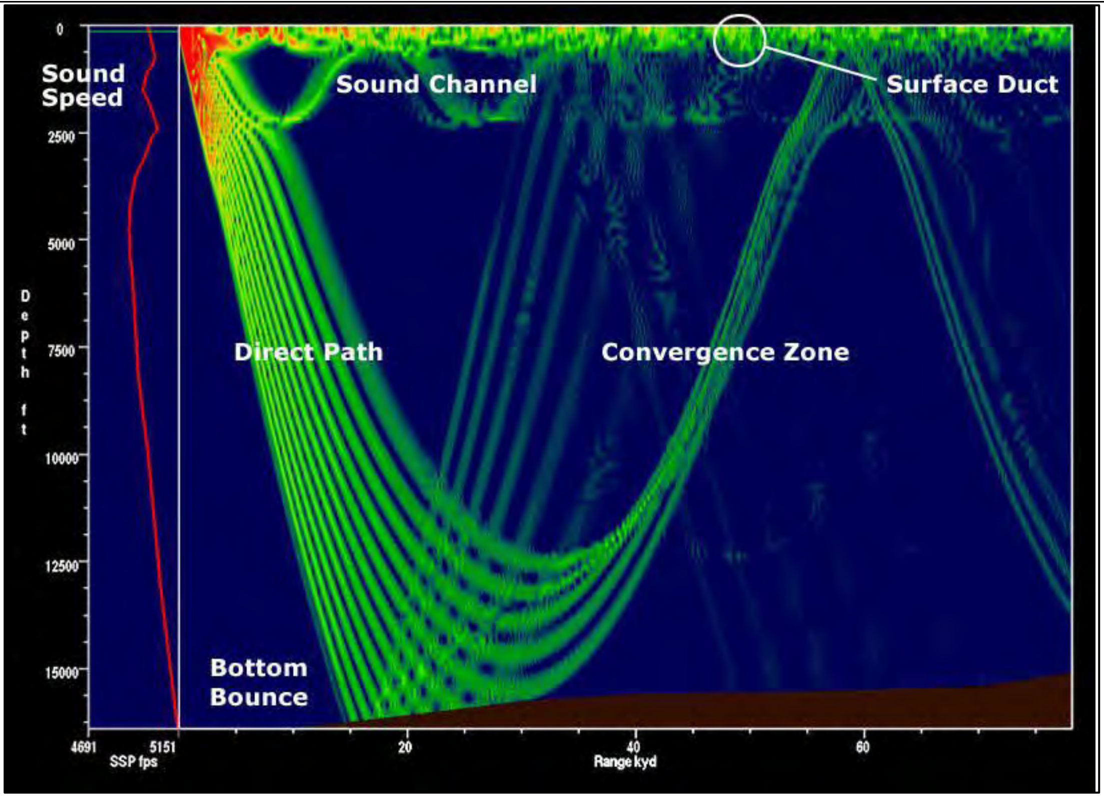
Absorption is the conversion of acoustic energy to kinetic energy in the particles of the propagation medium (Urick, 1983). Absorption is directly related to sound frequency, with higher frequencies having higher rates of absorption. Absorption rates range from 0.07 dB/kilometer for a 1 kHz sound to about 30 dB/kilometer for a 100 kHz sound. Therefore, absorption is the cause of a significant amount of attenuation for high- and very high-frequency sound sources, reducing the distance over which these sources may be perceived compared to mid- and low-frequency sound sources with the same source level.

B.3.3.3 Refraction

When a sound wave propagating in a medium encounters a second medium with a different density (e.g., the air-water boundary), part of the incident sound will be reflected back into the first medium and part will be transmitted into the second medium (Kinsler et al., 1982). The propagation direction will change as the sound wave enters the second medium; this phenomenon is called refraction. Refraction may also occur within a single medium if the properties of the medium change enough to cause a variation in the sound speed. Refraction of sound resulting from spatial variations in the sound speed is one of the most important phenomena that affect sound propagation in water (Urick, 1983).

As discussed in Section B.3.1, the sound speed in the ocean primarily depends on hydrostatic pressure (i.e., depth) and temperature. Although the actual variations in sound speed are small, the existence of sound speed gradients in the ocean has an enormous effect on the propagation of sound in the ocean. If one pictures sound as rays emanating from an underwater source, the propagation of these rays changes as a function of the sound speed profile in the water column. Specifically, the directions of the rays bend toward regions of slower sound speed. This phenomenon creates ducts in which sound becomes “trapped,” allowing it to propagate with high efficiency for large distances within certain depth boundaries. During winter months, the reduced sound speed at the surface due to cooling can create a surface duct that efficiently propagates sound such as commercial shipping noise (Figure **B**-**8**). Sources located within this surface duct can have their sounds trapped, but sources located below this layer would have their sounds refracted downward. The deep sound channel, or sound frequency and ranging channel, is another duct that exists where sound speeds are slowest deeper in the water column (600–1,200-meter depth at the mid-latitudes).

Similarly, the path of sound will bend toward regions of lower sound speed in air. Air temperature typically decreases with altitude, meaning sounds produced in air tend to bend skyward. When an atmospheric temperature inversion is present, air is cooler near the earth’s surface. In inversion conditions, sound waves near the earth’s surface will tend to refract downward.



[1 kiloyard (kyd) = 0.9 kilometers (km)]

Figure B-8 **Sound Propagation Showing Multipath Propagation and Conditions for Surface Duct**

B.3.3.4 Reflection and Multipath Propagation

In multipath propagation, sound may not only travel a direct path (with no reflection) from a source to a receiver, but also be reflected from the surface or bottom multiple times before reaching the receiver (Urick, 1983). Reflection is shown in Figure **B**-**8** at the sea floor (bottom bounce) and at the water surface. At some distances, the reflected wave will be in phase with the direct wave (their waveforms add together), and at other distances the two waves will be out of phase (their waveforms cancel). The existence of multiple sound paths, or rays, arriving at a single point can result in multipath interference, a condition that permits the addition and cancellation between sound waves, resulting in the fluctuation of sound levels over short distances.

Reflection plays an important role in the pressures observed at different locations in the water column. Near the bottom, the direct path pressure wave may sum with the bottom-reflected pressure wave, increasing the exposure. Near the surface, however, the surface-reflected pressure wave may destructively interfere with the direct path pressure wave, “cutting off” the wave and reducing exposure (called the Lloyd mirror effect). This can cause the sound level to decrease dramatically within the top few meters of the water column.

B.3.3.5 Diffraction, Scattering, and Reverberation

Diffraction, scattering, and reverberation are examples of what happens when sound waves interact with obstacles in the propagation path.

Diffraction may be thought of as the change of direction of a sound wave as it passes around an obstacle. Diffraction depends on the size of the obstacle and the sound frequency. The wavelength of the sound must be larger than the obstacle for notable diffraction to occur. If the obstacle is larger than the wavelength of sound, an acoustic shadow zone will exist behind the obstacle where the sound is unlikely to be detected. Common examples of diffraction include sound heard from a source around the corner of a building and sound propagating through a small gap in an otherwise closed door or window.

An obstacle or inhomogeneity (e.g., smoke, suspended particles, gas bubbles due to waves, and marine life) in the path of a sound wave causes scattering as these inhomogeneities reradiate incident sound in a variety of directions (Urick, 1983). Reverberation refers to the prolongation of a sound, after the source has stopped emitting, caused by multiple reflections at water boundaries (surface and bottom) and scattering.

B.3.3.6 Surface and Bottom Effects

Because the sea surface reflects and scatters sound, it has a major effect on the propagation of underwater sound in applications where either the source or receiver is at a shallow depth (Urick 1983). If the sea surface is smooth, the reflected sound pressure is nearly equal to the incident sound pressure; however, if the sea surface is rough, the amplitude of the reflected sound wave will be reduced. Sound waves reflected from the sea surface experience a phase reversal. When the surface-reflected waves interact with the direct path waves near the surface, a destructive interference pattern is created in which the received pressure approaches zero.

The sea bottom is also a reflecting and scattering surface, similar to the sea surface. Sound interaction with the sea bottom is more complex, however, primarily because the acoustic properties of the sea bottom are more variable, and the bottom is often layered into regions of differing density. As sound travels into the sea floor, it reflects off of these different density layers in complex ways. For sources in contact with the bottom, such as during pile driving or bottom-placed explosives, a ground wave is produced that travels through the bottom sediment and may refract back into the water column.

For a hard bottom such as rock, the reflected wave will be approximately in phase with the incident wave. Thus, near the ocean bottom, the incident and reflected sound pressures may add together (constructive interference), resulting in an increased sound pressure near the sea bottom. Soft bottoms, such as mud or sediment, absorb sound waves and reduce the level in the water column overall.

B.3.3.7 Air-Water Interface

Sound from aerial sources, such as aircraft and weapons firing, may be transmitted into the water under certain conditions. The most studied of these sources are fixed-wing aircraft and helicopters, which create noise with most energy below 500 Hz. Noise levels in water are highest at the surface and are highly dependent on the altitude of the aircraft and the angle at which the aerial sound encounters the ocean surface. Transmission of the sound once it is in the water is identical to any other sound as described in the sections above.

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Young (1973), Urick (1983), Richardson et al. (1995), Eller and Cavanagh (2000), Laney and Cavanagh (2000), and others. Sound is transmitted from an airborne source to a receptor underwater by four principal means: (1) a direct path, refracted upon passing through the air-water interface; (2) direct-refracted paths reflected from the bottom in shallow water; (3) evanescent transmission in which sound travels laterally close to the water surface; and (4) scattering from interface roughness due to wave motion.

When sound waves in air meet the water surface, the sound can either be transmitted across the air-water boundary or reflected off the water surface. When sound waves meet the water at a perpendicular angle (e.g., straight down from an in-air source to a flat water surface), the sound waves are both transmitted directly across the water surface in the same direction of travel and reflected 180 degrees back toward the original direction of travel. This can create a localized condition at the water surface where the incident and reflected waves sum, doubling the in-air overpressure (+6 dB). As the incident angle of the in-air sound wave changes from perpendicular, this phenomena is reduced, ultimately reaching the angle where sound waves are parallel to the water surface and there is no surface reflection.

The sound that enters the water is refracted due to the difference in sound velocity between air and water, as shown in Figure B-9. As the angle of the in-air incident wave moves away from perpendicular, the direction of travel of the underwater refracted waves becomes closer to parallel to the water surface. When the incident angle is reached where the underwater refracted sound wave is parallel to the water surface, all of the sound is reflected back into the air and no sound enters the water. This occurs at an angle of about 13–14 degrees. As a result, most of the acoustic energy is transmitted into the water through a relatively narrow cone extending vertically downward from the in-air source. The width of the footprint would be a function of the source altitude. Lesser amounts of sound may enter the water outside of this cone due to surface scattering (e.g., from water surface waves that can vary the angle of incidence over an area) and evanescent waves that are only present very near the surface.

If a sound wave is ideally transmitted into water (that is, with no surface transmission loss, such as due to foamy, wave conditions that could decrease sound entering the water), the sound pressure level underwater is calculated by changing the pressure reference unit from 20 µPa in air to 1 µPa in water. For a sound with the same pressure in air and water, this calculation results in a +26 dB sound pressure level in water compared to air. For this reason, sound pressure levels in water and sound pressure levels in air should never be directly compared.

B.4 Auditory Perception

Animals with an eardrum or similar structure, including mammals, birds, and reptiles, directly detect the pressure component of sound. Some marine fish also have specializations to detect pressure changes, although most invertebrates and many marine fish do not have anatomical structures that enable them to detect the pressure component of sound, and are only sensitive to the particle motion component of sound. This difference in acoustic energy sensing mechanisms limits the range at which these animals can detect most sound sources analyzed in this document. This is because, far from a sound source (i.e., in the far field), particle velocity and sound pressure are directly proportional. But close to a source (i.e., in the near field), particle velocity increases relative to sound pressure and may become more detectable to certain animals. As sound frequency increases, the wavelength becomes shorter, resulting in a smaller near field.

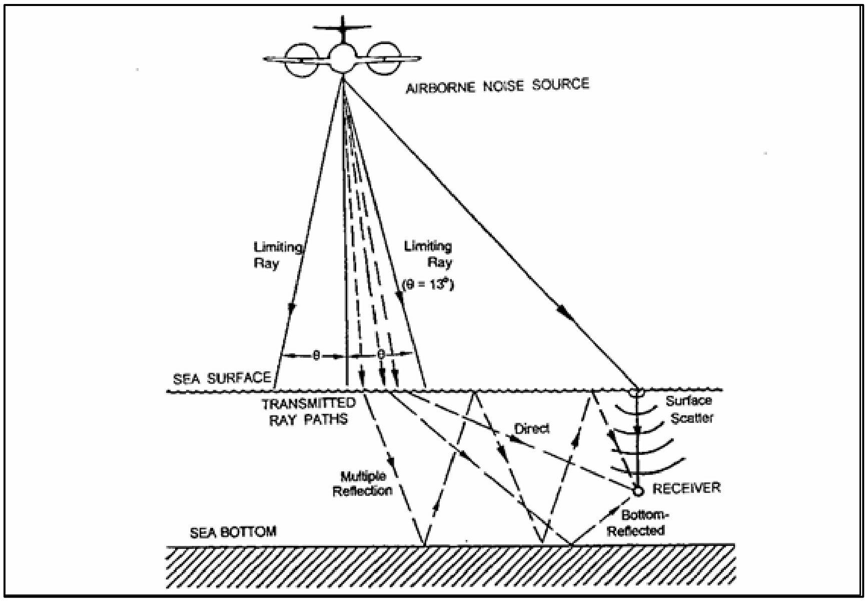


Figure B-9 Characteristics of Sound Transmission Through the Air-Water Interface

Because mammalian ears can detect large pressure ranges and humans judge the relative loudness of sounds by the ratio of the sound pressures (a logarithmic behavior), sound amplitude is described by the SPL, calculated by taking the logarithm of the ratio of the sound pressure to a reference pressure (see Section B.2.1). Use of a logarithmic scale compresses the wide range of pressure values into a more usable numerical scale. On the dB scale, the smallest audible sound in air (near total silence) to a human is 0 decibels referenced to 20 micropascals (dB re 20 µPa). If the sound intensity increases by a factor of 10, the SPL would increase to 10 dB re 20 µPa. If the sound intensity increases by a factor of 100, the SPL would increase to 20 dB re 20 µPa, and if the sound intensity increases by a factor of 1000, the SPL would be 30 dB re 20 µPa. A quiet conversation has an SPL of about 50 dB re 20 µPa, while the threshold of pain is around 120–140 dB re 20 µPa.

As described in Section B.2.1, SPLs under water differ from those in air because they rely on different reference pressures in their calculation; therefore, the two should never be directly compared.

While sound pressure and frequency are physical measures of the sound, loudness is a subjective attribute that varies with not only sound pressure, but also other attributes of the sound, such as frequency. For example, a human listener would perceive a 60 dB re 20 µPa sound at 2 kHz to be louder than a 60 dB re 20 µPa sound at 50 Hz, even though the SPLs are identical. This effect is most noticeable at lower sound pressure levels; however, at very high sound pressure levels, the difference in perceived loudness at different frequencies becomes smaller.

Many measurements of sound in air appear as dBAs in the literature because the intent of the authors is to assess noise impacts on humans. The auditory weighting concept can be applied to other species. When used in analyzing the impacts of sound on an animal, auditory weighting functions adjust received sound levels to emphasize ranges of best hearing and de-emphasize ranges of less or no sensitivity. Auditory weighting functions were developed for marine mammals and sea turtles and are used to assess acoustic impacts. For more information on weighting functions and their derivation for this analysis, see the technical report entitled *Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis* (Navy, 2017).

B.5 Noise Effects

Noise is of concern because of potential adverse effects. The following subsections describe how noise can affect communities and the environment, and how those effects are quantified. The specific topics discussed are:

- annoyance
- speech interference
- sleep disturbance
- noise-induced hearing impairment
- non-auditory health effects
- performance effects
- noise effects on children
- property values
- noise-induced vibration effects on structures and humans
- noise effects on terrain
- noise effects on historical and archaeological sites
- effects on domestic animals and wildlife

B.5.1 Annoyance

With the introduction of jet aircraft in the 1950s, it became clear that aircraft noise annoyed people and was a significant problem around airports. Early studies, such as those of Rosenblith et al. (1953) and Stevens et al. (1953) showed that effects depended on the quality of the sound, its level, and the number of flights. Over the next 20 years considerable research was performed refining this understanding and setting guidelines for noise exposure. In the early 1970s, the USEPA published its "Levels Document" (USEPA 1974) that reviewed the factors that affected communities. DNL (still known as L_{dn} at the time) was identified as an appropriate noise metric, and threshold criteria were recommended.

Threshold criteria for annoyance were identified from social surveys, where people exposed to noise were asked how noise affects them. Surveys provide direct real-world data on how noise affects actual residents.

Surveys in the early years had a range of designs and formats, and needed some interpretation to find common ground. In 1978, Schultz showed that the common ground was the number of people "highly annoyed," defined as the upper 28% range of whatever response scale a survey used (Schultz 1978). With that definition, he was able to show a remarkable consistency among the majority of the surveys for which data were available. Figure B-10 shows the result of his study relating DNL to individual annoyance measured by percent highly annoyed (%HA).

Schultz's original synthesis included 161 data points. Figure B-11 compares revised fits of the Schultz data set with an expanded set of 400 data points collected through 1989 (Finegold et al. 1994). The new form is the preferred form in the U.S., endorsed by the Federal Interagency Committee on Aviation Noise (FICAN 1997). Other forms have been proposed, such as that of Fidell and Silvati (2004), but have not gained widespread acceptance.

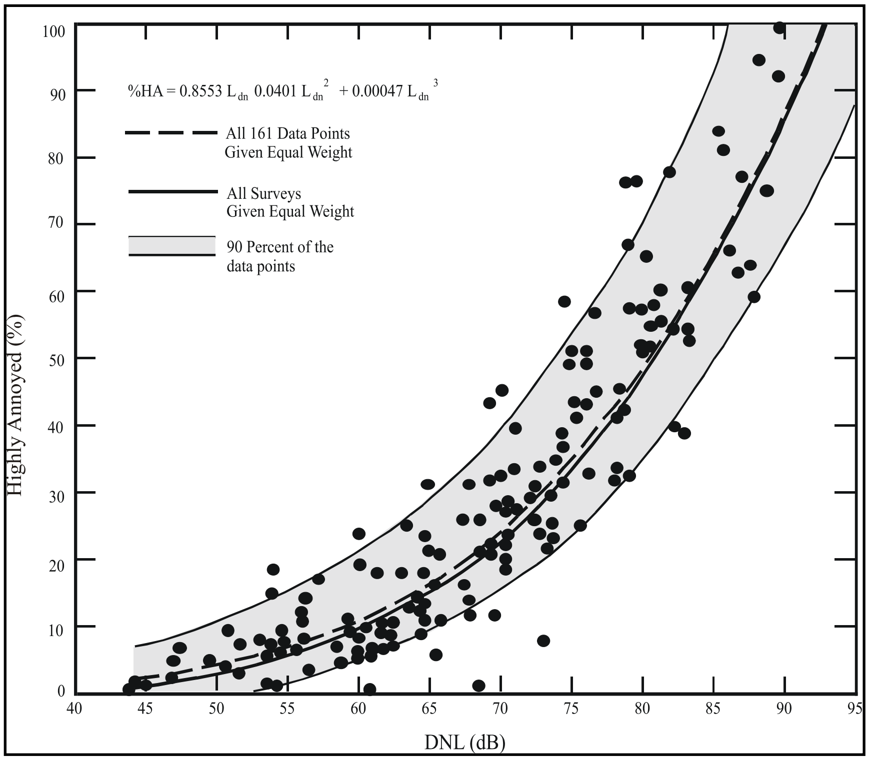


Figure B-10 Schultz Curve Relating Noise Annoyance to DNL (Schultz 1978)

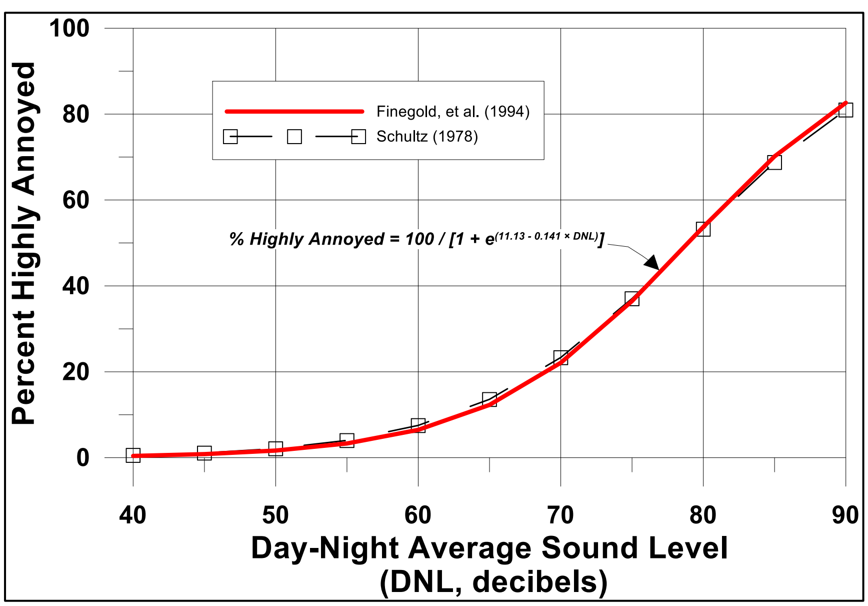


Figure B-11 Response of Communities to Noise; Comparison of Original Schultz (1978) with Finegold et al. (1994)

When the goodness of fit of the Schultz curve is examined, the correlation between groups of people is high, in the range of 85-90%. However, the correlation between individuals is much lower, at 50% or less. This is not surprising, given the personal differences between individuals. The surveys underlying the Schultz curve include results that show that annoyance to noise is also affected by non-acoustical factors. Newman and Beattie (1985) divided the non-acoustic factors into the emotional and physical variables shown in Table B-1.

Table B-1 Non-Acoustic Variables Influencing Aircraft Noise Annoyance

Emotional Variables	***Physical Variables***
Feeling about the necessity or preventability of the noise	Type of neighborhood;
Judgement of the importance and value of the activity that is producing the noise;	Time of day;
Activity at the time an individual hears the noise;	Season;
Attitude about the environment;	Predicitabiltiy of the noise;
General sensitivity to noise;	Control over the noise source; and
Belief about the effect of noise on health; and	Length of time individual is exposed to a noise.
Feeling of fear associated with the noise.	

Schreckenberg and Schuemer (2010) recently examined the importance of some of these factors on short term annoyance. Attitudinal factors were identified as having an effect on annoyance. In formal regression analysis, however, sound level (L_{eq}) was found to be more important than attitude. A series of studies at three European airports showed that less than 20 percent of the variance in annoyance can be explained by noise alone (Marki 2013)

A recent study by Plotkin et al. (2011) examined updating DNL to account for these factors. It was concluded that the data requirements for a general analysis were much greater than are available from most existing studies. It was noted that the most significant issue with DNL is that it is not readily understood by the public, and that supplemental metrics such as TA and NA were valuable in addressing attitude when communicating noise analysis to communities (DOD 2009a).

A factor that is partially non-acoustical is the source of the noise. Miedema and Vos (1998) presented synthesis curves for the relationship between DNL and percentage “Annoyed” and percentage “Highly Annoyed” for three transportation noise sources. Different curves were found for aircraft, road traffic, and railway noise. Table B-2 summarizes their results. Comparing the updated Schultz curve suggests that the percentage of people highly annoyed by aircraft noise may be higher than previously thought.

As noted by the World Health Organization (WHO), however, even though aircraft noise seems to produce a stronger annoyance response than road traffic, caution should be exercised when interpreting synthesized data from different studies (WHO 1999).

Consistent with WHO’s recommendations, the Federal Interagency Committee on Noise (FICON 1992) considered the Schultz curve to be the best source of dose information to predict community response to noise, but recommended further research to investigate the differences in perception of noise from different sources.

The U.S. Federal Aviation Administration is currently (as of 2015) conducting a major airport community noise survey at approximately 20 U.S. airports in order to update the relationship between aircraft noise and annoyance. Results from this study are expected to be released in 2017.

Table B-2 Percent Highly Annoyed for Different Transportation Noise Sources

DNL (dB)	*Percent Highly Annoyed (%HA)*			
	Miedema and Vos			*Schultz Combined*
	Air	*Road*	*Rail*	
55	12	7	4	3
60	19	12	7	6
65	28	18	11	12
70	37	29	16	22
75	48	40	22	36

Sources: (Miedema and Vos, 1998)
Key: dB = decibel; DNL = Day-Night Average Sound Level; HA = Highly Annoyed.

B.5.2 Speech Interference

Speech interference from noise is a primary cause of annoyance for communities. Disruption of routine activities such as radio or television listening, telephone use, or conversation leads to frustration and annoyance. The quality of speech communication is important in classrooms and offices. In the workplace, speech interference from noise can cause fatigue and vocal strain in those who attempt to talk over the noise. In schools it can impair learning.

There are two measures of speech comprehension:

1. **Word Intelligibility:** the percent of words spoken and understood. This might be important for students in the lower grades who are learning the English language, and particularly for students who have English as a Second Language.
2. **Sentence Intelligibility:** *the percent of sentences spoken and understood. This might be important for high-school students and adults who are familiar with the language, and who do not necessarily have to understand each word in order to understand sentences.*

U.S. Federal Criteria for Interior Noise

In 1974, the USEPA identified a goal of an indoor $L_{eq(24)}$ of 45 dB to minimize speech interference based on sentence intelligibility and the presence of steady noise (USEPA 1974). Figure B-12 shows the effect of steady indoor background sound levels on sentence intelligibility. For an average adult with normal hearing and fluency in the language, steady background indoor sound levels of less than 45 dB L_{eq} are expected to allow 100% sentence intelligibility.

The curve in Figure B-12 shows 99% intelligibility at L_{eq} below 54 dB, and less than 10% above 73 dB. Recalling that L_{eq} is dominated by louder noise events, the USEPA $L_{eq(24)}$ goal of 45 dB generally ensures that sentence intelligibility will be high most of the time.

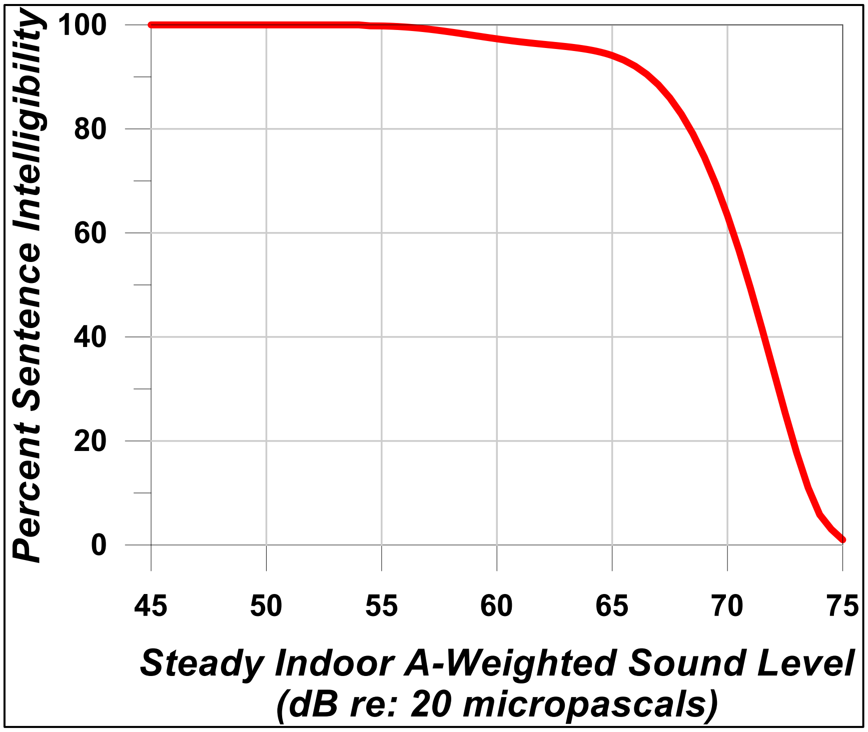


Figure B-12 Speech Intelligibility Curve (digitized from USEPA 1974)

Classroom Criteria

For teachers to be understood, their regular voice must be clear and uninterrupted. Background noise has to be below the teacher's voice level. Intermittent noise events that momentarily drown out the teacher's voice need to be kept to a minimum. It is therefore important to evaluate the steady background level, the level of voice communication, and the single-event level due to aircraft overflights that might interfere with speech.

Lazarus (1990) found that for listeners with normal hearing and fluency in the language, complete sentence intelligibility can be achieved when the signal-to-noise ratio (i.e., a comparison of the level of the sound to the level of background noise) is in the range of 15 to 18 dB. The initial ANSI classroom noise standard (ANSI 2002) and American Speech-Language-Hearing Association (ASLHA 2005) guidelines concur, recommending at least a 15 dB signal-to-noise ratio in classrooms. If the teacher's voice level is at least 50 dB, the background noise level must not exceed an average of 35 dB. The National Research Council of Canada (Bradley 1993) and WHO (1999) agree with this criterion for background noise.

For eligibility for noise insulation funding, the Federal Aviation Administration (FAA) guidelines state that the design objective for a classroom environment is 45 dB L_{eq} during normal school hours (FAA 1985).

Most aircraft noise is not continuous. It consists of individual events like the one sketched in Figure B-4. Since speech interference in the presence of aircraft noise is caused by individual aircraft flyover events, a time-averaged metric alone, such as L_{eq}, is not necessarily appropriate. In addition to the background level criteria described above, single-event criteria that account for those noisy events are also needed.

A 1984 study by Wyle for the Port Authority of New York and New Jersey recommended using Speech Interference Level (SIL) for classroom noise criteria (Sharp and Plotkin 1984). SIL is based on the maximum sound levels in the frequency range that most affects speech communication (500-2,000 Hz). The study identified an SIL of 45 dB as the goal. This would provide 90% word intelligibility for the short time periods during aircraft overflights. While SIL is technically the best metric for speech interference, it can be approximated by an L_{max} value. An SIL of 45 dB is equivalent to an A-weighted L_{max} of 50 dB for aircraft noise (Wesler 1986).

Lind et al. (1998) also concluded that an L_{max} criterion of 50 dB would result in 90% word intelligibility. Bradley (1985) recommends SEL as a better indicator. His work indicates that 95% word intelligibility would be achieved when indoor SEL did not exceed 60 dB. For typical flyover noise this corresponds to an L_{max} of 50 dB. While WHO (1999) only specifies a background L_{max} criterion, they also note the SIL frequencies and that interference can begin at around 50 dB.

The United Kingdom Department for Education and Skills (UKDfES) established in its classroom acoustics guide a 30-minute time-averaged metric of $L_{eq(30min)}$ for background levels and the metric of $L_{A1,30min}$ for intermittent noises, at thresholds of 30-35 dB and 55 dB, respectively. $L_{A1,30min}$ represents the A-weighted sound level that is exceeded 1% of the time (in this case, during a 30-minute teaching session) and is generally equivalent to the L_{max} metric (UKDfES 2003).

Table B-3 summarizes the criteria discussed. Other than the FAA (1985) 45 dB L_{max} criterion, they are consistent with a limit on indoor background noise of 35-40 dB L_{eq} and a single event limit of 50 dB L_{max}. It should be noted that these limits were set based on students with normal hearing and no special needs. At-risk students may be adversely affected at lower sound levels.

Table B-3 Indoor Noise Level Criteria Based on Speech Intelligibility

Source	*Metric/Level (dB)*	*Effects and Notes*
U.S. FAA (1985)	L_{eq}(during school hours) = 45 dB	Federal assistance criteria for school sound insulation; supplemental single-event criteria may be used.
Lind et al. (1998), Sharp and Plotkin (1984), Wesler (1986)	L_{max} = 50 dB / SIL 45	Single event level permissible in the classroom.
WHO (1999)	L_{eq} = 35 dB L_{max} = 50 dB	Assumes average speech level of 50 dB and recommends signal to noise ratio of 15 dB.
U.S. ANSI (2010)	L_{eq} = 35 dB, based on Room Volume (e.g., cubic feet)	Acceptable background level for continuous and intermittent noise.
UKDFES (2003)	$L_{eq(30min)}$ = 30-35 dB L_{max} = 55 dB	Minimum acceptable in classroom and most other learning environs.

Key: ANSI = American National Standards Institute; dB = Decibel; FAA = Federal Aviation Administration (US); L_{eq} = Equivalent Sound Level; L_{max} = Maximum Sound Level; SIL = Speech Interference Level; UK DFES = United Kingdom Department for Education and Skills; U.S. = United States; WHO = World Health Organization.

B.5.3 Sleep Disturbance

Sleep disturbance is a major concern for communities exposed to aircraft noise at night. A number of studies have attempted to quantify the effects of noise on sleep. This section provides an overview of the major noise-induced sleep disturbance studies. Emphasis is on studies that have influenced U.S. federal noise policy. The studies have been separated into two groups:

1. Initial studies performed in the 1960s and 1970s, where the research was focused on sleep observations performed under laboratory conditions.
2. Later studies performed in the 1990s up to the present, where the research was focused on field observations.

Initial Studies

The relation between noise and sleep disturbance is complex and not fully understood. The disturbance depends not only on the depth of sleep and the noise level, but also on the non-acoustic factors cited for annoyance. The easiest effect to measure is the number of arousals or awakenings from noise events. Much of the literature has therefore focused on predicting the percentage of the population that will be awakened at various noise levels.

FICON's 1992 review of airport noise issues (FICON 1992) included an overview of relevant research conducted through the 1970s. Literature reviews and analyses were conducted from 1978 through 1989 using existing data (Griefahn 1978; Lukas 1978; Pearsons et. al. 1989). Because of large variability in the data, FICON did not endorse the reliability of those results.

FICON did, however, recommend an interim dose-response curve, awaiting future research. That curve predicted the percent of the population expected to be awakened as a function of the exposure to SEL. This curve was based on research conducted for the U.S. Air Force (Finegold 1994). The data included most of the research performed up to that point, and predicted a 10% probability of awakening when exposed to an interior SEL of 58 dB. The data used to derive this curve were primarily from controlled laboratory studies.

Recent Sleep Disturbance Research – Field and Laboratory Studies

It was noted that early sleep laboratory studies did not account for some important factors. These included habituation to the laboratory, previous exposure to noise, and awakenings from noise other than aircraft. In the early 1990s, field studies in people's homes were conducted to validate the earlier laboratory work conducted in the 1960s and 1970s. The field studies of the 1990s found that 80-90% of sleep disturbances were not related to outdoor noise events, but rather to indoor noises and non-noise factors. The results showed that, in real life conditions, there was less of an effect of noise on sleep than had been previously reported from laboratory studies. Laboratory sleep studies tend to show more sleep disturbance than field studies because people who sleep in their own homes are used to their environment and, therefore, do not wake up as easily (FICAN 1997).

FICAN

Based on this new information, in 1997 FICAN recommended a dose-response curve to use instead of the earlier 1992 FICON curve (FICAN 1997). Figure B-13 shows FICAN's curve, the red line, which is based on the results of three field studies shown in the figure (Ollerhead et al. 1992; Fidell et al. 1994; Fidell et al. 1995a, 1995b), along with the data from six previous field studies.

The 1997 FICAN curve represents the upper envelope of the latest field data. It predicts the maximum percent awakened for a given residential population. According to this curve, a maximum of 3% of people would be awakened at an indoor SEL of 58 dB. An indoor SEL of 58 dB is equivalent to an outdoor SEL of about 83 dB, with the windows closed (73 dB with windows open).

Number of Events and Awakenings

It is reasonable to expect that sleep disturbance is affected by the number of events. The German Aerospace Center (DLR Laboratory) conducted an extensive study focused on the effects of nighttime aircraft noise on sleep and related factors (Basner 2004). The DLR study was one of the largest studies to examine the link between aircraft noise and sleep disturbance. It involved both laboratory and in-home field research phases. The DLR investigators developed a dose-response curve that predicts the number of aircraft events at various values of L_{max} expected to produce one additional awakening over the course of a night. The dose-effect curve was based on the relationships found in the field studies.

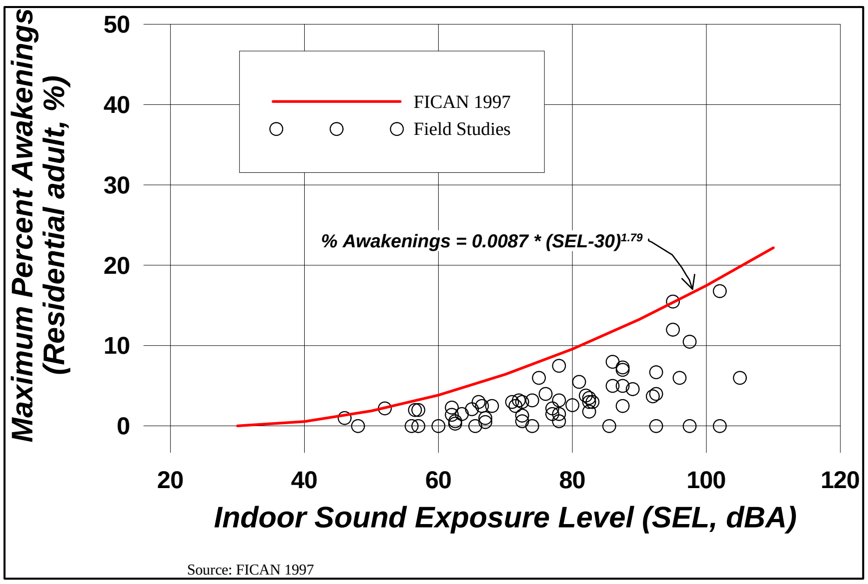


Figure B-13 FICAN 1997 Recommended Sleep Disturbance Dose-Response Relationship

Later studies by DLR conducted in the laboratory comparing the probability of awakenings from different modes of transportation showed that aircraft noise led to significantly lower awakening probabilities than either road or rail noise (Basner et al. 2011). Furthermore, it was noted that the probability of awakening, per noise event, decreased as the number of noise events increased. The authors concluded that by far the majority of awakenings from noise events merely replaced awakenings that would have occurred spontaneously anyway.

A different approach was taken by an ANSI standards committee (ANSI 2008). The committee used the average of the data shown in Figure B-13 rather than the upper envelope, to predict average awakening from one event. Probability theory is then used to project the awakening from multiple noise events.

Currently, there are no established criteria for evaluating sleep disturbance from aircraft noise, although recent studies have suggested a benchmark of an outdoor SEL of 90 dB as an appropriate tentative criterion when comparing the effects of different operational alternatives. The corresponding indoor SEL would be approximately 25 dB lower (at 65 dB) with doors and windows closed, and approximately 15 dB lower (at 75 dB) with doors or windows open. According to the ANSI (2008) standard, the probability of awakening from a single aircraft event at this level is between 1 and 2% for people habituated to the noise sleeping in bedrooms with windows closed, and 2-3% with windows open. The probability of the exposed population awakening at least once from multiple aircraft events at noise levels of 90 dB SEL is shown in Table B-4.

In December 2008, FICAN recommended the use of this new standard. FICAN also recognized that more research is underway by various organizations, and that work may result in changes to FICAN's position. Until that time, FICAN recommends the use of the ANSI (2008) standard (FICAN 2008). ANSI recently withdrew the 2008 standard due primarily to concerns that the method described overestimates impacts (American National Standards Institute, 2018). The method has not been replaced to date and remains a commonly used, conservative method for estimation of sleep disturbance.

Table B-4 Probability of Awakening from NA 90 SEL

Number of Aircraft Events at 90 dB SEL for Average 9-Hour Night	*Minimum Probability of Awakening at Least Once*	
	Windows Closed	*Windows Open*
1	1%	2%
3	4%	6%
5	7%	10%
9 (1 per hour)	12%	18%
18 (2 per hour)	22%	33%
27 (3 per hour)	32%	45%

Source: (DOD, 2009b)
Key: dB = decibel; NA = Number of Events At or Above a Selected Threshold; SEL = Sound Exposure Level.

Summary

Sleep disturbance research still lacks the details to accurately estimate the population awakened for a given noise exposure. The procedure described in the ANSI (2008) Standard and endorsed by FICAN is based on probability calculations that have not yet been scientifically validated. While this procedure certainly provides a much better method for evaluating sleep awakenings from multiple aircraft noise events, the estimated probability of awakenings can only be considered approximate.

B.5.4 Noise-Induced Hearing Impairment

Residents in surrounding communities express concerns regarding the effects of aircraft noise on hearing. This section provides a brief overview of hearing loss caused by noise exposure. The goal is to provide a sense of perspective as to how aircraft noise (as experienced on the ground) compares to other activities that are often linked with hearing loss.

Hearing Threshold Shifts

Hearing loss is generally interpreted as a decrease in the ear's sensitivity or acuity to perceive sound (i.e., a shift in the hearing threshold to a higher level). This change can either be a Temporary Threshold Shift (TTS) or a Permanent Threshold Shift (PTS) (Berger et al. 1995).

TTS can result from exposure to loud noise over a given amount of time. An example of TTS might be a person attending a loud music concert. After the concert is over, there can be a threshold shift that may last several hours. While experiencing TTS, the person becomes less sensitive to low-level sounds, particularly at certain frequencies in the speech range (typically near 4,000 Hz). Normal hearing eventually returns, as long as the person has enough time to recover within a relatively quiet environment.

PTS usually results from repeated exposure to high noise levels, where the ears are not given adequate time to recover. A common example of PTS is the result of regularly working in a loud factory. A TTS can eventually become a PTS over time with repeated exposure to high noise levels. Even if the ear is given time to recover from TTS, repeated occurrence of TTS may eventually lead to permanent hearing loss. The point at which a TTS results in a PTS is difficult to identify and varies with a person's sensitivity.

Criteria for Permanent Hearing Loss

It has been well established that continuous exposure to high noise levels will damage human hearing (USEPA 1978). A large amount of data on hearing loss have been collected, largely for workers in manufacturing industries, and analyzed by the scientific/medical community. The Occupational Safety and Health Administration (OSHA) regulation of 1971 places the limit on workplace noise exposure at an average level of 90 dB over an 8-hour work period or 85 dB over a 16-hour period (U.S. Department of Labor 1971). Some hearing loss is still expected at those levels. The most protective criterion, with no measurable hearing loss after 40 years of exposure, is an average sound level of 70 dB over a 24-hour period.

The USEPA established 75 dB $L_{eq(8)}$ and 70 dB $L_{eq(24)}$ as the average noise level standard needed to protect 96% of the population from greater than a 5 dB PTS (USEPA 1978). The National Academy of Sciences Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) identified 75 dB as the lowest level at which hearing loss may occur (CHABA 1977). WHO concluded that environmental and leisure-time noise below an $L_{eq(24)}$ value of 70 dB "will not cause hearing loss in the large majority of the population, even after a lifetime of exposure" (WHO 1999).

Hearing Loss and Aircraft Noise

The 1982 USEPA Guidelines report (USEPA 1982) addresses noise-induced hearing loss in terms of the "Noise-Induced Permanent Threshold Shift" (NIPTS). This defines the permanent change in hearing caused by exposure to noise. Numerically, the NIPTS is the change in threshold that can be expected from daily exposure to noise over a normal working lifetime of 40 years. A grand average of the NIPTS over time and hearing sensitivity is termed the Average NIPTS, or Ave. NIPTS for short. The Ave. NIPTS that can be expected for noise measured by the $L_{eq(24)}$ metric is given in Table B-5. Table B-5 assumes exposure to the full outdoor noise throughout the 24 hours. When inside a building, the exposure will be less (Eldred and von Gierke 1993).

The Ave. NIPTS is estimated as an average over all people exposed to the noise. The actual value of NIPTS for any given person will depend on their physical sensitivity to noise – some will experience more hearing loss than others. The USEPA Guidelines provide information on this variation in sensitivity in the form of the NIPTS exceeded by 10% of the population, which is included in Table B-5 in the "10th Percentile NIPTS" column (USEPA 1982). For individuals exposed to $L_{eq(24)}$ of 80 dB, the most sensitive of the population would be expected to show degradation to their hearing of 7 dB over time.

To put these numbers in perspective, changes in hearing level of less than 5 dB are generally not considered noticeable or significant. Furthermore, there is no known evidence that a NIPTS of 5 dB is perceptible or has any practical significance for the individual. Lastly, the variability in audiometric testing is generally assumed to be ±5 dB (USEPA 1974).

The scientific community has concluded that noise exposure from civil airports has little chance of causing permanent hearing loss (Newman and Beattie 1985). For military airbases, DOD policy requires that hearing risk loss be estimated for population exposed to $L_{eq(24)}$ of 80 dB or higher (DOD 2012), including residents of on-base housing. Exposure of workers inside the base boundary is assessed using DOD regulations for occupational noise exposure.

Table B-5 Average NIPTS and 10th Percentile NIPTS as a Function of $L_{eq(24)}$

Leq(24)	*Ave. NIPTS (dB)**	*10th Percentile NIPTS (dB)**
75-76	1.0	4.0
76-77	1.0	4.5
77-78	1.6	5.0
78-79	2.0	5.5
79-80	2.5	6.0
80-81	3.0	7.0
81-82	3.5	8.0
82-83	4.0	9.0
83-84	4.5	10.0
84-85	5.5	11.0
85-86	6.0	12.0
86-87	7.0	13.5
87-88	7.5	15.0
88-89	8.5	16.5
89-90	9.5	18.0

Sources: (DOD, 2012)
Key: dB = decibel; $L_{eq(24)}$ = Equivalent Sound Level over 24 hours; NIPTS = Noise-induced Permanent Threshold Shift.
Notes:
* rounded to the nearest 0.5 dB

Noise in low-altitude military airspace, especially along MTRs where L_{max} can exceed 115 dB, is of concern. That is the upper limit used for occupational noise exposure (e.g., U.S. Department of Labor 1971). One laboratory study (Ising et al. 1999) concluded that events with L_{max} above 114 dB have the potential to cause hearing loss. Another laboratory study of participants exposed to levels between 115 and 130 dB (Nixon et al. 1993), however, showed conflicting results. For an exposure to four events across that range, half the subjects showed no change in hearing, a quarter showed a temporary 5 dB decrease in sensitivity, and a quarter showed a temporary 5 dB increase in sensitivity. For exposure to eight events of 130 dB, subjects showed an increase in sensitivity of up to 10 dB (Nixon et al. 1993).

Summary

Aviation noise levels are not comparable to the occupational noise levels associated with hearing loss of workers in manufacturing industries. There is little chance of hearing loss at levels less than 75 dB DNL. Noise levels equal to or greater than 75 dB DNL can occur near military airbases, and DOD policy specifies that NIPTS be evaluated when exposure exceeds 80 dB $L_{eq(24)}$ (DOD 2009c). There is some concern about L_{max} exceeding 115 dB in low altitude military airspace, but no research results to date have definitely related permanent hearing impairment to aviation noise.

B.5.5 Non-auditory Health Effects

The potential for aircraft noise to impair one's health deserves special attention and accordingly has been the subject of numerous epidemiological studies and meta-analyses of the gathered data. The basic premise is that noise can cause annoyance, annoyance can cause stress, and prolonged stress is known to be a contributor to a number of health disorders, such as hypertension, myocardial infarction (heart attack), cardiovascular disease, and stroke. According to Kryter and Poza (1980) "It is more likely that noise related general ill-health effects are due to the psychological annoyance from the noise interfering with normal everyday behavior, than it is from the noise eliciting, because of its intensity, reflexive response in the autonomic or other physiological systems of the body."

An early study by Cantrell (1974) confirmed that noise can provoke stress, but noted that results on its effect on cardiovascular health were contradictory. Some studies in the 1990s found a connection between aircraft noise and increased blood pressure (Michalak et al. 1990; Rosenlund et al. 2001), while others did not (Pulles et al. 1990). This inconsistency in results led the World Health Organization in 2000 to conclude that there was only a weak association between long-term noise exposure and hypertension and cardiovascular effects, and that a dose-response relationship could not be established (WHO 2000). Later, van Kempen concluded that "Whereas noise exposure can contribute to the prevalence of cardiovascular disease, the evidence for a relation between noise exposure and ischemic heart disease is still inconclusive" (van Kempen et al. 2002)

More recently, major studies have been conducted in an attempt to identify an association between noise and health effects, develop a dose-response relationship, and identify a threshold below which the effects are minimal. The most important of these are briefly described below. In these studies researchers usually present their results in terms of the Odds Ratio, or OR, which is the ratio of the odds that health will be impaired by an increase in noise level of 10 dB to the odds that health would be impaired without any noise exposure. An OR of 1.25 means that there is a 25 percent increase in likelihood that noise will impair health. To put the OR number in context, an OR of 1.5 would be considered a weak relationship between noise and health; 3.5 would be a moderate relationship; 9.0 would be a strong relationship; and 32 a very strong relationship (Cohen 1988). The OR for the relationship between obesity and hypertension is 3.4 (Pikilidou et al. 2013), and that between smoking and coronary heart disease is 4.4 (Rosengren et al. 2009).

- A carefully designed study, Hypertension and Exposure to Noise near Airports (HYENA), was conducted around six European airports from 2002 through 2006 (Jarup et al. 2005, 2008, Babisch et al. 2008). There were 4,861 subjects, aged between 45 and 70. Blood pressure was measured and questionnaires administered for health, socioeconomic and lifestyle factors, including diet and physical exercise. Noise from aircraft and highways was predicted from models.

HYENA results showed an OR less than 1 for the association between daytime aircraft noise and hypertension which was not statistically significant[1], indicating no positive association. The OR for the

[1] In many of the studies reported above the researchers use the word "significant" to describe a relationship between noise and health, conjuring up the idea that the relationship is strong and that the effect is large. But this is an inappropriate and misleading use of the word in statistical analysis. What the researchers really mean is that the relationship is "statistically significant" in that they are sure that it is real. It does not mean that the effect is

relationship between nighttime aircraft noise and hypertension was 1.14 – a result that was marginally statistically significant. For daytime road traffic noise, the OR was 1.1 and marginally significant. The measured effects were small, and not necessarily distinct from other events. A close review of the data for nighttime aircraft noise raised some questions about the data and the methods employed (ACRP 2008). Using data from the HYENA study Haralabidis et al. (2008) reported an increase in systolic blood pressure of 6.2 millimeters of mercury (mmHg) for aircraft noise events (about 6 (about 5 percent) percent), and an increase of 7.4 mmHg (about 7 percent) for other indoor noises, such as snoring - a snoring partner and road traffic had similar impact on blood pressure.

- Ancona et al. (2010) reports a study on a randomly selected sample of subjects aged 45–70 years who had lived in the study area for at least 5 years. Personal data was collected via interview and blood pressure measurements were taken for a study population of 578 subjects. No statistically significant association was found between aircraft noise levels and hypertension for noise levels above 75 dB $L_{eq(24)}$ compared to levels below 65 dB. However, there was an increase in nocturnal systolic pressure of 5.4 mmHg (about 5 percent), for subjects in the highest exposure category (greater than or equal to 75 dB).
- Huss (2010) examined the risk of mortality from myocardial infarction (heart attack) resulting from exposure to aircraft noise using the Swiss National database of mortality records for the period 2000 to 2005. The analysis was conducted on a total of 4.6 million people with 15,500 deaths from acute myocardial infarction. The results showed that the risk of death from all circulatory diseases combined was not associated with aircraft noise, nor was there any association between noise and the risk of death from stroke. The overall risk of death from myocardial infarction alone was 1.07 and not statistically significant, but higher (OR = 1.3 and not statistically significant) in people exposed to aircraft noise of 60 dB DNL or greater for 15 years or more. The risk of death from myocardial infarction was also higher (OR = 1.10), and statistically significant, for those living near a major road. Cardiovascular risk factors, such as smoking, were not directly taken into account in this study.
- Floud (2013) used the HYENA data to examine the relationship between noise levels and self-reported heart disease and stroke. There was no association for daytime noise, and no statistically significant association for nighttime noise. However, for those exposed to nighttime aircraft noise for more than 20 years, the OR was 1.25 per 10 dB increase in noise (L_{night}) and marginally significant.
- Correia et al. (2013) evaluated the risk of hospitalization for cardiovascular diseases in older people (≥65 years) residing in areas exposed to DNL of at least 45 dB around U.S. airports. Health insurance data from 2009 Medicare records were examined for approximately 6 million people living in neighborhoods around 89 airports in the United States. The potential confounding effect of socioeconomic status was extracted from several zip code level variables from the 2000 U.S. census. No controls were included for smoking or diet, both of which are strong risk factors for cardiovascular disease. Noise levels were calculated at census block centroids. Taking into account the potential effects of air pollution, they report an OR of 1.035 that was marginally statistically significant. While the overall results show a link between

large or important, or that it has any decision-making utility. A relationship can be statistically significant, i.e., real, while being weak, or small and insignificant.

increased noise and increased health risk, some of the individual airport data show a decreased health risk with increased aircraft noise exposure.

- Hansell et al.(2013) investigated the association of aircraft noise with risk of hospital admission for, and mortality from, stroke, coronary heart disease, and cardiovascular disease in neighborhoods around London's Heathrow airport exposed to $L_{eq(16)}$ of at least 50 dB. The data were adjusted for age, sex, ethnicity, deprivation, and a smoking proxy (lung cancer mortality) at the census area level, but not at the individual level. It was important to consider the effect of ethnicity (in particular South Asian ethnicity, which is itself strongly associated with risk of coronary heart disease). The reported OR for stroke, heart disease, and cardiovascular disease were 1.24, 1.21, and 1.14 respectively. Similar results were reported for mortality.

The results suggest a higher risk of mortality from coronary heart disease than cardiovascular disease, which seems counter intuitive given that cardiovascular disease encompasses all the diseases of the heart and circulation, including coronary heart disease and stroke along with heart failure and congenital heart disease (ERCD 2014).

- Evrard et al. (2015) studied mortality rates for 1.9 million residents living in 161 communes near three major French airports (Paris-Charles de Gaulle, Lyon Saint-Exupéry, and Toulouse-Blagnac) for the period 2007 to 2010. Noise levels in the communes ranged from 42 to 64 dB L_{den}. Lung cancer mortality at the commune level was used as a proxy measure for smoking because data on individual smoking or smoking prevalence were not available. Noise exposure was expressed in terms of a population weighted level for each commune. After adjustment for concentration of nitrogen dioxide (NO_2), Risk Ratios (similar to Odds Ratios) per 10 dB increase in noise were found to be 1.18 for mortality from cardiovascular disease, 1.23 for mortality from coronary heart disease, and 1.31 for mortality from myocardial infarction. There was no association between mortality from stroke and aircraft noise. As the author notes, results at the commune level may not be applicable to the individual level.
- Matsui et al. (2008) reported higher OR for noise levels greater than L_{den} 70 dB, but not altogether statistically significant, for hypertension from the effects of military aircraft noise at Kadena Air Base in Okinawa. The study was conducted in 1995-1996 but used older noise data that was not necessarily appropriate for the same time period.
- A study of Noise-Related Annoyance, Cognition and Health (NORAH) designed to identify transportation noise effects in communities around German airports has reported results of self-monitoring of blood pressure of approximately 2,000 residents near Frankfurt airport exposed to aircraft $L_{eq(24)}$ in the range of 40 to 65 dB over the period 2012 to 2014 after the opening of a new runway (Shrekenberg 2015). The results showed small positive effects of noise on blood pressure without statistical significance. No statistically significant effect was determined between aircraft noise and hypertension as defined by WHO.

The NORAH study also included an examination of the effect of aircraft noise on cardiovascular disease (heart attack and stroke) based on examination of health insurance data between 2006 and 2010 for approximately 1 million people over the age of 40 exposed to aircraft $L_{eq(24)}$ in the range of 40 to 65 dB. A questionnaire was used to obtain information on confounding factors. The results showed non-statistically significant increase in risk for heart attack and stroke, and there was no apparent linear relationship between noise level and either effect. There was however a marginally significant but small increase in risk for heart failure (OR of 1.016). The risk of cardiovascular disease was found to be greater for road and rail noise than for aircraft noise.

The risk for unipolar depression was found to increase with exposure to aircraft noise (OR of 1.09), but the relationship was not linear - the risk decreasing at the higher noise levels, so this result was not considered reliable.

In many of the studies reported above the researchers use the word “significant” to describe a relationship between noise and health, conjuring up the idea that the relationship is strong and that the effect is large. But this is an inappropriate and misleading use of the word in statistical analysis. What the researchers really mean is that the relationship is “statistically significant” in that they are sure that it is real. It does not mean that the effect is large or important, or that it has any decision-making utility. A relationship can be statistically significant, i.e., real, while being weak, or small and insignificant.

In decision-making one would hardly rely on the results of a single study. Rather, one would like to see consistent results amongst studies and derive effect estimates from the different studies for a quantitative risk assessment (Babisch 2013). This has led to meta-analyses of the pooled results from field studies.

- Babisch and Kamp (2009) and Babisch (2013). The focus in this meta-analysis is on epidemiological studies or surveys directly related to associations between aircraft noise and cardiovascular disease (CVD) outcomes. Considering studies at 10 airports covering over 45,000 people, the pooled effect estimate of the relative risk for hypertension was 1.13 per 10 dB(A) and only marginally significant (WHO 2011). One of the studies included in the analysis was for military aircraft noise at Okinawa (see Matsui et al. 2008) for which the OR was 1.27 but not statistically significant. The authors conclude that “No single, generalized and empirically supported exposure-response relationship can be established yet for the association between aircraft noise and cardiovascular risk due to methodological differences between studies.” The pooled results show different slopes from different studies with different noise level ranges and methods being used.
- Huang el al. (2015) examined four research studies comprising a total of 16,784 residents. The overall OR for hypertension in residents with aircraft noise exposure was 1.36 for men and statistically significant, and 1.31 and not statistically significant for women. No account was taken for any confounding factors. The meta-analysis suggests that aircraft noise could contribute to the prevalence of hypertension, but the evidence for a relationship between aircraft noise exposure and hypertension is still inconclusive because of limitations in study populations, exposure characterization, and adjustment for important confounders.

  The four studies in Huang’s analysis include one by Black et al. (2007) that purports to show relatively high OR values for self-reported hypertension, but these results only applied to a select subset of those surveyed that reported high noise stress. When this data set is excluded, Huang’s meta-analysis yields results similar to those obtained in the HYENA and NORAH studies. Furthermore, the longitudinal study included in the analysis that followed 4721 people for 8 years (Eriksson et al. 2010) reported an OR of 1.02 that was not statistically significant.
- A meta-analysis of 11 studies on road and aircraft noise exposure conducted since the mid-1990s showed a marginally significant pooled relative risk for the incidence of ischemic heart disease of 1.08 per 10 dB increase in noise exposure (OR approximately 1.08), and 1.03 and not statistically significant for mortality from ischemic heart disease with the linear exposure-response starting at L_{den} 50 dB (Vienneau et al. 2015).

The connection from annoyance to stress to health issues requires careful experimental design because of the large number of confounding issues, such as heredity, medical history, smoking, diet, lack of exercise, air pollution, etc. Some highly publicized reports on health effects have, in fact, been rooted in poor science. Meecham and Shaw (1979) apparently found a relation between noise levels and mortality rates in neighborhoods under the approach path to Los Angeles International Airport. When the same data were analyzed by others (Frerichs et al. 1980) no relationship was found. Jones and Tauscher (1978) found a high rate of birth defects for the same neighborhood. But when the Centers For Disease Control performed a more thorough study near Atlanta’s Hartsfield International Airport, no relationships were found for DNL greater than 65 dB (Edmonds et al. 1979).

Moreover, the public’s understanding of the possible effects of aircraft noise has been hindered by the publication of overly sensational and misleading articles in the popular press, such as “Death by Aircraft Noise is a Real Concern for People Living Under the Flight Path” (Deutsche Welle 2013). Similarly, statements by reputed scientists have proved less than useful in the debate on the effects of aircraft noise on health (“It's quite clear that living near an airport is very dangerous for your health,” says Eberhard Greiser, an emeritus professor of epidemiology at Bremen University. “Jet noise is more dangerous than any other kind of road-traffic noise or rail noise because it is especially acute and sharp and it induces stress hormones” (Time 2009)). Such conclusions have been firmly criticized by other German researchers as lacking in rigor by not considering other known factors that cause health problems, and for analyzing only a selection of the available data (ANR 2010).

Summary

Research studies seem to indicate that aircraft noise may contribute to the risk of health disorders, along with other factors such as heredity, medical history, smoking, alcohol use, diet, lack of exercise, air pollution, etc., but that the measured effect is small compared to these other factors, and often not statistically significant, i.e., not necessarily real. Despite some sensational articles purporting otherwise, and the intuitive feeling that noise in some way must impair health, there are no studies that definitively show a causal and significant relationship between aircraft noise and health. Such studies are notoriously difficult to conduct and interpret because of the large number of confounding factors that have to be considered for their effects to be excluded from the analysis. The WHO notes that there is still considerable variation among studies (WHO 2011). And, almost without exception, research studies conclude that additional research is needed to determine if such a causal relationship exists. The European Network on Noise and Health (ENNAH 2013) in its summary report of 2013 concludes that “…while the literature on non-auditory health effects of environmental noise is extensive, the scientific evidence of the relationship between noise and non-auditory effects is still contradictory”.

As a result, it is not possible to state that there is sound scientific evidence that aircraft noise is a significant contributor to health disorders.

B.5.6 Performance Effects

The effect of noise on the performance of activities or tasks has been the subject of many studies. Some of these studies have found links between continuous high noise levels and performance loss. Noise-induced performance losses are most frequently reported in studies where noise levels are above 85 dB. Little change has been found in low-noise cases. Moderate noise levels appear to act as a stressor for more sensitive individuals performing a difficult psychomotor task.

While the results of research on the general effect of periodic aircraft noise on performance have yet to yield definitive criteria, several general trends have been noted including:

- A periodic intermittent noise is more likely to disrupt performance than a steady-state continuous noise of the same level. Flyover noise, due to its intermittent nature, might be more likely to disrupt performance than a steady-state noise of equal level.
- Noise is more inclined to affect the quality than the quantity of work.
- Noise is more likely to impair the performance of tasks that place extreme demands on workers.

B.5.7 Noise Effects on Children

Recent studies on school children indicate a potential link between aircraft noise and both reading comprehension and learning motivation. The effects may be small but may be of particular concern for children who are already scholastically challenged.

B.5.7.1 Effects on Learning and Cognitive Abilities

Early studies in several countries (Cohen et al. 1973, 1980, 1981; Bronzaft and McCarthy 1975; Green et al. 1982; Evans et al. 1998; Haines et al. 2002; Lercher et al. 2003) showed lower reading scores for children living or attending school in noisy areas than for children away from those areas. In some studies noise exposed children were less likely to solve difficult puzzles or more likely to give up.

A longitudinal study reported by Evans et al. (1998) conducted prior to relocation of the old Munich airport in 1992, reported that high noise exposure was associated with deficits in long term memory and reading comprehension in children with a mean age of 10.8 years. Two years after the closure of the airport, these deficits disappeared, indicating that noise effects on cognition may be reversible if exposure to the noise ceases. Most convincing was the finding that deficits in memory and reading comprehension developed over the two year follow-up for children who became newly noise exposed near the new airport: deficits were also observed in speech perception for the newly noise-exposed children

More recently, the Road Traffic and Aircraft Noise Exposure and Children's Cognition and Health (RANCH) study (Stansfeld et al. 2005; Clark et al. 2005) compared the effect of aircraft and road traffic noise on over 2.000 children in three countries. This was the first study to derive exposure-effect associations for a range of cognitive and health effects, and was the first to compare effects across countries.

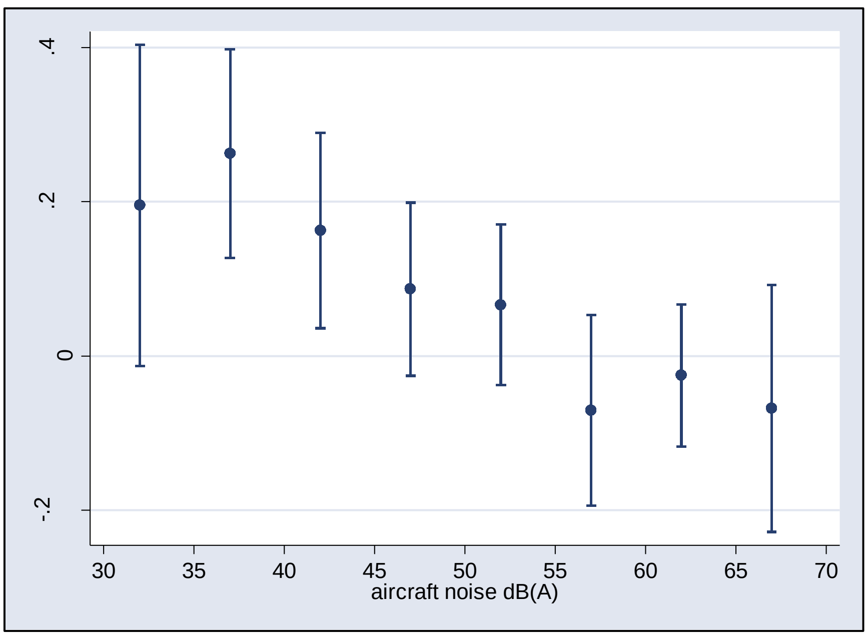
The study found a linear relation between chronic aircraft noise exposure and impaired reading comprehension and recognition memory. No associations were found between chronic road traffic noise exposure and cognition. Conceptual recall and information recall surprisingly showed better performance in high road traffic noise areas. Neither aircraft noise nor road traffic noise affected attention or working memory (Stansfeld et al. 2005; Clark et al. 2006).

Figure B-14 shows RANCH's result relating noise to reading comprehension. It shows that reading falls below average (a z-score of 0) at L_{eq} greater than 55 dB. Because the relationship is linear, reducing exposure at any level should lead to improvements in reading comprehension.

An observation of the RANCH study was that children may be exposed to aircraft noise for many of their childhood years and the consequences of long-term noise exposure were unknown. A follow-up study of the children in the RANCH project is being analyzed to examine the long-term effects on children's reading comprehension (Clark et al. 2009). Preliminary analysis indicated a trend for reading comprehension to be poorer at 15-16 years of age for children who attended noise-exposed primary schools. There was also a trend for reading comprehension to be poorer in aircraft noise exposed secondary schools. Further analysis adjusting for confounding factors is ongoing, and is needed to confirm these initial conclusions.

FICAN funded a pilot study to assess the relationship between aircraft noise reduction and standardized test scores (Eagan et al. 2004; FICAN 2007). The study evaluated whether abrupt aircraft noise reduction within classrooms, from either airport closure or sound insulation, was associated with improvements in test scores. Data were collected in 35 public schools near three airports in Illinois and Texas. The study used several noise metrics. These were, however, all computed indoor levels, which makes it hard to compare with the outdoor levels used in most other studies.

The FICAN study found a significant association between noise reduction and a decrease in failure rates for high school students, but not middle or elementary school students. There were some weaker associations between noise reduction and an increase in failure rates for middle and elementary schools. Overall the study found that the associations observed were similar for children with or without learning difficulties, and between verbal and math/science tests. As a pilot study, it was not expected to obtain final answers, but provided useful indications (FICAN 2007).



Sources: Stansfeld et al. 2005; Clark et al. 2006

Figure B-14 RANCH Study Reading Scores Varying with L_{eq}

A recent study of the effect of aircraft noise on student learning (Sharp et al. 2013) examined student test scores at a total of 6,198 U.S. elementary schools, 917 of which were exposed to aircraft noise at 46 airports with noise exposures exceeding 55 dB DNL. The study found small but statistically significant associations between airport noise and student mathematics and reading test scores, after taking demographic and school factors into account. Associations were also observed for ambient noise and total noise on student mathematics and reading test scores, suggesting that noise levels per se, as well as from aircraft, might play a role in student achievement.

As part of the Noise-Related Annoyance, Cognition and Health (NORAH) study conducted at Frankfurt airport, reading tests were conducted on 1,209 school children at 29 primary schools. It was found that there was a small decrease in reading performance that corresponded to a one-month reading delay.

While there are many factors that can contribute to learning deficits in school-aged children, there is increasing awareness that chronic exposure to high aircraft noise levels may impair learning. This awareness has led WHO and a North Atlantic Treaty Organization (NATO) working group to conclude that daycare centers and schools should not be located near major sources of noise, such as highways, airports, and industrial sites (NATO 2000; WHO 1999). The awareness has also led to the classroom noise standard discussed earlier (ANSI 2002).

B.5.7.2 Health Effects on Children

A number of studies, including some of the cognitive studies discussed above, have examined the potential for effects on children's health. Health effects include annoyance, psychological health, coronary risk, stress hormones, sleep disturbance and hearing loss.

Annoyance. Chronic noise exposure causes annoyance in children (Bronzaft and McCarthy 1975; Evans et al. 1995). Annoyance among children tends to be higher than for adults, and there is little habituation (Haines et al. 2001a). The RANCH study found annoyance may play a role in how noise affects reading comprehension (Clark et al. 2005).

Psychological Health. Lercher et al. (2002) found an association between noise and teacher ratings of psychological health, but only for children with biological risk defined by low birth weight and/or premature birth. Haines et al. (2001b) found that children exposed to aircraft noise had higher levels of psychological distress and hyperactivity. Stansfeld et al. (2009) replicated the hyperactivity result, but not distress.

As with studies of adults, the evidence suggests that chronic noise exposure is probably not associated with serious psychological illness, but there may be effects on well-being and quality of life. Further research is needed, particularly on whether hyperactive children are more susceptible to stressors such as aircraft noise.

Coronary Risk. The HYENA study discussed earlier indicated a possible relation between noise and hypertension in older adults. Cohen et al. (1980, 1981) found some increase in blood pressure among school children, but within the normal range and not indicating hypertension. Hygge et al. (2002) found mixed effects. The RANCH study found some effect for children at home and at night, but not at school (van Kempen 2006). However, the relationship between aircraft noise and blood pressure was not fully consistent between surveys in different countries. These findings, taken together with those from previous studies, suggest that no univocal conclusions can be drawn about the association between aircraft noise exposure and blood pressure. Overall the evidence for noise effects on children's blood pressure is mixed, and less certain than for older adults.

Stress Hormones. Some studies investigated hormonal levels between groups of children exposed to aircraft noise compared to those in a control group. Two studies analyzed cortisol and urinary catecholamine levels in school children as measurements of stress response to aircraft noise (Haines et al. 2001a, 2001b). In both instances, there were no differences between the aircraft-noise-exposed children and the control groups.

Sleep Disturbance. A sub-study of RANCH in a Swedish sample used sleep logs and the monitoring of rest/activity cycles to compare the effect of road traffic noise on child and parent sleep (Ohrstrom et al. 2006). An exposure-response relationship was found for sleep quality and daytime sleepiness for children. While this suggests effects of noise on children's sleep disturbance, it is difficult to generalize from one study.

Hearing loss. A few studies have examined hearing loss from exposure to aircraft noise. Noise-induced hearing loss for children who attended a school located under a flight path near a Taiwan airport was greater than for children at another school far away (Chen et al. 1997). Another study reported that hearing ability was reduced significantly in individuals who lived near an airport and were frequently exposed to aircraft noise (Chen and Chen 1993). In that study, noise exposure near the airport was greater than 75 dB DNL and L_{max} were about 87 dB during overflights. Conversely, several other studies reported no difference in hearing ability between children exposed to high levels of airport noise and children located in quieter areas (Andrus et al. 1975; Fisch 1977; Wu et al. 1995). It is not clear from those results whether children are at higher risk than adults, but the levels involved are higher than those desirable for learning and quality of life.

Ludlow and Sixsmith (1999) conducted a cross-sectional pilot study to examine the hypothesis that military jet noise exposure early in life is associated with raised hearing thresholds. The authors concluded that there were no significant differences in audiometric test results between military personnel who as children had lived in or near stations where fast jet operations were based, and a similar group who had no such exposure as children.

B.5.8 Property Values

Noise can affect the value of homes. Economic studies of property values based on selling prices and noise have been conducted to find a direct relation.

The value-noise relation is usually presented as the Noise Depreciation Index (NDI) or Noise Sensitivity Depreciation Index (NSDI), the percent loss of value per dB (measured by the DNL metric). An early study by Nelson (1978) at three airports found an NDI of 1.8-2.3% per dB. Nelson also noted a decline in NDI over time which he theorized could be due to either a change in population or the increase in commercial value of the property near airports. Crowley (1973) reached a similar conclusion. A larger study by Nelson (1980) looking at 18 airports found an NDI from 0.5 to 0.6% per dB.

In a review of property value studies, Newman and Beattie (1985) found a range of NDI from 0.2 to 2% per dB. They noted that many factors other than noise affected values.

Fidell et al. (1996) studied the influence of aircraft noise on actual sale prices of residential properties in the vicinity of a military base in Virginia and one in Arizona. They found no meaningful effect on home values. Their results may have been due to non-noise factors, especially the wide differences in homes between the two study areas.

Recent studies of noise effects on property values have recognized the need to account for non-noise factors. Nelson (2004) analyzed data from 33 airports, and discussed the need to account for those factors and the need for careful statistics. His analysis showed NDI from 0.3 to 1.5% per dB, with an average of about 0.65% per dB. Nelson (2007) and Andersson et al. (2013) discuss statistical modeling in more detail.

Enough data is available to conclude that aircraft noise has a real effect on property values. This effect falls in the range of 0.2 to 2.0% per dB, with the average on the order of 0.5% per dB. The actual value varies from location to location, and is very often small compared to non-noise factors.

B.5.9 Noise-Induced Vibration Effects on Structures and Humans

The sound from an aircraft overflight travels from the exterior to the interior of the house in one of two ways: through the solid structural elements and directly through the air. Figure B-15 illustrates the sound transmission through a wall constructed with a brick exterior, stud framing, interior finish wall, and absorbent material in the cavity. The sound transmission starts with noise impinging on the wall exterior. Some of this sound energy will be reflected away and some will make the wall vibrate. The vibrating wall radiates sound into the airspace, which in turn sets the interior finish surface vibrating, with some energy lost in the airspace. This surface then radiates sound into the dwelling interior. As the figure shows, vibrational energy also bypasses the air cavity by traveling through the studs and edge connections.

High noise levels can cause buildings to vibrate. If high enough, building components can be damaged. The most sensitive components of a building are the windows, followed by plaster walls and ceilings. Possibility of damage depends on the peak sound pressures and the resonances of the building. While certain frequencies (such as 30 Hertz for window breakage) may be of more concern than other frequencies, in general, only sounds lasting more than one second greater than an unweighted sound level of 130 dB in the 1 Hz to 1,000 Hz frequency range are potentially damaging to structural components (CHABA 1977; von Gierke and Ward 1991). Sound levels from normal aircraft operations are typically much less than 130 dB. Even sound from low altitude flyovers of heavy aircraft do not reach the potential for damage (Sutherland 1990).

Noise-induced structural vibration may cause annoyance to dwelling occupants because of induced secondary vibrations, or “rattle”, of objects within the dwelling – hanging pictures, dishes, plaques, and bric-a-brac. Loose window panes may also vibrate noticeably when exposed to high levels of airborne noise, causing homeowners to fear breakage. In general, rattling occurs at peak unweighted sound levels that last for several seconds at levels greater than 110 dB.

A field study (Schomer and Neathammer, 1985; Schomer and Neathammer, 1987) examined the role of structural vibration and rattle in human response to helicopter noise. It showed that human response is strongly and negatively influenced when the noise induces noticeable vibration and rattles in the house structure. The A-frequency-weighting was adequate to assess community response to helicopter noise when no vibration or rattle was induced. When rattle or vibrations were induced by the helicopter noise, however, A-weighting alone did not assess the community response adequately, such that significant corrections from 12 dB (for little vibration or rattles) to 20 dB (high level of vibration or rattles) needed to be applied for subjects indoors. It was also found that the presence or absence of high level noise-induced vibration and rattles was strongly dependent on the helicopter's slant distance. It was recommended that no housing or noise-sensitive land uses should be located in zones where high levels of vibration or rattle are induced by helicopter noise.

Community reactions to conventional helicopter noise from low numbers of operations for two helicopter types were studied by (Fields and Powell, 1987). Using resident interviews in combination with controlled helicopter operations, they obtained relations between the annoyance score and noise exposure for short-term (9-hour daytime) periods. It was determined that annoyance increased steadily with noise exposure measured in L_{eq} from 45 to 60 dBA for that period. Annoyance response in terms of percentage annoyed was also presented on this scale for various annoyance rating values. The shape of these curves is similar to the well-known dose-response relationship (Shultz curve) for general transportation noise, but relate to only the 9-hour daytime period, with no direct comparison with long-term noise exposure.

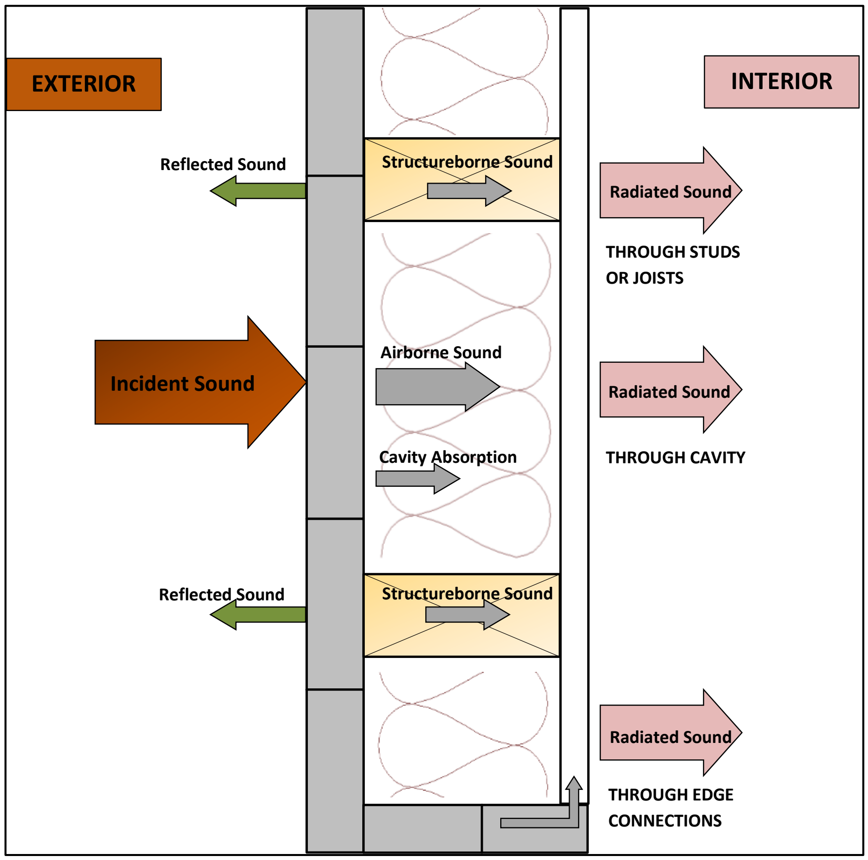


Figure B-15 Depiction of Sound Transmission through Built Construction

In a later review of human response to aircraft noise and induced building vibration, (Powell and Shepherd, 1989) also indicate that in aircraft noise surveys the annoyance scores are on average greater when vibration is detected than with no vibration detected. Based on the results of the study by (Fields and Powell, 1987) they conclude, however, that no effect of increased annoyance was found for cases where the helicopter noise level and slant distance were such that appreciable rattle was expected to occur, in contrast to the results of (Schomer and Neathammer, 1987). Powell and Shepherd also quote a laboratory study (Cawthorn et al., 1978), where the sound of rattling glassware added to the aircraft flyover noises did not increase the level of annoyance.

Community annoyance in the vicinity of airports due to noise-induced vibration and rattle resulted from aircraft ground operations was studied by (Fidell et al., 1999) and summarized in the Minneapolis-St. Paul International Airport Low Frequency Noise (LFN) Expert Panel Report (Sutherland et al., 2000). These field surveys of operations in the vicinity of a major international airport indicated that low-frequency aircraft noise can lead to secondary vibration and rattle in residential structures, which may significantly increase annoyance. These studies, however, have been criticized (FICAN 2002) due to the absence of direct measurements of vibration in support of the findings on the presence of perceptible vibration and rattle. These issues were further addressed by (Hodgdon et al., 2007). It was confirmed that the highest levels of noise near the runway during start-of-takeoff-roll and acceleration and during thrust reversal are at frequencies below 200 Hz. It was also found that aircraft noise exposure that contained audible rattle were not the most annoying, likely because the rattle content was audible, but not loud compared to the overall noise content. This result is consistent with an earlier study of human response to aircraft noise and induced building vibration (Powell and Shepherd, 1989).

In the assessment of vibration on humans, the following factors determine if a person will perceive and possibly react to building vibrations:

1. Type of excitation: steady state, intermittent, or impulsive vibration.
2. Frequency of the excitation. International Organization for Standardization (ISO) standard 2631-2 (ISO 1989) recommends a frequency range of 1 to 80 Hz for the assessment of vibration on humans.
3. Orientation of the body with respect to the vibration.
4. The use of the occupied space (i.e., residential, workshop, hospital).
5. Time of day.

Table B-6 lists the whole-body vibration criteria from ISO 2631-2 for one-third octave frequency bands from 1 to 80 Hz.

Table B-6 Vibration Criteria for the Evaluation of Human Exposure to Whole-Body Vibration

Frequency (Hz)	RMS Acceleration (m/s/s)		
	Combined Criteria Base Curve	Residential Night	Residential Day
1.00	0.0036	0.0050	0.0072
1.25	0.0036	0.0050	0.0072
1.60	0.0036	0.0050	0.0072
2.00	0.0036	0.0050	0.0072
2.50	0.0037	0.0052	0.0074
3.15	0.0039	0.0054	0.0077
4.00	0.0041	0.0057	0.0081
5.00	0.0043	0.0060	0.0086
6.30	0.0046	0.0064	0.0092
8.00	0.0050	0.0070	0.0100
10.00	0.0063	0.0088	0.0126
12.50	0.0078	0.0109	0.0156
16.00	0.0100	0.0140	0.0200
20.00	0.0125	0.0175	0.0250
25.00	0.0156	0.0218	0.0312
31.50	0.0197	0.0276	0.0394
40.00	0.0250	0.0350	0.0500
50.00	0.0313	0.0438	0.0626
63.00	0.0394	0.0552	0.0788
80.00	0.0500	0.0700	0.1000

Source: ISO 1989.

B.5.10 Noise Effects on Terrain

It has been suggested that noise levels associated with low-flying aircraft may affect the terrain under the flight path by disturbing fragile soil or snow, especially in mountainous areas, causing landslides or avalanches. There are no known instances of such events. It is improbable that such effects would result from routine subsonic aircraft operations.

B.5.11 Noise Effects on Historical and Archaeological Sites

Historical buildings and sites can have elements that are more fragile than conventional structures. Aircraft noise may affect such sites more severely than newer, modern structures. In older structures, seemingly insignificant surface cracks caused by vibrations from aircraft noise may lead to greater damage from natural forces (Hanson et al. 1991). There are few scientific studies of such effects to provide guidance for their assessment.

One study involved measurements of noise and vibration in a restored plantation house, originally built in 1795. It is located 1,500 feet from the centerline at the departure end of Runway 19L at Washington Dulles International Airport. The aircraft measured was the Concorde. There was special concern for the building’s windows, since roughly half of the house’s 324 panes were original. No instances of structural damage were found. Interestingly, despite the high levels of noise during Concorde takeoffs, the induced structural vibration levels were actually less than those induced by touring groups and vacuum cleaning (Wesler 1977).

As for conventional structures, noise exposure levels for normally compatible land uses should also be protective of historic and archaeological sites. Unique sites should, of course, be analyzed for specific exposure.

B.5.12 Effects on Domestic Animals and Wildlife

Hearing is critical to an animal’s ability to react, compete, reproduce, hunt, forage, and survive in its environment. While the existing literature does include studies on possible effects of jet aircraft noise and sonic booms on wildlife, there appears to have been little concerted effort in developing quantitative comparisons of aircraft noise effects on normal auditory characteristics. Behavioral effects have been relatively well described, but the larger ecological context issues, and the potential for drawing conclusions regarding effects on populations, has not been well developed.

The relationships between potential auditory/physiological effects and species interactions with their environments are not well understood. Manci et al. (1988), assert that the consequences that physiological effects may have on behavioral patterns are vital to understanding the long-term effects of noise on wildlife. Questions regarding the effects (if any) on predator-prey interactions, reproductive success, and intra-inter specific behavior patterns remain.

The following discussion provides an overview of the existing literature on noise effects (particularly jet aircraft noise) on animal species. The literature reviewed here involves those studies that have focused on the observations of the behavioral effects that jet aircraft and sonic booms have on animals.

A great deal of research was conducted in the 1960s and 1970s on the effects of aircraft noise on the public and the potential for adverse ecological impacts. These studies were largely completed in response to the increase in air travel and as a result of the introduction of supersonic jet aircraft. According to Manci et al. (1988), the foundation of information created from that focus does not necessarily correlate or provide information specific to the impacts to wildlife in areas overflown by aircraft at supersonic speed or at low altitudes.

The abilities to hear sounds and noise and to communicate assist wildlife in maintaining group cohesiveness and survivorship. Social species communicate by transmitting calls of warning, introduction, and other types that are subsequently related to an individual's or group's responsiveness.

Animal species differ greatly in their responses to noise. Noise effects on domestic animals and wildlife are classified as primary, secondary, and tertiary. Primary effects are direct, physiological changes to the auditory system, and most likely include the masking of auditory signals. Masking is defined as the inability of an individual to hear important environmental signals that may arise from mates, predators, or prey. There is some potential that noise could disrupt a species' ability to communicate or could interfere with behavioral patterns (Manci et al. 1988). Although the effects are likely temporal, aircraft noise may cause masking of auditory signals within exposed faunal communities. Animals rely on hearing to avoid predators, obtain food, and communicate with, and attract, other members of their species. Aircraft noise may mask or interfere with these functions. Other primary effects, such as ear drum rupture or temporary and permanent hearing threshold shifts, are not as likely given the subsonic noise levels produced by aircraft overflights.

Secondary effects may include non-auditory effects such as stress and hypertension; behavioral modifications; interference with mating or reproduction; and impaired ability to obtain adequate food, cover, or water. Tertiary effects are the direct result of primary and secondary effects, and include population decline and habitat loss. Most of the effects of noise are mild enough that they may never be detectable as variables of change in population size or population growth against the background of normal variation (Bowles 1995). Other environmental variables (e.g., predators, weather, changing prey base, ground-based disturbance) also influence secondary and tertiary effects, and confound the ability to identify the ultimate factor in limiting productivity of a certain nest, area, or region (Smith et al. 1988). Overall, the literature suggests that species differ in their response to various types, durations, and sources of noise (Manci et al. 1988).

Many scientific studies have investigated the effects of aircraft noise on wildlife, and some have focused on wildlife "flight" due to noise. Animal responses to aircraft are influenced by many variables, including size, speed, proximity (both height above the ground and lateral distance), engine noise, color, flight profile, and radiated noise. The type of aircraft (e.g., fixed-wing versus rotor-wing [helicopter] aircraft) and type of flight mission may also produce different levels of disturbance, with varying animal responses (Smith et al. 1988). Consequently, it is difficult to generalize animal responses to noise disturbances across species.

One result of the Manci et al. (1988) literature review was the conclusion that, while behavioral observation studies were relatively limited, a general behavioral reaction in animals from exposure to aircraft noise is the startle response. The intensity and duration of the startle response appears to be dependent on which species is exposed, whether there is a group or an individual, and whether there have been some previous exposures. Responses range from flight, trampling, stampeding, jumping, or running, to movement of the head in the apparent direction of the noise source. Manci et al. (1988) reported that the literature indicated that avian species may be more sensitive to aircraft noise than mammals.

B.5.12.1 Domestic Animals

Although some studies report that the effects of aircraft noise on domestic animals is inconclusive, a majority of the literature reviewed indicates that domestic animals exhibit some behavioral responses to military overflights but generally seem to habituate to the disturbances over a period of time. Mammals in particular appear to react to noise at sound levels higher than 90 dB, with responses including the startle response, freezing (i.e., becoming temporarily stationary), and fleeing from the sound source. Many studies on domestic animals suggest that some species appear to acclimate to some forms of sound disturbance (Manci et al. 1988). Some studies have reported such primary and secondary effects as reduced milk production and rate of milk release, increased glucose concentrations, decreased levels of hemoglobin, increased heart rate, and a reduction in thyroid activity. These latter effects appear to represent a small percentage of the findings occurring in the existing literature.

Some reviewers have indicated that earlier studies, and claims by farmers linking adverse effects of aircraft noise on livestock, did not necessarily provide clear-cut evidence of cause and effect (Cottereau 1978). In contrast, many studies conclude that there is no evidence that aircraft overflights affect feed intake, growth, or production rates in domestic animals.

Cattle

In response to concerns about overflight effects on pregnant cattle, milk production, and cattle safety, the U.S. Air Force prepared a handbook for environmental protection that summarized the literature on the impacts of low-altitude flights on livestock (and poultry) and includes specific case studies conducted in numerous airspaces across the country. Adverse effects have been found in a few studies but have not been reproduced in other similar studies. One such study, conducted in 1983, suggested that 2 of 10 cows in late pregnancy aborted after showing rising estrogen and falling progesterone levels. These increased hormonal levels were reported as being linked to 59 aircraft overflights. The remaining eight cows showed no changes in their blood concentrations and calved normally. A similar study reported abortions occurred in three out of five pregnant cattle after exposing them to flyovers by six different aircraft. Another study suggested that feedlot cattle could stampede and injure themselves when exposed to low-level overflights (U.S. Air Force 1994a).

A majority of the studies reviewed suggests that there is little or no effect of aircraft noise on cattle. Studies presenting adverse effects to domestic animals have been limited. A number of studies (Parker and Bayley 1960; Casady and Lehmann 1967; Kovalcik and Sottnik 1971) investigated the effects of jet aircraft noise and sonic booms on the milk production of dairy cows. Through the compilation and examination of milk production data from areas exposed to jet aircraft noise and sonic boom events, it was determined that milk yields were not affected. This was particularly evident in those cows that had been previously exposed to jet aircraft noise.

A study examined the causes of 1,763 abortions in Wisconsin dairy cattle over a 1-year time period and none were associated with aircraft disturbances (U.S. Air Force 1993). In 1987, researchers contacted seven livestock operators for production data, and no effects of low-altitude and supersonic flights were noted. Of the 43 cattle previously exposed to low-altitude flights, 3 showed a startle response to an F/A-18 aircraft flying overhead at 500 feet above ground level (AGL) and 400 knots by running less than 10 meters (m). They resumed normal activity within 1 minute (U.S. Air Force 1994a). Beyer (1983) found that helicopters caused more reaction than other low-aircraft overflights, and that the helicopters at 30-60 feet overhead did not affect milk production and pregnancies of 44 cows in a 1964 study (U.S. Air Force 1994a).

Additionally, Beyer (1983) reported that five pregnant dairy cows in a pasture did not exhibit fright-flight tendencies or disturb their pregnancies after being overflown by 79 low-altitude helicopter flights and 4 low-altitude, subsonic jet aircraft flights. A 1956 study found that the reactions of dairy and beef cattle to noise from low-altitude, subsonic aircraft were similar to those caused by paper blowing about, strange persons, or other moving objects (U.S. Air Force 1994a).

In a report to Congress, the U. S. Forest Service concluded that "evidence both from field studies of wild ungulates and laboratory studies of domestic stock indicate that the risks of damage are small (from aircraft approaches of 50-100 m), as animals take care not to damage themselves (U.S. Forest Service 1992). If animals are overflown by aircraft at altitudes of 50-100 m, there is no evidence that mothers and young are separated, that animals collide with obstructions (unless confined) or that they traverse dangerous ground at too high a rate." These varied study results suggest that, although the confining of cattle could magnify animal response to aircraft overflight, there is no proven cause-and-effect link between startling cattle from aircraft overflights and abortion rates or lower milk production.

Horses

Horses have also been observed to react to overflights of jet aircraft. Several of the studies reviewed reported a varied response of horses to low-altitude aircraft overflights. Observations made in 1966 and 1968 noted that horses galloped in response to jet flyovers (U.S. Air Force 1993). Bowles (1995) cites Kruger and Erath as observing horses exhibiting intensive flight reactions, random movements, and biting/kicking behavior. However, no injuries or abortions occurred, and there was evidence that the mares adapted somewhat to the flyovers over the course of a month (U.S. Air Force 1994a). Although horses were observed noticing the overflights, it did not appear to affect either survivability or reproductive success. There was also some indication that habituation to these types of disturbances was occurring.

LeBlanc et al. (1991), studied the effects of F-14 jet aircraft noise on pregnant mares. They specifically focused on any changes in pregnancy success, behavior, cardiac function, hormonal production, and rate of habituation. Their findings reported observations of "flight-fright" reactions, which caused increases in heart rates and serum cortisol concentrations. The mares, however, did habituate to the noise. Levels of anxiety and mass body movements were the highest after initial exposure, with intensities of responses decreasing thereafter. There were no differences in pregnancy success when compared to a control group.

Swine

Generally, the literature findings for swine appear to be similar to those reported for cows and horses. While there are some effects from aircraft noise reported in the literature, these effects are minor. Studies of continuous noise exposure (i.e., 6 hours, 72 hours of constant exposure) reported influences on short-term hormonal production and release. Additional constant exposure studies indicated the observation of stress reactions, hypertension, and electrolyte imbalances (Dufour 1980). A study by Bond et al. (1963), demonstrated no adverse effects on the feeding efficiency, weight gain, ear physiology, or thyroid and adrenal gland condition of pigs subjected to observed aircraft noise. Observations of heart rate increase were recorded; noting that cessation of the noise resulted in the return to normal heart rates. Conception rates and offspring survivorship did not appear to be influenced by exposure to aircraft noise.

Similarly, simulated aircraft noise at levels of 100-135 dB had only minor effects on the rate of feed utilization, weight gain, food intake, or reproduction rates of boars and sows exposed, and there were no injuries or inner ear changes observed (Gladwin et al. 1988; Manci et al. 1988).

Domestic Fowl

According to a 1994 position paper by the U.S. Air Force on effects of low-altitude overflights (below 1,000 feet) on domestic fowl, overflight activity has negligible effects (U.S. Air Force 1994b). The paper did recognize that given certain circumstances, adverse effects can be serious. Some of the effects can be panic reactions, reduced productivity, and effects on marketability (e.g., bruising of the meat caused during “pile-up” situations).

The typical reaction of domestic fowl after exposure to sudden, intense noise is a short-term startle response. The reaction ceases as soon as the stimulus is ended, and within a few minutes all activity returns to normal. More severe responses are possible depending on the number of birds, the frequency of exposure, and environmental conditions. Large crowds of birds, and birds not previously exposed, are more likely to pile up in response to a noise stimulus (U.S. Air Force 1994b). According to studies and interviews with growers, it is typically the previously unexposed birds that incite panic crowding, and the tendency to do so is markedly reduced within five exposures to the stimulus (U.S. Air Force 1994b). This suggests that the birds habituate relatively quickly. Egg productivity was not adversely affected by infrequent noise bursts, even at exposure levels as high as 120-130 dB.

Between 1956 and 1988, there were 100 recorded claims against the Navy for alleged damage to domestic fowl. The number of claims averaged three per year, with peak numbers of claims following publications of studies on the topic in the early 1960s. Many of the claims were disproved or did not have sufficient supporting evidence. The claims were filed for the following alleged damages: 55% for panic reactions, 31% for decreased production, 6% for reduced hatchability, 6% for weight loss, and less than 1% for reduced fertility (U.S. Air Force 1994b).

The review of the existing literature suggests that there has not been a concerted or widespread effort to study the effects of aircraft noise on commercial turkeys. One study involving turkeys examined the differences between simulated versus actual overflight aircraft noise, turkey responses to the noise, weight gain, and evidence of habituation (Bowles et al. 1990). Findings from the study suggested that turkeys habituated to jet aircraft noise quickly, that there were no growth rate differences between the experimental and control groups, and that there were some behavioral differences that increased the difficulty in handling individuals within the experimental group.

Low-altitude overflights were shown to cause turkey flocks that were kept inside turkey houses to occasionally pile up and experience high mortality rates due to the aircraft noise and a variety of disturbances unrelated to aircraft (U.S. Air Force 1994b).

B.5.12.2 Wildlife

Studies on the effects of overflights and sonic booms on wildlife have been focused mostly on avian species and ungulates such as caribou and bighorn sheep. Few studies have been conducted on marine mammals, small terrestrial mammals, reptiles, amphibians, and carnivorous mammals. Generally, species that live entirely below the surface of the water have also been ignored due to the fact they do not experience the same level of sound as terrestrial species (National Park Service 1994). Wild ungulates appear to be much more sensitive to noise disturbance than domestic livestock. This may be due to previous exposure to disturbances. One common factor appears to be that low-altitude flyovers seem to be more disruptive in terrain where there is little cover (Manci et al. 1988).

Mammals

Terrestrial Mammals

Studies of terrestrial mammals have shown that noise levels of 120 dB can damage mammals' ears, and levels at 95 dB can cause temporary loss of hearing acuity. Noise from aircraft has affected other large carnivores by causing changes in home ranges, foraging patterns, and breeding behavior. One study recommended that aircraft not be allowed to fly at altitudes below 2,000 feet AGL over important grizzly and polar bear habitat. Wolves have been frightened by low-altitude flights that were 25-1,000 feet AGL. However, wolves have been found to adapt to aircraft overflights and noise as long as they were not being hunted from aircraft (Dufour 1980).

Wild ungulates (American bison, caribou, bighorn sheep) appear to be much more sensitive to noise disturbance than domestic livestock (Weisenberger et al. 1996). Behavioral reactions may be related to the past history of disturbances by such things as humans and aircraft. Common reactions of reindeer kept in an enclosure exposed to aircraft noise disturbance were a slight startle response, rising of the head, pricking ears, and scenting of the air. Panic reactions and extensive changes in behavior of individual animals were not observed. Observations of caribou in Alaska exposed to fixed-wing aircraft and helicopters showed running and panic reactions occurred when overflights were at an altitude of 200 feet or less. The reactions decreased with increased altitude of overflights, and, with more than 500 feet in altitude, the panic reactions stopped. Also, smaller groups reacted less strongly than larger groups. One negative effect of the running and avoidance behavior is increased expenditure of energy. For a 90-kilogram animal, the calculated expenditure due to aircraft harassment is 64 kilocalories per minute when running and 20 kilocalories per minute when walking. When conditions are favorable, this expenditure can be counteracted with increased feeding; however, during harsh winter conditions, this may not be possible. Incidental observations of wolves and bears exposed to fixed-wing aircraft and helicopters in the northern regions suggested that wolves are less disturbed than wild ungulates, while grizzly bears showed the greatest response of any animal species observed (Weisenberger et al. 1996).

It has been proven that low-altitude overflights do induce stress in animals. Increased heart rates, an indicator of excitement or stress, have been found in pronghorn antelope, elk, and bighorn sheep. As such reactions occur naturally as a response to predation, infrequent overflights may not, in and of themselves, be detrimental. However, flights at high frequencies over a long period of time may cause harmful effects. The consequences of this disturbance, while cumulative, are not additive. It may be that aircraft disturbance may not cause obvious and serious health effects, but coupled with a harsh winter, it may have an adverse impact. Research has shown that stress induced by other types of disturbances produces long-term decreases in metabolism and hormone balances in wild ungulates.

Behavioral responses can range from mild to severe. Mild responses include head raising, body shifting, or turning to orient toward the aircraft. Moderate disturbance may be nervous behaviors, such as trotting a short distance. Escape is the typical severe response.

Marine Mammals

The physiological composition of the ear in aquatic and marine mammals exhibits adaptation to the aqueous environment. These differences (relative to terrestrial species) manifest themselves in the auricle and middle ear (Manci et al. 1988). Some mammals use echolocation to perceive objects in their surroundings and to determine the directions and locations of sound sources (Simmons 1983 in Manci et al. 1988).

In 1980, the Acoustical Society of America held a workshop to assess the potential hazard of manmade noise associated with proposed Alaska Arctic (North Slope-Outer Continental Shelf) petroleum operations on marine wildlife and to prepare a research plan to secure the knowledge necessary for proper assessment of noise impacts (Acoustical Society of America 1980). Since 1980 it appears that research on responses of aquatic mammals to aircraft noise and sonic booms has been limited. Research conducted on northern fur seals, sea lions, and ringed seals indicated that there are some differences in how various animal groups receive frequencies of sound. It was observed that these species exhibited varying intensities of a startle response to airborne noise, which was habituated over time. The rates of habituation appeared to vary with species, populations, and demographics (age, sex). Time of day of exposure was also a factor (Muyberg 1978 in Manci et al. 1988).

Studies accomplished near the Channel Islands were conducted near the area where the space shuttle launches occur. It was found that there were some response differences between species relative to the loudness of sonic booms. Those booms that were between 80 and 89 dB caused a greater intensity of startle reactions than lower-intensity booms at 72-79 dB. However, the duration of the startle responses to louder sonic booms was shorter (Jehl and Cooper 1980).

Jehl and Cooper (1980) indicated that low-flying helicopters, loud boat noises, and humans were the most disturbing to pinnipeds. According to the research, while the space launch and associated operational activity noises have not had a measurable effect on the pinniped population, it also suggests that there was a greater "disturbance level" exhibited during launch activities. There was a recommendation to continue observations for behavioral effects and to perform long-term population monitoring (Jehl and Cooper 1980).

The continued presence of single or multiple noise sources could cause marine mammals to leave a preferred habitat. However, it does not appear likely that overflights could cause migration from suitable habitats as aircraft noise over water is mobile and would not persist over any particular area. Aircraft noise, including supersonic noise, currently occurs in the overwater airspace of Eglin, Tyndall, and Langley AFBs from sorties predominantly involving jet aircraft. Survey results reported in Davis et al. (2000), indicate that cetaceans (i.e., dolphins) occur under all of the Eglin and Tyndall marine airspace. The continuing presence of dolphins indicates that aircraft noise does not discourage use of the area and apparently does not harm the locally occurring population.

In a summary by the National Park Service (1994) on the effects of noise on marine mammals, it was determined that gray whales and harbor porpoises showed no outward behavioral response to aircraft noise or overflights. Bottlenose dolphins showed no obvious reaction in a study involving helicopter overflights at 1,200 to 1,800 feet above the water. Neither did they show any reaction to survey aircraft unless the shadow of the aircraft passed over them, at which point there was some observed tendency to dive (Richardson et al. 1995). Other anthropogenic noises in the marine environment from ships and pleasure craft may have more of an effect on marine mammals than aircraft noise (U.S. Air Force 2000). The noise effects on cetaceans appear to be somewhat attenuated by the air/water interface. The cetacean fauna along the coast of California have been subjected to sonic booms from military aircraft for many years without apparent adverse effects (Tetra Tech, Inc. 1997).

Manatees appear relatively unresponsive to human-generated noise to the point that they are often suspected of being deaf to oncoming boats [although their hearing is actually similar to that of pinnipeds

(Bullock et al. 1980)]. Little is known about the importance of acoustic communication to manatees, although they are known to produce at least ten different types of sounds and are thought to have sensitive hearing (Richardson et al. 1995). Manatees continue to occupy canals near Miami International Airport, which suggests that they have become habituated to human disturbance and noise (Metro-Dade County 1995). Since manatees spend most of their time below the surface and do not startle readily, no effect of aircraft overflights on manatees would be expected (Bowles et al. 1993).

Birds

Auditory research conducted on birds indicates that they fall between the reptiles and the mammals relative to hearing sensitivity. According to Dooling (1978), within the range of 1,000 to 5,000 Hz, birds show a level of hearing sensitivity similar to that of the more sensitive mammals. In contrast to mammals, bird sensitivity falls off at a greater rate to increasing and decreasing frequencies. Passive observations and studies examining aircraft bird strikes indicate that birds nest and forage near airports. Aircraft noise in the vicinity of commercial airports apparently does not inhibit bird presence and use.

High-noise events (like a low-altitude aircraft overflight) may cause birds to engage in escape or avoidance behaviors, such as flushing from perches or nests (Ellis et al. 1991). These activities impose an energy cost on the birds that, over the long term, may affect survival or growth. In addition, the birds may spend less time engaged in necessary activities like feeding, preening, or caring for their young because they spend time in noise-avoidance activity. However, the long-term significance of noise-related impacts is less clear. Several studies on nesting raptors have indicated that birds become habituated to aircraft overflights and that long-term reproductive success is not affected (Ellis et al. 1991; Grubb and King 1991). Threshold noise levels for significant responses range from 62 dB for Pacific black brant to 85 dB for crested tern (Brown 1990; Ward and Stehn 1990).

Songbirds were observed to become silent prior to the onset of a sonic boom event (F-111 jets), followed by “raucous discordant cries.” There was a return to normal singing within 10 seconds after the boom (Higgins 1974 in Manci et al. 1988). Ravens responded by emitting protestation calls, flapping their wings, and soaring.

Manci et al. (1988), reported a reduction in reproductive success in some small territorial passerines (i.e., perching birds or songbirds) after exposure to low-altitude overflights. However, it has been observed that passerines are not driven any great distance from a favored food source by a nonspecific disturbance, such as aircraft overflights (U.S. Forest Service 1992). Further study may be warranted.

A cooperative study between the DoD and the U.S. Fish and Wildlife Service (USFWS), assessed the response of the red-cockaded woodpecker to a range of military training noise events, including artillery, small arms, helicopter, and maneuver noise (Pater et al. 1999). The project findings show that the red-cockaded woodpecker successfully acclimates to military noise events. Depending on the noise level that ranged from innocuous to very loud, the birds responded by flushing from their nest cavities. When the noise source was closer and the noise level was higher, the number of flushes increased proportionately. In all cases, however, the birds returned to their nests within a relatively short period of time (usually within 12 minutes). Additionally, the noise exposure did not result in any mortality or statistically detectable changes in reproductive success (Pater et al. 1999). Red-cockaded woodpeckers did not flush when artillery simulators were more than 122 m away and SELs were 70 dB.

Lynch and Speake (1978) studied the effects of both real and simulated sonic booms on the nesting and brooding eastern wild turkey in Alabama. Hens at four nest sites were subjected to between 8 and 11 combined real and simulated sonic booms. All tests elicited similar responses, including quick lifting of the head and apparent alertness for 10-20 seconds. No apparent nest failure occurred as a result of the sonic booms. Twenty-one brood groups were also subjected to simulated sonic booms. Reactions varied slightly between groups, but the largest percentage of groups reacted by standing motionless after the initial blast. Upon the sound of the boom, the hens and poults fled until reaching the edge of the woods (approximately 4-8 m). Afterward, the poults resumed feeding activities while the hens remained alert for a short period of time (approximately 15-20 seconds). In no instances were poults abandoned, nor did they scatter and become lost. Every observation group returned to normal activities within a maximum of 30 seconds after a blast.

Bald Eagle

A study by Grubb and King (1991) on the reactions of the bald eagle to human disturbances showed that terrestrial disturbances elicited the greatest response, followed by aquatic (i.e., boats) and aerial disturbances. The disturbance regime of the area where the study occurred was predominantly characterized by aircraft noise. The study found that pedestrians consistently caused responses that were greater in both frequency and duration. Helicopters elicited the highest level of aircraft-related responses. Aircraft disturbances, although the most common form of disturbance, resulted in the lowest levels of response. This low response level may have been due to habituation; however, flights less than 170 m away caused reactions similar to other disturbance types. Ellis et al. (1991) showed that eagles typically respond to the proximity of a disturbance, such as a pedestrian or aircraft within 100 m, rather than the noise level. Fleischner and Weisberg (1986) stated that reactions of bald eagles to commercial jet flights, although minor (e.g., looking), were twice as likely to occur when the jets passed at a distance of 0.5 mile or less. They also noted that helicopters were four times more likely to cause a reaction than a commercial jet and 20 times more likely to cause a reaction than a propeller plane.

The USFWS advised Cannon AFB that flights at or below 2,000 feet AGL from October 1 through March 1 could result in adverse impacts to wintering bald eagles (USFWS 1998). However, Fraser et al. (1985) suggested that raptors habituate to overflights rapidly, sometimes tolerating aircraft approaches of 65 feet or less.

Golden Eagle

In their guidelines for aerial surveys, USFWS (Pagel et al. 2010) summarized past studies by stating that most golden eagles respond to survey aircraft (fixed- and rotary-wing aircraft) by remaining on their nests, and continuing to incubate or roost. Surveys take place generally as close as 10 to 20 meters from cliffs (including hovering less than 30 seconds if necessary to count eggs) and no farther than 200 meters from cliffs depending on safety (Pagel et al. 2010).

Grubb et al. (2007) experimented with multiple exposure to two helicopter types and concluded that flights with a variety of approach distances (800, 400, 200, and 100 meters) had no effect on golden eagle nesting success or productivity rates within the same year or on rates of renewed nesting activity the following year when compared to the corresponding figures for the larger population of non-manipulated nest sites (Grubb et al. 2007). They found no significant, detrimental, or disruptive responses in 303 helicopter passes near eagles. In 227 AH-64 Apache helicopter experimental passes (considered twice as loud as a civilian helicopter also tested) at test distances of 0–800 meters from nesting golden eagles, 96 percent resulted in no more response than watching the helicopter pass. No greater reactions occurred until after hatching when individual golden eagles exhibited five flatten and three fly behaviors at three nest sites. The flight responses occurred at approach distances of

200 meters or less. No evidence was found of an effect on subsequent nesting activity or success, despite many of the helicopter flights occurring during early courtship and nest repair. None of these responding pairs failed to successfully fledge young, except for one nest that fell later in the season. Excited, startled, avoidance reactions were never observed. Non-attending eagles or those perched away from the nests were more likely to fly than attending eagles, but also with less potential consequence to nesting success (Grubb et al. 2007). Golden eagles appeared to become less responsive with successive exposures. Much of helicopter sound energy may be at a lower frequency than golden eagles can hear, thus reducing expected impacts. Grubb et al. (2007) found no relationship between helicopter sound levels and corresponding eagle ambient behaviors or limited responses, which occurred throughout recorded test levels (76.7–108.8 dB, unweighted). The authors thought that the lower than expected behavioral responses may be partially due to the fact that the golden eagles in the area appear acclimated to the current high levels of outdoor recreational, including aviation, activities. Based on the results of this study, the authors recommended reduction of existing buffers around nest sites to 100 meters (325 feet) for helicopter activity.

Richardson and Miller (1997) reviewed buffers as protection for raptors against disturbance from ground-based human activities. No consideration of aircraft activity was included. They stressed a clear line of sight as an important factor in a raptor's response to a particular disturbance, with visual screening allowing a closer approach of humans without disturbing a raptor. A GIS-assisted viewshed approach combined with a designated buffer zone distance was found to be an effective tool for reducing potential disturbance to golden eagles from ground-based activities (Richardson and Miller 1997). They summarized recommendations that included a median 0.5-mile (800-meter) buffer (range = 200-1,600 m, n = 3) to reduce human disturbances (from ground-based activities such as rock climbing, shooting, vehicular activity) around active golden eagle nests from February 1 to August 1 based on an extensive review of other studies (Richardson and Miller 1997). Physical characteristics (i.e., screening by topography or vegetation) are important variables to consider when establishing buffer zones based on raptors' visual- and auditory-detection distances (Richardson and Miller 1997).

Osprey

A study by Trimper et al. (1998), in Goose Bay, Labrador, Canada, focused on the reactions of nesting osprey to military overflights by CF-18 Hornets. Reactions varied from increased alertness and focused observation of planes to adjustments in incubation posture. No overt reactions (e.g., startle response, rapid nest departure) were observed as a result of an overflight. Young nestlings crouched as a result of any disturbance until 1 to 2 weeks prior to fledging. Helicopters, human presence, float planes, and other ospreys elicited the strongest reactions from nesting ospreys. These responses included flushing, agitation, and aggressive displays. Adult osprey showed high nest occupancy rates during incubation regardless of external influences. The osprey observed occasionally stared in the direction of the flight before it was audible to the observers. The birds may have been habituated to the noise of the flights; however, overflights were strictly controlled during the experimental period. Strong reactions to float planes and helicopter may have been due to the slower flight and therefore longer duration of visual stimuli rather than noise-related stimuli.

Red-tailed Hawk

Anderson et al. (1989), conducted a study that investigated the effects of low-level helicopter overflights on 35 red-tailed hawk nests. Some of the nests had not been flown over prior to the study. The hawks that were naïve (i.e., not previously exposed) to helicopter flights exhibited stronger avoidance behavior

(9 of 17 birds flushed from their nests) than those that had experienced prior overflights. The overflights did not appear to affect nesting success in either study group. These findings were consistent with the belief that red-tailed hawks habituate to low-level air traffic, even during the nesting period.

Upland Game Birds

Greater Sage-grouse

The greater sage-grouse was recently designated as a candidate species for protection under the Endangered Species Act after many years of scrutiny and research (USFWS 2010). This species is a widespread and characteristic species of the sagebrush ecosystems in the Intermountain West. Greater sage-grouse, like most bird species, rely on auditory signals as part of mating. Sage-grouse are known to select their leks based on acoustic properties and depend on auditory communication for mating behavior (Braun 2006). Although little specific research has been completed to determine what, if any, effects aircraft overflight and sonic booms would have on the breeding behavior of this species, factors that may be important include season and time of day, altitude, frequency, and duration of overflights, and frequency and loudness of sonic booms.

Booth *et al.* (2009) found, while attempting to count sage-grouse at leks (breeding grounds) using light sport aircraft at 150 meters (492 feet) to 200 meters (650 feet) AGL, that sage-grouse flushed from leks on 12 of 14 approaches when the airplane was within 656 to 984 feet (200–300 meters) of the lek. In the other two instances, male grouse stopped exhibiting breeding behavior and crouched but stayed on the lek. The time to resumption of normal behavior after disturbance was not provided in this study. Strutting ceased around the time when observers on the ground heard the aircraft. The light sport aircraft could be safely operated at very low speed (68 kilometers/hour or 37 nautical miles/hour) and was powered by either a two-stroke or a four-stroke engine. It is unclear how the response to the slow-flying light sport aircraft used in the study would compare to overflight by military jets, operating at speeds 10 to 12 times as great as the aircraft used in the study. It is possible that response of the birds was related to the slow speed of the light sport aircraft causing it to resemble an aerial predator.

Other studies have found disturbance from energy operations and other nearby development have adversely affected breeding behavior of greater sage-grouse (Holloran 2005; Doherty 2008; Walker *et al.* 2007; Harju *et al.* 2010). These studies do not specifically address overflight and do not isolate noise disturbance from other types (e.g., visual, human presence) nor do they generally provide noise levels or qualification of the noise source (e.g., continuous or intermittent, frequency, duration).

Because so few studies have been done on greater sage-grouse response to overflights or sonic booms, research on related species may be applicable. Observations on other upland game bird species include those on the behavior of four wild turkey (Meleagris gallapavo) hens on their nests during real and simulated sonic booms (Manci *et al.* 1988). Simulated sonic booms were produced by firing 5-centimeter mortar shells, 300 to 500 feet from the nest of each hen. Recordings of pressure for both types of booms measured 0.4 to 1.0 pounds per square foot (psf) at the observer's location.

Turkey hens exhibited only a few seconds of head alert behavior at the sound of the sonic boom. No hens were flushed off the nests, and productivity estimates revealed no effect from the booms. Twenty brood groups were also subjected to simulated sonic booms. In no instance did the hens desert any poults (young birds), nor did the poults scatter or desert the rest of the brood group. In every observation, the brood group returned to normal activity within 30 seconds after a simulated sonic boom. Similarly, researchers cited in Manci *et al.* (1988) observed no difference in hatching success of bobwhite quail (*Colinus virginianus*) exposed to simulated sonic booms of 100 to 250 micronewtons per square meter.

Migratory Waterfowl

Fleming et al. (1996) conducted a study of caged American black ducks found that noise had negligible energetic and physiologic effects on adult waterfowl. Measurements included body weight, behavior, heart rate, and enzymatic activity. Experiments also showed that adult ducks exposed to high noise events acclimated rapidly and showed no effects.

The study also investigated the reproductive success of captive ducks, which indicated that duckling growth and survival rates at Piney Island, North Carolina, were lower than those at a background location. In contrast, observations of several other reproductive indices (i.e., pair formation, nesting, egg production, and hatching success) showed no difference between Piney Island and the background location. Potential effects on wild duck populations may vary, as wild ducks at Piney Island have presumably acclimated to aircraft overflights. It was not demonstrated that noise was the cause of adverse impacts. A variety of other factors, such as weather conditions, drinking water and food availability and variability, disease, and natural variability in reproduction, could explain the observed effects. Fleming noted that drinking water conditions (particularly at Piney Island) deteriorated during the study, which could have affected the growth of young ducks. Further research would be necessary to determine the cause of any reproductive effects (Fleming et al. 1996).

Another study by Conomy et al. (1998) exposed previously unexposed ducks to 71 noise events per day that equaled or exceeded 80 dB. It was determined that the proportion of time black ducks reacted to aircraft activity and noise decreased from 38% to 6% in 17 days and remained stable at 5.8% thereafter. In the same study, the wood duck did not appear to habituate to aircraft disturbance. This supports the notion that animal response to aircraft noise is species-specific. Because a startle response to aircraft noise can result in flushing from nests, migrants and animals living in areas with high concentrations of predators would be the most vulnerable to experiencing effects of lowered birth rates and recruitment over time. Species that are subjected to infrequent overflights do not appear to habituate to overflight disturbance as readily.

Black brant studied in the Alaska Peninsula were exposed to jets and propeller aircraft, helicopters, gunshots, people, boats, and various raptors. Jets accounted for 65% of all the disturbances. Humans, eagles, and boats caused a greater percentage of brant to take flight. There was markedly greater reaction to Bell-206-B helicopter flights than fixed-wing, single-engine aircraft (Ward et al. 1986).

The presence of humans and low-flying helicopters in the Mackenzie Valley North Slope area did not appear to affect the population density of Lapland longspurs, but the experimental group was shown to have reduced hatching and fledging success and higher nest abandonment. Human presence appeared to have a greater impact on the incubating behavior of the black brant, common eider, and Arctic tern than fixed-wing aircraft (Gunn and Livingston 1974).

Gunn and Livingston (1974) found that waterfowl and seabirds in the Mackenzie Valley and North Slope of Alaska and Canada became acclimated to float plane disturbance over the course of three days. Additionally, it was observed that potential predators (bald eagle) caused a number of birds to leave their nests. Non-breeding birds were observed to be more reactive than breeding birds. Waterfowl were affected by helicopter flights, while snow geese were disturbed by Cessna 185 flights. The geese flushed when the planes were less than 1,000 feet, compared to higher flight elevations. An overall reduction in flock sizes was observed. It was recommended that aircraft flights be reduced in the vicinity of premigratory staging areas.

Manci et al. 1988, reported that waterfowl were particularly disturbed by aircraft noise. The most sensitive appeared to be snow geese. Canada geese and snow geese were thought to be more sensitive than other animals such as turkey vultures, coyotes, and raptors (Edwards et al. 1979).

Wading and Shorebirds

Black et al. (1984), studied the effects of low-altitude (less than 500 feet AGL) military training flights with sound levels from 55 to 100 dB on wading bird colonies (i.e., great egret, snowy egret, tricolored heron, and little blue heron). The training flights involved three or four aircraft, which occurred once or twice per day. This study concluded that the reproductive activity--including nest success, nestling survival, and nestling chronology--was independent of F-16 overflights. Dependent variables were more strongly related to ecological factors, including location and physical characteristics of the colony and climatology.

Another study on the effects of circling fixed-wing aircraft and helicopter overflights on wading bird colonies found that at altitudes of 195 to 390 feet, there was no reaction in nearly 75% of the 220 observations. Approximately 90% displayed no reaction or merely looked toward the direction of the noise source. Another 6% stood up, 3% walked from the nest, and 2% flushed (but were without active nests) and returned within 5 minutes (Kushlan 1978). Apparently, non-nesting wading birds had a slightly higher incidence of reacting to overflights than nesting birds. Seagulls observed roosting near a colony of wading birds in another study remained at their roosts when subsonic aircraft flew overhead (Burger 1981). Colony distribution appeared to be most directly correlated to available wetland community types and was found to be distributed randomly with respect to military training routes. These results suggest that wading bird species presence was most closely linked to habitat availability and that they were not affected by low-level military overflights (U.S. Air Force 2000).

Burger (1986) studied the response of migrating shorebirds to human disturbance and found that shorebirds did not fly in response to aircraft overflights, but did flush in response to more localized intrusions (i.e., humans and dogs on the beach). Burger (1981) studied the effects of noise from JFK Airport in New York on herring gulls that nested less than 1 kilometer from the airport. Noise levels over the nesting colony were 85-100 dB on approach and 94-105 dB on takeoff. Generally, there did not appear to be any prominent adverse effects of subsonic aircraft on nesting, although some birds flushed when the Concorde flew overhead and, when they returned, engaged in aggressive behavior. Groups of gulls tended to loaf in the area of the nesting colony, and these birds remained at the roost when the Concorde flew overhead. Up to 208 of the loafing gulls flew when supersonic aircraft flew overhead. These birds would circle around and immediately land in the loafing flock (U.S. Air Force 2000).

In 1970, sonic booms were potentially linked to a mass hatch failure of sooty terns on the Dry Tortugas (Austin et al. 1970). The cause of the failure was not certain, but it was conjectured that sonic booms from military aircraft or an overgrowth of vegetation were factors. In the previous season, sooty terns were observed to react to sonic booms by rising in a “panic flight,” circling over the island, then usually settling down on their eggs again. Hatching that year was normal. Following the 1969 hatch failure, excess vegetation was cleared and measures were taken to reduce supersonic activity. The 1970 hatch appeared to proceed normally. A colony of noddies on the same island hatched successfully in 1969, the year of the sooty tern hatch failure.

Subsequent laboratory tests of exposure of eggs to sonic booms and other impulsive noises (Cottereau 1972; Cogger and Zegarra 1980; Bowles et al. 1991, 1994) failed to show adverse effects on hatching of eggs. A structural analysis by Ting et al. (2002) showed that, even under extraordinary circumstances, sonic booms would not damage an avian egg.

Burger (1981) observed no effects of subsonic aircraft on herring gulls in the vicinity of JFK International Airport. The Concorde aircraft did cause more nesting gulls to leave their nests (especially in areas of higher density of nests), causing the breakage of eggs and the scavenging of eggs by intruder prey. Clutch sizes were observed to be smaller in areas of higher-density nesting (presumably due to the greater tendency for panic flight) than in areas where there were fewer nests.

Raptors

In a literature review of raptor responses to aircraft noise, Manci et al. (1988) found that most raptors did not show a negative response to overflights. When negative responses were observed they were predominantly associated with rotor-winged aircraft or jet aircraft that were repeatedly passing within 0.5 mile of a nest.

Ellis et al. (1991), performed a study to estimate the effects of low-level military jet aircraft and mid- to high-altitude sonic booms (both actual and simulated) on nesting peregrine falcons and seven other raptors (common black-hawk, Harris' hawk, zone-tailed hawk, red-tailed hawk, golden eagle, prairie falcon, bald eagle). They observed responses to test stimuli, determined nest success for the year of the testing, and evaluated site occupancy the following year. Both long- and short-term effects were noted in the study. The results reported the successful fledging of young in 34 of 38 nest sites (all eight species) subjected to low-level flight and/or simulated sonic booms. Twenty-two of the test sites were revisited in the following year, and observations of pairs or lone birds were made at all but one nest. Nesting attempts were underway at 19 of 20 sites that were observed long enough to be certain of breeding activity. Re-occupancy and productivity rates were within or above expected values for self-sustaining populations.

Short-term behavior responses were also noted. Overflights at a distance of 150 m or less produced few significant responses and no severe responses. Typical responses consisted of crouching or, very rarely, flushing from the perch site. Significant responses were most evident before egg laying and after young were "well grown." Incubating or brooding adults never burst from the nest, thus preventing egg breaking or knocking chicks out of the nest. Jet passes and sonic booms often caused noticeable alarm; however, significant negative responses were rare and did not appear to limit productivity or re-occupancy. Due to the locations of some of the nests, some birds may have been habituated to aircraft noise. There were some test sites located at distances far from zones of frequent military aircraft usage, and the test stimuli were often closer, louder, and more frequent than would be likely for a normal training situation (Ellis et al. 1991).

Manci et al. (1988), noted that a female northern harrier was observed hunting on a bombing range in Mississippi during bombing exercises. The harrier was apparently unfazed by the exercises, even when a bomb exploded within 200 feet. In a similar case of habituation/non-disturbance, a study on the Florida snail-kite stated the greatest reaction to overflights (approximately 98 dB) was "watching the aircraft fly by." No detrimental impacts to distribution, breeding success, or behavior were noted.

Fish and Amphibians

The effects of overflight noise on fish and amphibians have not been well studied, but conclusions regarding their expected responses have involved speculation based upon known physiologies and behavioral traits of these taxa (Gladwin *et al.* 1988). Although fish do startle in response to low-flying aircraft noise, and probably to the shadows of aircraft, they have been found to habituate to the sound and overflights. Amphibians that respond to low frequencies and those that respond to ground vibration, such as spadefoot toads, may be affected by noise.

Summary

Some physiological/behavioral responses such as increased hormonal production, increased heart rate, and reduction in milk production have been described in a small percentage of studies. A majority of the studies focusing on these types of effects have reported short-term or no effects.

The relationships between physiological effects and how species interact with their environments have not been thoroughly studied. Therefore, the larger ecological context issues regarding physiological effects of jet aircraft noise (if any) and resulting behavioral pattern changes are not well understood.

Animal species exhibit a wide variety of responses to noise. It is therefore difficult to generalize animal responses to noise disturbances or to draw inferences across species, as reactions to jet aircraft noise appear to be species-specific. Consequently, some animal species may be more sensitive than other species and/or may exhibit different forms or intensities of behavioral responses. For instance, wood ducks appear to be more sensitive and more resistant to acclimation to jet aircraft noise than Canada geese in one study. Similarly, wild ungulates seem to be more easily disturbed than domestic animals.

The literature does suggest that common responses include the "startle" or "fright" response and, ultimately, habituation. It has been reported that the intensities and durations of the startle response decrease with the numbers and frequencies of exposures, suggesting no long-term adverse effects. The majority of the literature suggests that domestic animal species (cows, horses, chickens) and wildlife species exhibit adaptation, acclimation, and habituation after repeated exposure to jet aircraft noise and sonic booms.

Animal responses to aircraft noise appear to be somewhat dependent on, or influenced by, the size, shape, speed, proximity (vertical and horizontal), engine noise, color, and flight profile of planes. Helicopters also appear to induce greater intensities and durations of disturbance behavior as compared to fixed-wing aircraft. Some studies showed that animals that had been previously exposed to jet aircraft noise exhibited greater degrees of alarm and disturbance to other objects creating noise, such as boats, people, and objects blowing across the landscape. Other factors influencing response to jet aircraft noise may include wind direction, speed, and local air turbulence; landscape structures (i.e., amount and type of vegetative cover); and, in the case of bird species, whether the animals are in the incubation/nesting phase.

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Appendix C
Noise Study

Final Report

Aircraft Noise Study to Support the Environmental Impact Statement for the Patuxent River Complex

June 2019

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List of Acronyms

A/C	aircraft
AAM	Advanced Acoustic Model
AGL	above ground level
AGNM	Air Gunnery Noise Model
AICUZ	Air Installations Compatible Use Zones
Alt	Action Alternative
ANSI	American National Standards Institute
ATC	Air Traffic Control
AVG	average
BRRC	Blue Ridge Research and Consulting, LLC
CDNL	C-weighted day-night average sound level
dB	decibel
dBA	A-weighted decibels
dBC	C-weighted decibels
deg	degrees
DNL	day-night average sound level
DNWG	Defense Noise Working Group
DoD	Department of Defense
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ETR	engine thrust request
F	Fahrenheit
FAA	Federal Aviation Administration
FCLP	Field Carrier Landing Practice
FICON	Federal Interagency Committee on Noise
FICUN	Federal Interagency Committee on Urban Noise
FIST	Flight Information Scheduling and Tracking
ft	feet
GASEPF	General Aviation Single Engine Fixed Propeller
GCA	Ground Controlled Approach
Helos	helicopters
HP	Horsepower
Hz	hertz
ID	identification number
IFR	instrument flight rules
Kts	knots
L_{Aeq}	equivalent A-weighted sound level
L_{Amax} or L_{max}	maximum sound level (A-weighted decibels)
lbs/hr	pounds per hour
L_{dn}	A-weighted day-night average sound level
L_{dnmr}	A-weighted onset-rate adjusted monthly day-night average sound level
L_{eq}	Equivalent Sound Level
$L_{eq(8h)}$	equivalent sound level averaged over 8 hours
L_{max}	maximum sound level
L_{Pk}	peak pressure level

max	maximum
MDARNG	Maryland Army National Guard
min	Minutes
MOA	Military Operating Area
MR_NMAP	Military Operating Area and Route Noise Map Model
MSL	mean sea level
MTR	Military Training Route
N/A	not applicable
NA_L	number of events above a threshold sound level
NAS	Naval Air Station
NAVAIR	Naval Air System Command
NAWCAD	Naval Air Warfare Center Aircraft Division
NLR	noise level reduction
NM	nautical mile
NTWL	Naval Test Wing Atlantic
OAETC	Open-Air Engine Test Cell
OLF	Outlying Landing Field
PFO	Precautionary Flame Out
PPR	Prior Permission Required
PRC	Patuxent River Complex
RPM	revolutions per minute
SAR	Search and Rescue
SEL	sound exposure level
SELr	onset-rate adjusted sound exposure level
SFO	Simulated Flame Out
SHARP	Sierra Hotel Airport Reporting Program
TA	Time Above
TPS	Test Pilot School
TUAS	Tactical Unmanned Aircraft System
UAS	Unmanned Aircraft System
UASTD	Unmanned Aircraft Systems Test Directorate
USN	United States Navy
VFR	visual flight rules
VORTAC	Very High Frequency Omni-Directional Radio Range Tactical Air Navigation Aid
VTUAS	Vertical Take-off and Landing Unmanned Aircraft System

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Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

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1 Introduction

This noise analysis report supports the US Navy's (USN) preparation of an Environmental Impact Statement (EIS) for testing and training operations at Naval Air Station (NAS) Patuxent River, Outlying Field (OLF) Webster, and the Atlantic Test Range. The Patuxent River Complex (PRC) includes supporting land areas (NAS Patuxent River, OLF Webster, and the Bloodsworth Island Range), water areas (e.g., Chesapeake Bay, lower Potomac, St. Mary's, and lower Patuxent River), airspace, and Atlantic Test Ranges' assets (e.g., fixed targets, aim points, recovery areas, and instrumentation sites) (Figure 1-1). This analysis presents a No Action Alternative along with two Action Alternatives. These Action Alternatives include an increase in overall operations compared to the No Action Alternative. This report is divided into sections that present the study's objectives and goals, the data used in the noise model, the noise model analysis, and results. The first section provides an overview of the No Action and Action Alternatives. Section 2 summarizes the noise metrics used to describe and quantify the noise environments, and provides a brief description of the computer noise analysis model used to calculate the noise exposures. Section 3 provides the results of the airfield analysis at NAS Patuxent River and OLF Webster for the No Action Alternative. Section 4 provides the airspace noise analysis results for the PRC for the No Action and the Alternatives. Section 5 discusses the results of sonic booms from supersonic aircraft operations, along with noise from aerial weaponry operations within the PRC. Section 6 presents supplemental metrics results at representative locations throughout the study area.

1.1 Purpose

The objectives of this aircraft noise study are to model the community noise levels from all current and projected aircraft operations within the PRC, which includes NAS Patuxent River and OLF Webster. This analysis includes airspace, supersonic, and aircraft munitions noise, in addition to airfield noise. The No Action Alternative represents a 10-year average of fiscal year (FY) 2008 through 2017 of aircraft operations. This long span of annual operations data was used to capture the varying nature of test aircraft operations. The data collected on the aircraft flight hours for each squadron under the No Action Alternative were used to determine flight hour estimates under each of the Action Alternatives. The methodology for this flight hour estimate, or scaling factor, is discussed in Section 3.1.

1.2 Description of NAS Patuxent River and OLF Webster

NAS Patuxent River is home to Naval Air System Command (NAVAIR) headquarters, the Naval Air Warfare Center Aircraft Division (NAWCAD), and the U.S. Naval Test Pilot School. The PRC serves as a center for test and evaluation and systems acquisition relating to naval aviation and is host to more than 50 tenants including three Services (Navy, Air Force, and Army), federal agencies, and private industry. NAVAIR at NAS Patuxent River is one of eight NAVAIR sites that provide the highest standards in warfare technology through supremacy in naval aviation technologies. The mission of NAWCAD at NAS Patuxent River is to support NAVAIR in providing the warfighter with absolute combat power through technologies that deliver dominant combat effects and matchless capabilities. The mission of NAS Patuxent River is to provide effective and affordable integrated warfare systems and life-cycle support by performing research, development, test and evaluation, engineering, and fleet support for manned and unmanned aircraft, engines, avionics, aircraft support systems, and ship/shore/air operations.

Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

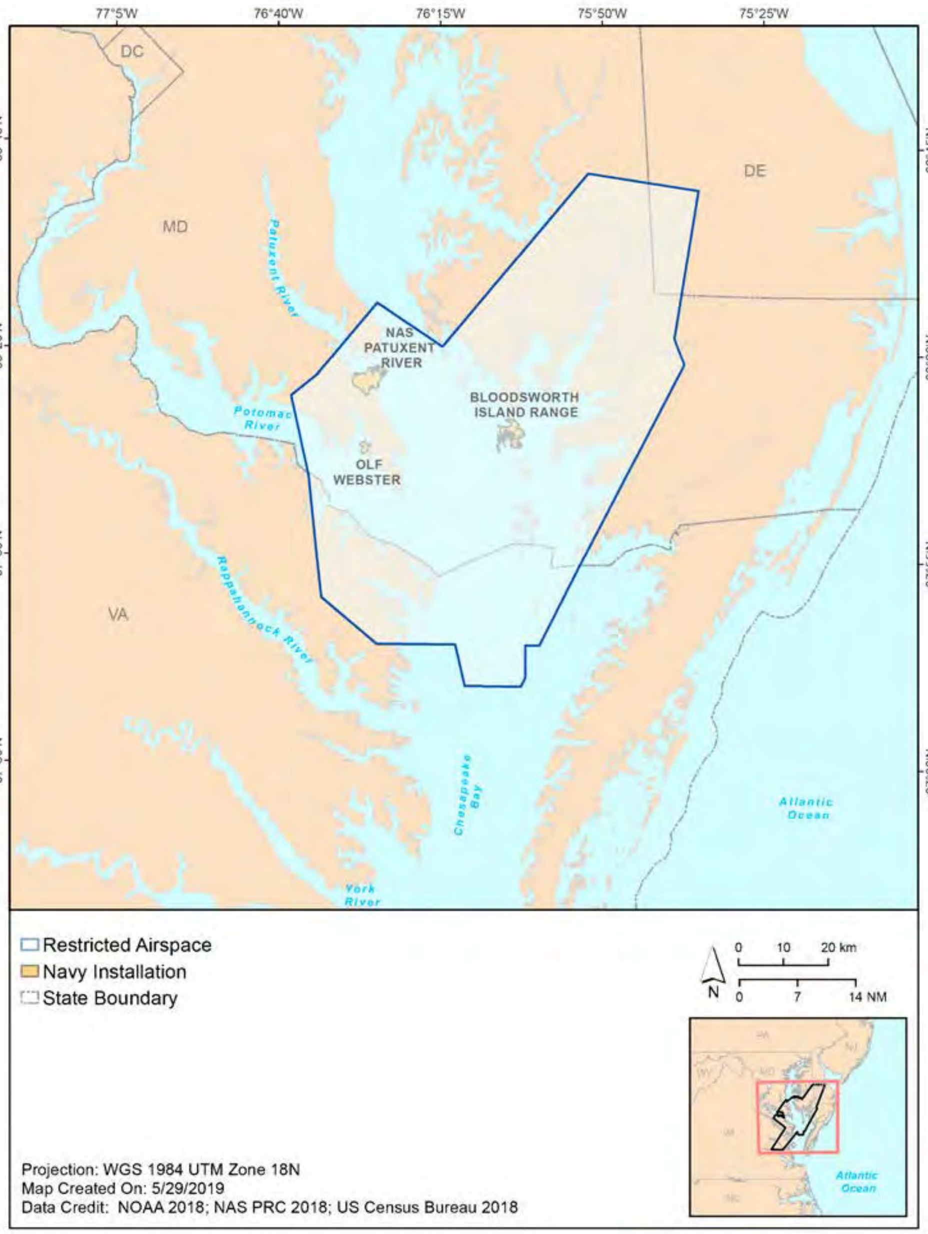

Figure 1-1. Patuxent River Complex and Associated Airspace and Ranges

2

NAS Patuxent River is located in Patuxent River, MD, adjacent to Lexington Park, and encompasses over 13,800 acres and houses 935 buildings (including 10 hangars, totaling more than 8.76 million square feet), with five active runways (longest is 11,800 feet), and possesses 5,000 square miles of controlled airspace of which 780 square miles are restricted.

Located 12 miles southwest of NAS Patuxent River, OLF Webster is home to the NAWCAD 4.11 and NAWCAD 5.1.11, Coast Guard Station St. Inigoes, and a component of the Maryland Army National Guard (MDARNG). NAWCAD 5.1.11 supports fixed and rotary wing autonomous/semi-autonomous remotely piloted aircraft, including the MQ-8B Fire Scout Vertical Take-off and Landing Unmanned Aircraft System (VTUAS) and the RQ-7B Shadow 200 Tactical Unmanned Aircraft System (TUAS). Additionally, UX-24, formerly known as the Unmanned Aircraft Systems Test Directorate (UASTD), operates and maintains two Aerostar Unmanned Aircraft Systems (UAS) that provide customers a safe and efficient method to test a variety of payloads. UX-24 also assists other platform flight tests with support to range clearance operations. The MDARNG operates the RQ-7B Shadow 200 TUAS at OLF Webster.

1.3 Description of Alternatives

The EIS No Action Alternative and two Action Alternatives were analyzed in this noise study. The No Action Alternative is the 10-year annual average of operational data across all squadrons operating at NAS Patuxent River and OLF Webster. It represents a total of 20,100 flight hours across all squadrons (including transients). The Action Alternatives are titled Alternatives 1 and 2 and involve the projected future flight hour estimates for each squadron. Alternative 1 represents a total of 23,400 flight hours at NAS Patuxent River and OLF Webster and Alternative 2 represents a total of 26,000 flight hours. The data collected on the aircraft flight hours for each squadron under the No Action Alternative was used to determine projected flight hour estimates under each of the Action Alternatives. The methodology for this flight hour estimate or scaling factor is discussed in Section 3.1.

The Action Alternatives take into consideration the aircraft platforms that will be retired in the future or are no longer part of a squadron at NAS Patuxent River. For instance, the P-3 and T-6 are no longer part of the VX-20 squadron, although they are modeled in the No Action Alternative. These aircraft have been removed from the Action Alternatives. The No Action represents an average of the past 10 years of aircraft operations, while the Action Alternatives reflect estimated future operations. The Action Alternatives also include future platforms such as the MQ-25. A full list of aircraft modeled in the No Action and Action Alternatives is presented in Section 3.

1.4 Historical Annual Flight Hours

NAS Patuxent River is primarily a test and evaluation facility; therefore, flight hours for each squadron are tracked and used as the basis of flight projections instead of operations or sorties. As a result, the historical data collected are flight hours. For most squadrons, flight hour data are collected from the Flight Information Scheduling and Tracking (FIST) database. For those squadrons who do not use FIST (i.e., VQ-4, VXS-1, VX-1, and MDARNG), flight hours are reported directly to the NAVAIR Ranges Sustainability Office. Flight hours for transient aircraft utilizing PRC airspace only are captured in an Air Traffic Control (ATC) Actuals database. Combining these data sets, Table 1-1 displays the historical flight hours of each squadron that utilizes NAS Patuxent River and OLF Webster. The annual flight hours for all aircraft at NAS Patuxent River and OLF Webster range from a low of 18,438 hours in 2015 to a high of 23,264 hours in 2012. The 10-year average of 20,054 flight hours, rounded up to 20,100 hours, was used for the No Action Alternative and is displayed in Table 3-2 in Section 3. Action Alternatives 1 and 2 were based on subject matter expert projections for future average and peak flight hours, respectively. To derive the operational totals for the No Action Alternative and projected Action Alternatives needed for noise modeling, the FIST system sorties and landings data were used. This process to convert flight hours to operations is further discussed in Sections 3 and 4.

Table 1-1. Total Historical Annual Squadron Flight Hours at NAS Patuxent River and OLF Webster

Squadron	FY 08	FY 09	FY 10	FY 11	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	10-YR Average	10-YR Peak (FY 12)
Transient (Non-FIST)	1,843	1,761	1,720	1,863	1,321	1,286	1,003	756	1,235	655	1,344	1,321
Transient (FIST)	68	95	95	535	220	225	221	294	352	305	241	220
HX-21	2,365	2,217	1,896	2,272	1,975	2,152	1,801	1,721	1,887	1,947	2,023	1,975
UX-24 / UASTD	356	233	101	227	616	352	434	365	393	487	356	616
Air Ops	1,338	1,568	1,642	1,462	1,447	1,277	1,044	1,045	775	820	1,242	1,447
TPS	6,460	5,196	5,788	6,583	7,194	6,706	6,021	5,822	5,962	6,098	6,183	7,194
VX-20	3,116	3,344	4,228	5,512	5,452	4,130	3,819	3,814	3,977	3,845	4,124	5,452
VX-23	3,068	2,821	2,910	3,586	4,309	4,185	3,828	3,748	3,609	3,230	3,529	4,309
VXS-1	282	355	443	302	157	240	344.7	257.6	168.9	266.9	282	157
VX-1	131.825	399	350	14	81	93	45.7	8	63.9	385	157	81
MDARNG	95	119	206	49	0	145.2	177.1	248.3	300.5	170.7	151	151
VQ-4	440.5	388.5	417	426	492	378	368	359.5	451	490	421	492
Total	**19,563**	**18,497**	**19,796**	**22,831**	**23,264**	**21,169**	**19,107**	**18,438**	**19,174**	**18,700**	**20,054**	**23,415**

Key: UASTD = Unmanned Aircraft Systems Test Directorate; FIST = Flight Information Scheduling and Tracking; FY = fiscal year; MDARNG = Maryland Army National Guard.
Notes: 10-year average of 20,054 was rounded up to 20,100 flight hours for the No Action Alternative.
10-year peak of 23,415 was rounded down to 23,400 flight hours for Action Alternative 1.

2 Noise Metrics & Models

Military aircraft testing and training operations generate noise that has the potential to affect residents and land uses. Although many other sources of noise are present in today's communities, aircraft noise is readily identifiable based on its uniqueness. An assessment of aircraft noise requires a general understanding of how sound affects people and the natural environment, as well as how it is measured.

Around a military or civilian airfield, the noise environment is normally described in terms of the time-average sound level generated by aircraft operating at that facility. In this study, operations consist of the flight activities conducted during an average annual day, including arrivals and departures at the airfield, flight patterns in the general vicinity of the airfield, and ground run-up and maintenance operations. These noise events are described as *transient noise*, which has a gradual onset and has a duration greater than a few seconds.

The noise environment close to military testing and training areas includes various types of noise sources that can either be classified as transient or impulsive noise. *Impulsive noise* refers to sudden noise events with rapid onsets and very brief durations such as sonic booms or aerial weapon firing. Additionally, noise for airspace training operations varies dramatically compared to airfield noise. As opposed to patterned or continuous noise environments associated with airfields, overflights within a range can be highly variable in occurrence and location. Individual military overflight events also differ from typical community noise events because noise from a low-altitude, high-airspeed flyover can have a sudden onset (i.e., exhibiting a rate of increase in sound level – onset rate – of up to 30 to 150 decibel (dB) per second).

2.1 Noise Metrics

A noise metric refers to a unit or quantity that measures an aspect of the received noise used in environmental noise analyses. A metric is used to relate the received noise to its various effects. To quantify these effects, the Department of Defense (DoD) and the Federal Aviation Administration (FAA) use a series of metrics to describe the noise environment from aircraft operations. These metrics range from simple to descriptive to complex measures of the noise environment.

Simple metrics quantify the sound levels occurring during an individual aircraft overflight (single event) and the total noise exposure from the event. Single noise events can be described with the maximum sound level (L_{Amax}) and sound exposure level (SEL) metrics. SEL is used to relate the modeled noise with the potential for sleep disturbance. Another simple measure of instantaneous noise level is the Peak Sound Pressure Level that is used primarily for impulsive noise associated with sonic booms and gun firings. For this noise study, the SEL and L_{Amax} metrics are used in the Supplemental Metrics (Section 6) at the representative locations to present the noise levels of single flyover events. Peak Sound Pressure Level is used to quantify single air munitions events in Section 5.2.

Descriptive metrics are used to quantify a listener's experience in a noise environment. Two of the common descriptive metrics are the frequency of occurrence of noise events (Number of Events Above a Threshold Sound Level, NA_L) and the cumulative duration of the events (Time Above, TA) above a given threshold level. These metrics provide an estimate of "how often" and "how long" noise events would occur in a given location. These metrics provide a good measure of the noise that may be experienced from proposed operations, and they can be related to speech interference for both the general population and classroom. For this analysis, NA_L is utilized for assessing speech interference at the representative locations described in Section 6. Currently, the calculation of TA is not reliable with NoiseMap 7.3 (NoiseMap is described in section 2.2) (Downing, 2016). Therefore, the TA metric is not used in this noise study.

Complex metrics quantify the cumulative noise exposure using a number of different methods of analyzing the noise based on the expected flight and aircraft engine run-up maintenance schedules. Some common metrics are the Equivalent Sound Level (L_{eq}) and the Day/Night Average Sound Level or A-weighted Day-Night Average Sound Level (DNL or L_{dn}). DNL is the fundamental metric used to describe the aircraft noise environment in and around an airfield and is directly related to the long-term community annoyance resulting from this noise. The other metrics (simple and descriptive) supplement this long-term characterization of the noise environment and help to clarify different aspects of the noise effects. DNL is the metric used in this study to analyze the cumulative noise exposure and to generate the noise contour map. Both DNL and L_{eq} are used for the supplemental metric results at the representative locations (Section 6).

Frequency Weighting. To assess the effects from these different types of noise events, noise metrics can use different weighting factors, which emphasize certain parts of the audio frequency spectrum. The normal human ear detects sounds in the range from 20 Hertz (Hz) to 20,000 Hz, and it is most sensitive to sounds in the 1,000 to 4,000 Hz range. Community noise is therefore assessed using a filter that approximates the frequency response of the human ear, adjusting low and high frequencies to match the sensitivity of the ear. This "A-weighting" filter is used to assess most community noise sources. However, for impulsive noise, a "C-weighting" filter is used. "C-weighting" denotes an adjustment to the frequency content of a noise event to represent human response to louder noise levels. Compared to A-weighting, C-weighting enhances the lower frequency content of a noise event. For this noise study, A-weighting is used for noise generated by aircraft arrival, departure, closed pattern, and airspace operations while C-weighting is used for supersonic and aircraft munitions noise.

2.1.1 Maximum Sound Level (L_{Amax})

The highest A-weighted integrated sound level measured during a single noise event in which the sound level changes value with time (e.g., an aircraft overflight) is called the maximum A-weighted sound level (L_{Amax}). During an aircraft overflight, the noise level starts at the ambient or background sound level, rises to the maximum level as the aircraft flies closest to the observer, and returns to the background level as the aircraft recedes into the distance. L_{Amax} indicates the maximum sound level occurring for a fraction of a second during the event. For aircraft noise, the "fraction of a second" over which the maximum level is defined is generally 1/8th of a second. The maximum sound level is important in judging the interference caused by a noise event with conversation, TV listening, sleep, or other common activities. Although it provides some measure of the intrusiveness of the event, it does not completely describe the total event, because it does not include the period of time over which the sound is heard. In this noise study, L_{Amax} is used to quantify the maximum sound level of aircraft overflights at the representative locations described in Section 6 and within the airspace areas within the PRC for the airspace analysis presented in Section 4.2.

2.1.2 Sound Exposure Level (SEL)

SEL is a metric that represents both the intensity of a sound and its duration. Individual time-varying noise events (e.g., aircraft overflights) have two main characteristics: a sound level that changes throughout the event and a period of time during which the event is heard. SEL provides a measure of the net exposure of the entire acoustic event, but it does not directly represent the sound level heard at any given time. During an aircraft flyover, SEL would include both the maximum sound level and the lower sound levels produced during onset and recess periods of the overflight.

SEL is a logarithmic measure of the total acoustic energy transmitted to the listener during the event. Mathematically, it represents the sound level of a constant sound that would, in one second, generate the same acoustic energy as the actual time-varying noise event. For sound from aircraft overflights, which typically last more than one second, the SEL is usually greater than the L_{Amax} because an individual overflight takes seconds and the L_{Amax} occurs in a fraction of a second. SEL also provides the best measure to compare noise levels from different aircraft and/or operations. For aircraft noise, the SEL metric utilizes A-weighting. For airspace noise modeling, the onset-rate adjusted sound exposure level (SELr) is used, which has a penalty ranging from 0 to 11 decibels (dB) (higher penalties for higher aircraft airspeed operations) applied to the SEL to account for the added intrusiveness of high speed aircraft operations in the airspaces. This noise study uses SEL for the single event supplemental metrics presented in Section 6.6. SELr is used for the PRC airspace single event overflight noise results found in Section 4.2.

2.1.3 Peak Pressure Level (L_{Pk})

The peak pressure level (L_{Pk}) is the highest instantaneous, unweighted sound level over any given time period. It is used to quantify impulsive, short duration events such as a weapon firing or a sonic boom. L_{Pk} is used to assess potential of structural damage and the risk of complaints. High peak sound levels can generate complaints from people in the local community. L_{Pk} is used in this noise study to quantify the supersonic aircraft events and the use of aircraft munitions in the PRC.

2.1.4 Number-of-Events above a Threshold Level

The Number-of-Events Above a threshold level (NA_L) describes the number of noise events that exceed a threshold level during a defined time period. The threshold level is generally defined by either L_{Amax} or SEL and the value is denoted by the subscript. For example, NA_{65} denotes the number of events that exceed 65 A-weighted decibels (dBA) for a given time period. The time period can range from a particular hour of the day to any or all 24 hours of a day and depends on the descriptive nature of the NA_L analysis. For example, to determine the number of events occurring during a school day, the time period would include the hours the local school is occupied. It is important to note that the metrics used for the threshold and time period are not explicitly stated in the NA_L metric and must be defined in the text of the analysis. For this analysis, the SEL is used as the basis of the calculations of NA_L.

2.1.5 Equivalent A-weighted Sound Level (L_{Aeq})

A complex noise metric that is useful in describing noise is the Equivalent A-weighted Sound Level (L_{Aeq}). L_{Aeq} relates the time varying noise level to a steady-state noise level that has the same total energy over a specified time period. The L_{Aeq} metric can provide a more accurate quantification of noise exposure for a specific period, particularly for daytime periods when the nighttime adjustment under the DNL metric is inappropriate.

Just as SEL has proven to be a good measure of the noise impact of a single event, L_{Aeq} has been established to be a good measure of the impact of a series of events during a given time period. Also, while L_{Aeq} is defined as an average, it is effectively a sum over that time period and is, thus, a measure of the cumulative impact of noise. For example, the sum of all noise-generating events during the period of 0700 to 1600 could provide the relative impact of noise events for a typical school day and would be denoted by $L_{eq,8hr}$. In this noise study, $L_{eq,8hr}$ is used to assess the cumulative classroom speech interference during the 8-hour school day. Results are presented in Section 6.5.

2.1.6 Day/Night Average Sound Level, DNL or L_{dn}

Day-Night Average Sound Level (DNL or L_{dn}) is a complex metric that accounts for the SEL of all noise events in a 24-hour period. To account for increased human sensitivity to noise at night (2200 to 0700), a 10 dB adjustment is applied to nighttime events. The adjustment added to the DNL metric accounts for the added intrusiveness of sounds that occur during normal sleeping hours, both because of the increased sensitivity to noise during those hours and because ambient sound levels during nighttime are typically about 10 dB lower than during daytime hours.

DNL is an average quantity mathematically representing the continuous A-weighted sound level that would be present if all of the variations in sound level that occur over a 24-hour period were smoothed out so as to contain the same total sound energy. DNL accounts for the maximum noise levels, the duration of the events (operations), the number of events and the timing of their occurrence over a 24-hour period. Like SEL, DNL does not represent the sound level heard at any particular time, but it quantifies the total sound energy received. While it is normalized as an average, it represents all of the sound energy, and is therefore a cumulative measure. Section 3.2 presents the DNL contour map for the No Action Alternative and Section 4.2 presents the Action Alternatives.

Although DNL provides a single measure of the overall noise impact, it does not provide specific information on the number of noise events or the individual sound levels that occur during the 24-hour period. For example, a daily average sound level of 65 dB could result from very few noisy events or a large number of quieter events.

For airspace noise, the conventional DNL metric is adjusted to account for the potential "surprise" effect on humans from the sudden onset of aircraft noise events with an adjustment up to 11 dB above the normal SEL (Stusnick et al., 1992 & 1993). Onset rates between 15 to 150 dB per second require an adjustment of 0 to 11 dB, while onset rates below 15 dB per second require no adjustment. The adjusted DNL is designated as the A-weighted Onset-Rate Adjusted Monthly Day-Night Average Sound Level (L_{dnmr}).

For impulsive noise, a C-weighted DNL (CDNL) is used to represent the long-term noise exposure from these events. This metric is the same as DNL except C-weighting is used. CDNL is used in this analysis for supersonic and aircraft munitions noise.

2.1.7 Noise Analysis

2.1.7.1 Community Annoyance

In 1979, the Federal Interagency Committee on Urban Noise (FICUN) was established, and the committee published *Guidelines for Considering Noise in Land-Use Planning and Control* (FICUN, 1980). These guidelines complement federal agency criteria by providing for the consideration of noise in all land-use planning and interagency/intergovernmental processes. The FICUN established DNL, which is the most appropriate descriptor for all noise sources. In 1982, the Environmental Protection Agency (EPA) published *Guidelines for Noise Impact Analysis* to provide all types of decision-makers with analytic procedures to uniformly express and quantify noise impacts (EPA, 1982). The American National Standards Institute (ANSI) endorsed DNL in 1990 as the "acoustical measure to be used in assessing compatibility between various land uses and outdoor noise environment" (ANSI, 2003). In 1992, the

Federal Interagency Committee on Noise (FICON) reaffirmed the use of DNL as the principal aircraft noise descriptor in the document titled *Federal Agency Review of Selected Airport Noise Analysis Issues* (FICON, 1992). In general, scientific studies and social surveys have found a high correlation between the percentages of groups of people highly annoyed and the level of average noise exposure measured in DNL (Schultz, 1974; Fidell, et al., 1991; Finegold, et al., 1994).

2.1.7.1.1 *Supplemental Analysis*

Additional effects can also be assessed to extend the description of the noise environment at some representative location around an airfield. These additional analyses utilized supplemental metrics to model specific effects such as speech interference, sleep disturbance, and classroom impacts. These supplemental analyses are described in the Defense Noise Working Group (DNWG) guidelines (DNWG, 2009a & 2009b). For this analysis, the following supplemental analyses are included: speech interference, sleep disturbance, and classroom speech interference.

2.1.7.1.2 *Speech Interference*

Indoor speech interference from flight operations can be annoying to the public. For this analysis, the recommended conservative indoor noise threshold of 50 dBA is used to indicate flight events, which have the potential to interfere with indoor speech. NA_L is utilized to estimate the number of events that exceed this threshold. Currently, NoiseMap7 only predicts single event levels with SELs. Thus, to calculate the interior noise level, 10 dBA was subtracted from the calculated SEL to estimate the interior L_{Amax} (L_{Amax} is on average approximately 10 dBA less than SEL) and then Noise Level Reductions (NLR) of 15 dB and 25 dB were applied to account for windows being either opened or closed, respectively (FICON, 1992). When windows are open, the noise reduction from the outside of the house to inside is 15 dB (this depends on house construction and is an average). When windows are closed, the noise reduction from the outside of the house to the inside is 25 dB (this depends on the windows type and is an average for newer construction homes). Thus, to calculate the number of events above 50 dBA indoors with windows open, a 65 dBA threshold is applied (50 dBA plus house reduction of 15 dBA). To calculate the number of events above 50 dBA indoors with windows closed, a 75 dBA threshold is applied (50 dBA plus house and windows reduction of 25 dBA). Additionally, for this analysis only the acoustic daytime events (0700 to 2200) are considered.

2.1.7.1.3 *Sleep Disturbance*

The potential for sleep disturbance from flight operations at NAS Patuxent River and OLF Webster exists for the surrounding communities. The probabilities of awakenings are calculated at representative locations for operations occurring between 2200 and 0700. The estimation procedure follows the recommended method outlined in the American National Standard Quantities and Procedures for Description and Measurement of Environmental Sound – Part 6: Methods for Estimation of Awakenings Associated with Outdoor Noise Events Heard in Homes (ANSI, 2008). This method estimates the probability of a single awakening from nighttime operations based on the received outdoor SEL. The estimations included the probability of awakening within a home with windows open and windows closed. For open windows, an NLR of 15 dB is assumed to estimate the interior sound levels. For closed windows, a NLR of 25 dB is used (FICON, 1992).

2.1.7.1.4 *Classroom Interference*

To assess the potential impacts to the school and classroom environment, two metrics were calculated to estimate the noise levels generated during the school day: $L_{eq,8hr}$ and NA_L. The $L_{eq,8hr}$ metric provides the average sound level generated by aircraft operations during a school day, and NA_L estimates the number of potentially interfering flight events. DNWG guidelines for classroom interference (DNWG, 2013) recommend using an outdoor $L_{eq,8hr}$ of 60 dBA as a screening level to indicate schools requiring further assessment. For schools within the 60 dBA $L_{eq,8hr}$, NA_L should be calculated for an interior level of 50 dBA as utilized for indoor speech interference. For the estimation of these metrics, the flight operations are scaled by a factor of 8/15 to account for the difference in the 8-hour school day and the 15-hour acoustic daytime period used for the DNL calculation. For the NA_L calculation, the same procedures are utilized as for speech interference.

2.2 Computerized Noise Exposure Models

2.2.1 NoiseMap and AAM

To analyze aircraft noise exposure around airfield facilities, NoiseMap (Czech & Plotkin, NMAP 7.0 User's Manual, Wyle Research Report, WR 98-13, 1998) and the Advanced Acoustic Model (AAM) (Bradley, Hobbs, Wilmer, & Czech, 2016) are typically used. NoiseMap is a suite of computer programs that was developed by the US Air Force. AAM is a suite of computer programs developed by the National Aeronautics and Space Administration for both single event and cumulative helicopter flight noise analysis. AAM is the DoD-recommended noise model for helicopter flyover noise modeling. Previously, the Rotorcraft Noise Model was used for helicopter modeling, but it has been replaced by AAM. It should be noted that hover and static helicopter operations are currently modeled with NoiseMap.

The latest NoiseMap package of computer programs consists of BaseOps Version 7 (Wasmer & Maunsell, 2006a), OMEGA10, OMEGA11 (Mohlman, 1983), NoiseMap Version 7.3 (Czech, 2014; Downing, 2016), NMPlot Version 4.6 (Wasmer & Maunsell, 2006b), and the latest issue of NOISFILE (Downing, 2016). NOISEFILE is the DoD noise database originating from noise measurements of controlled flyovers at prescribed power, speed, and drag configurations for many models of aircraft. AAM is also incorporated into this suite of programs through the integration of the data input module BASEOPS. With BASEOPS, the user enters the runway coordinates, airfield information, flight tracks, flight profiles along each track by each aircraft, numbers of flight operations, run-up coordinates, run-up profiles, and run-up operations. After the operational parameters are defined, both NoiseMap and AAM calculate DNL values on a grid of ground locations on and around the facility. The NMPlot program draws contours of equal DNL for overlay onto land-use maps. For this noise study, NoiseMap Version 7.3 and AAM version 2 were used to generate DNL contours of 55, 60, 65, 70, 75, 80, and 85 dBA.

NoiseMap and AAM also have the flexibility of calculating sound levels (SEL, $L_{eq,24hr}$, and DNL) at specified points so that noise values at representative locations around an airfield can be described in more detail. Section 6 contains supplemental metrics calculated by NoiseMap and AAM at representative locations.

Together, NoiseMap and AAM compare “before and after” community noise effects. NoiseMap and AAM provide noise level estimations prior to implementation of a proposed action and field verification. The noise modeling results of these computer programs, along with noise analysis metrics and guidelines presented in Section 2.1 provide a relative measure of noise effects around air facilities.

2.2.2 MOA and Route NoiseMap Model (MR_NMap)

Analyses of aircraft noise exposures and compatible land uses around and underneath airspace testing and training ranges are normally accomplished using MR_NMap. The US Air Force developed this general purpose computer model for calculating noise exposures occurring away from airbases, including Military Operating Areas (MOAs) and ranges, as well as along Military Training Routes (MTRs). This model expands the calculation of noise exposures away from airbases by using algorithms from both NoiseMap (Moulton, 1992) and ROUTEMAP (Moulton, 1992; Bradley, 1996). MR_NMap uses two primary noise models to calculate the noise exposure: area and track operations. Area operations capture operations that do not have well defined tracks, but occur within a defined area, such as air-to-air combat within a MOA. Track operations are used for well-defined flight track, such as MTRs, aerial refueling, and strafing tracks. For this analysis, most of the operations within the PRC are area operations, but there are some track operations modeled for the Chesapeake test track.

The program uses the same user interface, BaseOps, as NoiseMap, for the development of the input data. For track operations, input requirements are the same as for ROUTEMAP, but more than just MTRs can be modeled. For area operations, the model allows flexibility. If little is known about the airspace utilization within a MOA, then the MOA boundaries can simply be used and the operations are uniformly distributed within the defined area. However, if more is known about how and where the aircraft fly within the MOA, subareas can be defined within the MOA to more accurately model the noise exposure.

Once the airspace is defined, the user must describe the mission types occurring within each airspace segment. Individual aircraft missions include the altitude distribution, average airspeed, and average engine power settings. These individual profiles are coupled with airspace components and annual operational rates. After the airspace and operational parameters are defined, MR_NMap calculates the resulting L_{dn} or L_{dnmr}. The model calculates these noise metrics either for a user-defined grid or at user-defined points. The grid calculation can be passed to NMPlot to plot the noise contours as provided in this analysis. The specific point calculation generates a table that provides the noise exposure, as well as the top contributors to the noise exposure. This table was used to generate the PRC airspace single event overflight noise results presented in Section 4.2.

2.2.3 PCBoom

PCBoom (Version 6) computes single-event sonic boom footprints and signatures from any supersonic vehicle executing any maneuver in a three-dimensional atmosphere, including winds and terrain effects (Plotkin, 1996 & 2010). This model has been verified with field measurements and accurately accounts for focusing of the sonic boom from aircraft maneuvers (Downing, 1998). The program has a menu interface that simplifies use and the presentation of results. The user specifies the aircraft, the maneuver, and atmospheric conditions. The primary output is the sonic boom footprint, which is defined in terms of contours of equal overpressure (or other amplitude metric) on the ground relative to the aircraft's position. PCBoom also generates sonic boom signatures, pressure-time-histories, and spectra of booms on the ground.

Although PCBoom is a single event sonic boom type model, the individual sonic boom footprints were accumulated into a calculated CDNL grid for the presentation of cumulative sonic boom CDNL contours. The current DoD cumulative sonic boom model, BooMap3, would not accurately model the type of supersonic events occurring at PRC. BooMap3 is for air combat supersonic events. Supersonic events at PRC are straight line segments that are either level or in diving flight. Additionally, BooMap assumes a fairly random heading for the supersonic segment, whereas the events at PRC have a range of set headings. For this analysis, the individual sonic boom footprints were combined to estimate the CDNL from the supersonic operations occurring within the PRC airspace.

2.2.4 Air Gunnery Noise Model

Air Gunnery Noise Model (AGNM) addresses the generation and propagation of noise from air-weaponry operations. The model handles the complexity of the distributed noise events while maintaining the accurate acoustical modeling required for environmental noise analysis. This noise analysis utilizes AGNM Version 2.0 and this version utilizes BaseOps for operational data entry.

One of the complexities related to AGNM is that aircraft rarely fly the exact attack profile prescribed and in some cases, the attack run is simply a generalized fan where the pilot can approach the target from a range of headings. To solve this problem of an unknown source location, a generalized statistical firing volume is used. This volume is defined by the parameters of the attack run with a three-dimensional Gaussian distribution of firing points. The noise footprint is then calculated to represent the noise from a single bullet fired from within the space. This statistical method is not representative of a single bullet fired, and instead, represents the average noise expected once a statistically large number of bullets have been fired. AGNM handles the noise from the muzzle blast, as well as the ballistic wave of the projectile. The results from AGNM include CDNL and L_{Pk} noise contours. The AGNM is utilized in this noise study to analyze aircraft munitions at the Hannibal and Hooper targets.

2.2.5 Airfield Analysis at NAS Patuxent River and OLF Webster for the No Action Alternative

The types of testing and training operations conducted at NAS Patuxent River and OLF Webster are numerous and variable. Assessment of aircraft noise requires a range of data to describe the types, frequency, and locations of noise-generating operations occurring within and between the two airfields. The primary sources of data are the FIST data; Air Traffic Activity Reports; interviews with aircrews, air traffic controllers, aircraft maintenance staff, planners, and schedulers; and annual reports pulled from the Query Tool. The data from these sources were compiled and integrated into a data validation package. This package includes the frequency of flight operations, time periods of operations, airfield layout, runway utilization, traffic flow utilization, flight tracks, flight profiles, and maintenance locations and operations. The majority of the operational data within this package was collected during a site visit from May 14-18, 2018. The operational data description was finalized and validated by all squadrons on 09 November 2018. This validated operational data was then used in the noise model. The following sections describe the modeled aircraft operations.

2.3 NAS Patuxent River and OLF Webster No Action Alternative Aircraft Operations

During the site visit to NAS Patuxent River and OLF Webster, several sources of data were provided by the NAVAIR Ranges Sustainability Office and were the starting point for the data collection. Table 2-1 displays the data collected, the sources of the data, and the date or date range of the data collected.

Table 2-1. Data Collection Sources and Dates

Data Type	Date
NAS Patuxent River AICUZ Study and Noise Study	2009
OLF Webster AICUZ data and EIS	2006 AICUZ and 1998 EIS
FIST Data ○ These data were used to derive average annual operations (arrival, departure, and closed pattern) and 2200-0700 operations at NAS Patuxent River and OLF Webster. ○ Sorties and landings were provided for all platforms and across all squadrons. The number of closed patterns per sortie was derived by taking landings and dividing by sorties. ○ For VXS-1, VX-1, and VQ-4 squadrons, FIST data was incomplete or not available, so used pilot estimates/flight logs for VXS-1 and VX-1, and used SHARP data (10-year average) for VQ-4 operations.	CY 2008–CY 2017
Supersonic Runs Data from the Query Tool from BayWatch and ATC	FY 2008–FY 2017 (10 years)
Ammunition Store Release Data from the Query Tool	FY 2008–FY 2017 (10 years)
OAETC Facility Noise Survey Data (from David Boyer – NAWCAD Propulsion Support Equipment Evaluation and Verification Branch)	FY 2013–FY 2017 (5 years)
Number of launches of each aircraft type for the TC-7 catapult (Jonathan Stevenson)	CY 2013–CY 2017 (5 years)
Total Annual Operations Runway Utilization (NAS Patuxent River Air Traffic Activity Reports)	CY 2013–CY 2017 (5 years)
F-35B and F-35C Flight Simulator Data (VX-23)	F-35B Flight Simulator Run was made May 2018; F-35C Flight Simulator Run was made June 2018.
PPR logs used to derive transient aircraft operations involving the airfield and 10-year ATC actuals data for transient airspace only operations	6 months PPR logs (January through June 2018) and ATC actuals data FY 2008–FY 2017 (10 years)

Key: AICUZ = Air Installations Compatible Use Zones; NAS = Naval Air Station; OLF = Outlying Landing Field; EIS = Environmental Impact Statement; FIST = Flight Information Scheduling and Tracking; FY = fiscal year; SHARP = Sierra Hotel Airport Reporting Program; ATC = Air Traffic Control; OAETC = Open-Air Engine Test Cell; NAWCAD = Naval Air Warfare Center Aircraft Division; PPR = Prior Permission Required.

2.3.1 No Action Alternative Squadron Specific Data Modeling

The following sections pertain to the data collection of each squadron during the site visit and the data validation process. This section also details the aircraft substitutions that were used in the modeling. Additionally, some aircraft are no longer part of a squadron, but they were included in the No Action

Alternative because of their impact in the 10-year average. These aircraft were not modeled in the Action Alternatives.

2.3.1.1 Test Pilot School Data Collection

For the Test Pilot School (TPS), since many different aircraft are part of the 10-year average operations data, the most utilized aircraft associated with TPS were modeled and acted as surrogates for all the other aircraft. Thus, all aircraft at the TPS were grouped into the following categories along with the aircraft(s) modeled for that category: Fighter (T-38 and F/A-18E/F), Helicopter (H-60 and H-72), Single Engine Propeller Aircraft (T-6), Twin Engine Turboprop (C-12), and Small Jet (C-21). If a less utilized aircraft fell into a category with multiple modeled aircraft (such as the T-38 and F/A-18E/F), then the modeled surrogate aircraft was the aircraft that is most similar in engine type and design as the substituted aircraft.

Closed pattern operations were determined from the FIST landing data, and the percent usage between NAS Patuxent River and OLF Webster was determined from the squadron interview. For the C-12, 28 percent are performed at NAS Patuxent River and 72 percent are performed at OLF Webster. For the T-6, 57 percent are performed at NAS Patuxent River and 43 percent are performed at OLF Webster. For the H-60 and H-72 helicopters, 90 percent are performed at NAS Patuxent River and 10 percent are performed at OLF Webster.

2.3.1.2 VX-23 Data Collection

The primary aircraft of VX-23 are the F/A-18C/D, F/A-18E/F, EA-18G, F-35B/C, and T-45. The FIST data lists only F/A-18 and F-35 without the variant listed, but the squadron provided the following breakdown for the No Action Alternative: 50 percent of F/A-18 operations are C/D model (Hornet), 40 percent are E/F model (Super Hornet), and 10 percent are EA-18G model (Growler). Since the E/A-18G Growler does not have noise source data, the E/F Super Hornet is the surrogate, so 50 percent of F/A-18 operations for the No Action are the E/F Super Hornet model. For the F-35, 60 percent are the B model and 40 percent are the C model for No Action Alternative. For the development of flight profile parameters, the squadron provided examples of simulator data for the F-35B/C. These examples were used to derive standard profiles for the F-35B/C, and the squadron reviewed and approved these flight profiles for use in the noise modeling.

MQ-25 is expected to begin service at NAS Patuxent River starting in FY 2022. Thus, MQ-25 is not modeled in the No Action Alternative, but it is included in the Action Alternatives. MQ-25 is expected to fly 20 weeks per year and 100 flying days per year. This expected operational tempo will generate 120 annual sorties for Alternative 1 and 133 sorties for Alternative 2. These MQ-25 sorties will include local patterns. For catapult sorties, three patterns on average are estimated. For carrier suitability testing sorties, five patterns are estimated. The MQ-25 surrogate is the C-21, as the C-21 engine closest resembles the MQ-25 engine in the noise model.

2.3.1.3 Search and Rescue and Maryland Army National Guard (MDARNG) Data Collection

For Search and Rescue (SAR), the No Action Alternative models both the MH-60 and the C-12. The C-12 is no longer part of SAR, but it was included in the No Action due to the large number of operations in the 10-year average of FIST data for SAR. For the Action Alternatives, the C-12 is removed from SAR operations and only the MH-60 is modeled. The MH-60 departs from and arrives at the Naval Air Warfare Center helipad. The MDARNG operates the RQ-7 at OLF Webster. The RQ-7 has no current source noise data. The General Aviation Single Engine Fixed Propeller (GASEPF) aircraft within NoiseFile was used as a surrogate because it is the smallest single engine aircraft in the noise model to represent the RQ-7.

2.3.1.4 VX-20 Data Collection

The primary aircraft in VX-20 are the MQ-4, C-38, P-8, E-2, C-12, C-130, and E-6B. The C-21 (Learjet 35) is the surrogate for the C-38, the T-2, and the MQ-4. The T-2s were replaced by the C-38 Courier. Since the C-21 is the closest aircraft in NoiseFile to the C-38, the C-21 is also used as the surrogate for the T-2. The MQ-4 engine is most similar to the C-21 engine of all the options of aircraft in the noise model. Additionally, since the MQ-4 is a new platform (hasn't been flying at Patuxent River for the past 10 years), 2017 data from FIST was used for the operations of the MQ-4 instead of the 10-year average. The E-2 is the surrogate for the C-2 since the C-2 is a derivative of the E-2 (same platform and engines). The P-3 is no longer in VX-20 (was removed from VX-20 in 2016), so the P-3 is modeled in the No Action (10-year average), but it is not modeled in the Action Alternatives. The T-6 is the surrogate aircraft for the T-34, but it is removed from the Action Alternatives since the T-34 is no longer part of VX-20. Boeing 737-700 is surrogate for P-8 (closest platform in NoiseFile to the P-8); however, for run-up operation modeling, C-22 is used as a surrogate for P-8 since 737-700 does not have any static run-up data in NoiseFile.

2.3.1.5 HX-21 Data Collection

The primary aircraft in HX-21 are H-1, V-22, H-60, CH-53, and Presidential VH-92 and H-3. All helicopter operations were modeled in AAM. H-1 and H-60 utilize the NAWC Pad; V-22 utilizes the 109 Pad 95 percent of time and the runways 5 percent of time; CH-53 utilizes the main runways and Runway 02/20; and Presidential VH-92 and H-3 utilize the Presidential helipad. No noise source data for the Presidential VH-92 and H-3 is included in NoiseFile, so the CH-53E was used as the surrogate helicopter. For the CH-53K no noise source data exists, so the CH-53E is the only variant of the CH-53 modeled.

2.3.1.6 VX-1 Data Collection

The primary aircraft in VX-1 are the E-2, P-8, and H-60R/S. The FIST data for VX-1 was incomplete, so pilot estimates of sorties and closed pattern operations were used. E-2 performs 3 sorties per week and operates 50 weeks per year with 1 closed pattern per sortie. P-8 performs 4 sorties per week and operates 50 weeks per year with 1 closed pattern per sortie. H-60 performs 150 flights over 5 months, or 350 flights per year with 0.6 closed patterns per sortie.

2.3.1.7 VQ-4 Data Collection

The E-6B (based on the Boeing 707) is the only aircraft used by VQ-4 squadron. Since VQ-4 uses the SHARP system instead of FIST, a 10-year average of SHARP data was used for number of sorties. For the closed pattern rate, the pilots estimated the number of closed patterns per sortie since this type of data is not included in the SHARP data system.

2.3.1.8 VXS-1 Data Collection

The primary aircraft in VXS-1 are the P-3 and the C-12. FIST data were not used due to incomplete data, so 10 years of logs were used since they contain both flight hours as well as number of flights for VXS-1.

The pilots estimated the operational split between P-3 and C-12 at 70 percent to 30 percent. The pilot estimates for the number of closed patterns per sortie were also used: two patterns per sortie for P-3 and three patterns per sortie for C-12. The pilot estimates of 10% of arrivals occur between 2200-0700 was used since the flight time was not included in the VXS-1 logs.

2.3.1.9 UX-24 Data Collection

The UX-24 squadron has group 3 and group 4 UASs including RQ-21, RQ-26A, and MQ-8. Group 1 and 2 UASs were not modeled, because they are so small there is nothing in the noise model to accurately model the low level of noise from these small UASs. UH-1 is the surrogate helicopter for the MQ-8, and GASEPF aircraft is the surrogate for the RQ-21 and RQ-26 since it is smallest (in size and engine power) aircraft available in the noise model. MQ-8 uses spot 1 75 percent of time and spot 2 25 percent of time. Spot 1 and spot 2 are the MQ-8 takeoff and landing pads. RQ-21/26 flies Route A 75 percent of time, Route B 12.5 percent of time, and Route C 12.5 percent of time (UAV training routes publication LUO-314.22).

2.3.1.10 Transient Aircraft Data Collection

Transient aircraft operations come from 2 sources: 10-year average of FIST data and 6 months of Prior Permission Required (PPR) logs multiplied by 2 to represent a full year. The total transient operations represent the addition of these two sources. Transient aircraft operations include an annual average of 89 fighter jet sorties, 120 helicopter/tilt-rotor sorties, and 128 cargo/surveillance/multi-mission aircraft sorties.

2.3.2 No Action NAS Patuxent River and OLF Webster Annual Flight Operations

No Action Alternative aircraft activity at NAS Patuxent River and OLF Webster was modeled based on a 10-year average of FIST data with some supplemental transient aircraft data to fill the identified gaps (6 months of PPR logs). This dataset included annual sorties, landings, and acoustic nighttime (2200-0700 hours) sorties and landings for each aircraft type within each squadron. The number of closed patterns per sortie was derived by taking the number of landings and dividing by sorties. One Closed Pattern Circuit (one time around the pattern) is counted as two operations: one arrival and one departure. A sortie typically consists of multiple airfield operations: a departure along with local closed pattern work before a final arrival to a full stop. For this reason, airfield operations are shown in these tables instead of sorties. Using these data, the annual acoustic day (0700-2200) and acoustic night (2200-0700) arrivals, departures, and closed pattern operations were derived for most squadrons. Table 2-2 presents the No Action Alternative (10-year average) Annual Flight Hours and Total Annual Operations (rounded to the nearest 10 operations) at NAS Patuxent River and OLF Webster for each squadron. A further breakout of arrival, departure, and closed pattern operations (unrounded) for each aircraft within each squadron for the No Action Alternative is displayed in Table 2-3. The aircraft and squadrons that utilize OLF Webster are the Test Pilot School C-12, T-6, H-60, and H-72; HX-21 Squadron's H-60, H-1, and CH-53E; and all aircraft in UX-24 and the RQ-7 of MDARNG. Appendix A provides detailed tables on the distribution of sorties and closed patterns per sortie for each aircraft within each squadron.

Table 2-2. No Action Alternative 10-year Average Annual Flight Hours and Operations at NAS Patuxent River and OLF Webster

Organization	Squadron	No Action Hours	No Action Operations
Naval Test Wing Atlantic (NTWL) Tenant	TPS	6,197	34,480
	VX-20	4,134	8,380
	VX-23	3,537	12,010
	HX-21	2,028	12,300
	UX-24	357	990
	AIR OPS (SAR)	1,245	5,280
	Total	*17,498*	*73,440*
NAS Patuxent River Tenant	VQ-4	422	1,080
	VXS-1	283	980
	VX-1	157	2,720
	MDARNG	151	270
	Total	*1,013*	*5,050*
Non-NAS Patuxent River	Transient (FIST)	242	480
	Transient (Non-FIST)	1,347	1,590
	Total	*1,589*	*2,070*
TOTAL		***20,100***	***80,560***

Key: FIST = Flight Information Scheduling and Tracking; MDARNG = Maryland Army National Guard; NTWL = Naval Test Wing Atlantic; NAS = Naval Air Station; OLF = Outlying Landing Field; OPS=operations; SAR=Search and Rescue; TPS=Test Pilot School.

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Table 2-3. Modeled Annual No Action Alternative Operations by Aircraft and Squadron

Group	*Squadron*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
MV-22	HX-21	218	218	523	959
H-60	HX-21	597	597	2,746	3,940
H-1 (includes TH-57 ops - modeled as UH-1N)	HX-21	404	404	5,494	6,302
CH-53E/K (includes CH-46 ops)	HX-21	97	97	504	698
Presidential VH-92 (modeled as CH-53)	HX-21	23	23	138	184
Presidential H-3 (modeled as CH-53E)	HX-21	27	27	162	216
C-12/C-26	TPS	365	365	2,117	2,847
C-21 (LEAR jet)	TPS	218	218	392	828
F/A-18E/F	TPS	263	263	526	1,052
UH-72 (and H-58)	TPS	787	787	9,444	11,018
UH-60	TPS	662	662	4,634	5,958
T-6	TPS	883	883	5,651	7,417
T-38	TPS	1,219	1,219	2,926	5,364
MQ-4 (Modeled as C-21)	VX-20	60	60	0	120
C-21 (surrogate for C-38 and T-2)	VX-20	233	233	885	1,351
P-8	VX-20	148	148	296	592
E-2	VX-20	368	368	903	1,639
P-3	VX-20	182	182	619	983
C-12	VX-20	82	82	312	476
T-6	VX-20	220	220	1,496	1,936
707 (E-6B) Turbofans CFM-56	VX-20	44	44	106	194
C-130	VX-20	339	339	407	1,085
F/A-18C/D	VX-23	976	976	2,574	4,526
F/A-18E/F	VX-23	976	976	2,574	4,526
F-35B	VX-23	374	374	408	1,156
F-35C	VX-23	250	250	272	772
T-45	VX-23	172	172	690	1,034
H-60	SAR	472	472	1,699	2,643
C-12	SAR	471	471	1,696	2,638
E-2	VX-1	150	150	300	600
P-8	VX-1	250	250	500	1,000
H-60R/S	VX-1	350	350	420	1,120
NP-3 Orion	VXS-1	104	104	416	624
C-12	VXS-1	45	45	270	360
707 (E-6B) Turbofans CFM-56	VQ-4	448	448	179	1,075
UH-1 (surrogate for MQ-8)	UX-24	188	188	113	489
GASEPF (surrogate for RQ-21 and RQ-26A)	UX-24	105	105	294	504
GASEPF (surrogate for RQ-7)	MDARNG	56	56	157	269
C-12	Total Transients	46	46	120	212
C-130	Total Transients	52	52	62	166
C-21	Total Transients	26	26	31	83
F-18E/F	Total Transients	37	37	59	133
F-35C	Total Transients	25	25	25	75
GASEPF	Total Transients	62	62	161	285
H-60	Total Transients	96	96	422	614
MV-22	Total Transients	24	24	106	154
P-3	Total Transients	38	38	46	122
P-8	Total Transients	38	38	46	122
T-38	Total Transients	27	27	43	97
Total		**13,297**	**13,297**	**53,964**	**80,558**

Key: GASEPF = General Aviation Single Engine Fixed Propeller; MDARNG = Maryland Army National Guard; SAR=Search and Rescue; TPS=Test Pilot School.

2.3.3 NAS Patuxent River and OLF Webster Runway Utilization

Aircraft noise modeling is based on the distribution of operations among runways and flight tracks. The modeled distributions for NAS Patuxent River are based on detailed runway operations data that were obtained for calendar year (CY) 2013 through 2017. CY 2016 Runway data were excluded in the average since not all runways were active during 2016. The four-year average of the runway operations data is displayed in Table 2-4 and was used for all aircraft and across all squadrons except for MQ-4 at NAS Patuxent River. The MQ-4 used Runway 14/32 exclusively. For Runway 02/20 closed patterns, Runway 02 is utilized for 35 percent of pattern operations and Runway 20 is utilized for 65 percent of pattern operations. Runway 02/20 utilization is separate from the main runways since the squadrons that utilize runway 02/20 provided information on how often that runway is utilized. Therefore, the modeling only required how often the Runway 02 direction is utilized vs the Runway 20 direction. Although OLF Webster runway utilization is now tracked, at the time of data collection, insufficient data existed for an accurate modeling of runway utilization. Therefore, the NAS Patuxent River main runways utilization is used for OLF Webster, as shown in Table 2-5.

Table 2-4. Runway Utilization for NAS Patuxent River

Runway	% Utilization
06	27%
14	14%
24	26%
32	33%
02	35%
20	65%

Key: NAS = Naval Air Station

Table 2-5. Runway Utilization for OLF Webster

Runway	% Utilization
08	27%
15	14%
26	26%
33	33%

Key: OLF = Outlying Landing Field

2.3.4 Flight Operation Type Distributions

The next step in the noise modeling process is to develop the average frequency of each flight operation conducted throughout the year. Table 2-6 and Table 2-7 show the VX-23 and TPS squadrons, respectively, percent distributions of the total annual operations by aircraft and operation type at NAS Patuxent River.

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Table 2-6. VX-23 Operational Distributions by Aircraft and Operation Type

Operation	Type	F/A-18C/D and E/F	F-35B	F-35C	T-45
Arrivals	Straight-in Arrival (VFR)	5%	5%	5%	5%
	Overhead Break Arrival	57%	34%	56%	38%
	PFO Arrival		1%	1%	38%
	Straight-in to Slow Landing		20%		
	Straight-in to Vertical Landing		15%		
	Instrument Approach	38%	25%	38%	20%
		good	*good*	*good*	*good*
Departures	Military		1%	1%	100%
	Afterburner Takeoff to Mil Climb	100%	74%	99%	
	Short Takeoff to Mil Climb		25%		
		good	*good*	*good*	*good*
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	60%	41%	50%	40%
	FCLP Pattern (600 ft AGL left hand pattern)	5%	15%	15%	
	PFO Pattern		1%	1%	40%
	IFR Pattern or GCA Box	35%	27%	34%	20%
	Touch and Go to Slow Landing		1%		
	Touch and Go to Vertical Landing		15%		
		good	*good*	*good*	*good*

Key: AGL = above ground level: FCLP = Field Carrier Landing Practice; IFR = instrument flight rules; GCA = Ground Controlled Approach; Mil=military; PFO = Precautionary Flame Out; VFR = visual flight rules.

Table 2-7. Test Pilot School Operational Distributions by Aircraft and Operation Type

Operation	Type	T-38/F-18	T-6	C-12/C-21	H-60/H-72
Arrivals	Straight-in Arrival	5%	5%	90%	100%
	Overhead Break Arrival	90%	90%	5%	
	Carrier Break Arrival				
	SFO Arrival				
	Straight-in to Slow Landing				
	Tactical - Overhead Break				
	IFR Straight-in	5%	5%	5%	
		good	*good*	*good*	*good*
Departures	Military		100%	100%	100%
	Afterburner Takeoff to Mil Climb	100%			
	Short Takeoff to Mil Climb				
		good	*good*	*good*	*good*
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	90%	90%	90%	90%
	SFO Pattern				
	IFR Pattern or GCA Box	10%	10%	10%	10%
	Touch and Go to Slow Landing				
		good	*good*	*good*	*good*

Key: GCA = Ground Controlled Approach; IFR = instrument flight rules; SFO = Simulated Flame Out; VFR = visual flight rules.

These two squadrons are displayed in this section because they are the top contributing squadrons to the overall noise footprint in the area surrounding NAS Patuxent River. The "good" cells shown in the table (as well as the tables in Appendix A) show that the percentages add up to 100. This quality control feature

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of the data validation package allows the user to input data that adds to the correct total. The operation type distributions displayed in these tables were collected through interviews with the squadron personnel during the site visit. The operation type distributions of all other squadrons are displayed in the data validation package in Appendix A.

2.3.5 Acoustical Day/Night

The percent utilizations of acoustical day (0700-2200) and acoustical night (2200-0700) aircraft activity for each airframe and operation type at NAS Patuxent River and OLF Webster were derived from the FIST data for the squadrons that utilize the FIST data system. For the squadrons that do not utilize FIST (VX-1, VXS-1, and VQ-4), pilot estimates were used for the percent utilization of operations occurring during acoustical day and acoustical night. The percent of acoustical night operations varies greatly from one aircraft type to the next and for the various squadrons at NAS Patuxent River since the mission types are unique across each squadron and platform. The acoustical day and acoustical night percent utilization of each aircraft across every squadron at NAS Patuxent River and OLF Webster is listed in Table 2-8. Note that since the MDARNG RQ-7, UX-24, RQ-21, and RQ-26 were modeled as GASEPF, those aircraft operations were combined in the UX-24 squadron and are listed under GASEPF.

2.3.6 Flight Tracks

The modeled flight tracks include instrument flight rules (IFR) and visual flight rules (VFR) arrivals, departures, and closed patterns. The flight tracks were developed based on the squadron interviews during the site visit, then later confirmed via the data validation process. The modeled fixed wing and helicopter tracks at NAS Patuxent River are displayed in Figure 2-1 through Figure 2-6. In Figure 2-6, only Runway 24 VFR Pattern flight tracks are shown for clarity. The closed pattern tracks on all other runways are identical, just orientated with the directions of the other runways. The modeled tracks at OLF Webster are displayed in Figure 2-7 through Figure 2-10. The interfacility tracks shown on the maps are tracks flown between NAS Patuxent River and OLF Webster. Appendix B provides the maps of the tracks that are flown for each individual aircraft across all squadrons at NAS Patuxent River and OLF Webster along with the traffic flow utilization of each track.

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Table 2-8. Acoustical Day/Night Operations Distributions by Squadron, Aircraft, and Operation Type for NAS Patuxent River and OLF Webster

	VX-23				TPS				HX-21						SAR	
	MQ-25		**All Other A/C**		**C-12/C-26**		**All Others**		**H-60**		**UH-1**		**All Other A/C**		**H-60 and C-12**	
Operation	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**
Straight-in Arrival	95.0%	5.0%	98%	2%	96%	4%	100%	0%	92%	8%	94%	6%	97%	3%	95%	5%
Overhead Break Arrival			100%	0%	100%	0%	100%	0%							100%	0%
Departures	95.0%	5.0%	99.5%	0.5%	99.5%	0.5%	100%	0%	99%	1%	99%	1%	99%	1%	99.5%	0.5%
Closed Patterns	95.0%	5.0%	100%	0%	100%	0%	100%	0%	99%	1%	99%	1%	100%	0%	100%	0%

	VX-20															
	MQ-4		**C-38(C-21)**		**P-8**		**E-2**		**P-3**		**C-12**		**T-6**		**C-130**	
Operation	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**
Straight-in Arrival	84%	16%	95%	5%	96%	4%	95%	5%	90%	10%	93%	7%	99%	1%	97%	3%
Overhead Break Arrival			100%	0%			99%	1%					99%	1%		
Departures	99%	1%	100%	0%	99%	1%	98%	2%	96%	4%	99%	1%	100%	0%	99%	1%
VFR Touch and Go Pattern					100%	0%	98%	2%	100%	0%			100%	0%	100%	0%
IFR GCA Box Pattern			95%	5%	100%	0%	96%	4%	100%	0%	93%	7%	100%	0%	100%	0%

	VX-1				VXS-1				VQ-4		UX-24				Transients	
	E-2 and P-8		**Helos**		**P-3**		**C-12**		**E-6B**		**UH-1**		**GASEPF**		**All A/C**	
Operation	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**	**Acoustic Day 0700 to 2200**	**Acoustic Night 2200 to 0700**
Straight-in Arrival	95%	5%	100%	0%	90%	10%	90%	10%	83.0%	17.0%	99.5%	0.5%	99%	1%	95%	5%
Overhead Break Arrival																
Departures	100%	0%	100%	0%	90%	10%	90%	10%	93.0%	7.0%	99.5%	0.5%	99.5%	0.5%	97%	3%
Closed Patterns	100%	0%	100%	0%	100%	0%	100%	0%	93.0%	7.0%	100%	0%	100%	0%	100%	0%

Key: A/C = aircraft; GASEPF = General Aviation Single Engine Fixed Propeller; GCA = Ground Controlled Approach; Helos = helicopters; IFR = instrument flight rules; NAS = Naval Air Station; OLF = Outlying Landing Field; SAR = Search and Rescue; TPS = Test Pilot School; VFR = visual flight rules.

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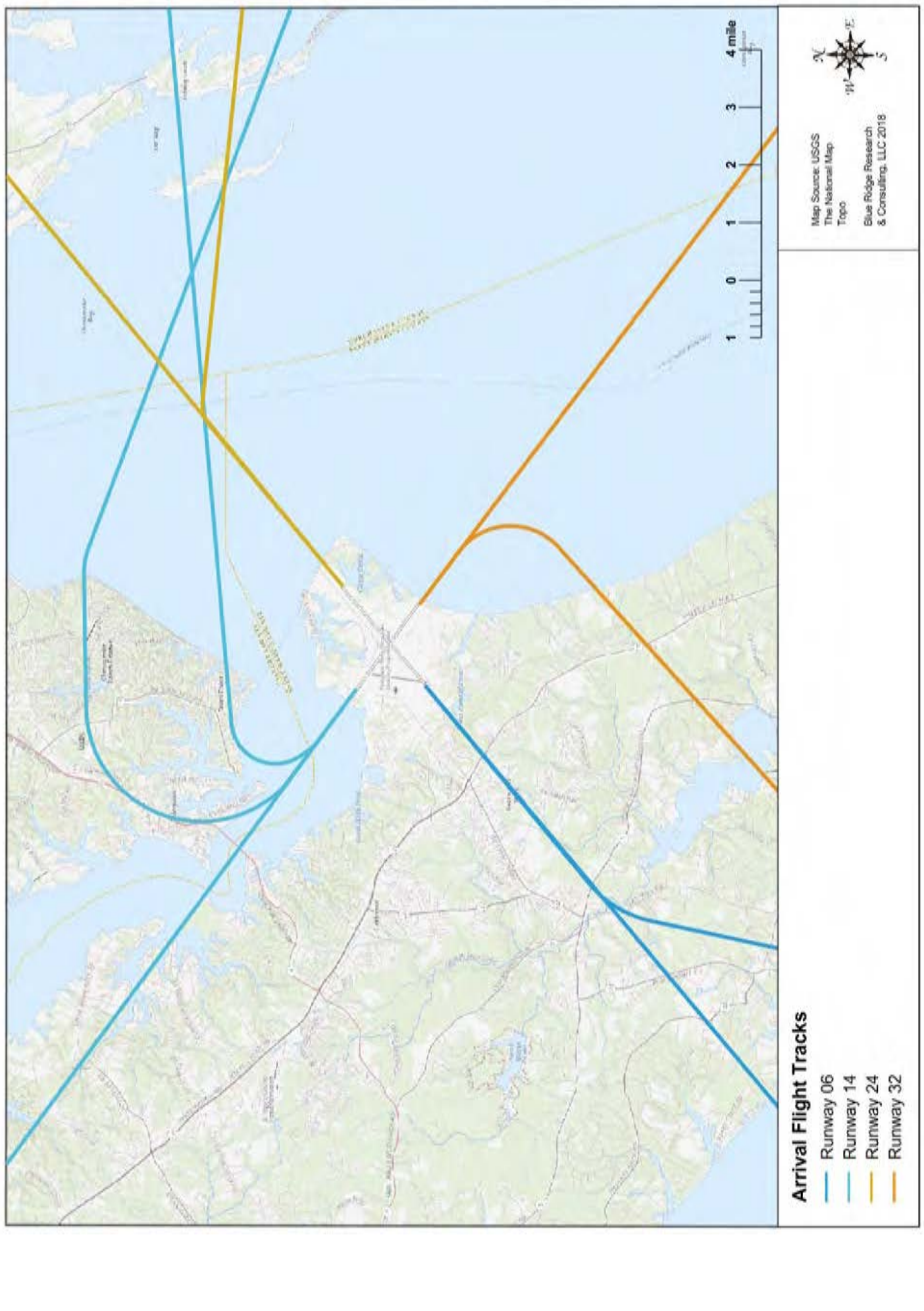

Figure 2-1. NAS Patuxent River Fixed Wing Arrival Flight Tracks

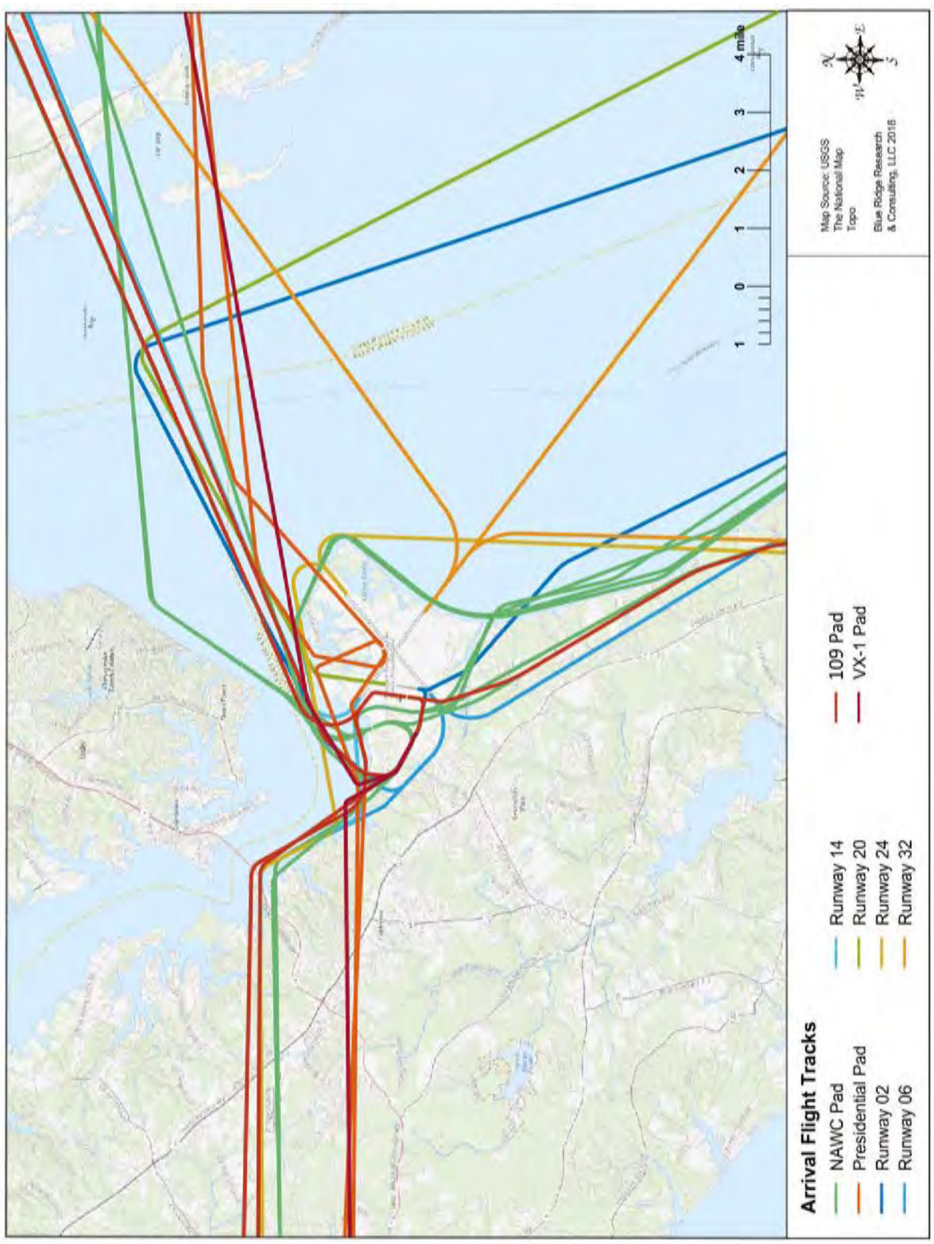

Figure 2-2. NAS Patuxent River Helicopter Arrival Flight Tracks

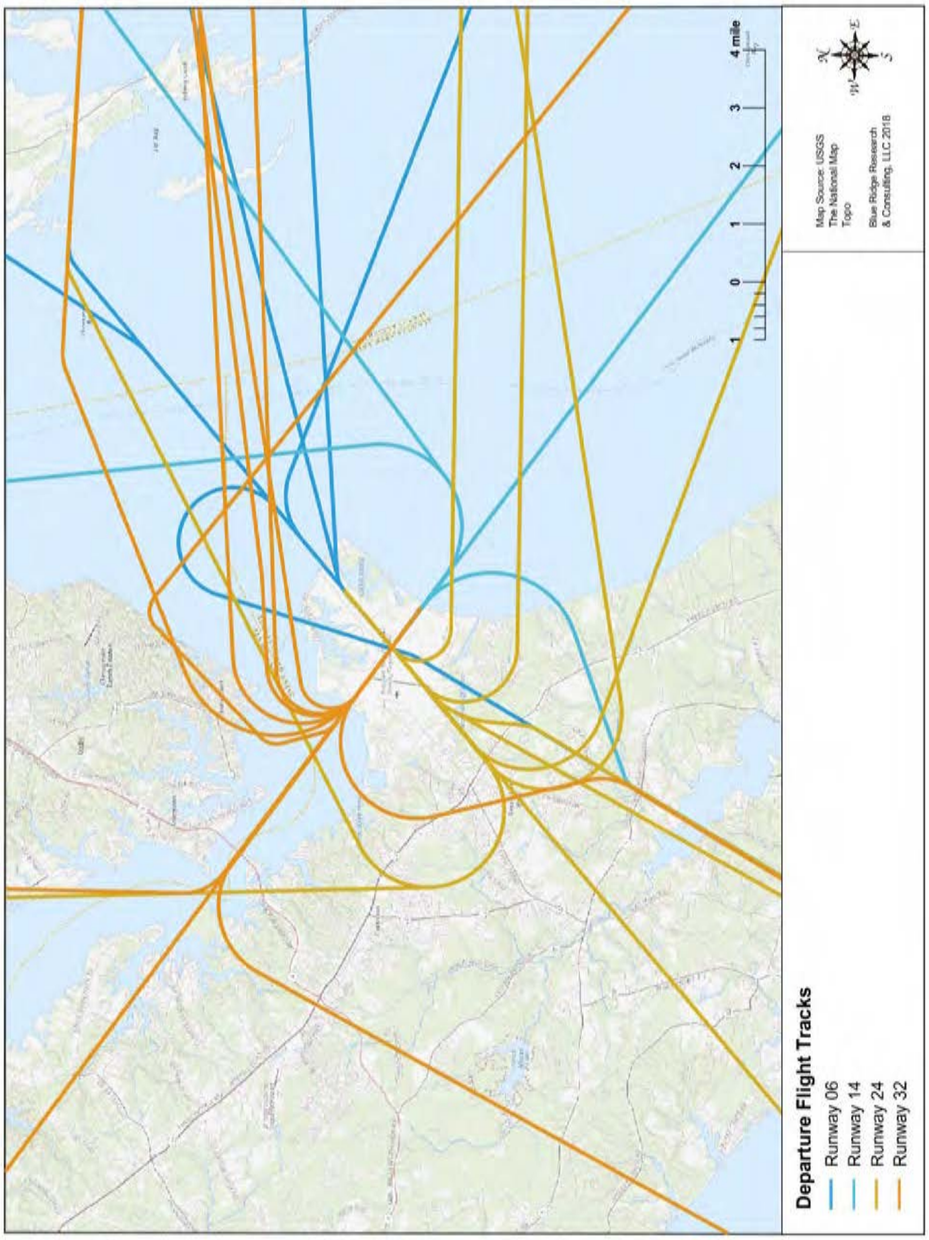

Figure 2-3. NAS Patuxent River Fixed Wing Departure Flight Tracks

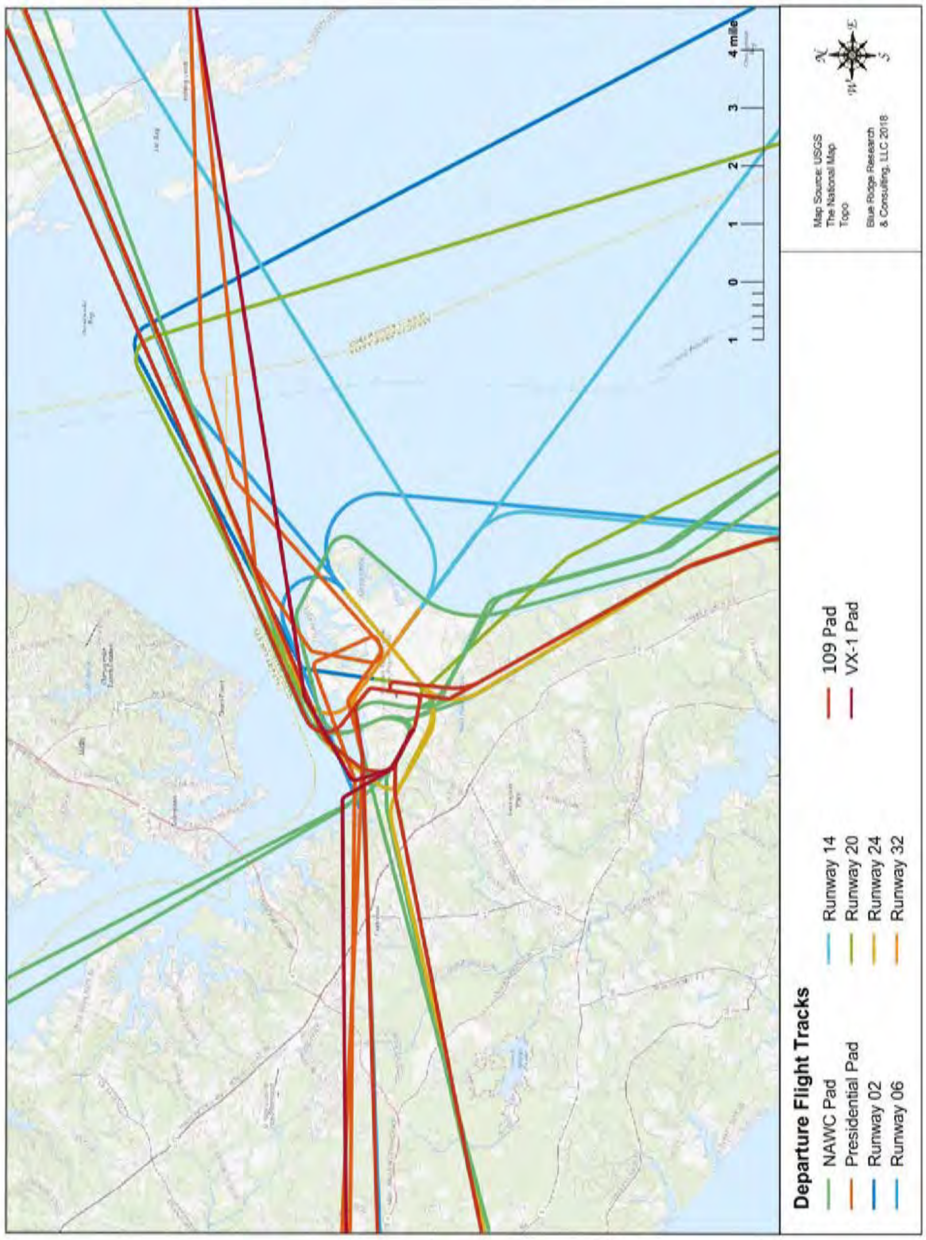

Figure 2-4. NAS Patuxent River Helicopter Departure Flight Tracks

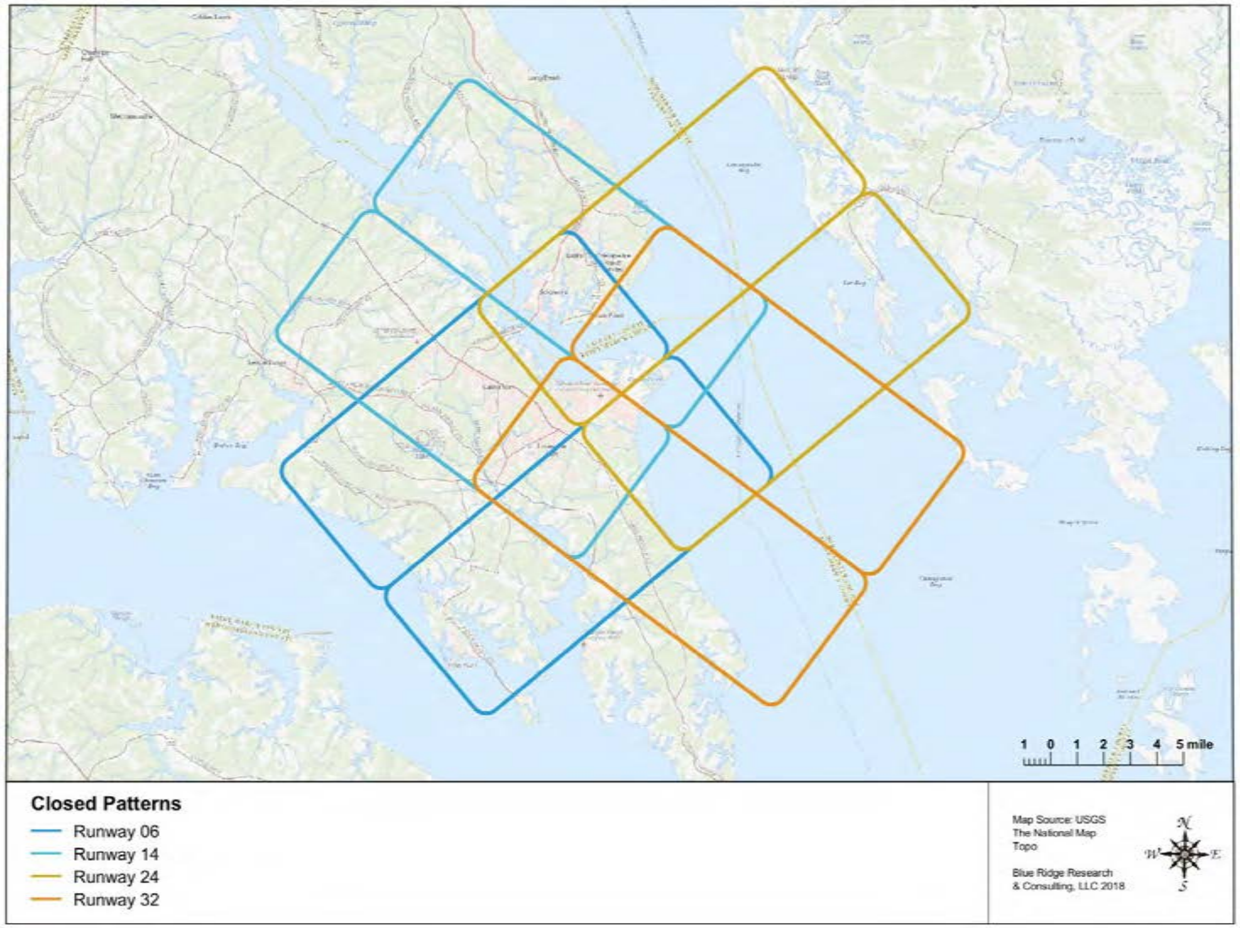

Figure 2-5. NAS Patuxent River Fixed Wing IFR Closed Pattern Flight Tracks

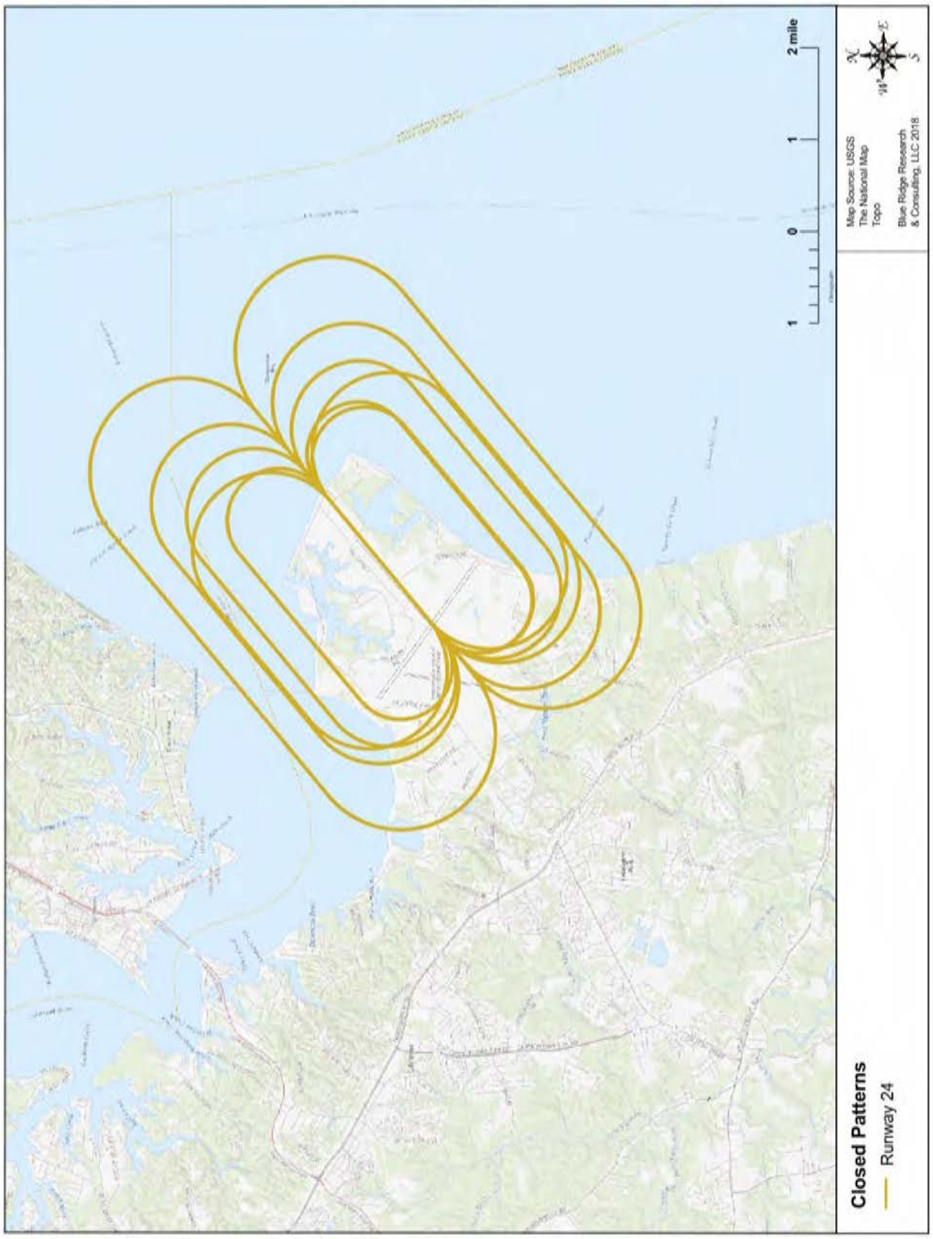

Figure 2-6. NAS Patuxent River Fixed Wing VFR Closed Pattern Flight Tracks

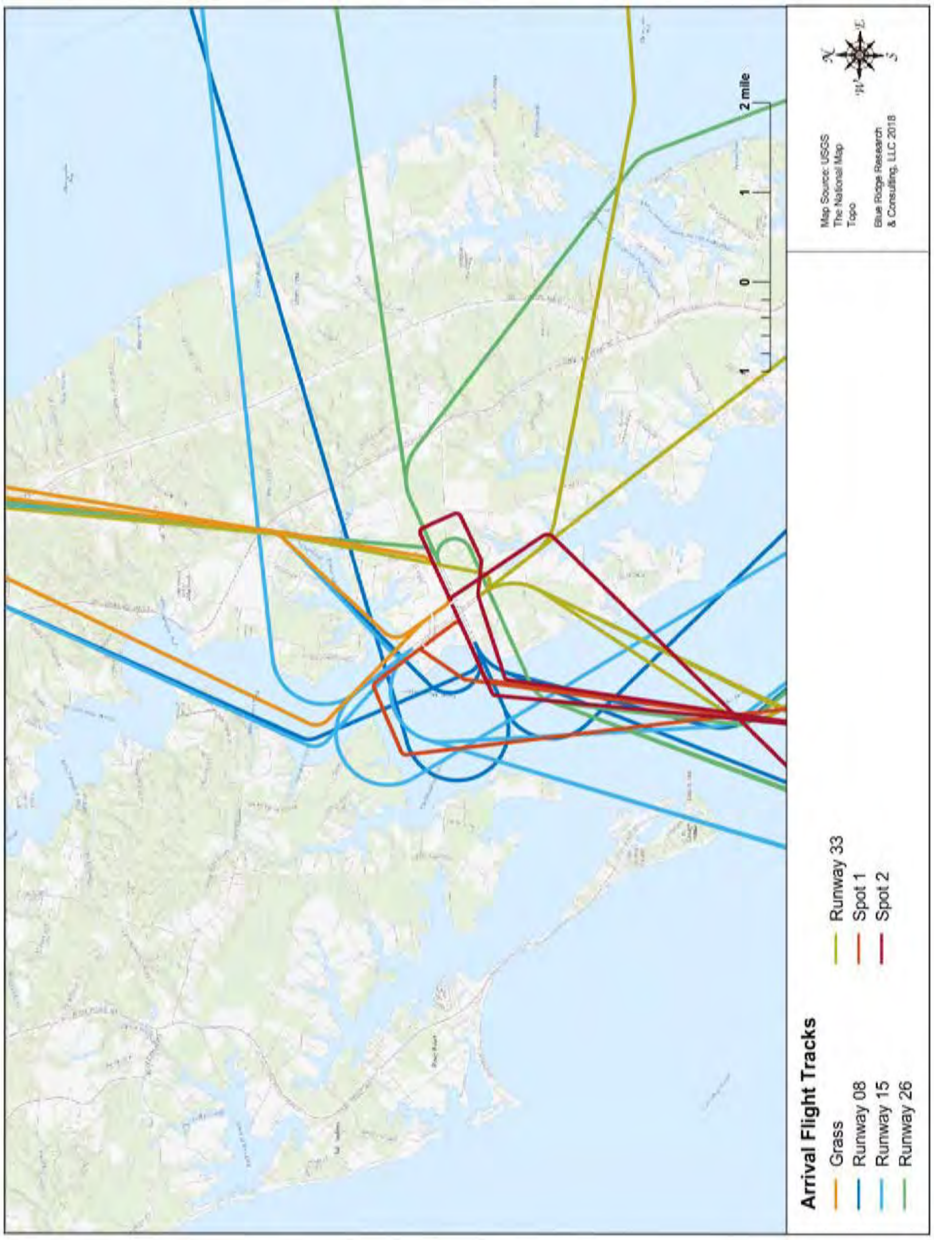

Figure 2-7. OLF Webster Fixed Wing and Helicopter Arrival Flight Tracks

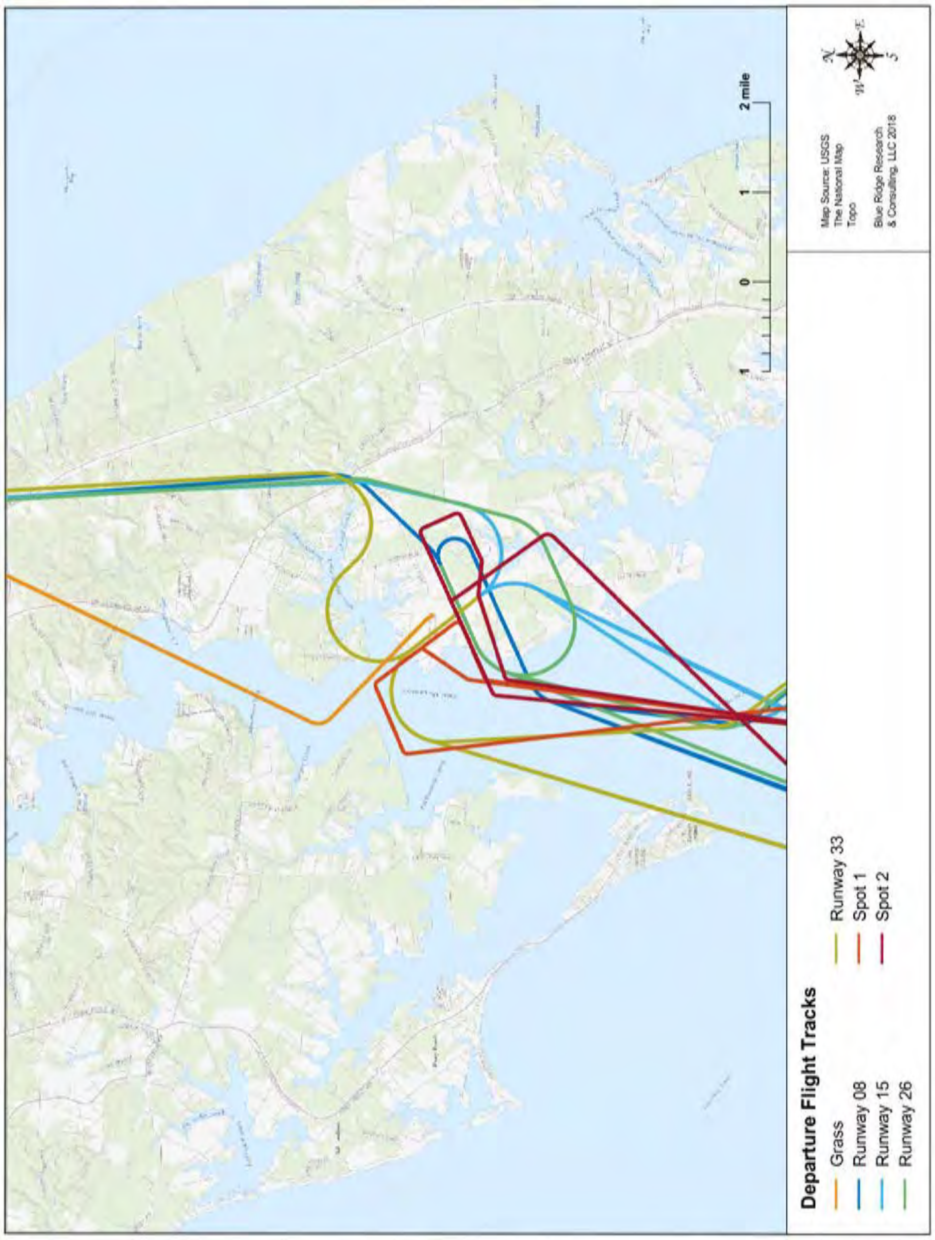

Figure 2-8. OLF Webster Fixed Wing and Helicopter Departure Flight Tracks

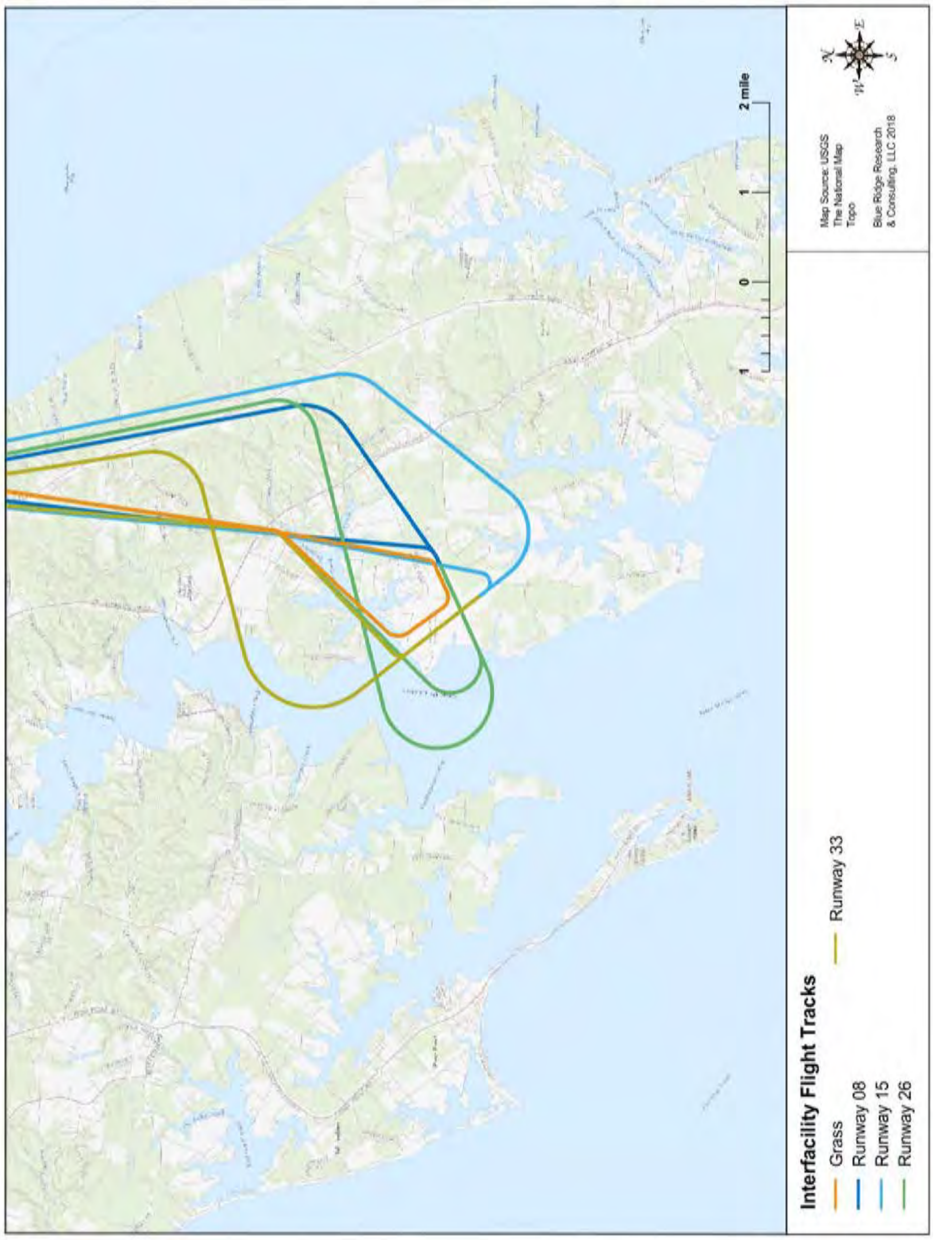

Figure 2-9. OLF Webster Fixed Wing and Helicopter Interfacility Flight Tracks

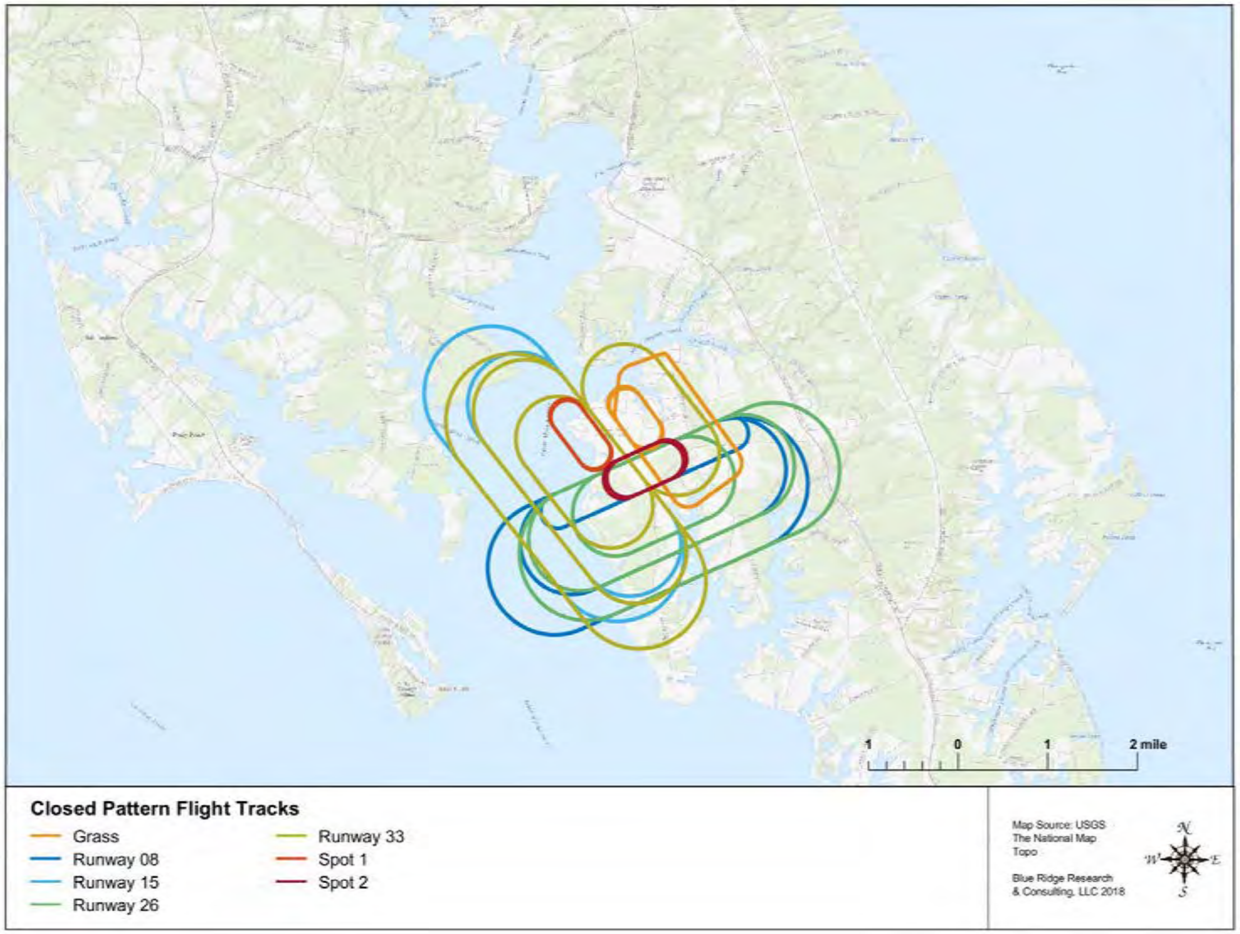

Figure 2-10. OLF Webster Fixed Wing and Helicopter Closed Pattern Flight Tracks

2.3.7 Flight Profiles

The modeled flight profiles were developed based on interviews with the aircrews operating at NAS Patuxent River and OLF Webster. These discussions required an iterative process as the aircrews and modelers worked together to translate the flying parameters into the parameters utilized by the noise model. This process ensures that the modeled flight profiles provide an accurate description of the aircrews' nominal flight procedures throughout the year. For the transient aircraft, if the transient aircraft type is the same aircraft type as a based aircraft, then the based aircraft profile is used for the transient aircraft profile. If there are no based aircraft profiles for a transient aircraft type, then the transient aircraft profile is used from the previous analysis. The NAS Oceana Super Hornet profiles were used as the basis for this study's Super Hornet profiles since the NAS Oceana profiles are more current than the NAS Patuxent River profiles derived in the previous Air Installations Compatible Use Zones (AICUZ). These NAS Oceana profiles were reviewed by the Super Hornet Pilot from the VX-23 squadron and were approved as accurate profiles for this noise study.

Representative flight profiles for all based aircraft within the NoiseMap and AAM models are provided in Appendix C. Each figure includes a table of flight parameters describing the flight trajectory along the flight track. The parameters are varied linearly between the points denoted by the corresponding letter. For departure and pattern profiles, the trajectories proceed as the aircraft flies. However, for arrivals, the trajectories are described in reverse. Please note that some of the following profiles depicted have trajectories that extend beyond the map range. Only one representative profile is shown for each squadron, aircraft, and operation type because all profiles for that operation type are either identical or very similar. If all modeled profiles of all modeled aircraft were displayed, then there would be nearly 1,000 displayed profiles, many of which are redundant.

It is important to note a few of the modeling parameters. First, the terms "Variable" and "Parallel" refer to noise interpolation codes that are used to distinguish between clean and dirty configurations, respectively, when the noise data is significantly different between the configurations for an individual aircraft. (The "dirty" configuration has flaps and landing gear extended.)

2.3.8 Weather Data

The weather data used within NoiseMap is displayed in Table 2-9. These data were sourced from weather.gov and are used to determine the effect of atmospheric absorption that occurs during noise propagation. NoiseMap utilizes the daily average temperatures, relative humidity, and atmospheric pressure for each month to determine the appropriate values to represent the nominal acoustic absorption for a given year. For these monthly averages, the values for March were determined by the model to best represent acoustical absorption for the year. It should be noted these values represent the nominal acoustic absorption condition of the atmosphere and not the average weather conditions for the area.

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Table 2-9. Weather Data Inputs for NoiseMap

Weather Data for NoiseMap	Temperature (F)	Relative Humidity (%)
January	35	59%
February	45	72%
March	41	55%
April	55	54%
May	73	69%
June	77	68%
July	78	64%
August	81	69%
September	77	77%
October	64	67%
November	52	67%
December	38	60%

Key: F = Fahrenheit

2.3.9 NAS Patuxent River Static Pads and Profiles

The ground run-up locations at NAS Patuxent River are displayed in Figure 2-11. Ground run-up operations and profiles for the No Action Alternative based aircraft at the various NAS Patuxent River static pad locations are displayed in Table 2-10. No static operations occur at OLF Webster.

Figure 2-11. Ground Run-up Locations at NAS Patuxent River

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Table 2-10. Ground Run-up Operations and Profiles for NAS Patuxent River

Squadron	Test Name	Aircraft	Engine Type	Modeled Aircraft / Engine (if different)	Location	Magnetic Heading (deg)	Annual Events: Events	Annual Events: % Day (0700-2200)	Annual Events: % Night (2200-0700)	Power Setting	Duration at Power Setting (Minutes)	Number of Engines Running Simultaneously
HX-21	Pre and post flight turns	H-60			NAWC pad	175	597	90%	10%	idle	20	2
		H-1			NAWC pad	175	404	92%	8%	idle	20	1
		V-22			109 pad	200	218	95%	5%	idle	20	2
		CH-53			In front of Hanger 101	200	146	95%	5%	idle	20	3
		VH-92		H-60	Presidential pad	79	250	90%	10%	idle	20	2
		H-3		CH-53	Presidential pad	79	50	95%	5%	idle	20	2
	Dedicated Maintenance turns	H-60			Seawall (both lines)	170	50	95%	5%	idle	120	2
		H-1			Seawall (both lines)	170	50	95%	5%	idle	120	1
		V-22			Seawall (both lines)	170	50	95%	5%	idle	120	2
		CH-53			In front of Hanger 101	200	50	100%	0%	idle	120	3
		VH-92		H-60	Seawall (both lines)	170	50	95%	5%	idle	120	2
		H-3		CH-53	Seawall (both lines)	170	50	95%	5%	idle	120	2
SAR	Spin up before launch	H-60			NAWC pad	175	472	95%	5%	idle	60	2
VXS-1	High Power Turns	P-3			Off-duty runway or Taxiway Alpha	into wind	12	100%	0%	idle	19	2
								100%	0%	max	0.5	2
		C-12			Off-duty runway or Taxiway Alpha	into wind	6	100%	0%	idle	19	2
								100%	0%	max	0.5	2
	Low Power Turns	P-3			Hanger 109 Ramp	200	24	100%	0%	idle	60	4
		C-12			Inactive Runway or Alpha	into wind	24	100%	0%	idle	60	2
VQ-4	High Power Turns	E-6			VQ-4 Ramp	35	3	90%	10%	max	10	1
VX-20	Runway Hold Short Runs	C-38		C-21	Runway Hold Short	point towards runway	41	100%	0%	65%	3	1
		C-12			Runway Hold Short	point towards runway	41	100%	0%	65%	3	1
	High Power Turns	P-8			Approach End of Rwy 06	100	1	100%	0%	max	1	2
	Low Power Turns	P-8			Building 305 behind the hanger	115	12	100%	0%	40% N1	30	2
		E-2			Hanger 306	115	60	99%	1%	1800 ISHP	25	2
	High Power Turns	E-2			Taxiway Alpha or on Runway 02/20	into wind	60	99%	1%	4600 ISHP	7	1
								99%	1%	idle	15	2
VX-23	High Power Turns	F-18C/D			Center Field Stand	0	12	99%	1%	AB	2	2
								99%	1%	Mil	3	2
								99%	1%	50%	25	2
								99%	1%	Idle	30	2
					Hush House	20	12	99%	1%	AB	2	2
								99%	1%	Mil	3	2
								99%	1%	50%	25	2
								99%	1%	Idle	30	2
		F-18E/F			Center Field Stand	90	12	99%	1%	AB	2	2
								99%	1%	Mil	3	2
								99%	1%	50%	25	2
								99%	1%	Idle	30	2
					Hush House	180	12	99%	1%	AB	2	2
								99%	1%	Mil	3	2
								99%	1%	50%	25	2
								99%	1%	Idle	30	2
	Low Power Parking Turns	F-18C/D			VX-23 Parking Spots	20	300	99%	1%	80%	5	2
								99%	1%	Idle	55	2
		F-18E/F			VX-23 Parking Spots	20	300	99%	1%	80%	5	2
								99%	1%	Idle	59	2

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Table 2-10. Ground Run-up Operations and Profiles for NAS Patuxent River (continued)

Squadron	Test Name	Aircraft	Engine Type	Modeled Aircraft / Engine (if different)	Location	Magnetic Heading (deg)	Annual Events: Events	Annual Events: % Day (0700-2200)	Annual Events: % Night (2200-0700)	Power Setting	Duration at Power Setting (Minutes)	Number of Engines Running Simultaneously
VX-1	High Power turns	E-2			Taxiway Alpha	110	12	99%	1%	100% max	14	1
					Taxiway Charlie	50	12	99%	1%	100% max	14	1
		P-8			Runway 06 Threshold	300	3	99%	1%	90%	10	1
					Runway 02/20	15	3	99%	1%	90%	10	1
	Low Power turns	E-2			VX-1 parking	300	150	95%	5%	idle	45	2
		P-8			VX-1 parking	300	17	95%	5%	idle	5	2
Open-Air Engine Test Cell	Open-Air Engine Test Cell Runs	N/A	T700-401	AH-1/UH-1	Test Pad #2375	West	10	95%	5%	Idle	21.7	1
										Mil	21.7	1
			T-56-425/427	E-2	Test Pad #2353	SW	13	95%	5%	Idle	40.9	1
										Mil	40.9	1
			T-56-14	P-3	Test Pad #2353	SW	6	95%	5%	Idle	37.8	1
										Mil	37.8	1
			T-56-16	C-130	Test Pad #2353	SW	5	95%	5%	Idle	40.7	1
										Mil	27.1	1
			T64-419	CH-53	Test Pad #2375	West	1	95%	5%	Idle	27.7	1
										Mil	14.3	1
			F404-400	F-18A/C	Test Pad #1689	SW	11	95%	5%	Idle	17	1
										Mil	39.1	1
										AB	0.6	1
			F414	F-18E/F	Test Pad #1689	SW	16	95%	5%	Idle	16.6	1
										Mil	16.6	1
										AB	1.4	1
			T700-401	H-60	Test Pad #2375	West	7	95%	5%	Idle	34.7	1
										Mil	23.1	1
			J52	EA-6B	Test Pad #1689	SW	1	95%	5%	Idle	22.2	1
										Mil	54	1
Test Pilot School	Low Power Runs	F/A-18E/F			TPS Flight Line	West	90	100%	0%	up to 80	30	2
		T-38C			TPS Flight Line	South	204	100%	0%	up to 80	20	1
		T-6B			TPS Flight Line	North	264	100%	0%	30% torque	15	1
		NU-1B		T-6	TPS Flight Line	West	36	100%	0%	up to 80	30	1
		U-6A		T-6	TPS Flight Line	West	24	100%	0%	up to 80	30	1
		C-12C			TPS Flight Line	West	144	100%	0%	up to 71	10	1
		C-26A		C-21	TPS Flight Line	West	144	100%	0%	up to 71	10	1
		OH-58C		AH-1/UH-1	TPS Flight Line	varies with wind	84	100%	0%	100	60	1
		UH-60A/L			TPS Flight Line	varies with wind	84	100%	0%	100	60	1
		UH-72A		H-60	TPS Flight Line	North or south	4	100%	0%	70	10	1
	High Power Turns	F/A-18E/F			Center field	South West	9	100%	0%	idle	30	2
										50%	25	2
										100% Mil	5	2
		T-38C			Center field	South West	48	100%	0%	idle	30	1
										50%	50	1
										100% Mil	10	1
		T-6B			TPS Flight Line	West	12	100%	0%	Max	15	1
		NU-1B		T-6	TPS Flight Line	West	12	100%	0%	Max	60	1
		U-6A		T-6	TPS Flight Line	West	24	100%	0%	Max	60	1
		C-12C			TPS Flight Line	West	24	100%	0%	Max	10	1
		C-26A		C-21	TPS Flight Line	West	24	100%	0%	Max	10	1

Key: deg = degrees; max = maximum; NAS = Naval Air Station; NAWC = Naval Air Warfare Center; Rwy = Runway; SAR = Search and Rescue; SW = southwest; TPS = Test Pilot School.

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2.4 NAS Patuxent River and OLF Webster No Action Alternative Acoustic Environment

2.4.1 No Action Alternative DNL Noise Contours

The approved data validation package was used as the modeling input for the noise analysis, and NoiseMap version 7.3 was used to calculate and plot the DNL 55 dB through 85 dB contours for the No Action Alternative, shown in Figure 2-12 for NAS Patuxent River and Figure 2-13 for OLF Webster. At OLF Webster, resultant DNL values are below 65 dBA, so only the 55 and 60 dBA DNL contours are shown. At NAS Patuxent River, the DNL contour lobes extend farthest along the runway centerlines, as these lobes are generated by VFR and IFR arrivals and the arrival portion of Ground Controlled Approach (GCA) patterns. Along the coastline south of the airfield, the contours propagate farther over the water than over the land. This portion of the noise is controlled by low power run-up from VX-23, which is near the water. The noise from these run-ups is propagating farther over the water than over the land due to lower sound absorption of the water compared to land. Also, several curved lobes in the 65 dBA DNL contours are observed. These lobes are caused by F/A-18E/F Super Hornet VFR Closed Pattern flight profiles switching from lower power setting to higher power setting during a turn. Further explanations of the various lobes and islands in the DNL contours and differences between the No Action DNL contours and the Alternatives DNL contours are described in Section 3.2.2.

2.4.2 No Action Alternative DNL and SEL at Representative Locations

Representative locations were selected by the NAVAIR Ranges Sustainability Office for DNL analysis as well as for additional supplemental analyses. These locations are shown in Figure 2-14. The No Action Alternative overall DNL and maximum SEL of a single modeled aircraft event at each of the representative locations are listed in Table 2-11. The location with the highest DNL is Cedar Cove Apartments (PO8). Cedar Cove Apartments and Drum Point Club (PO3) have the highest maximum SEL from a single modeled aircraft event. At each location, the noise model outputs the top 20 contributors to the overall DNL. The maximum SEL comes from the aircraft event with the highest SEL out of these top 20 contributors, and it is not necessarily the event that is the top contributor to the overall DNL. Supplemental metrics at these locations are presented in Section 6.

Table 2-11. No Action Alternative DNL and Maximum SEL at Each Representative Location

Representative Locations		DNL	Max SEL
ID	Description	(dBA)	(dBA)
P01	Asbury Solomons	47	103
P02	Our Lady Star of the Sea School	58	110
P03	Drum Point Club	64	113
P04	Captain Walter Francis Duke Elementary School	48	95
P05	Green Holly Elementary School	48	93
P06	Chancellors Run Activity Center	45	90
P07	Lexington Park Elementary School	59	107
P08	Cedar Cove Apartments	66	113
P09	Spring Ridge Middle School	46	96
P10	Elms Beach Park	52	102
P11	Historic St. Mary's City	40	94
P12	Harry Lundeberg School of Seamanship	42	86
P13	St. Ignatius Roman Catholic Church	47	95
P14	Point Lookout State Park	23	73
P15	Northumberland Elementary School	24	73

Key: dBA = A=weighted decibels; DNL = day-night average sound level; ID = identification number; SEL = sound exposure level.

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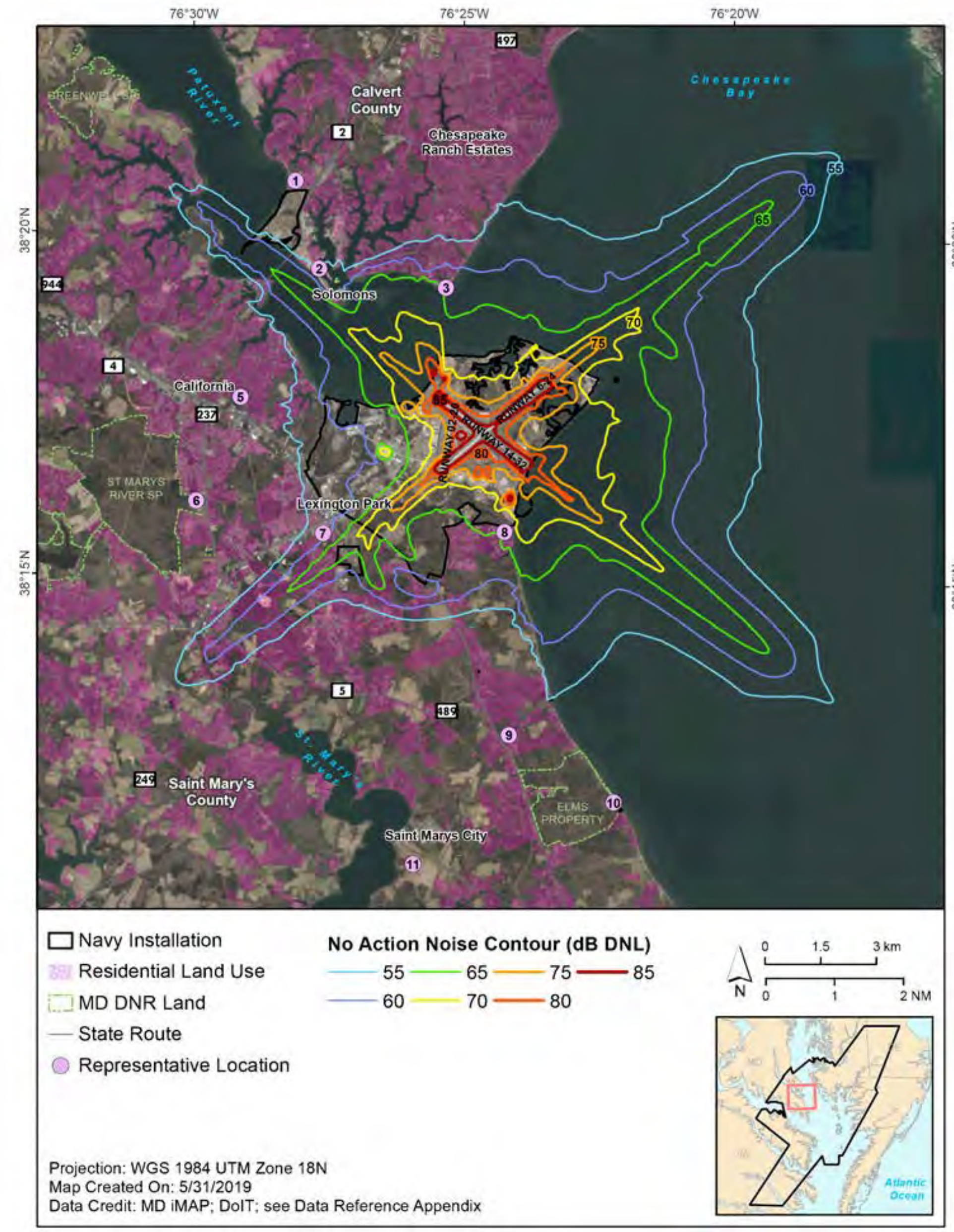

Figure 2-12. NAS Patuxent River DNL Contours for No Action Alternative

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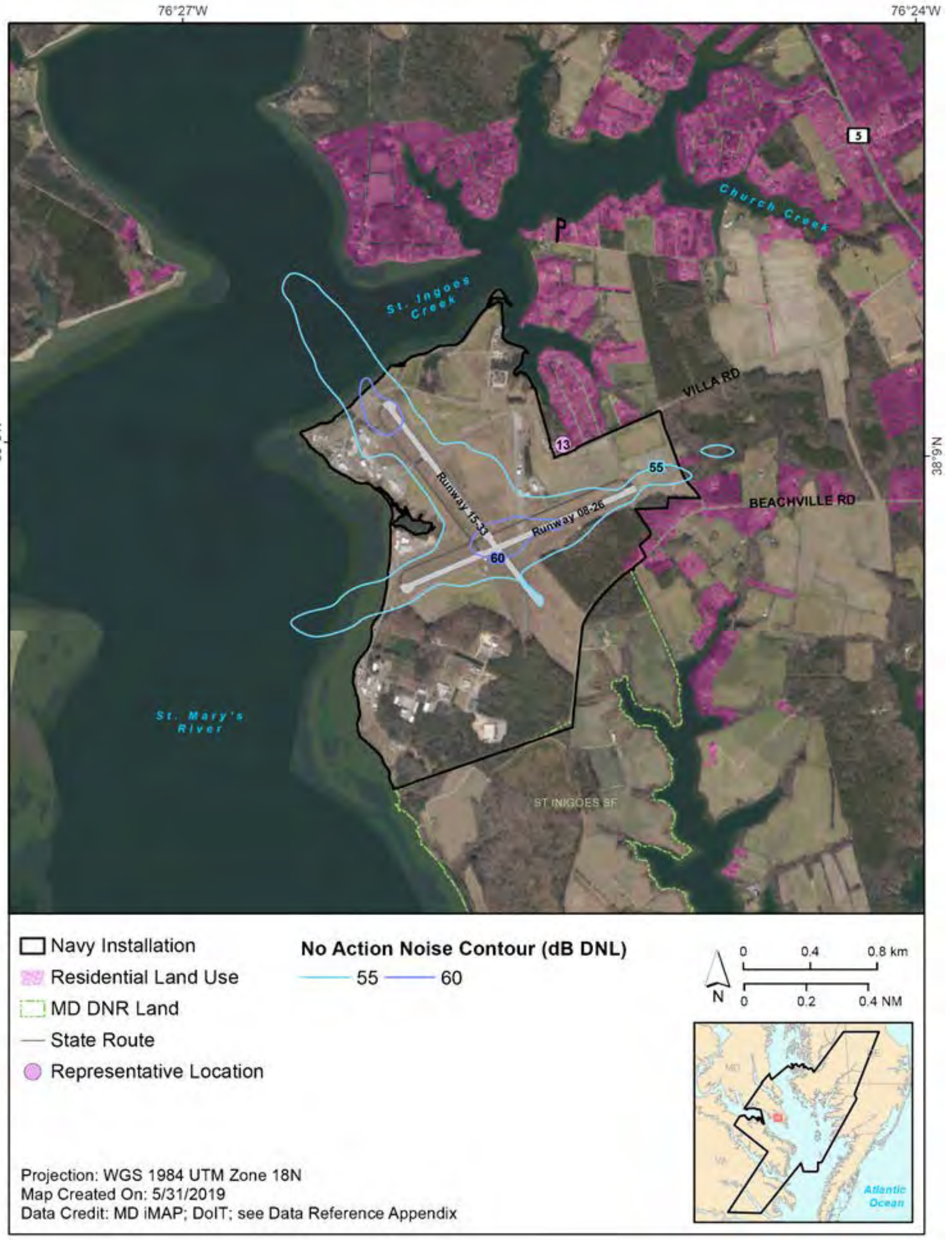

Figure 2-13. OLF Webster DNL Contour for No Action Alternative

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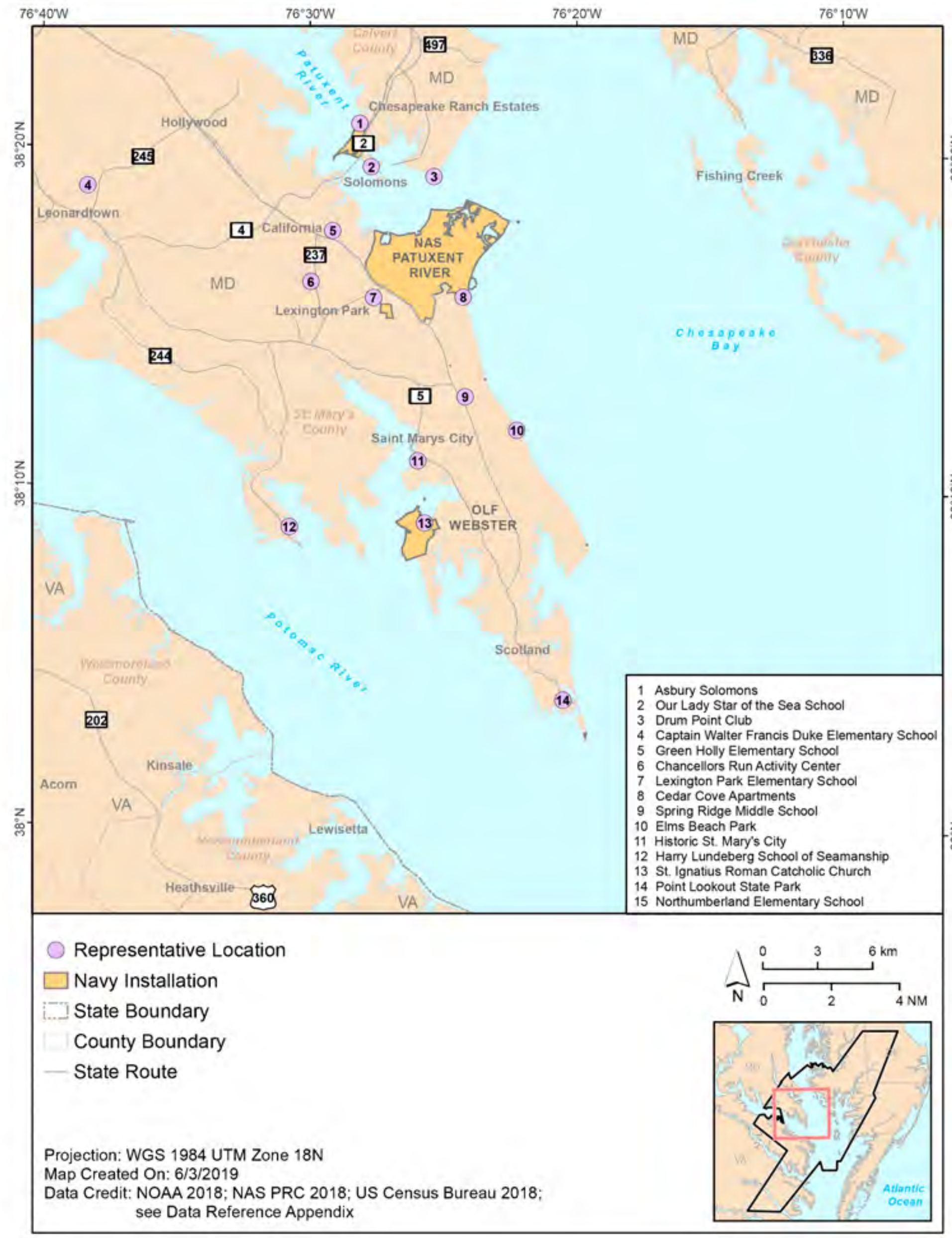

Figure 2-14. NAS Patuxent River Noise Study Representative Locations for DNL and Supplemental Metrics Analyses

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3 Airfield Analysis at NAS Patuxent River and OLF Webster for the Action Alternatives

The Proposed Action consists of Alternative 1 and Alternative 2, and these alternatives represent two different flight hour increases over the No Action 10-year average level of flight hours at NAS Patuxent River and OLF Webster. While the No Action represents 20,100 total annual flight hours for all squadrons and transient aircraft at NAS Patuxent River and OLF Webster, Alternative 1 increases the operations to 23,400 annual flight hours, and Alternative 2 further increases the operations to 26,000 annual flight hours. Additionally, the aircraft type distributions within most squadrons are changed for the Alternatives relative to the No Action. These changes account for the expected future distribution of aircraft types flying at NAS Patuxent River and OLF Webster.

3.1 NAS Patuxent River and OLF Webster Action Alternatives Aircraft Operations

Several squadrons provided projected future flight hours by aircraft platform based on information or data on their individual future fleet-mix. The aircraft platforms in the TPS, VXS-1, and VX-1 squadrons were scaled equally (all aircraft within the squadron had the same scale factor that was applied for the entire squadron) from the No Action Alternative to the estimated Alternative 1 and Alternative 2 hours since no change is expected or known in their future aircraft composition.

3.1.1 Action Alternatives Squadron Specific Data Modeling

This section provides the operational data items that are different from the No Action Alternative. Operational parameters that do not vary between the No Action and the Action Alternatives are the following:

- Runways
- Runway Utilization
- Flight Tracks and their Utilizations
- Operational Type Distributions
- Acoustical Day Night Distributions
- Flight Profiles
- Static Operation Locations and Profiles
- Weather Data

For SAR, the H-60 is the only aircraft modeled in the Alternatives since the C-12 is no longer part of SAR at NAS Patuxent River. In VX-20, P-3 and T-6 (used as the modeling surrogate for T-34) are removed from the Alternatives as those aircraft are no longer part of VX-20. Additionally, the C-2 is replaced with the V-22 from HX-21, so those sorties are moved from VX-20 to HX-21 in the Alternatives. In VX-23, the F-35B/C is expected to decrease future utilization while the F/A-18E/F and EA-18G are expected to increase future utilization at NAS Patuxent River. Additionally, the variant utilization of both the F-35 and the F/A-18 is expected to change. In the Alternatives, 25 percent of F/A-18 operations is the C/D Hornet model (instead of 50 percent from the No Action), 50 percent is the E/F Super Hornet model (instead of 40 percent) and 25 percent is the E/A-18G Growler model (instead of 10 percent). For HX-21 future Alternatives, CH-53K is utilized in place of CH-53E. However, since there is no noise source data for the CH-53K, the CH-53E is the only variant of the CH-53 that is modeled.

3.1.2 Action Alternatives NAS Patuxent River and OLF Webster Annual Flight Operations

To develop the modeled operations for each aircraft within each squadron, the first step calculates individual aircraft/squadron combination scaling factors to increase their flight hours from the No Action Alternative to the Action Alternatives. Table 3-1 lists these calculated scale factors for Alternatives 1 and 2. The scale factors are the numbers that the No Action hours have to be multiplied by to equal the Alternative 1 and Alternative 2 hours.

The second step applies these calculated flight hour scale factors to the No Action Alternative operations of the corresponding platforms and squadrons shown in Table 3-3 of Section 3.1. This step assumes that the hours per sortie and the closed pattern rate (average patterns per sortie) are the same in the Action Alternatives as the No Action. Table 3-2 lists the Total Annual Operations modeled under the No Action in the first column, the same scale factors that were calculated from Table 3-1 in the columns with the green highlighted headings, and the Total Annual Operations derived for Alternatives 1 and 2 (multiplying the No Action Operations by the scale factor for each Alternative). The numbers of static operations are also scaled on these same scaling factors, which are specific to each squadron and aircraft within each squadron from Table 3-1 and Table 3-2.

3.2 NAS Patuxent River and OLF Webster Action Alternatives Acoustic Environment

3.2.1 Action Alternatives DNL Noise Contours

The DNL 55 dB through 85 dB contours for the Action Alternatives 1 and 2 are shown in Figure 3-1 and Figure 3-2, respectively, for NAS Patuxent River and Figure 3-3 and Figure 3-4, respectively, for OLF Webster. These figures display the Alternative contours as solid lines and the No Action results as shaded areas. At OLF Webster, from the No Action to the Alternatives, the DNL values are still very low, and the 65 dBA contour is the very small green island centered at the more heavily utilized of the two helipads for the MQ-8 Fire Scout UAS. At NAS Patuxent River, the DNL contours are very similar to the No Action contours. As expected, some of the lobes in the 65 and 70 dBA contours extend out a bit farther than in the No Action, and each contour set is a bit larger/wider than the No Action due to the increase of overall operations between the No Action and the Alternatives. Further explanations of the various lobes and islands in the DNL contours and differences between the No Action DNL contours and the Alternatives DNL contours are described in Section 4.2.

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Table 3-1. Action Alternatives 1 and 2 Flight Hours and Scale Factors Required to Reach these Flight Hours

Organization	Squadron	Platform	No Action	Alternative 1	Scale Factor for Alt 1	Alternative 2	Scale Factor for Alt 2
Naval Test Wing Atlantic (NTWL) Tenant	TPS	Various	6,197	7,079	1.142	7,865	1.269
	VX-20	P-3	648	0	0.000	0	0.000
		T-6/T-34	345	0	0.000	0	0.000
		C-12 Tac	194	455	2.342	505	2.602
		C-130	790	710	0.899	789	0.999
		C-38	352	474	1.344	526	1.493
		E-2	984	580	0.589	644	0.655
		E-6B	157	178	1.130	197	1.256
		MQ-4 Triton	93	163	1.744	181	1.937
		P-8	570	1,302	2.284	1,447	2.538
	VX-23	F/A-18E/F and EA-18G	1,634	2,663	1.630	2,960	1.812
		F/A-18C/D	1,089	888	0.815	986	0.905
		F-35B	374	142	0.380	158	0.422
		F-35C	249	142	0.570	158	0.634
		T-45	191	207	1.084	230	1.205
		MQ-25A	0	296	1.000	329	1.111
	HX-21	CH-53	132	355	2.690	395	2.989
		H-1	557	355	0.638	395	0.708
		MH-60R/S	1,025	1,421	1.386	1,578	1.540
		Presidential (VH-92, H-3, VH-71)	81	533	6.576	592	7.307
		V-22	233	320	1.373	355	1.524
	UX-24	UAS Group 1-2	93	438	4.714	487	5.238
		UAS Group 3	79	250	3.143	278	3.492
		UAS Group 4	185	379	2.052	421	2.280
	AIR OPS (SAR)	C-12 and MH-60S SAR	1,245	704	1.131	783	1.258
	Total		*17,498*	*20,032*		*22,258*	
NAS Patuxent River Tenant	VQ-4	E-6B	422	498	1.181	554	1.313
	VXS-1	P-3, C-12	283	334	1.180	371	1.311
	VX-1	E-2, P-3, P-8, H-60	157	186	1.184	207	1.318
	MDARNG	RQ-7 Shadow	151	474	3.136	526	3.483
	Total		*1,013*	*1,492*		*1,658*	
Non-NAS Patuxent River	Transient (FIST)	Various	242	285	1.178	316	1.306
	Transient (ATC Actuals)	Various	1,347	1,591	1.181	1,768	1.313
	Total		*1,589*	*1,876*		*2,084*	
TOTAL			***20,100***	***23,400***		***26,000***	

Key: ATC = Air Traffic Control; FIST = Flight Information Scheduling and Tracking; MDARNG = Maryland Army National Guard; NAS = Naval Air Station; NTWL = Naval Test Wing Atlantic; OPS = operations; SAR = Search and Rescue; TPS = Test Pilot School; UAS = Unmanned Aircraft System.

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Table 3-2. Total Annual Operations for the No Action and Action Alternatives 1 and 2

Organization	Squadron	Platform	No Action	Scale Factor for Alt 1	Alternative 1	Scale Factor for Alt 2	Alternative 2
Naval Test Wing Atlantic (NTWL) Tenant	TPS	Various	34,480	1.142	39,387	1.269	43,761
	VX-20	P-3	985	0.000	0	0.000	0
		T-6/T-34	1,937	0.000	0	0.000	0
		C-12 Tac	476	2.342	1,115	2.602	1,238
		C-130	1,085	0.899	976	0.999	1,084
		C-38	1,351	1.344	1,816	1.493	2,018
		E-2	1,640	0.589	967	0.655	1,073
		E-6B	194	1.130	219	1.256	244
		MQ-4 Triton	120	1.744	209	1.937	232
		P-8	592	2.284	1,352	2.538	1,503
	VX-23	F/A-18E/F and EA-18G	5,430	1.630	8,850	1.812	9,836
		F/A-18C/D	3,620	0.815	2,952	0.905	3,278
		F-35B	1,155	0.380	439	0.422	488
		F-35C	771	0.570	439	0.634	489
		T-45	1,034	1.084	1,121	1.205	1,246
		MQ-25A	0	1.000	396	1.111	440
	HX-21	CH-53	698	2.690	1,878	2.989	2,087
		H-1	6,302	0.638	4,018	0.708	4,464
		MH-60R/S	3,940	1.386	5,460	1.540	6,067
		Presidential (VH-92, H-3, VH-71)	400	6.576	2,631	7.307	2,923
		V-22	960	1.373	1,318	1.524	1,463
	UX-24	UAS Group 1-2	90	4.714	424	5.238	471
		UAS Group 3	446	3.143	1,402	3.492	1,558
		UAS Group 4	454	2.052	932	2.280	1,035
	AIR OPS (SAR)	C-12 and MH-60S SAR	5,280	1.131	2,987	1.258	3,321
	Total		*73,440*		*81,288*		*90,319*
NAS Patuxent River Tenant	VQ-4	E-6B	1,080	1.181	1,275	1.313	1,418
	VXS-1	P-3, C-12	980	1.180	1,156	1.311	1,285
	VX-1	E-2, P-3, P-8, H-60	2,720	1.184	3,220	1.318	3,586
	MDARNG	RQ-7 Shadow	270	3.136	847	3.483	941
	Total		*5,050*		*6,498*		*7,230*
Non-NAS Patuxent River	Transient (FIST)	Various	480	1.178	565	1.306	627
	Transient (ATC Actuals)	Various	1,590	1.181	1,878	1.313	2,087
	Total		*2,070*		*2,443*		*2,714*
TOTAL			***80,560***		***90,229***		***100,263***

Key: ATC = Air Traffic Control; FIST = Flight Information Scheduling and Tracking; MDARNG = Maryland Army National Guard; NAS = Naval Air Station; NTWL = Naval Test Wing Atlantic; OPS = operations; SAR = Search and Rescue; TPS = Test Pilot School; UAS = Unmanned Aircraft System.

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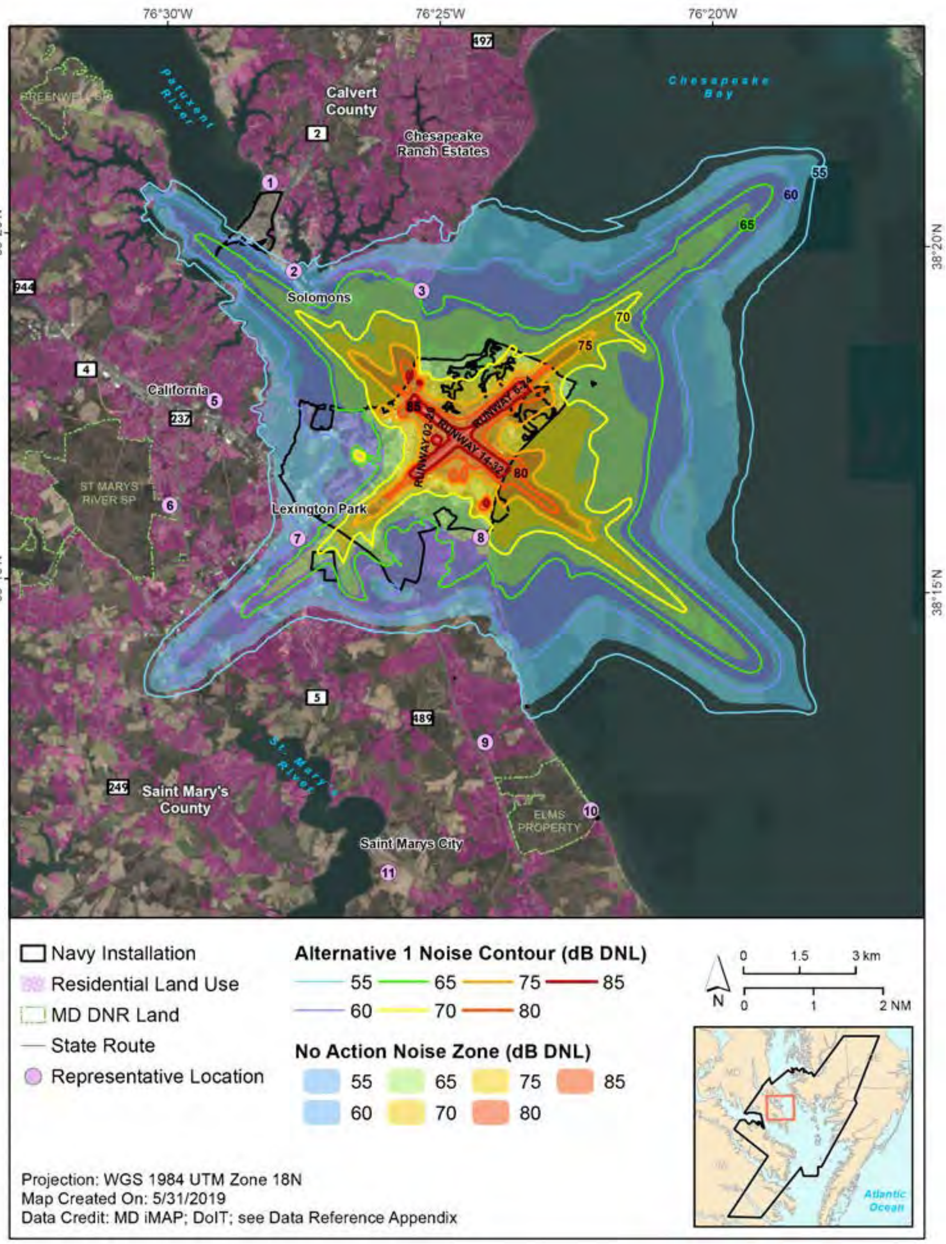

Figure 3-1. NAS Patuxent River DNL Contours for Alternative 1

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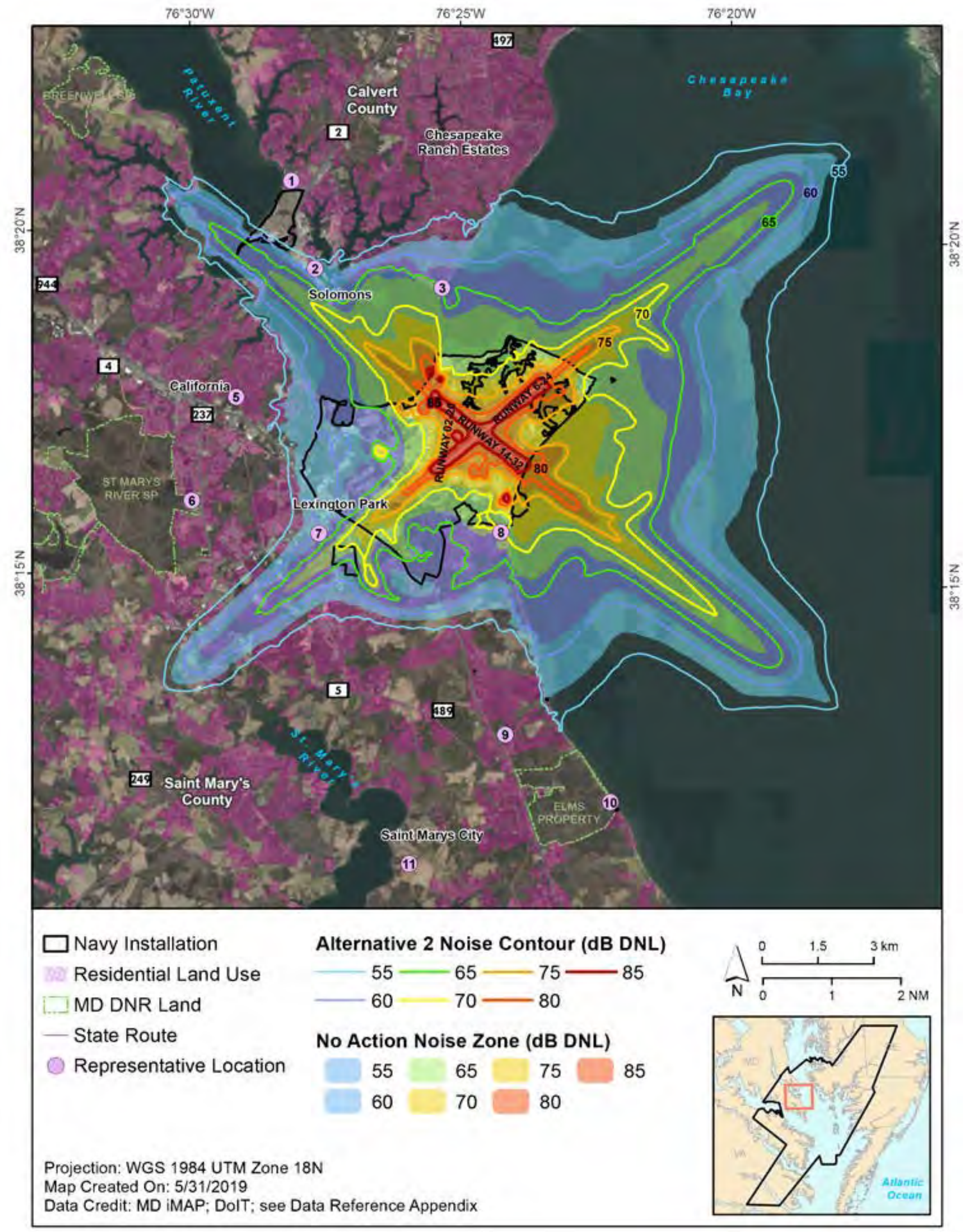

Figure 3-2. NAS Patuxent River DNL Contours for Alternative 2

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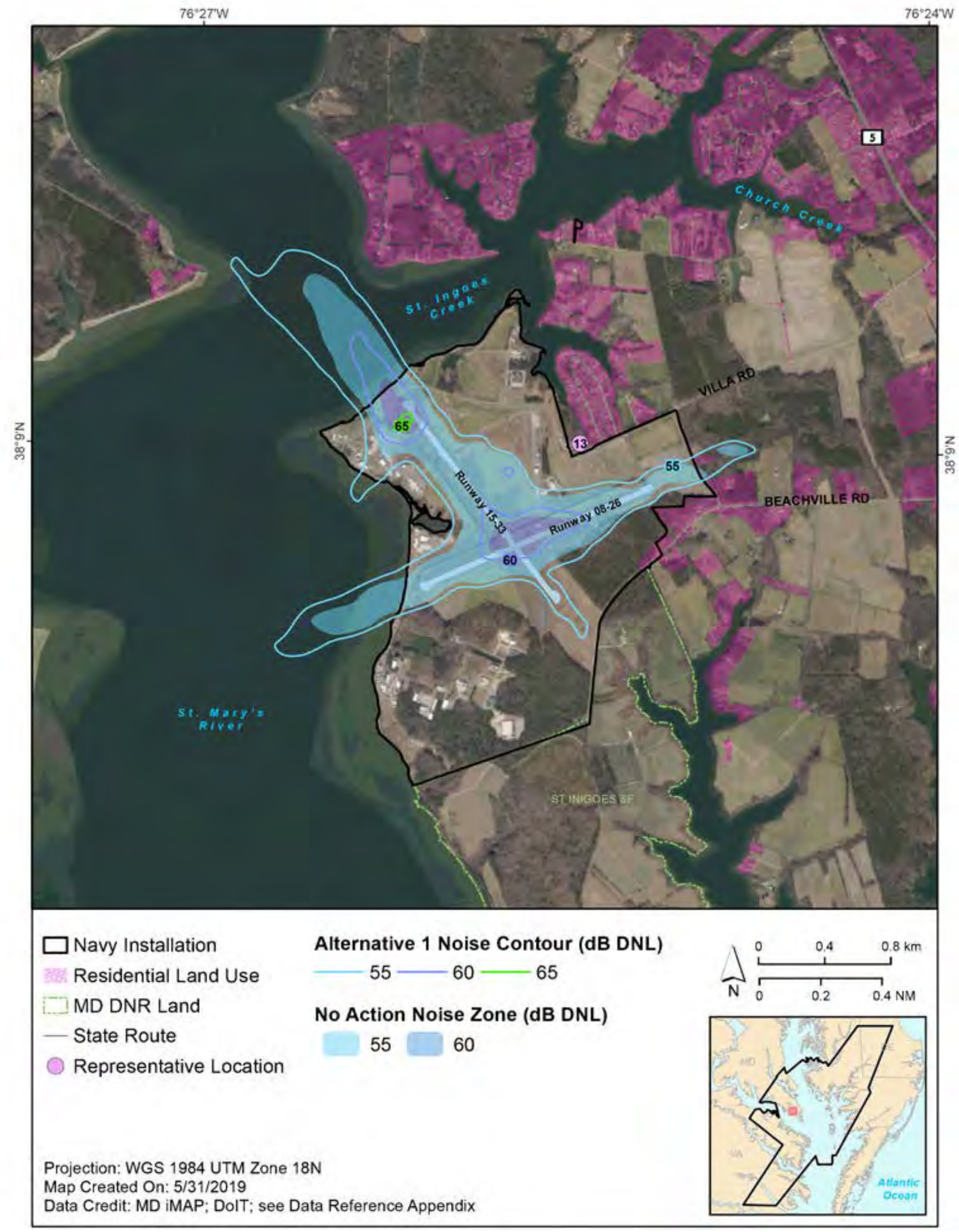

Figure 3-3. OLF Webster DNL Contours for Alternative 1

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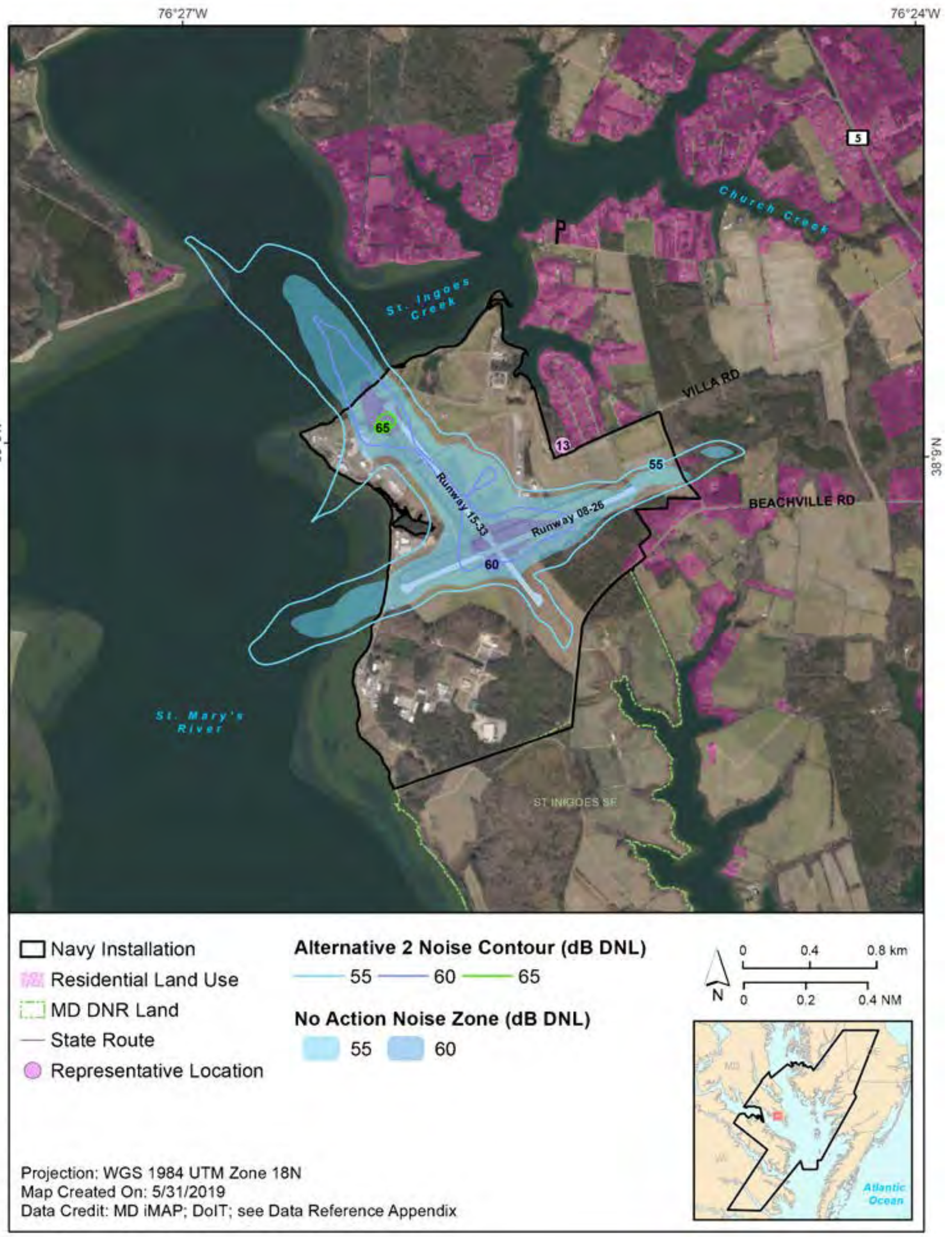

Figure 3-4. OLF Webster DNL Contours for Alternative 2

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3.2.2 Noise Contour Description Points Analysis and Comparison with the No Action Alternative

The purpose of this section is to show the contributors behind the various DNL noise contour lobes and islands and to describe the differences between the No Action Alternative and Action Alternatives. Figure 3-5 shows the NAS Patuxent River noise contour description points and the No Action Alternative and Alternative 2 DNL contours. Alternative 2 is utilized for this description and comparison since Alternative 2 has a greater increase in flight hours compared to Alternative 1 over the No Action Alternative. The Alternative 2 DNL contours are 1-4 dB greater than the No Action Alternative DNL contours, with the greatest differences occurring over water (due to greater propagation of sound over water versus over land). Table 3-3 gives the explanations for the DNL contour shape, increase, or difference at each of the noise contour description points at NAS Patuxent River. The majority of the top contributors of the DNL contour shapes or increases are the VX-23 F/A-18E/F Super Hornet. Eight of the 15 noise contour description points are at DNL contour lobes resulting from VX-23 F/A-18E/F VFR closed pattern operations.

To compare the NAS Patuxent River No Action and Alternative 2 65 dBA DNL contours to the 2009 AICUZ 65 dBA DNL contours, Figure 3-6 presents the noise contour description points for the comparison. Table 3-4 gives the explanations for the differences in DNL between this analysis and the 2009 AICUZ. The largest difference between this analysis (No Action and Alternatives) and the previous analysis (2009 AICUZ) arises from differences in the modeled flight profiles for the F/A-18E/F Super Hornets. Over the past 10 years, new Super Hornet flight profiles have been refined at bases such as NAS Oceana and NAS Whidbey Island. The NAS Oceana Super Hornet profiles were used as the basis for this study's Super Hornet profiles, but the profiles were adjusted based on local course rules. These profiles were then validated by the VX-23 Super Hornet pilot and used in this study.

Table 3-3. Explanations of the Shapes, Increase, or Differences for the NAS Patuxent River No Action and Alternative 2 DNL Contours at Each Noise Contour Description Point

Location Number	DNL Level	Scenario	Top Contributor	Explanation
1	55	No Action and Alt 2	VX-23 F-18E/F 80% Static Run-ups	Low power runs from VX-23 (location #8) are propagating over the water more than land from VX-23 static run-up location.
2	65	No Action	Runway 06 VX-23 and TPS F-18E/F VFR Patterns	VX-23 and TPS F-18E/F operations increase under the alternatives, so the closed pattern operation that has only a small extrusion in the 65 DNL contour for No Action (e.g., location #2) has a much larger extrusion over land in the alternatives (e.g., location #5) as the DNL contour follows this closed pattern track as more operations are added. There is a decrease in power between the end of the downwind leg and the mid-turn to final, which creates a gap in the contours for the alternatives, but is less noticeable in the No Action due to fewer operations.
3	65	No Action		
4	65	Alt 2		
5	65	Alt 2		
6	70	Alt 2	Runway 24 VX-23 and TPS F-18E/F VFR Patterns	As the F-18E/F turns to final, the engine power increases and generates noise – this follows the track from the turn to final and is more pronounced in Alts 1 and 2 because there are a greater number of F-18E/F operations compared to the No Action Alternative.
7	70	No Action and Alt 2	VX-1 E-2 Low Power Turns	Parking run-ups for E-2.
8	85	No Action and Alt 2	VX-23 F-18E/F 80% Static Run-ups	VX-23 F-18E/F can run up to 80% power on the apron for parking runs.
9	85	No Action and Alt 2	OAETC Engine Runs for F-18A/C and F-18E/F	The Open-Air Engine Test Cell (OAETC) engine runs are directly next to the water and the noise propagates over the Bay toward Solomons Island.
10	65	No Action and Alt 2		
11	65	No Action and Alt 2	Runway 14 VX-23F-18E/F VFR Patterns	The top contributor at this point is a combination of the F-18E/F closed pattern track and the OAETC engine run-ups.
12	65	No Action	VX-23 F-18E/F Straight-in Arrival	The top contributor along each runway's extended centerline are straight-in arrivals from the VX-23 Super Hornet.
13	65	No Action	VX-23 F-18E/F Straight-in Arrival	Change in straight-in arrival power at this location in combination with the GCA box pattern changes results in "arrowhead" shape.

Table 3-3. Explanations of the Shapes, Increase, or Differences for the NAS Patuxent River No Action and Alternative 2 DNL Contours at Each Noise Contour Description Point

Location Number	DNL Level	Scenario	Top Contributor	Explanation
14	65	No Action and Alt 2	VX-23 F-18C/D VFR Pattern	The VFR Pattern for the F-18C/D has a shorter final than the F-18E/F, so this DNL lobe is closer to the runway than the lobe from the F-18E/F.
15	58	No Action	VX-23 F-18E/F VFR Pattern	This bubble in the 60 dBA DNL contour is a reduction (less than 60 dBA) because there is a Hornet (F-18C/D) pattern just above the bubble and a Super Hornet (F-18E/F) pattern just below the bubble. In some situations, this results in enough of a decrease between the tracks to create a "hole" in the DNL contour. This is not the case for Alternatives 1 and 2 because there is a higher number of Hornet and Super Hornet patterns that this "bubble" goes away (the DNL between the tracks is greater than 60 dBA for the alternatives).

Key: Alt = Action Alternative; dBA = A-weighted sound level; DNL = day-night average sound level; OAETC = Open-Air Engine Test Cell; VFR = visual flight rules.

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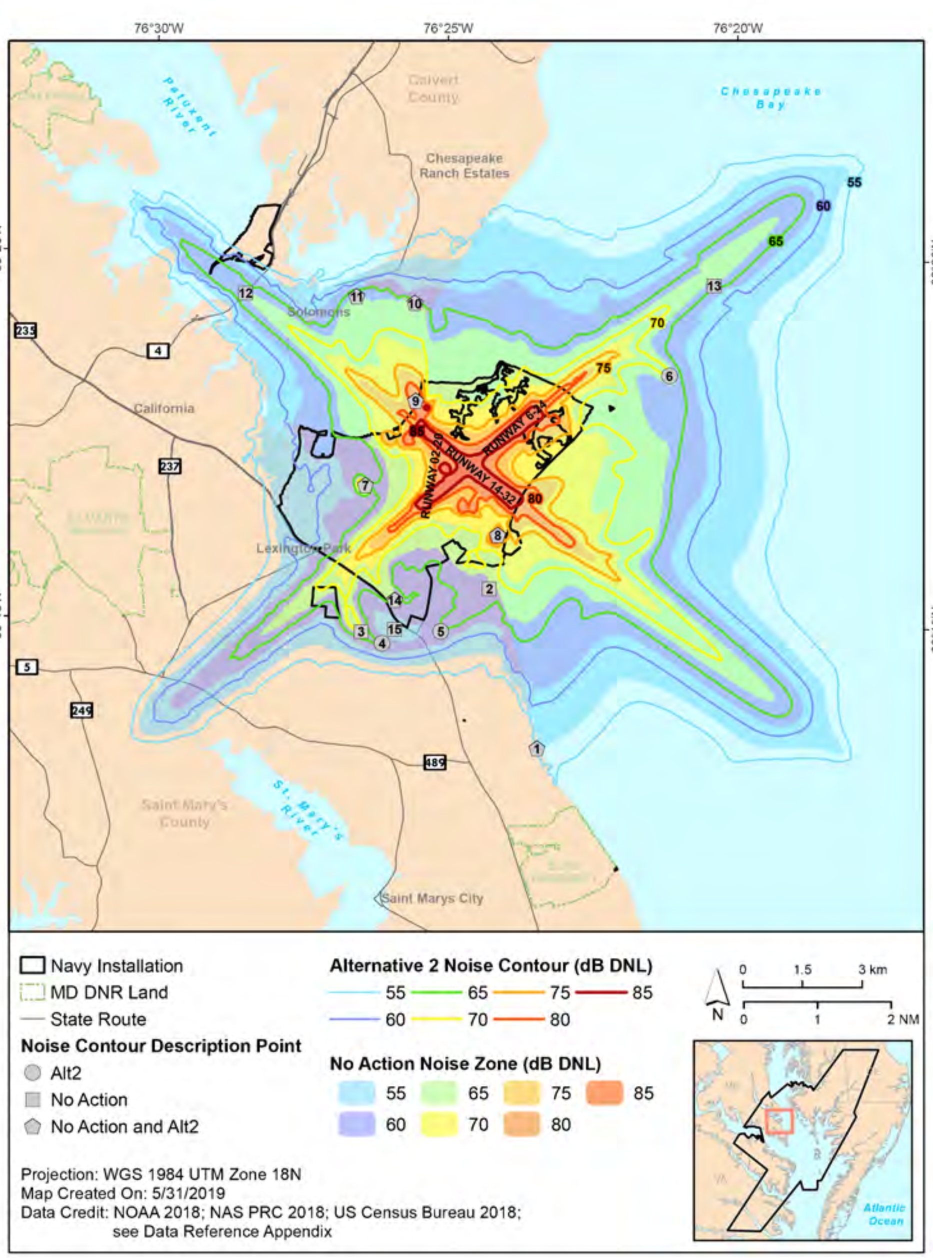

Figure 3-5. Noise Contour Description Points and Comparison with the No Action Alternative

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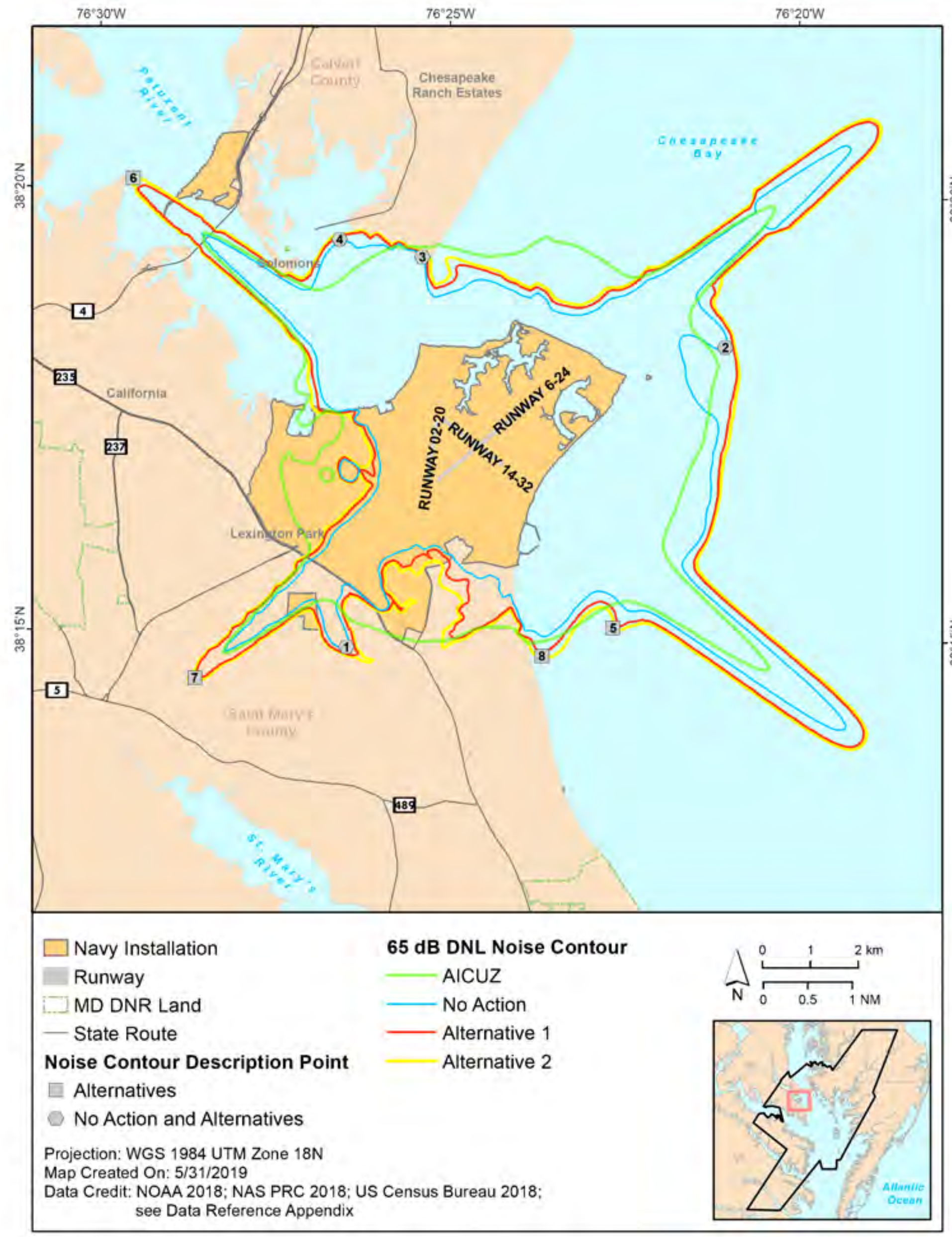

Figure 3-6. NAS Patuxent River DNL Noise Contour Description Points for 65 dBA DNL Contour Comparison of Alternative 2 and No Action to the 2009 AICUZ

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Table 3-4. Explanations of Difference between the NAS Patuxent River No Action/Alternatives and the 2009 AICUZ for the 65 dBA DNL Contours at Each Noise Contour Description Point

Location Number	DNL Level	Scenario	Top Contributor	Explanation
1	65	No Action and Alternatives	VX-23 F-18E/F Super Hornet Runway 06 VFR Closed Patterns	Based on interviews with VX-23, modeled a wider Super Hornet pattern with a longer final that was modeled in the 2009 AICUZ. This pushes the DNL contours farther out because of the mid-turn to final has an increase in power, which is the contributor for these DNL lobes. For location #3, the OAETC Hornet engine runs are also a top contributor.
2	65	No Action and Alternatives	VX-23 F-18E/F Super Hornet Runway 24 VFR Closed Patterns	
3	65	No Action and Alternatives	VX-23 F-18E/F Super Hornet Runway 14 VFR Closed Patterns	
4	65	No Action and Alternatives		
5	65	Alternatives	VX-23 F-18E/F Super Hornet Runway 32 VFR Closed Patterns	
6	65	Alternatives	VX-23 F-18E/F Super Hornet Straight-in Arrivals to Runway 14	For the Super Hornet Straight-in Arrivals, based on interviews with the pilots along with previously modeled profiles at NAS Oceana, modeled an increase in power at approximately 5 NM from the runway threshold and at 1,600 ft. MSL altitude. This is different than what was modeled for the 2009 AICUZ, as these modeled updated profiles are a bit louder for straight-in arrivals.
7	65	Alternatives	VX-23 F-18E/F Super Hornet Straight-in Arrivals to Runway 06	
8	65	Alternatives	VX-23 F-18E/F Super Hornet Parking Run-ups	Parking run-ups up to 80% NC are on the apron at VX-23.This noise propagates south over the water.

Key: AICUZ = Air Installations Compatible Use Zones; DNL = day-night average sound level; OAETC = Open-Air Engine Test Cell; NM = nautical mile; MSL = mean sea level, NC = engine performance parameter.

Figure 3-7 shows the noise contour description points for 54 Webster. These locations were placed at extrusions, lobes, or islands in the DNL contours at OLF Webster for the No Action and Alternative 2 to explain the reason for these features in the DNL contours. Table 3-5 presents the explanations for these DNL contour features and the reason for changes in the Alternative DNL contours relative to the No Action contours. The No Action and Action Alternatives DNL contours at OLF Webster are much smaller than the DNL contours presented in the 1998 EIS. The 1998 EIS modeled more fixed wing aircraft and helicopter operations at OLF Webster and no or very few UAS operations. However, more UAS operations are occurring at OLF Webster today. These UAS operations are generally quieter than the larger fixed-wing aircraft and helicopters that previously used OLF Webster. Since fixed wing aircraft and UAS aircraft cannot use the airfield concurrently at OLF Webster, the fixed wing and helicopters use OLF Webster less often than they did over two decades ago. The TPS usage of OLF Webster has remained nearly the same as in 1998, but there was a total of 69,836 operations for OLF Webster in the 1998 EIS while the current noise study has 7,303 total operations at OLF Webster. This difference in modeled operations is the main driver for changes to the noise contours.

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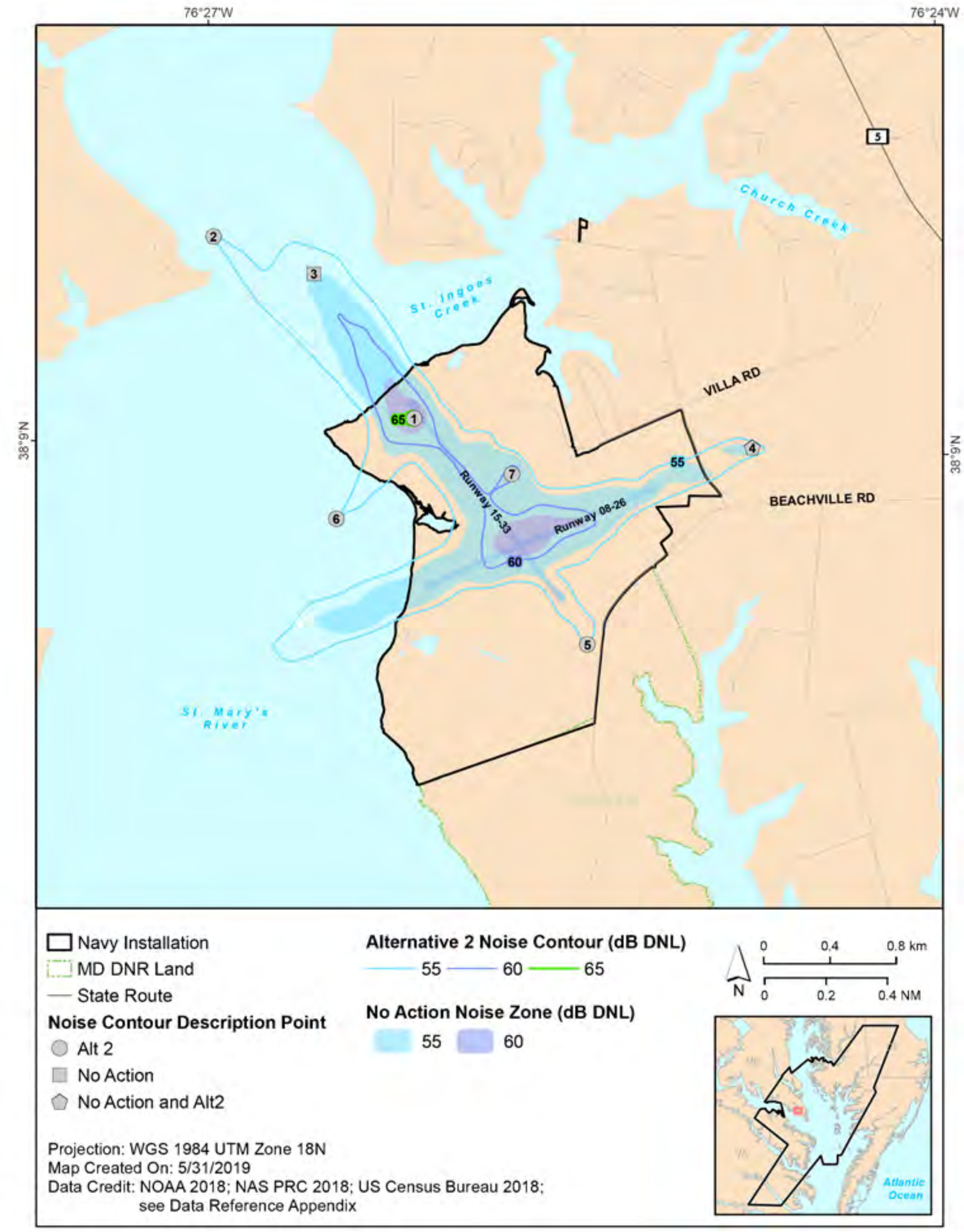

Figure 3-7. OLF Webster DNL Noise Contour Description Points with Alternative 2 and No Action DNL Contours

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Table 3-5. Explanations of the Shapes, Increases, or Differences for the OLF Webster No Action and Alternative 2 DNL Contours at Each Noise Contour Description Point

Location Number	DNL Level	Scenario	Top Contributor	Explanation
1	65	Alt 2	MQ-8 Firescout Departures from Spot 1	75% of MQ-8 departures are from Spot 1 (at location #1). Group 4 UAS are expected to increase by a factor of 2.1 and 2.3 for Alternative 1 and Alternative 2, respectively, so the DNL contours are greater for the alternatives than for the No Action.
2	55	Alt 2	MQ-8 Firescout Departure from Spot 1 to North	
3	55	No Action	Runway 33 T-6 VFR Closed Patterns	T-6 Closed Pattern profile for Runway 33 is at 100% takeoff power above this point.
4	55	No Action and Alt 2	Runway 08 T-6 VFR Closed Pattern	T-6 Closed Pattern profile for Runway 06 is at 100% takeoff power above this point.
5	55	Alt 2	Runway 15 T-6 VFR Closed Pattern	The contour is smaller for Runway 15 closed patterns because Runway 15 is the least utilized runway at Webster with only 14% annual average utilization.
6	55	Alt 2	MQ-8 Firescout Departures from Spot 1 to Southwest	After departing Spot 1, 30% of these departures head southwest, resulting in this sharp DNL contour to the southwest. There are 2.1 and 2.3 times more Firescout sorties for Alternative 1 and 2 (respectively) than in the No Action, so the contour is much more pronounced for the alternatives.
7	60	Alt 2	Test Pilot School H-72 Grass Patterns	40% of TPS H-60 and H-72 sorties go to Webster for pattern work and only 1% of HX-21, H-1, and H-60 go to Webster. The previous analysis (based on the 1998 EIS) had nearly 70,000 annual operations at Webster, while the current analysis only has 7,300 annual operations. This reduction in operations is the reason for the much smaller contours. The major contributor from the previous EIS analysis appeared to be helicopter grass patterns, but fewer helicopter operations were modeled this time around (based on squadron interviews).

Key: Alt = Action Alternative; DNL = Day-Night Average Sound Level; EIS = Environmental Impact Statement; Helo = helicopter; UAS = Unmanned Aircraft System; VFR = visual flight rules.

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3.2.3 Proposed Action Alternatives DNL and SEL at Representative Locations

Alternative 1 overall DNL and maximum SEL of a single aircraft event at each of the representative locations are listed in Table 3-6, and the Alternative 2 DNL and maximum SEL of a single aircraft event at each of the locations are listed in Table 3-7. The locations were presented in Figure 2-14 of Section 2.4.2. The location with the highest DNL and greatest increase in DNL in Alternative 1 over the No Action is Cedar Cove Apartments (PO8) with 68 dBA DNL, which is a 2 dBA increase over the No Action. In Alternative 2, seven locations have a 2 dBA DNL increase over the No Action. There are no increases in the max SEL, which means that the same highest SEL contributor (within the top 20 contributors to the overall DNL) in the No Action is also the highest in Alternatives 1 and 2. Supplemental metrics at these locations are presented in Section 6.

Table 3-6. Alternative 1 DNL and Maximum SEL at Each Representative Location

Representative Location		DNL (dBA)			Max SEL (dBA)		
ID	Description	No Action	Alternative 1	Increase re No Action	No Action	Alternative 1	Increase re No Action
P01	Asbury Solomons	47	47	-	103	103	-
P02	Our Lady Star of the Sea School	58	59	+1	110	110	-
P03	Drum Point Club	64	65	+1	113	113	-
P04	Captain Walter Francis Duke Elementary School	48	49	+1	95	95	-
P05	Green Holly Elementary School	48	49	+1	93	93	-
P06	Chancellors Run Activity Center	45	46	+1	90	90	-
P07	Lexington Park Elementary School	59	60	+1	107	107	-
P08	Cedar Cove Apartments	66	68	+2	113	113	-
P09	Spring Ridge Middle School	46	46	-	96	96	-
P10	Elms Beach Park	52	53	+1	102	102	-
P11	Historic St. Mary's City	40	41	+1	94	94	-
P12	Harry Lundeberg School of Seamanship	42	42	-	86	86	-
P13	St. Ignatius Roman Catholic Church	47	48	+1	95	95	-
P14	Point Lookout State Park	23	24	+1	73	73	-
P15	Northumberland Elementary School	24	25	+1	73	73	-

Key: DNL = day-night average sound level; dBA = A=weighted decibels; max = maximum; SEL = sound exposure level.

Table 3-7. Alternative 2 DNL and Maximum SEL at Each Representative Location

Representative Location		DNL (dBA)			Max SEL (dBA)		
ID	Description	No Action	Alternative 2	Increase re No Action	No Action	Alternative 2	Increase re No Action
P01	Asbury Solomons	47	48	+1	103	103	-
P02	Our Lady Star of the Sea School	58	60	+2	110	110	-
P03	Drum Point Club	64	65	+1	113	113	-
P04	Captain Walter Francis Duke Elementary School	48	49	+1	95	95	-
P05	Green Holly Elementary School	48	50	+2	93	93	-
P06	Chancellors Run Activity Center	45	46	+1	90	90	-
P07	Lexington Park Elementary School	59	61	+2	107	107	-
P08	Cedar Cove Apartments	66	68	+2	113	113	-
P09	Spring Ridge Middle School	46	46	-	96	96	-
P10	Elms Beach Park	52	53	+1	102	102	-
P11	Historic St. Mary's City	40	42	+2	94	94	-
P12	Harry Lundeberg School of Seamanship	42	42	-	86	86	-
P13	St. Ignatius Roman Catholic Church	47	49	+2	95	95	-
P14	Point Lookout State Park	23	24	+1	73	73	-
P15	Northumberland Elementary School	24	26	+2	73	73	-

Key: DNL = day-night average sound level; dBA = A=weighted sound level, Decibel; SEL = sound exposure level.

4 Patuxent River Complex Airspace Noise Analysis

4.1 PRC Airspace Operational Parameters

The PRC is composed of several specific airspace units. The modeled units are displayed in Figure 4-1. A field is provided in the FIST database for pilots to record airspaces used during flights; however, this data is entered inconsistently. Therefore, PRC airspace utilization was determined solely by pilot interviews for NAS Patuxent River squadrons. For each airspace unit, the following parameters were provided: annual operations, altitude distributions, average airspeed and power settings, and mission durations. The following subsections list the validated squadron specific airspace parameters. The percentage utilizations of aircraft sorties to each airspace area within the PRC may not add up to 100 percent. This utilization is based on all sorties, some of which do not utilize PRC, and thus, they are not modeled. Note that restricted areas R-4002 and R-4007 were not modeled because they are flown infrequently. During the interviews, no pilots mentioned flying in R-4002 or R-4007, although the larger restricted areas include parts of R-4002 and R-4007. There are overlapping restricted areas in the PRC.

4.1.1 Test Pilot School Airspace Parameters

For TPS PRC fixed-wing airspace utilization, 95 percent of all T-38 and T-6 sorties utilize R-4006 and R-4008 (combined area), 90 percent of F/A-18E/F sorties utilize R-4006 and R-4008 (combined area), 75 percent of C-12 and C-21 sorties utilize R-4006. For the TPS helicopters, 95 percent of H-60 and H-72 sorties utilize West, South, and East Helo Operating Areas (equal use among the 3 areas), and 5 percent of sorties utilize R-4006.

The altitude bands flown by these aircraft, durations within the airspace, average airspeeds, and average engine powers are listed in Table 4-1.

Table 4-1. Test Pilot School Airspace Operational Parameters

Airspace Altitude Profiles

Aircraft	Altitude Band Utilization (ft MSL)								Duration	Airspeed	Power
	1,000-3,000	1,000-4,000	4,000-6,000	5,000-10,000	5,000-6,000	6,000-10,000	6,000-18,000	10,000-20,000			
T-38				10%				90%	40 min	350-400 kts	90% RPM
T-6			5%				95%		1.2 hours	160 kts	50%
C-12/C-21					5%	95%			1.5 hours	150-180 kts	60% Torque
H-60/H-72 in West Helo		100%							1.5 hours	100-110 kts	N/A
H-60/H-72 in East and South Areas	100%								1.5 hours	100-110 kts	N/A
F-18				10%				90%	40 min	350-400 kts	90% RPM

Key: ft = feet; Helo = helicopter; kts = knots; min = minutes; MSL = mean sea level; N/A = not applicable; RPM = revolutions per minute.

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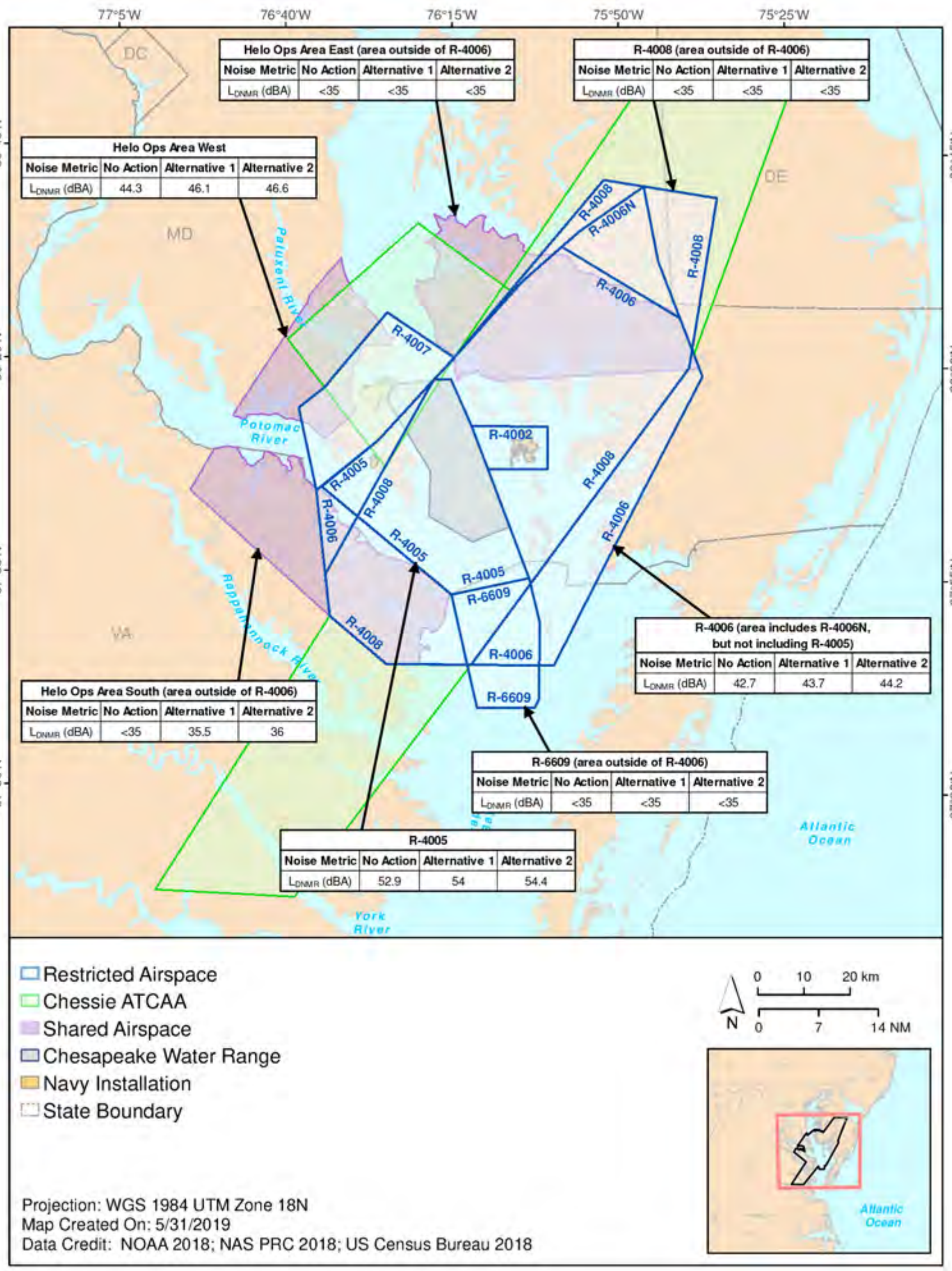

Figure 4-1. PRC Airspace Areas Modeled in the Noise Analysis

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4.1.2 VX-23 Airspace Parameters

For VX-23 PRC airspace utilization, 6 percent of all sorties of F/A-18 (all variants) utilize R-4005 and 54 percent utilize the combined R-4006 and R-4008 area. For F-35 (both variants), 2 percent of all sorties utilize R-4005 and 18 percent utilize the combined R-4006 and R-4008 area. For T-45, 10 percent of all sorties utilize R-4005 and 89 percent utilize the combined R-4006 and R-4008 area. For MQ-25, 10 percent of all sorties utilize R-4005, 65 percent utilize R-4006, 5 percent utilize R-4008, and 5 percent utilize the test track.

The altitude bands flown by these aircraft, durations within the airspace, average airspeeds, and average engine powers are listed in Table 4-2.

Table 4-2. VX-23 Airspace Operational Parameters

Airspace Altitude Profiles

Aircraft	Altitude Band Utilization (ft MSL)						Duration in Area	AVG Airspeed	AVG power setting
	1,000-3,500	3,500-10,000	10,000-20,000	20,000-25,000	25,000-30,000	30,000-40,000			
F-18 in R-4005	100%						1.2 hours	350 kts	90% RPM
F-18 in R-4006		40%	40%	20%					
F-18 in R-4008					47%	53%			
F-35B/C in R-4005	100%						0.8 hours	300 kts	90% ETR
F-35B/C in R-4006		40%	40%	20%					
F-35B/C in R-4008					47%	53%			
T-45 in R-4005	100%						1 hour	325 kts	92% RPM
T-45 in R-4006		40%	40%	20%					
T-45 in R-4008					47%	53%			

Aircraft	Altitude Band Utilization (ft MSL)			Duration	Airspeed	Power
	2,000-5,000	15,000-25,000	25,000-30,000			
MQ-25 in R-4006		100%		4 hours	200 kts	50%
MQ-25 in R-4005	100%					
MQ-25 in R-4008			100%			

Key: AVG = average; ETR = engine thrust request; ft = feet; kts = knots; MSL = mean sea level; RPM = revolutions per minute.

4.1.3 Search and Rescue Airspace Parameters

Based on the squadron interviews, SAR does not utilize the PRC airspace, so only arrivals, departures, and patterns at NAS Patuxent River were modeled.

4.1.4 VX-20 Airspace Parameters

For VX-20 airspace utilization, 50 percent of all C-38 and C-12 sorties utilize R-4006 and 10 percent utilize R-4005. For P-8 and P-3, 20 percent utilize R-4006, 22 percent utilize R-4005, and 8 percent utilize R-4008. For E-2, 55 percent utilize the combined R-4006 and R-4008 area. For T-6 and C-130, 100 percent of all sorties utilize the combined R-4006 and R-4008 area. E-6B does not utilize the PRC airspace.

The altitude bands flown by these aircraft, durations within the airspace, average airspeeds, and average engine powers are listed in Table 4-3.

Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

Table 4-3. VX-20 Airspace Operational Parameters

Aircraft	Altitude Band Utilization (ft MSL)								AVG Airspeed	Duration in the Area	AVG power setting
	600 AGL-3,000	3,500-5,000	5,000-10,000	10,000-25,000	15,000-20,000	18,000-40,000	20,000-27,000	25,000-40,000			
E-2/T-6					34%		66%		150 kts	3.5 hours	1,000 lbs/hr per side
P-8/P-3 in R-4005	100%								225 kts	4 hours	13,000 lbs thrust per motor
P-8/P-3 in R-4006		10%	40%	50%					225 kts	4 hours	13,000 lbs thrust per motor
P-8/P-3 in R-4008								100%	225 kts	4 hours	13,000 lbs thrust per motor
C-38(C-21) /C-12 in R-4005	100%								200 kts	4 hours	50% power
C-38(C-21) /C-12 in R-4006				100%					200 kts	4 hours	50% power
C-130 in R-4006		10%	40%	50%					225 kts	4 hours	850 CTIT

Key: AVG = average; CTIT = Celsius turbine inlet temperature; ETR = engine thrust request; ft = feet; kts = knots; lbs/hr = pounds per hour; MSL = mean sea level; RPM = revolutions per minute.

4.1.5 HX-21 Airspace Parameters

For HX-21 airspace utilization, 44 percent of all H-60 sorties are to the West Helo Operating Area, 5 percent are to the East Helo Operating Area, 5 percent are to the South Helo Operating Area, 15 percent are to R-4005, and 1 percent are to OLF Webster. For H-1, 70 percent of sorties are to the West Helo Operating Area, 24 percent are to R-4005, and 1 percent are to OLF Webster. For MV-22, 10 percent of all sorties are to West Helo Operating Area, 20 percent are to East Helo Operating Area, and 30 percent are to R-4005. For CH-53E/K, 50 percent of sorties are to R-4005N, 40 percent are to R-4005S, and 10 percent are to R-6609. For the Presidential VH-92 and H-3 (both modeled as CH-53E), 23 percent of sorties are to the West Helo Operating Area, 5 percent are to the East Helo Operating Area, 7 percent are to the South Helo Operating Area, 5 percent are to R-4005, and 2 percent are to OLF Webster.

The altitude bands flown by these aircraft, durations within the airspace, average airspeeds, and average engine powers are listed in Table 4-4.

Table 4-4. HX-21 Airspace Operational Parameters

Aircraft	Utilized Altitude Bands (ft MSL)								Airspeed	Duration
	surface-1,000	1,000-3,000	3,000-5,000	3,000-8,000	surface-4,000	4,000-10,000	5,000-18,000	10,000-24,000		
H-1 in R-4005	10%	75%		15%					100 kts	1.5 hours
H-1 in West area		100%							101 kts	1.5 hours
H-60 (all areas)	59%	40%		1%					102 kts	2 hours
V-22					10%	70%		20%	200 kts	2 hours
CH-53E/K		20%	60%				20%		120 kts	1.5 hours
Presidential VH-92 and H-3		100%							100 kts	1.5 hours

Key: ft = feet; kts = knots; MSL = mean sea level.

4.1.6 VX-1 Airspace Parameters

Most VX-1 sorties are to areas other than the PRC and are not modeled. For the modeled VX-1 airspace utilization, 34 percent of all E-2 sorties are to the combined R-4006 and R-4008 area. For P-8, 5 percent of all sorties are to the combined R-4006 and R-4008 area. For H-60, 20 percent of sorties are to the East Helo Operating Area.

The altitude bands flown by these aircraft, durations within the airspace, average airspeeds, and average engine powers are listed in Table 4-5.

Table 4-5. VX-1 Airspace Operational Parameters

Airspace Altitude Profiles

Aircraft	Altitude Band Utilization (ft MSL)						Duration in Area	AVG Airspeed	AVG power setting
	500 AGL-1,000	5,000-6,000	5,000-20,000	15,000-16,000	16,000-39,000	20,000-26,000			
H-60	100%						1 hr	70 kts	N/A
P-8		10%		38%	52%		4 hr	250 kts	77%
E-2			20%			80%	3.5 hr	150 kts	50% (1,000 lb/hr per side)

Key: AGL = above ground level; AVG = average; ft = feet; kts = knots; lb/hr = pounds per hour; MSL = mean sea level; N/A = not applicable.

4.1.7 VQ-4 Airspace Parameters

VQ-4 does not utilize the PRC airspace for training. Only arrivals, departures, and closed patterns at NAS Patuxent River were modeled.

4.1.8 VXS-1 Airspace Parameters

For VXS-1 airspace utilization, 90 percent of all P-3 sorties utilize R-4006 and 50 percent of all C-12 sorties utilize R-4006. The remainder of the P-3 and C-12 sorties are to other areas outside of the PRC and are not modeled. The altitude bands flown by these aircraft, durations within the airspace, average airspeeds, and average engine powers are listed in Table 4-6.

Table 4-6. VXS-1 Airspace Operational Parameters

Airspace Altitude Profiles

Aircraft	Altitude Band Utilization (ft MSL)				Duration in Area	AVG Airspeed	AVG power setting
	3,500-5,000	5,000-10,000	10,000-15,000	15,000-20,000			
P-3	1%	15%	1%	83%	5.5 hours	200 kts	2,500 HP per engine
C-12	1%	99%	0%	0%	1.5 hours	180 kts	55% Torque

Key: AVG = average; ft = feet; HP = horsepower; kts = knots; MSL = mean sea level.

4.1.9 UX-24 and MDARNG Airspace Parameters

For the airspace utilization of UX-24 and MDARNG (both operating out of OLF Webster), 20 percent of MQ-8 (modeled as UH-1) sorties are to R-4005W, 60 percent are to R-4005SW, 10 percent are to R-6609, and 10 percent are to R-4006S. For the RQ-21 and RQ-26 of UX-24 and the RQ-7 of MDARNG (all modeled as GASEPF), 25 percent of sorties are to R-4005W and 75 percent are to R-4005SW. The altitude bands flown by these aircraft, durations within the airspace, average airspeeds, and average engine powers are listed in Table 4-7.

Table 4-7. UX-24 and MDARNG Airspace Operational Parameters

Aircraft	Altitude Band Utilization (ft MSL)									Duration in Area	AVG Airspeed	AVG power setting
	2,000-3,000	3,000-10,000	3,000-3,500	5,000-10,000	8,000-9,000	9,000-10,000	6,000-7,000	7,000-10,000	3,000-6,000			
MQ-8 in 4005W	80%	20%								3 hours	55 kts	N/A
MQ-8 in 4005SW			80%	20%								
MQ-8 in 6009					80%	20%						
MQ-8 in 4006S							80%	20%				
RQ-7, RQ-21, RQ-26									100%	4 hours	58 kts	50% (5,000 RPM)

Key: AVG = average; ft = feet; kts = knots; MDARNG = Maryland Army National Guard; MSL = mean sea level; N/A = not applicable; RPM = revolutions per minute.

4.1.10 Transient Aircraft Airspace Parameters

A-10 and F-16 transients were modeled in the airspace analysis. These data came from ATC airspace records and represent an average of 1,347 flight hours over the 10-year period of CY 2008 – CY 2017. It is assumed that the PPR logs account for part of these transients that land at the NAS Patuxent River airfield. The A-10 and F-16 transients were modeled in R-4006 from 3,500 feet mean sea level (MSL) (floor of R-4006) to 25,000 feet MSL with equal distribution across this altitude band.

4.1.11 Military Training Routes

Logs were obtained for MTRs VR-1711, VR-1712, and VR-1713, since parts of these MTRs intersect the PRC. Although VR-1709 intersects the northern part of PRC, logs for VR-1709 were not provided. Five annual sorties were recorded on VR-1711, 66 were recorded on VR-1712, and 71 were recorded on VR-1713. This represents approximately one sortie per five days on VR-1712 and VR-1713. These events will be noticeable when they occur but will not generate any average noise footprint since they occur so infrequently; therefore, they are not modeled.

4.2 PRC Airspace Noise Analysis Results

Airspace testing and training has a large variability in aircraft mission types, maneuvers, and spatial utilization within each airspace, so the noise model uniformly distributes the operations across the entire modeled area. Thus, the calculated L_{dnmr} noise is also distributed equally within each airspace unit. Therefore, Table 4-8 presents the L_{dnmr} noise within each airspace area. The highest distributed noise exposure and the only L_{dnmr} that is over 50 dBA is in R-4005. The L_{dnmr} in R-4005 is 52.9 dBA for the No Action, 54.0 for Alternative 1, and 54.4 for Alternative 2.

While Table 4-8 shows the cumulative average annual noise exposure, noise from airspace testing and training operations are more infrequent and variable compared to airfield noise. To address single event noise events of aircraft utilizing the various airspaces, Table 4-9 presents the single event overflight SEL_r and L_{Amax} noise. The Route NoiseMap Model, MR_NMap, utilizes SELr to give a penalty for the high speed airspace operations. The higher the speed the aircraft is traveling in the airspace or along a route, the greater the penalty in the SELr. This table presents the single event noise exposure SEL_r and maximum noise level L_{Amax} for aircraft at the lowest altitude that they would possibly be flying in airspace area listed. These airspace altitude distributions, aircraft power settings and airspeeds were determined from interviews with the aircraft pilots and represent the average mission parameters the aircraft would be flying in these airspaces. It's important to note that quieter aircraft at a lower altitude can have greater noise impacts than louder aircraft at higher altitudes. For example, the HX-21 H-60 in the West Helo Operating Area at 100 feet above ground level (AGL) has higher SEL_r and L_{Amax} values than the VX-23 F/A-18C/D in R-4006 at 3,500 feet AGL.

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Table 4-8. PRC Airspace Analysis L_{DNMR} (dBA) Results for Each Airspace Area

PRC Airspace Name	LDNMR Results		
	No Action LDNMR (dBA)	Alternative 1 LDNMR (dBA)	Alternative 2 LDNMR (dBA)
Helo Ops Area East (area outside of R-4006)	<35	<35	<35
Helo Ops Area South (area outside of R-4006)	<35	35.5	36
Helo Ops Area West	44.3	46.1	46.6
R-4005	52.9	54	54.4
R-4006 (area includes R-4006N, but not including R-4005)	42.7	43.7	44.2
R-4008 (area outside of R-4006)	<35	<35	<35
R-6609 (area outside of R-4006)	<35	<35	<35

Key: < = less than; dBA = A-weighted decibels; AGL = above ground level; L_{dnmr} = A-weighted onset-rate adjusted monthly day-night average sound level; PRC = Patuxent River Complex.

Table 4-9. PRC Airspace Single Event Overflight SEL_r and L_{Amax} Noise Results

Aircraft	Squadron	Airspace Area	Airspace Floor Altitude (lowest the aircraft will likely fly in the area)	Aircraft Power Setting	Aircraft Airspeed (kts)	SELR (dBA)	Lmax (dBA)
H-60	HX-21	West Helo Operating Area / R-4005	100 ft AGL	N/A	120	97	93
CH-53	HX-21	West Helo Operating Area / R-4005	1,000 ft AGL	N/A	100	95	88
H-1	HX-21	West Helo Operating Area	1,000 ft AGL	N/A	120	90	76
H-1	HX-21	R-4005	100 ft AGL	N/A	100	101	91
F-18E/F	VX-23	R-4005	1,000 ft AGL	90% NC	350	110	106
F-18C/D	VX-23	R-4005	1,000 ft AGL	90% NC	350	104	99
T-45	VX-23	R-4005	1,000 ft AGL	92% RPM	325	91	86
F-35B	VX-23	R-4005	1,000 ft AGL	90% ETR	300	114	108
F-35C	VX-23	R-4005	1,000 ft AGL	90% ETR	300	115	110
F-18E/F	VX-23	R-4006	3,500 ft AGL	90% NC	350	98	91
F-18C/D	VX-23	R-4006	3,500 ft AGL	90% NC	350	91	83
T-45	VX-23	R-4006	3,500 ft AGL	92% RPM	325	80	71
F-35B	VX-23	R-4006	3,500 ft AGL	90% ETR	300	102	93
F-35C	VX-23	R-4006	3,500 ft AGL	90% ETR	300	103	94
MQ-25 (C-21)	VX-23	R-4005	2,000 ft AGL	50% NC	200	68	57
P-8	VX-20	R-4005	600 ft AGL	13,000 LBS	225	110	107
P-3	VX-20	R-4005	600 ft AGL	4,000 ESHP	225	96	92
C-130	VX-20	R-4006	3,500 ft AGL	850 CTIT	225	78	70
T-6	TPS	R-4006	4,000 ft AGL	50% Torque	160	67	59
H-60	TPS	R-4006	1,000 ft AGL	N/A	100	85	76
T-38	TPS	R-4006	5,000 ft AGL	90% RPM	350	68	58

Key: AGL = above ground level; CTIT =Celsius turbine inlet temperature; dBA = A-weighted decibels; ESHP = equivalent shaft horsepower; ETR = engine thrust request; ft = feet; Helo = helicopter; kts = knots; lbs = pounds; L_{max} = maximum sound level in A-weighted decibels; L_{max} = maximum sound level; N/A = not applicable; NC = core engine speed; RPM = revolutions per minute; SEL = sound exposure level; SEL_r = onset rate adjusted sound exposure level.

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5 PRC Supersonic Aircraft Noise and Aircraft Munitions Noise

5.1 Supersonic Aircraft Noise Analysis

PCBoom6 was used to model the sonic boom exposures for supersonic aircraft operations within the PRC. Although PCBoom is a single event sonic boom type model, the resulting individual sonic boom footprints were accumulated into a calculated CDNL grid for the presentation of cumulative sonic boom CDNL contours. The current DoD cumulative sonic boom model, BooMap3, does not accurately model the type of supersonic events occurring at PRC. BooMap3 estimated the sonic boom exposures from air combat maneuvering training. This training involves a wide distribution of supersonic maneuvering trajectories. However, supersonic events at PRC are primarily straight line segments, which are either level or in diving flight.

The 10 years of supersonic trajectory data were input into PCBoom to generate an ensemble of sonic boom footprints. These individual sonic boom footprints were combined to calculate the long-term exposure in the form of CDNL contours of the sonic booms. The supersonic trajectory data include aircraft type, start/stop distances and radials, start and stop altitudes, and maximum Mach number. The heading of the trajectory was calculated from the distances and radials, which were relative to the Patuxent River Very High Frequency Omni-Directional Radio Range Tactical Air Navigation Aid (VORTAC). The supersonic modeling assumes a standard acceleration for each aircraft starting at Mach 1 at the beginning of the segment. The aircraft accelerates to the maximum Mach number listed in the telemetry data, then maintains that Mach number. Standard deceleration of each aircraft is also assumed, and the aircraft decelerates from the maximum Mach number back to Mach 1 such that Mach 1 is reached at the end of the supersonic segment.

5.2 Aircraft Munitions Noise Analysis

AGNM version 2.0 (BaseOps integrated version) was used for aircraft munitions modeling. Aircraft in the PRC primarily utilize Hannibal and Hooper targets and both targets are used in the modeling. Rockets are limited to inert 5-inch and 2.75-inch forward firing aircraft rockets for inshore weapon use, and the expenditure rate is low. For modeling, it will be assumed that 100 percent of the rockets contain live motors. The Optimal Release Envelope for weapons on the H-60 was obtained during the interview process, but the fixed-wing optimal release envelope is unknown since it occurs so infrequently and varies by test program. Therefore, for the fixed-wing aircraft, the modeled optimal release envelope was chosen from recent data utilized in the Noise Study for Military Activities at the Fallon Range Training Complex (June 2018) since the same weapon/aircraft combinations at NAS Patuxent River are also used at Fallon Range. CDNL contours as well as L_{Pk} were generated from the aircraft munitions modeling. Since the supersonic aircraft activity and the aircraft munitions activity occur in the same general area (over the Chesapeake Bay Water Range), the CDNL results of the aircraft sonic boom analysis and aircraft munitions analysis were combined and presented on the same maps and are shown in Section 5.3.

5.3 Sonic Boom and Aircraft Munitions Noise Results

Figure 5-1 presents the combined sonic boom and aircraft munitions CDNL contours for the PRC. These CDNL results are in C-weighted decibels (dBC) to reflect the impulsive low frequency noise of sonic booms and aircraft munitions. The No Action sonic boom CDNL contour is less than 45 dBC, as only the 40 dBC level is shown in the map. The sonic boom 40 dBC footprint does extend outside of the Chesapeake Bay Water Range, but it does not go over land. The Hannibal and Hooper targets are shown on the map and the munitions CDNL contours extend south of Hooper target and surrounding Hannibal target. The different shape of the CDNL contours between the two targets is due to the different weapons systems, aircraft types, and run-in headings used for those targets.

Figure 5-2 and Figure 5-3 display the Alternative 1 and Alternative 2 CDNL contours for sonic boom and munitions noise for the PRC. The sonic boom 40 dBC contour extends over a much greater area under Alternatives 1 and 2 compared to the No Action Alternative. This increase arises from the increase in future year TPS and VX-23 F/A-18E/F Super Hornet operations for Alternatives 1 and 2. Additionally, the sonic boom exposure contribution to the CDNL increases slightly above 45 dBC. One small 45 dBC island appears in the southwest corner of the range for Alternative 1, and 3 small 45 dBC islands are calculated near the edge of the range for Alternative 2. For the aircraft munitions noise, the CDNL contours surrounding the two targets increased only slightly between the No Action and the Alternatives due to the overall increase in operations for each squadron. No other aspects of the aircraft munitions modeling changed between the No Action and the Alternatives. Overall, the calculated CDNL values are very low and near the lower limits of the model's accuracy.

Figure 5-4 presents the aircraft munitions peak noise results for all alternatives. The peak pressure (L_{Pk}) is the highest instantaneous, unweighted sound level over any given time period. Because it is a single event metric, the results are equivalent across all alternatives since the only difference in the munitions noise between the No Action and the Action Alternatives is the number of munitions expended. For munitions noise, the standard noise levels to display on maps are peak levels (pK) 115 dB_{PK} and 130 dB_{PK}. These munition levels are associated with complaint risk. For levels above 130 dB_{PK}, complaint risk is high. For levels between 115 dB_{PK} and 130 dB_{PK}, complaint risk is moderate, and below 115 dB_{PK}, complaint risk is low (Department of the Army, 2007).

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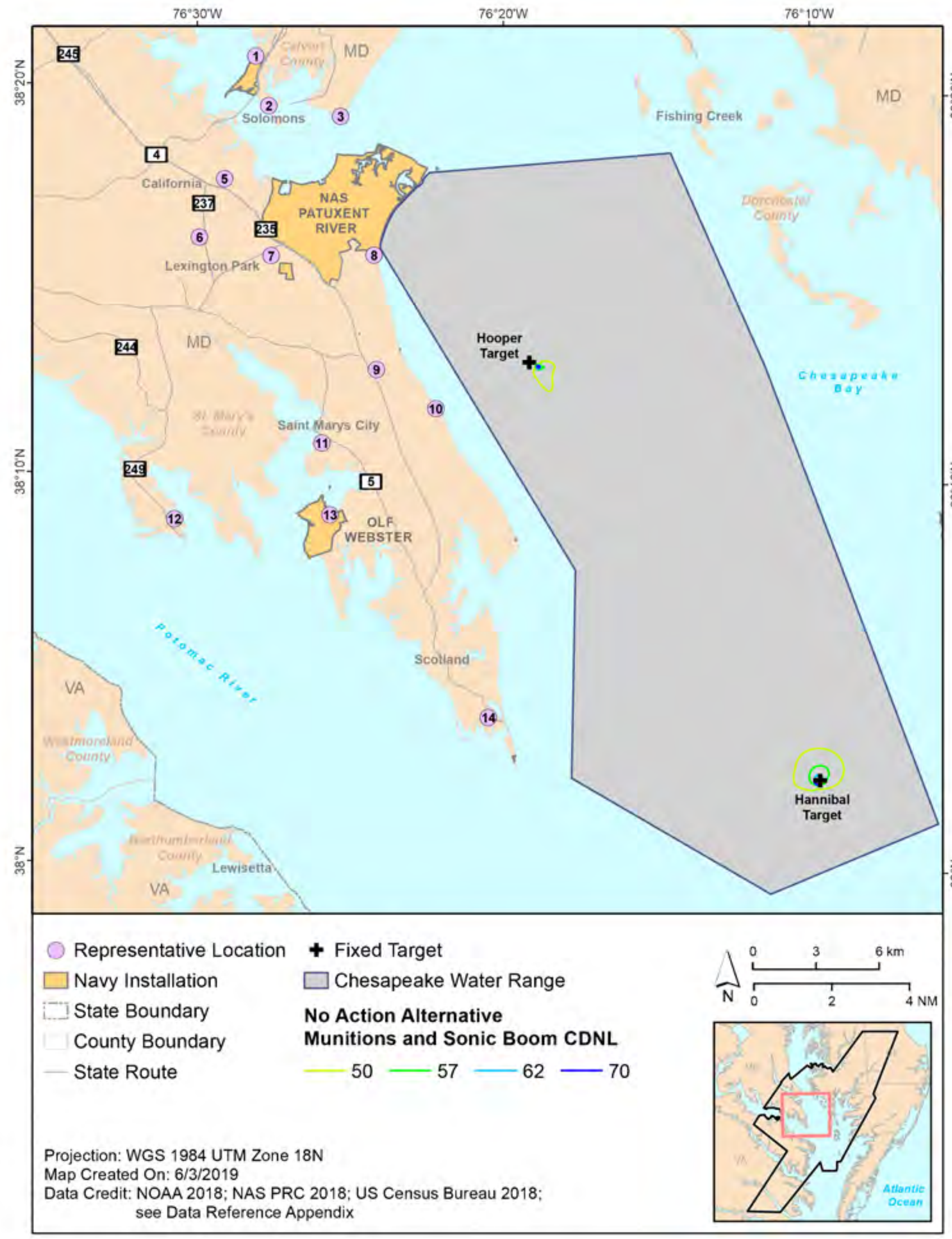

Figure 5-1. No Action Sonic Boom and Aircraft Munitions CDNL Results

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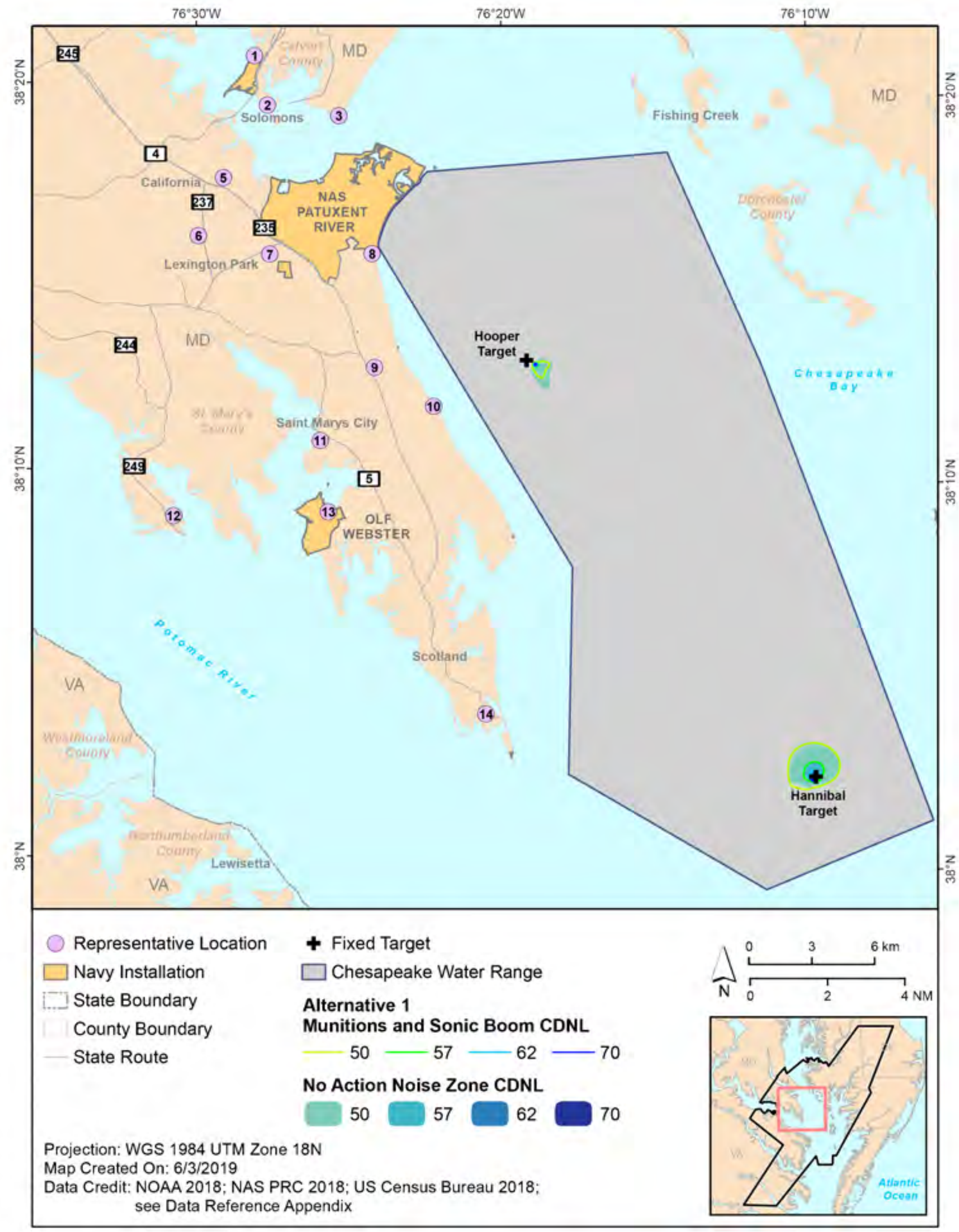

Figure 5-2. Alternative 1 Sonic Boom and Aircraft Munitions CDNL Results

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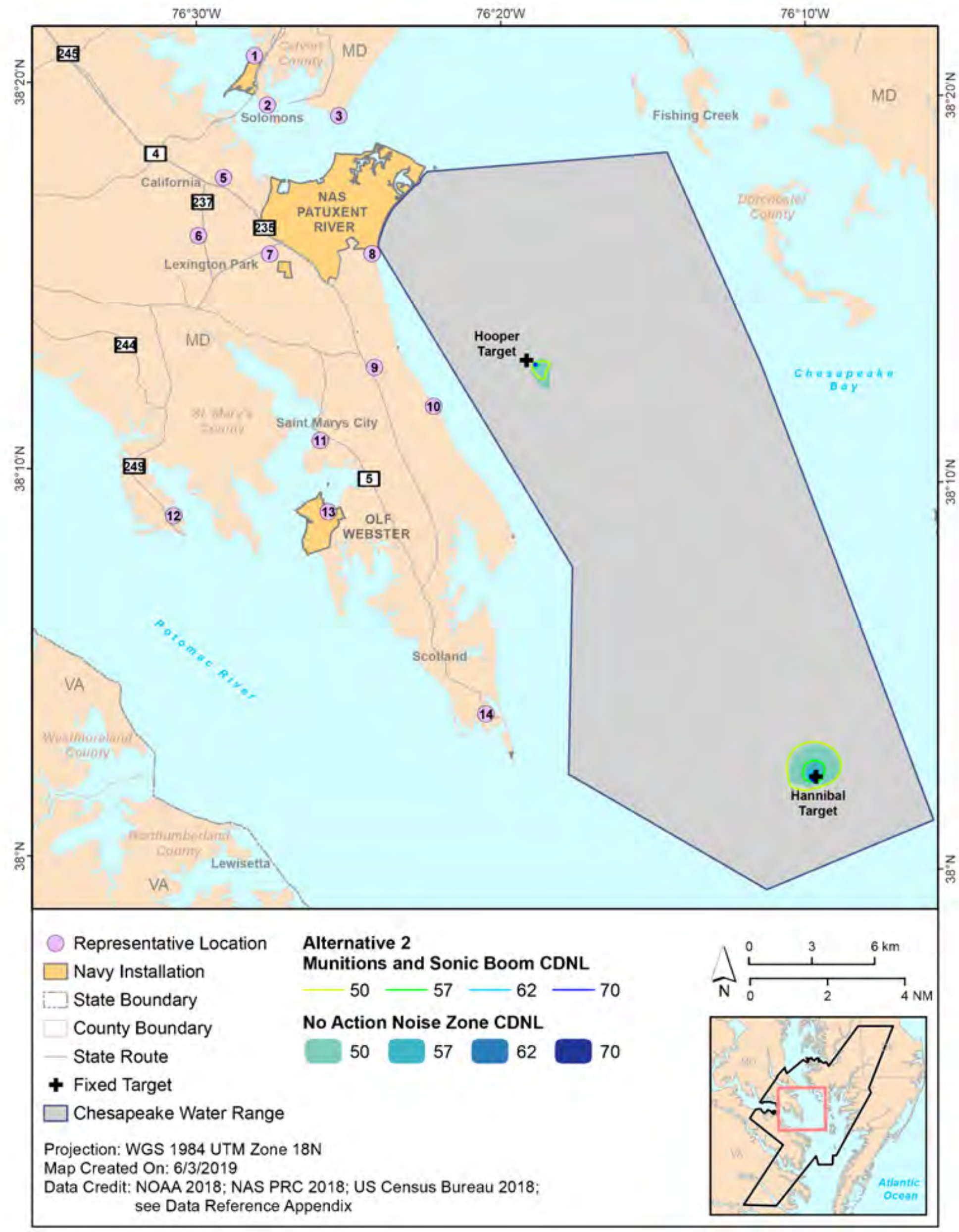

Figure 5-3. Alternative 2 Sonic Boom and Aircraft Munitions CDNL Results

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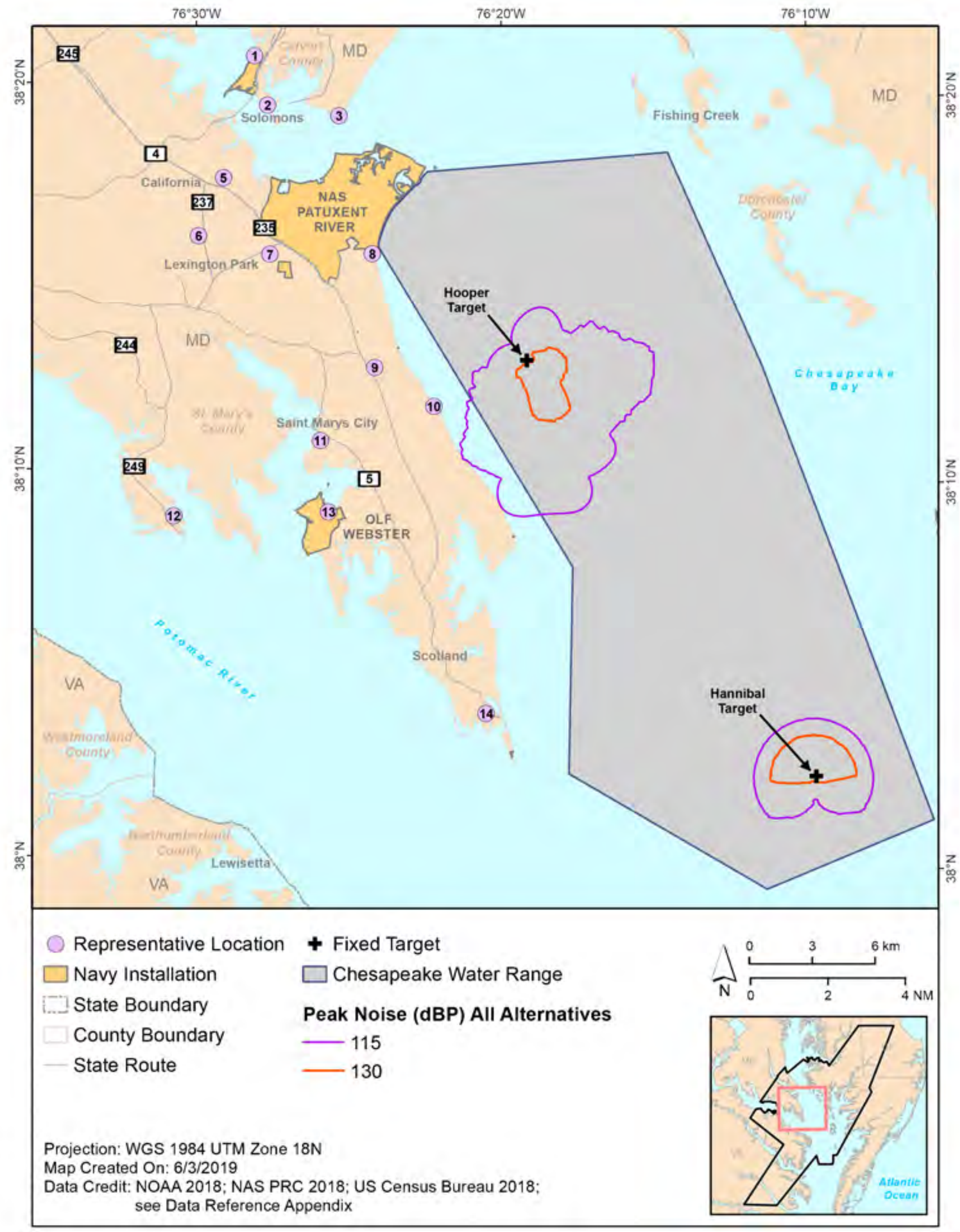

Figure 5-4. Aircraft Munitions Peak Noise Results

6 Supplemental Metrics Results

This section presents the supplemental metrics at the 15 points of interest in the areas surrounding NAS Patuxent River and OLF Webster. See Figure 2-14 for the map of these 15 locations. The important aspect of these comparisons is the variations between alternatives. The individual values provide some description of the long-term noise environment, but the day-to-day operations will vary throughout the year.

6.1 Outdoor Annual Number of Events Exceeding 80, 90, and 100 dBA L_{Amax}

This subsection presents the number of events that exceed L_{Amax} levels of 80, 90, and 100 dBA during a 24-hour day, multiplied by 365 to represent a full year. L_{Amax} is the maximum sound level of the aircraft overflight, so these annual events represent the number of annual events above three different levels of aircraft "loudness." Table 6-1, Table 6-2, and Table 6-3 present the No Action, Alternative 1, and Alternative 2 outdoor number of event exceeding levels of 80, 90, and 100 dBA L_{Amax}. Figure 6-1 gives some example sound levels for comparison to the 80, 90, and 100 dBA L_{Amax} level thresholds (FAA.gov, 2019).

Figure 6-1. Comparative Noise Levels in dBA

Table 6-1. No Action Outdoor Number of Annual Events Exceeding 80, 90, and 100 dBA L_{Amax}

Representative Locations		NA 80 Lmax (dBA)	NA 90 Lmax (dBA)	NA 100 Lmax (dBA)
ID	Description			
P01	Asbury Solomons	155	33	0
P02	Our Lady Star of the Sea School	1,689	268	17
P03	Drum Point Club	6,453	1,270	276
P04	Captain Walter Francis Duke Elementary School	923	0	0
P05	Green Holly Elementary School	310	0	0
P06	Chancellors Run Activity Center	24	0	0
P07	Lexington Park Elementary School	2,814	652	20
P08	Cedar Cove Apartments	8,088	3,612	544
P09	Spring Ridge Middle School	120	0	0
P10	Elms Beach Park	1,064	162	0
P11	Historic St. Mary's City	26	0	0
P12	Harry Lundeberg School of Seamanship	0	0	0
P13	St. Ignatius Roman Catholic Church	144	0	0
P14	Point Lookout State Park	0	0	0
P15	Northumberland Elementary School	0	0	0

Key: dBA =A-weighted decibels; ID = identification number; L_{Amax} = maximum sound level in A-weighted decibels; L_{max} = maximum sound level; NA=number of annual events.

Table 6-2. Alternative 1 Outdoor Number of Annual Events Exceeding 80, 90, and 100 dBA L_{Amax}

Representative Locations		NA 80 Lmax (dBA)			NA 90 Lmax (dBA)			NA 100 Lmax (dBA)		
ID	Description	No Action	Alternative 1	Increase re No Action	No Action	Alternative 1	Increase re No Action	No Action	Alternative 1	Increase re No Action
P01	Asbury Solomons	155	258	103	33	27	-6	0	0	0
P02	Our Lady Star of the Sea School	1,689	2,140	451	268	332	64	17	20	3
P03	Drum Point Club	6,453	7,751	1,298	1,270	1,581	311	276	331	55
P04	Captain Walter Francis Duke Elementary School	923	1,150	227	0	0	0	0	0	0
P05	Green Holly Elementary School	310	250	-60	0	0	0	0	0	0
P06	Chancellors Run Activity Center	24	43	19	0	0	0	0	0	0
P07	Lexington Park Elementary School	2,814	3,582	768	652	805	153	20	40	20
P08	Cedar Cove Apartments	8,088	9,386	1,298	3,612	4,566	954	544	921	377
P09	Spring Ridge Middle School	120	103	-17	0	0	0	0	0	0
P10	Elms Beach Park	1,064	1,444	380	162	263	101	0	0	0
P11	Historic St. Mary's City	26	45	19	0	0	0	0	0	0
P12	Harry Lundeberg School of Seamanship	0	0	0	0	0	0	0	0	0
P13	St. Ignatius Roman Catholic Church	144	241	97	0	0	0	0	0	0
P14	Point Lookout State Park	0	0	0	0	0	0	0	0	0
P15	Northumberland Elementary School	0	0	0	0	0	0	0	0	0

Key: dBA =A-weighted decibels; ID = identification number; L_{Amax} = maximum sound level in A-weighted decibels; L_{max} = maximum sound level; NA = number of annual events; re = in reference to.

Table 6-3. Alternative 2 Outdoor Number of Annual Events Exceeding 80, 90, and 100 dBA L_{Amax}

Representative Locations		NA 80 Lmax (dBA)			NA 90 Lmax (dBA)			NA 100 Lmax (dBA)		
ID	Description	No Action	Alternative 2	Increase re No Action	No Action	Alternative 2	Increase re No Action	No Action	Alternative 2	Increase re No Action
P01	Asbury Solomons	155	287	132	33	30	-3	0	0	0
P02	Our Lady Star of the Sea School	1,689	2,379	690	268	369	101	17	22	5
P03	Drum Point Club	6,453	8,614	2,161	1,270	1,757	487	276	368	92
P04	Captain Walter Francis Duke Elementary School	923	1,262	339	0	0	0	0	0	0
P05	Green Holly Elementary School	310	278	-32	0	0	0	0	0	0
P06	Chancellors Run Activity Center	24	48	24	0	0	0	0	0	0
P07	Lexington Park Elementary School	2,814	3,981	1,167	652	894	242	20	44	24
P08	Cedar Cove Apartments	8,088	10,458	2,370	3,612	5,074	1,462	544	1,023	479
P09	Spring Ridge Middle School	120	114	-6	0	0	0	0	0	0
P10	Elms Beach Park	1,064	1,605	541	162	292	130	0	0	0
P11	Historic St. Mary's City	26	49	23	0	0	0	0	0	0
P12	Harry Lundeberg School of Seamanship	0	0	0	0	0	0	0	0	0
P13	St. Ignatius Roman Catholic Church	144	268	124	0	0	0	0	0	0
P14	Point Lookout State Park	0	0	0	0	0	0	0	0	0
P15	Northumberland Elementary School	0	0	0	0	0	0	0	0	0

Key: dBA =A-weighted decibels; ID = identification number; L_{Amax} = maximum sound level in A-weighted decibels; L_{max} = maximum sound level; NA = number of annual events; re = in reference to.

6.2 Outdoor Speech Interference

This section presents the outdoor speech interference of the No Action Alternative and Action Alternatives, displayed in Table 6-4 through Table 6-6. Note that the school representative locations are not displayed because the 8-hour averaged metrics in Section 6.5 is used. For outdoor speech interference, the number of events per hour that exceeds 50 dBA L_{Amax} during both 0700-2200 and 2200-0700 time periods is the metric recommended by DNWG for outdoor speech interference. This is because sentence intelligibility decreases above sound levels of 50 dBA. This metric represents the potential number of outdoor speech interruptions per hour (average) during the day (0700-2200) and night (2200-0700) due to aircraft overflights. There is only an hourly daytime (0700-2200) increase over the No Action of one event per hour for P01 (Asbury Solomons) for Alternative 1, and one event per hour for P01 (Asbury Solomons) and P10 (Elms Beach Park) for Alternative 2.

Table 6-4. No Action Events per Hour Outdoor Speech Interference

Representative Locations		Annual Average Outdoor Daily Events per Hour	
ID	Description	Daytime (0700-2200)	Nighttime (2200-0700)
P01	Asbury Solomons	2	0
P03	Drum Point Club	6	0
P06	Chancellors Run Activity Center	3	0
P08	Cedar Cove Apartments	6	0
P10	Elms Beach Park	3	0
P11	Historic St. Mary's City	2	0
P12	Harry Lundeberg School of Seamanship	1	0
P13	St. Ignatius Roman Catholic Church	2	0
P14	Point Lookout State Park	0	0

Note: Number of events at or above 50 dB Lmax; reflects potential for outdoor speech interference.
Key: ID = identification number.

Table 6-5. Alternative 1 Events per Hour Outdoor Speech Interference

Representative Locations		Annual Average Outdoor Daily Events per Hour			
		Alternative 1		Increase re No Action	
ID	Description	Daytime (0700-2200)	Nighttime (2200-0700)	Daytime (0700-2200)	Nighttime (2200-0700)
P01	Asbury Solomons	3	0	+1	-
P03	Drum Point Club	6	0	-	-
P06	Chancellors Run Activity Center	3	0	-	-
P08	Cedar Cove Apartments	6	0	-	-
P10	Elms Beach Park	3	0	-	-
P11	Historic St. Mary's City	2	0	-	-
P12	Harry Lundeberg School of Seamanship	1	0	-	-
P13	St. Ignatius Roman Catholic Church	2	0	-	-
P14	Point Lookout State Park	0	0	-	-

Note: Number of events at or above 50 dB Lmax; reflects potential for outdoor speech interference.
Key: ID = identification number; re = in reference to.

Table 6-6. Alternative 2 Events per Hour Outdoor Speech Interference

Representative Locations		Annual Average Outdoor Daily Events per Hour			
		Alternative 2		Increase re No Action	
ID	Description	Daytime (0700-2200)	Nighttime (2200-0700)	Daytime (0700-2200)	Nighttime (2200-0700)
P01	Asbury Solomons	3	0	+1	-
P03	Drum Point Club	6	0	-	-
P06	Chancellors Run Activity Center	3	0	-	-
P08	Cedar Cove Apartments	6	0	-	-
P10	Elms Beach Park	4	0	+1	-
P11	Historic St. Mary's City	2	0	-	-
P12	Harry Lundeberg School of Seamanship	1	0	-	-
P13	St. Ignatius Roman Catholic Church	2	0	-	-
P14	Point Lookout State Park	0	0	-	-

Note: Number of events at or above 50 dB Lmax; reflects potential for outdoor speech interference.
Key: ID = identification number; re = in reference to.

6.3 Indoor Speech Interference

This section describes the potential of daytime (0700-2200) speech interference (see Section 2.1.7.1.2). Table 6-7, Table 6-8, and Table 6-9 provide the No Action, Alternative 1, and Alternative 2 average hourly number of events that have the potential to interfere with indoor speech. Note that schools are not included in this table because there is a separate metric used for calculating classroom speech interference. Since the noise model outputs the outdoor number of exceedances results, the windows open scenario assumes a 15 dBA NLR for interior levels with the windows open, and the windows closed scenario assumes a 25 dBA NLR for interior levels with the windows closed. For Alternative 1, there is less than 0.5 events per hour increase in the average daily events per hour for both the windows open and windows closed scenarios. For Alternative 2, P08 (Cedar Cove Apartments) and P10 (Elms Beach Park) have one more average indoor daytime event per hour than the No Action for the windows open scenario.

Table 6-7. No Action Events per Hour Indoor Speech Interference

Representative Locations		Annual Average Daily Indoor Daytime (0700-2200) Events per Hour (1)	
ID	Description	Windows Open	Windows Closed
P01	Asbury Solomons	1	-
P03	Drum Point Club	3	2
P06	Chancellors Run Activity Center	1	-
P08	Cedar Cove Apartments	3	2
P10	Elms Beach Park	1	-
P11	Historic St. Mary's City	-	-
P13	St. Ignatius Roman Catholic Church	1	-
P14	Point Lookout State Park	-	-

Note: With an indoor Maximum Sound Level of at Least 50 dB; assumes 15 dB and 25 dB of Noise Level Reductions for windows open and closed, respectively.

Key: ID = identification number.

Table 6-8. Alternative 1 Events per Hour Indoor Speech Interference

Representative Locations		Annual Average Daily Indoor Daytime (0700-2200) Events per Hour (1)			
		Alternative 1		Increase re No Action	
ID	Description	Windows Open	Windows Closed	Windows Open	Windows Closed
P01	Asbury Solomons	1	0	-	-
P03	Drum Point Club	3	2	-	-
P06	Chancellors Run Activity Center	1	0	-	-
P08	Cedar Cove Apartments	3	2	-	-
P10	Elms Beach Park	1	0	-	-
P11	Historic St. Mary's City	0	0	-	-
P13	St. Ignatius Roman Catholic Church	1	0	-	-
P14	Point Lookout State Park	0	0	-	-

Note: With an indoor Maximum Sound Level of at Least 50 dB; assumes 15 dB and 25 dB of Noise Level Reductions for windows open and closed, respectively.

Key: ID = identification number; re = in reference to.

Table 6-9. Alternative 2 Events per Hour Indoor Speech Interference

Representative Locations		Annual Average Daily Indoor Daytime (0700-2200) Events per Hour[(1)]			
		Alternative 2		Increase re No Action	
ID	Description	Windows Open	Windows Closed	Windows Open	Windows Closed
P01	Asbury Solomons	1	0	-	-
P03	Drum Point Club	3	2	-	-
P06	Chancellors Run Activity Center	1	0	-	-
P08	Cedar Cove Apartments	4	2	+1	-
P10	Elms Beach Park	2	0	+1	-
P11	Historic St. Mary's City	0	0	-	-
P13	St. Ignatius Roman Catholic Church	1	0	-	-
P14	Point Lookout State Park	0	0	-	-

Note: With an indoor Maximum Sound Level of at least 50 dB; assumes 15 dB and 25 dB of Noise Level Reductions for windows open and closed, respectively.
Key: ID = identification number; re = in reference to.

6.4 Sleep Disturbance

This section describes the potential of nighttime (2200-0700) sleep disturbance (see Section 2.1.7.1.3). Table 6-10, Table 6-11, and Table 6-12 provide the No Action, Alternative 1, and Alternative 2 annual average nightly (2200-0700) probability of awakening (percent). The probabilities of awakening are very minimal due to the low number of average daily 2200-0700 flights at NAS Patuxent River and OLF Webster. The Alternatives have only a slight 1 percent increase in probability of awakening at P08 with windows closed under Alternative 1. Under Alternative 2, there would be a 1 percent probability increase at P03 and P06 with windows open and at P08 with windows closed.

Table 6-10. No Action Potential of 2200-0700 Sleep Disturbance

Representative Locations		Annual Average Nightly (2200-0700) Probability of Awakening (%) [(1)]	
ID	Description	Windows Open	Windows Closed
P01	Asbury Solomons	0%	0%
P03	Drum Point Club	1%	1%
P06	Chancellors Run Activity Center	0%	0%
P08	Cedar Cove Apartments	1%	0%
P10	Elms Beach Park	1%	0%
P11	Historic St. Mary's City	0%	0%
P14	Point Lookout State Park	0%	0%

Note: Assumes 15 dB and 25 dB of Noise Level Reductions for windows open and closed, respectively.
Key: ID = identification number.

Table 6-11. Alternative 1 Potential of 2200-0700 Sleep Disturbance

Location of Interest		Annual Average Nightly (2200-0700) Probability of Awakening (%) (1)			
		Alternative 1		Increase re No Action	
ID	Description	Windows Open	Windows Closed	Windows Open	Windows Closed
P01	Asbury Solomons	0%	0%	-	-
P03	Drum Point Club	1%	1%	-	-
P06	Chancellors Run Activity Center	0%	0%	-	-
P08	Cedar Cove Apartments	1%	1%	-	+1%
P10	Elms Beach Park	1%	0%	-	-
P11	Historic St. Mary's City	0%	0%	-	-
P14	Point Lookout State Park	0%	0%	-	-

Note: Assumes 15 dB and 25 dB of Noise Level Reductions for windows open and closed, respectively.
Key: ID = identification number; re = in reference to.

Table 6-12. Alternative 2 Potential of 2200-0700 Sleep Disturbance

Representative Locations		Annual Average Nightly (2200-0700) Probability of Awakening (%) (1)			
		Alternative 2		Increase re No Action	
ID	Description	Windows Open	Windows Closed	Windows Open	Windows Closed
P01	Asbury Solomons	0%	0%	-	-
P03	Drum Point Club	2%	1%	+1%	-
P06	Chancellors Run Activity Center	1%	0%	+1%	-
P08	Cedar Cove Apartments	1%	1%	-	+1%
P10	Elms Beach Park	1%	0%	-	-
P11	Historic St. Mary's City	0%	0%	-	-
P14	Point Lookout State Park	0%	0%	-	-

Note: Assumes 15 dB and 25 dB of Noise Level Reductions for windows open and closed, respectively.
Key: ID = identification number; re = in reference to.

6.5 Classroom Speech Interference

For the classroom speech interference analysis, an 8-hour school day period was used instead of the full 24 hours or during acoustic day (0700-2200) or acoustic night (2200-0700). Table 6-13 provides the No Action estimated values for the average, school-day, outdoor noise levels ($L_{eq,8hr}$) along with the indoor noise levels ($L_{eq,8hr}$) and average number of hourly events that have the potential to interfere with classroom speech, both with windows open and windows closed. Table 6-14 and Table 6-15 present the Alternative 1 and Alternative 2 classroom speech interference results. The events per hour represent the number of single flyover events above a max sound level of 50 dBA, while the $L_{eq,8hr}$ is the equivalent sound level of these events averaged over 8 hours (duration of a school day). Thus, there could be multiple events per hour exceeding 50 dBA inside the classroom, but the equivalent sound level averaged over the full 8 hours could be less than 45 dBA. The results follow the similar trends for the DNL. For the average school day noise level, Alternative 1 generates a one dBA increase in the $L_{eq,8hr}$ relative to the No Action Alternative for all schools except for P12 and for both windows open and windows closed. For Alternative 2, two schools (P02 and P07) generate a two dBA increase in the $L_{eq,8hr}$ relative to the No Action Alternative for both windows open and closed, and all other schools generate a one dBA increase in the $L_{eq,8hr}$. There is no increase between the Alternatives and No Action for the number of events per hour above 50 dBA L_{Amax} within the classrooms (both with windows open and windows closed).

Table 6-13. No Action Classroom Speech Interference for Schools

Point of Interest		Annual Average Daily Indoor Daytime (0700-2200) Events per Hour (1)	
ID	Description	Windows Open	Windows Closed
P01	Asbury Solomons	1	-
P02	Our Lady Star of the Sea School	2	1
P03	Drum Point Club	3	2
P04	Captain Walter Francis Duke Elementary School	-	-
P05	Green Holly Elementary School	1	-
P06	Chancellors Run Activity Center	1	-
P07	Lexington Park Elementary School	2	1
P08	Cedar Cove Apartments	3	2
P09	Spring Ridge Middle School	1	-
P10	Elms Beach Park	1	-
P11	Historic St. Mary's City	-	-
P12	Harry Lundeberg School of Seamanship	1	-
P13	St. Ignatius Roman Catholic Church	1	-
P14	Point Lookout State Park	-	-
P15	Northumberland Elementary School	-	-

Note: (1) with an indoor Maximum Sound Level of at Least 50 dB; assumes 15 dB and 25 dB of Noise Level Reductions for windows open and closed, respectively.
Key: dB = decibels; ID = identification number; $L_{eq(8h)}$ = equivalent sound level averaged over 8 hours.

Table 6-14. Alternative 1 Classroom Speech Interference for Schools

Point of Interest		Annual Average Daily Indoor Daytime (0700-2200) Events per Hour (1)			
		Alternative 1		Increase re No Action	
ID	Description	Windows Open	Windows Closed	Windows Open	Windows Closed
P01	Asbury Solomons	1	0	-	-
P02	Our Lady Star of the Sea School	2	1	-	-
P03	Drum Point Club	3	2	-	-
P04	Captain Walter Francis Duke Elementary School	0	0	-	-
P05	Green Holly Elementary School	1	0	-	-
P06	Chancellors Run Activity Center	1	0	-	-
P07	Lexington Park Elementary School	2	1	-	-
P08	Cedar Cove Apartments	3	2	-	-
P09	Spring Ridge Middle School	1	0	-	-
P10	Elms Beach Park	1	0	-	-
P11	Historic St. Mary's City	0	0	-	-
P12	Harry Lundeberg School of Seamanship	1	0	-	-
P13	St. Ignatius Roman Catholic Church	1	0	-	-
P14	Point Lookout State Park	0	0	-	-
P15	Northumberland Elementary School	0	0	-	-

Note: (1) with an indoor Maximum Sound Level of at Least 50 dB; assumes 15 dB and 25 dB of Noise Level Reductions for windows open and closed, respectively.
Key: dB = decibels; ID = identification number; Leq(8h) = equivalent sound level averaged over 8 hours; re = in reference to.

Table 6-15. Alternative 2 Classroom Speech Interference for Schools

Representative Locations		Alternative 2					Increase re No Action				
			Indoor (1)					Indoor (1)			
			Windows Open		Windows Closed			Windows Open		Windows Closed	
ID	Description	Outdoor $L_{eq(8h)}$ (dB)	$L_{eq(8h)}$ (dB)	Events per Hour(2)	$L_{eq(8h)}$ (dB)	Events per Hour(2)	Outdoor $L_{eq(8h)}$ (dB)	$L_{eq(8h)}$ (dB)	Events per Hour(2)	$L_{eq(8h)}$ (dB)	Events per Hour(2)
P02	Our Lady Star of the Sea School	61	46	2	<45	1	+2	+2	-	+2	-
P04	Captain Walter Francis Duke Elementary School	46	<45	-	<45	-	+1	+1	-	+1	-
P05	Green Holly Elementary School	50	<45	1	<45	-	+1	+1	-	+1	-
P07	Lexington Park Elementary School	62	47	2	<45	1	+2	+2	-	+2	-
P09	Spring Ridge Middle School	48	<45	1	<45	-	+1	+1	-	+1	-
P12	Harry Lundeberg School of Seamanship	<45	<45	1	<45	-	+1	+1	-	+1	-
P15	Northumberland Elementary School	<45	<45	-	<45	-	+1	+1	-	+1	-
Number of Sites Exceeding 1 Intrusive Event per Hour				5		2			-		-
Minimum Number of Intrusive Events per Hour if Exceeding 1				2		2			0		0
Maximum Number of Intrusive Events per Hour if Exceeding 1				4		2			0		0

Notes:
(1) assumes 15 dB and 25 dB of Noise Level Reductions for windows open and closed, respectively.
(2) Number of Average School-Day Events per hour during 8-hour school day (0800-1600) At or Above an Indoor Maximum (single-event) Sound Level (L_{max}) of 50 dB.

Key: dB = decibels; ID = identification number; $L_{eq(8h)}$ = equivalent sound level averaged over 8 hours; re = in reference to.

6.6 Single Event Noise Analysis

For single event overflights, Table 6-16 displays the results of a comparative analysis that shows the differences in the SEL and L_{Amax} for the arrival, departure, and closed pattern flight profiles of the top contributing aircraft at NAS Patuxent River. Noise levels were calculated using NoiseMap Version 7.3 and the same operational data (e.g., flight tracks and flight profiles) were used to calculate the DNL noise contours. Representative location P03 (Drum Point Club) was selected as the analysis point for the departure and closed pattern flights, and P07 (Lexington Park Elementary School) was selected as the analysis point for the arrival flights. The profile selected for each aircraft was the one with the highest SEL at the analyzed location point. Actual individual overflight noise levels vary from the noise levels listed because of variations in aircraft configuration, flight track, altitude, and atmospheric conditions. The different climb out rates for the departures of the various aircraft result in different aircraft altitudes above P03 at the point with the highest SEL. This difference due to the aircraft profile differences results in a higher or lower SEL and L_{Amax} depending on the altitude of the aircraft.

Table 6-17, Table 6-18, and Table 6-19 list the top contributors to the overall DNL at each representative location for the No Action Alternative, Alternative 1, and Alternative 2. The top contributor is the aircraft that impacts the contours the most at that specific location. The top contributor can be different for the No Action Alternative than for the Action Alternatives because certain aircraft such as the F-35 were projected to have operation reductions from the No Action Alternative to the Action Alternatives, while other aircraft such as the F/A-18E/F had operation increases from the No Action Alternative to the Action Alternatives. This different weighting of operations can cause a contributor to rise or fall in the list of top contributors at a location. Aircraft contributors are the same for Alternatives 1 and 2, but the number of operations of each contributor is different.

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Table 6-16. SEL and L_{Amax} Comparison of Aircraft Operations at NAS Patuxent River

Aircraft	Squadron	Operation Type	Engine Power	Airspeed (knots)	Altitude (feet MSL)	Slant Distance (feet)	SEL (dBA)	Lmax (dBA)
F-18E/F (Afterburner)	VX-23 and TPS	Departure	95% NC	300	4954	5301	99.7	90.9
F-18C/D (Afterburner)	VX-23		96.5% NC	250	3397	3553	104.3	92.1
F-35B (Afterburner)	VX-23		72% ETR	300	2503	2660	102.9	92.6
F-35B (Military)	VX-23		72% ETR	300	1829	2044	106.2	96.7
F-35C (Afterburner)	VX-23		100% ETR	272	2224	2272	107.7	100.7
F-35C (Military)	VX-23		100% ETR	265	1954	2175	109.2	101.7
T-38 (Afterburner)	TPS		100% RPM	230	1846	2032	99.1	88.1
F-18E/F	VX-23 and TPS	VFR Closed Pattern	84% NC	130	640	717	112.6	103.6
F-18C/D	VX-23		86.1% NC	140	556	550	111.2	108.3
F-35B	VX-23		40% ETR	180	887	943	100.8	93.2
F-35C	VX-23		28% ETR	200	910	964	98.3	89.4
T-38	TPS		90% RPM	180	1039	1409	85.7	64.4
F-18E/F	VX-23 and TPS	Straight-in Arrival	85% NC	135	704	2170	106.1	98.6
F-18C/D	VX-23		88% NC	140	782	2194	101.4	93.5
F-35B	VX-23		35% ETR	160	910	2237	90.2	79.3
F-35C	VX-23		28% ETR	235	864	2220	87.7	78
T-38	TPS		90% RPM	200	698	2169	80.2	71.3

Key: dBA = A-weighted decibels; ETR = engine thrust request; L_{Amax} = maximum sound level in A-weighted decibels; L_{max} = maximum sound level; MSL = mean sea level; NAS = Naval Air Station; NC = core engine speed; RPM = revolutions per minute; SEL = sound exposure level; TPS = Test Pilot School; VFR = visual flight rules.

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Table 6-17. No Action Top Contributor to the Overall DNL at Each Representative Location

Representative Locations		Operation of Top Contributor to the Overall DNL for No Action					
ID	Description	Squadron	Aircraft	Operation Type	Annual Acoustic Daytime (0700-2200) Operations at this SEL	Annual Acoustic Nighttime (2200-0700) Operations at this SEL	SEL (dBA)
P01	Asbury Solomons	VX-23	F-35B	Straight-in to Slow Landing	11	0	101.5
P02	Our Lady Star of the Sea School	VX-23	F-18E/F	Straight-in Arrival	51	1	107.8
P03	Drum Point Club	VX-23	F-18E/F	VFR Closed Pattern	95	0	110
P04	Captain Walter Francis Duke Elementary School	VX-23	F-18E/F	IFR GCA Box Pattern	9	0	94.6
P05	Green Holly Elementary School	VX-23	F-18C/D	Afterburner Departure	160	1	92
P06	Chancellors Run Activity Center	VQ-4	E-6B	Departure	65	5	88.2
P07	Lexington Park Elementary School	VX-23	F-18E/F	Straight-in Arrival	98	2	106.1
P08	Cedar Cove Apartments	VX-23	F-18E/F	VFR Closed Pattern	176	0	112.6
P09	Spring Ridge Middle School	VX-23	F-35B	Straight-in to Slow Landing	33	1	95.9
P10	Elms Beach Park	VX-23	F-18E/F	IFR GCA Box Pattern	100	0	98.4
P11	Historic St. Mary's City	VX-23	F-18E/F	IFR GCA Box Pattern	22	0	94.3
P12	Harry Lundeberg School of Seamanship	VX-23	F-18C/D	Overhead Break Arrival	165	0	83.8
P13	St. Ignatius Roman Catholic Church	TPS	T-6	Webster Field VFR Pattern	305	0	89.4
P14	Point Lookout State Park	TPS	T-6	Webster Field Interfacility Arrival	24	0	73.1
P15	Northumberland Elementary School	VX-23	F-18E/F	Afterburner Departure	160	1	65.9

Key: dBA = A-weighted decibels; DNL = day-night average sound level; GCA = Ground Controlled Approach; ID = identification number; IFR = instrument flight rules; SEL = sound exposure level; TPS = Test Pilot School; VFR = visual flight rules.

Table 6-18. Alternative 1 Top Contributor to the Overall DNL at Each Representative Location

Representative Locations		Operation of Top Contributor to the Overall DNL for Alternative 1					
ID	Description	Aircraft Group	Aircraft	Operation Type	Daytime (0700-2200) Operations at this SEL	Nighttime (2200-0700) Operations at this SEL	SEL (dBA)
P01	Asbury Solomons	VX-23	F-18E/F	Straight-in Arrival	100	2	92.4
P02	Our Lady Star of the Sea School	VX-23	F-18E/F	Straight-in Arrival	100	2	107.8
P03	Drum Point Club	VX-23	F-18E/F	VFR Closed Pattern	185	0	110
P04	Captain Walter Francis Duke Elementary School	VX-23	F-18E/F	IFR GCA Box Pattern	18	0	94.6
P05	Green Holly Elementary School	VX-23	F-18E/F	Afterburner Departure	314	1	90.1
P06	Chancellors Run Activity Center	VX-23	F-18E/F	Afterburner Departure	314	1	85.8
P07	Lexington Park Elementary School	VX-23	F-18E/F	Straight-in Arrival	192	4	106.1
P08	Cedar Cove Apartments	VX-23	F-18E/F	VFR Closed Pattern	343	0	112.6
P09	Spring Ridge Middle School	TPS	T-6	Webster Field Interfacility Departure	55	0	92.2
P10	Elms Beach Park	VX-23	F-18E/F	IFR GCA Box Pattern	197	0	98.4
P11	Historic St. Mary's City	VX-23	F-18E/F	IFR GCA Box Pattern	42	0	94.3
P12	Harry Lundeberg School of Seamanship	VQ-4	E-6B	Departure	51	4	85.9
P13	St. Ignatius Roman Catholic Church	TPS	T-6	Webster Field VFR Pattern	349	0	89.4
P14	Point Lookout State Park	TPS	T-6	Webster Field Interfacility Arrival	27	0	73.1
P15	Northumberland Elementary School	VX-23	F-18E/F	Afterburner Departure	314	1	65.9

Key: dBA = A-weighted decibels; DNL = day-night average sound level; GCA = Ground Controlled Approach; ID = identification number; IFR = instrument flight rules; SEL = sound exposure level; TPS = Test Pilot School; VFR = visual flight rules.

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Table 6-19. Alternative 2 Top Contributor to the Overall DNL at Each Representative Location

Representative Locations		Operation of Top Contributor to the Overall DNL for Alternative 2					
ID	Description	Aircraft Group	Aircraft	Operation Type	Daytime (0700-2200) Operations at this SEL	Nighttime (2200-0700) Operations at this SEL	SEL (dBA)
P01	Asbury Solomons	VX-23	F-18E/F	Straight-in Arrival	111	2	92.4
P02	Our Lady Star of the Sea School	VX-23	F-18E/F	Straight-in Arrival	111	2	107.8
P03	Drum Point Club	VX-23	F-18E/F	VFR Closed Pattern	205	0	110
P04	Captain Walter Francis Duke Elementary School	VX-23	F-18E/F	IFR GCA Box Pattern	20	0	94.6
P05	Green Holly Elementary School	VX-23	F-18E/F	Afterburner Departure	349	2	90.1
P06	Chancellors Run Activity Center	VX-23	F-18E/F	Afterburner Departure	349	2	85.8
P07	Lexington Park Elementary School	VX-23	F-18E/F	Straight-in Arrival	214	4	106.1
P08	Cedar Cove Apartments	VX-23	F-18E/F	VFR Closed Pattern	382	0	112.6
P09	Spring Ridge Middle School	TPS	T-6	Webster Field Interfacility Departure	61	0	92.2
P10	Elms Beach Park	VX-23	F-18E/F	IFR GCA Box Pattern	215	0	98.4
P11	Historic St. Mary's City	VX-23	F-18E/F	IFR GCA Box Pattern	47	0	94.3
P12	Harry Lundeberg School of Seamanship	VQ-4	E-6B	Departure	57	4	85.9
P13	St. Ignatius Roman Catholic Church	TPS	T-6	Webster Field VFR Pattern	387	0	89.4
P14	Point Lookout State Park	TPS	T-6	Webster Field Interfacility Arrival	31	0	73.1
P15	Northumberland Elementary School	VX-23	F-18E/F	Afterburner Departure	349	2	65.9

Key: dBA = A-weighted decibels; DNL = day-night average sound level; GCA = Ground Controlled Approach; ID = identification number; IFR = instrument flight rules; SEL = sound exposure level; TPS = Test Pilot School; VFR = visual flight rules.

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Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

Appendix A: Data Validation Tables

HX-21 Data Validation

FIST Annual Operations at NAS Pax River

Group	10 year Average of Sorties	Unit / Description	# of Flying Days	# of Flying Weeks per Year	Basis of Sorties (# of days)	Patterns per Sortie	Annual Departures	Annual Arrivals	Annual Closed Pattern Operations	Total Annual Operations
MV-22	218	HX-21	365	50	Y	1.20	218	218	523	959
H-60	597	HX-21	365	50	Y	2.30	597	597	2746	3940
H-1 (includes TH-57 ops - modeled as UH-1N)	404	HX-21	365	50	Y	6.80	404	404	5494	6302
CH-53E (includes CH-46 ops - modeled as CH-53E)	97	HX-21	365	50	Y	2.60	97	97	504	698
Presidential VH-71 (modeled as CH-53)	23	HX-21	365	50	Y	3.00	23	23	138	184
Presidential H-3 (modeled as CH-53)	27	HX-21	365	50	Y	3.00	27	27	162	216

Operation Type Distribution

Operation	Type	CH-53K/E	All Others
Arrivals	Straight-in Arrival (course rule)	100%	98%
	PAR Arrival (1600 ft in area - large pattern).		2%
	Carrier Break Arrival		
	SFO Arrival		
	Straight-in to Slow Landing		
	Tactical - overhead break		
	Instrument approach		
		good	*good*
Departures	Military	100%	100%
	Afterburner Takeoff to Mil Climb		
	Short Takeoff to Mil Climb		
		good	*good*
Closed Patterns	Runway 220 Pattern (same as grass but shifted over to runway)	100%	
	IFR Pattern or GCA Box		10%
	grass pattern (VFR)		90%
		good	*good*

Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

From Pad	H-60	H-1	V-22	CH-53K/E	Presidential VH-71 and H-3
To West (West Seaplane basin)	60%	75%	40%		
East (via River Mouth)	39%	24%	50%	10%	
Crossfield	1%	1%	10%	10%	
Depart Runway 14 straight-out (3-4 NM out into RA)				80%	
Depart via Turf then West					37.5%
Depart via Turf then East					12.5%
Depart via Runway then West					37.5%
Depart via Runway then East					12.5%
	good	good	good	good	good
To Pad	**H-60**	**H-1**	**V-22**	**CH-53K/E**	**Presidential S-92 and H-3**
From West (Bridge Arrival)	60%	75%	40%		
East (via River Mouth)	35%	20%	50%	10%	
Crossfield	1%	1%	10%	10%	
Gold Coast	4%	4%			
Runway 32 straight-in				80%	
Arrive via Turf from West					18.75%
Arrive via Turf from East					6.25%
Arrive via Runway from West					56.25%
Arrive via Runway from East					18.75%
	good	good	good	good	good

Key: GCA = Ground Controlled Approach; IFR = instrument flight rules; NM = nautical miles; PAR = precision approach radar; RA = Restricted Area; SFO = Simulated Flame Out; VFR = visual flight rules.

Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

Operation Type Distribution

Operation	Type	T-38/F-18	T-6	C-12/C-21	H-60/H-72
Arrivals	Straight-in Arrival	5%	5%	90%	100%
	Overhead Break Arrival	90%	90%	5%	
	Carrier Break Arrival				
	SFO Arrival				
	Straight-in to Slow Landing				
	Tactical - overhead break				
	IFR Straight-in	5%	5%	5%	
		good	*good*	*good*	*good*
Departures	Military		100%	100%	100%
	Afterburner Takeoff to Mil Climb	100%			
	Short Takeoff to Mil Climb				
		good	*good*	*good*	*good*
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	90%	90%	90%	90%
	SFO Pattern				
	IFR Pattern or GCA Box	10%	10%	10%	10%
	Touch and Go to Slow Landing				
		good	*good*	*good*	*good*

TPS Data Validation

10 year Annual Average of FIST Operations at NAS Pax River

Aircraft	*Sorties at Full Unit Strength*	*Unit / Description*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
C-12/C-26	359	TPS	240	48	Y	2.90	359	359	2082	2800
C-21 (LEAR jet)	214	TPS	240	48	Y	0.9	214	214	385	813
F/A-18E/F	258	TPS	240	48	Y	1.00	258	258	516	1032
UH-72	773	TPS	240	48	Y	6.00	773	773	9276	10822
UH-60	650	TPS	240	48	Y	3.5	650	650	4550	5850
T-6	867	TPS	240	48	Y	3.2	867	867	5549	7283
T-38	1197	TPS	240	48	Y	1.2	1197	1197	2873	5267

Key: GCA = Ground Controlled Approach; IFR = instrument flight rules; SFO = Simulated Flame Out; VFR = visual flight rules.

Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

NAS Pax River Directional Flow Patterns of Based Aircraft
See the Track Map .pdf file for details on the flight tracks.

Departures	C-12/C-21 Rwys 06/14/32	C-12/C-21 Rwy 24	T-38/F-18/T-6 Rwys 06/32	T-38/F-18/T-6 Rwy 14	T-38/F-18/T-6 Rwy 24	H-60/H-72
Barren Departure	100%	90%	80%		65%	
Direct to Area		10%		90%	25%	
IFR Departure			10%	10%	10%	
Adam Departure			10%			
Helo West						75%
Helo Rivermouth East						15%
Helo Crossfield (South)						10%
	good	good	good	good	good	good

Arrivals	C-12/C-21	T-38/F-18/T-6	H-60/H-72
Piney VFR	57%	57%	
Barren VFR	38%	38%	
IFR Straight-in	5%	5%	
Helo West			75%
Helo Rivermouth East			5%
Helo East to Drum Point and up coast			10%
Helo Crossfield (South)			10%
	good	good	good

Key: IFR = instrument flight rules; VFR = visual flight rules.

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Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

Operation Type Distribution

Operation	Type	MQ-4	C-38 (C-21) /C-12	P-8/P-3/C-130	E-2/ T-6
Arrivals	VFR Straight-in Arrival		25%	50%	67%
	Overhead Break Arrival				33%
	Carrier Break Arrival				
	SFO Arrival				
	Straight-in to Slow Landing				
	Tactical - overhead break				
	Instrument approach	100%	75%	50%	
		good	*good*	*good*	*good*
Departures	Military	100%	100%	100%	100%
	Afterburner Takeoff to Mil Climb				
	Short Takeoff to Mil Climb				
		good	*good*	*good*	*good*
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)		2%	50%	50%
	SFO Pattern				
	IFR Pattern or GCA Box		98%	50%	50%
	Touch and Go to Slow Landing				
			good	*good*	*good*

VX-20 Data Validation

FIST 10 year average VX-20 Operations (These will be modeled)

Aircraft	*Sorties at Full Unit Strength*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
MQ-4 (Modeled as C-21)	60	365	20	Y	0.00	60	60	0	120
C-21 (surrogate for C-38 and T-2)	233	365	39	Y	1.90	233	233	885	1351
P-8	148	365	52	Y	1.00	148	148	296	592
E-2	368	260	45	Y	1.20	368	368	883	1619
P-3	182	365	52	Y	1.70	182	182	619	983
C-12	82	365	52	Y	1.90	82	82	312	476
T-6	220	365	52	Y	3.40	220	220	1496	1936
707 (E-6B) Turbofans CFM-56	44	365	52	Y	1.20	44	44	106	194
C-130	339	365	52	Y	0.60	339	339	407	1085

Key: GCA = Ground Controlled Approach; IFR = instrument flight rules; SFO = Simulated Flame Out; VFR = visual flight rules.

Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

NAS Pax River Directional Flow Patterns of Based Aircraft

See the Track Map .pdf file for details on the flight tracks.

Departures	MQ-4	C-38 (C-21) /C-12	P-8/P-3	E-2/T-6 / C-130
South/West	0%	25%		40%
North/East (to Range or WA)	100%	75%		60%
COLIN intersection (12 DME) (just outside restricted area) IFR			14%	
SWABY departure IFR			14%	
Course rules departure (BARREN Rwy 06, PINEY Rwy 24)			40%	
Direct to Area			10%	
North towards GARED intersection IFR			17%	
386 airspace - Whiskey 386 test track - directly northeast (Salisbury SBY route)			4%	
386 airspace - Whiskey 386 test track - directly 13-14 southeast (Snowhill SWL route)			1%	
	good	*good*	*good*	*good*
Arrivals	**MQ-4**	**C-38 (C-21) /C-12**	**P-8/P-3**	**E-2/T-6 / C-130**
South/West	0%			40%
North/East	100%			60%
Straight-in (IFR)		75%	50%	
Course Rules VFR		25%	50%	
	good	*good*	*good*	*good*

Key: DME = distance measuring equipment; IFR = instrument flight rules; SBY = Salisbury Regional Airport; SWL = Snow Hill navigational aid; WA = warning area.

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Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

Operation Type Distribution

Operation	Type	F/A-18 C/D and E/F	F-35B	F-35C	T-45
Arrivals	Straight-in Arrival (VFR)	5%	5%	5%	5%
	Overhead Break Arrival	57%	34%	56%	38%
	PFO Arrival		1%	1%	38%
	Straight-in to Slow Landing		20%		
	Straight-in to Vertical Landing		15%		
	Instrument approach	38%	25%	38%	20%
		good	*good*	*good*	*good*
Departures	Military		1%	1%	100%
	Afterburner Takeoff to Mil Climb	100%	74%	99%	
	Short Takeoff to Mil Climb		25%		
		good	*good*	*good*	*good*
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	60%	41%	50%	40%
	FCLP Pattern (600 ft AGL left hand pattern)	5%	15%	15%	
	PFO Pattern		1%	1%	40%
	IFR Pattern or GCA Box	35%	27%	34%	20%
	Touch and Go to Slow Landing		1%		
	Touch and Go to Vertical Landing		15%		
		good	*good*	*good*	*good*

Key: VFR = visual flight rules; IFR = instrument flight rules; GCA = Ground Controlled Approach.

VX-23 Data Validation

10-year average FIST Data Annual Operations at NAS Pax River

Aircraft	*Sorties at Full Unit Strength*	*Unit / Description*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
F/A-18C/D	976	Assumes 50% of F-18 ops in FIST are A/B variant	365	52	Y	1.30	976	976	2538	4490
F/A-18E/F	976	Assumes 50% of F-18 ops in FIST are E/F variant	365	52	Y	1.30	976	976	2538	4490
F-35B	374	Assumes 60% of F-35 ops in FIST are B variant	365	52	Y	0.50	374	374	374	1122
F-35C	250	Assumes 40% of F-35 ops in FIST are C variant	365	52	Y	0.50	250	250	250	750
T-45	172		365	52	Y	2.00	172	172	688	1032

Key: FIST = Flight Information Scheduling and Tracking.

NAS Pax River Directional Flow Patterns of Based Aircraft
See the Track Map .pdf file for details on the flight tracks.

Runways 06 and 32 Departures	F-18A-F	F-35B	F-35C	T-45
Course Rules to East	50%	49%	49%	50%
Depart and Re-enter		1%	1%	
Swaby IFR to South	10%	10%	10%	10%
Piney VFR to South	40%	40%	40%	40%
	good	good	good	good

Runways 14 and 24 Departures	F-18A-F	F-35B	F-35C	T-45
Course Rules to East	7.5%	7.5%	7.5%	7.5%
Depart and Re-enter		1.0%	1.0%	
Swaby IFR to South	1.5%	1.5%	1.5%	1.5%
Piney VFR to South	6.0%	6.0%	6.0%	6.0%
Direct to Area	85%	84%	84%	85%
	good	good	good	good

Runway 06, 14, 24 Arrivals	F-18A-F	F-35B	F-35C	T-45
Course Rules arrival (Piney from south,	62%	70%	62%	80%
Instrument straight-in arrival	38%	30%	38%	20%
	good	good	good	good

Runway 32 Arrivals	F-18A-F	F-35B	F-35C	T-45
Course Rules arrival (Piney from south,	40%	48%	40%	40%
Instrument straight-in and Straight fron	60%	52%	60%	60%
	good	good	good	good

Key: IFR = instrument flight rules; VFR = visual flight rules.

Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

Operation Type Distribution

Operation	Type	H-60	C-12
Arrivals	VFR Straight-in Arrival	98%	90%
	Overhead Break Arrival		5%
	Carrier Break Arrival		
	SFO Arrival		
	Straight-in to Slow Landing		
	Tactical - overhead break		
	Instrument approach	2%	5%
		good	*good*
Departures	Military	100%	100%
	Afterburner Takeoff to Mil Climb		
	Short Takeoff to Mil Climb		
		good	*good*
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	90%	90%
	SFO Pattern		
	IFR Pattern or GCA Box	10%	10%
	Touch and Go to Slow Landing		
		good	*good*
VFR is 70% in Turf area, 15% grass pattern, 15% Rwy02/20 pattern			

Key: GCA = Ground Controlled Approach; IFR = instrument flight rules; SFO = Simulated Flame Out; VFR = visual flight rules.

Search and Rescue Data Validation

10-year Average FIST Data Annual Operations at NAS Pax River									
Group	*Sorties at Full Unit Strength*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
H-60	472	365	52	Y	1.80	472	472	1699	2643
C-12 (remove from Alts)	471	365	52	Y	1.80	471	471	1696	2638

Key: FIST = Flight Information Scheduling and Tracking; NAS = Naval Air Station.

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NAS Pax River Directional Flow Patterns of Based Aircraft		
See the Track Map .pdf file for details on the flight tracks.		
Departures	**H-60**	**C-12**
Depart East through Rivermouth (North flow)	90%	
Depart East in South flow	9%	
Depart South (hug the coast towards Norfolk)	1%	
Barren Departure (North Flow)		
Piney Departure (South Flow)		
Barren Departure		90%
Direct to Area		10%
	good	*good*
Arrivals	**H-60**	**C-12**
From East directly to NAWC pad	90%	
From East but arrive to pad from South	8%	
IFR Instrument Approach to Runway 32	2%	
VFR Piney Arrival (North flow)		
VFR Barren Arrival (South flow)		
Piney VFR		57%
Barren VFR		38%
IFR Straight-in		5%
	good	*good*

Key: IFR = instrument flight rules; NAWC = Naval Air Warfare Center; VFR = visual flight rules.

Operation Type Distribution

Operation	Type	E-2	P-8	Helos
Arrivals	VFR Straight-in Arrival	1%	5%	100%
	Overhead Break Arrival	50%		
	Carrier Break Arrival			
	SFO Arrival			
	Straight-in to Slow Landing			
	Tactical - overhead break			
	Instrument approach	49%	95%	
		good	*good*	*good*
Departures	VFR Departure	100%	5%	100%
	IFR Departure (Swaby and Salisbury)		95%	
	Short Takeoff to Mil Climb			
		good	*good*	*good*
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	50%	5%	100%
	SFO Pattern			
	IFR Pattern or GCA Box	50%	95%	
	Touch and Go to Slow Landing			
		good	*good*	*good*

Key: GCA = Ground Controlled Approach; IFR = instrument flight rules; SFO = Simulated Flame Out; VFR = visual flight rules.

VX-1 Data Validation

Pilot Estimated Annual Operations at NAS Pax River

Group	*Sorties at Full Unit Strength*	*Unit / Description*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
E-2	3	3 per week; 50 weeks; 3 hours per trip	365	50	W	1.00	150	150	300	600
P-8	5	4 per week; 50 weeks; 4 hours per trip	365	50	W	1.00	250	250	500	1000
H-60R/S	350	150 flights over 5 months. 350 flights per year	365	50	Y	0.60	350	350	420	1120

note: FIST data for VX-1 was 20 sorties per year. Since this data is incomplete, used pilot estimates instead

NAS Pax River Directional Flow Patterns of Based Aircraft
See the Track Map .pdf file for details on the flight tracks.

Departures	E-2	P-8	Helos
Depart East/North (Barren)	60%	60%	50%
Depart South/West (Piney)	40%	40%	50%
	good	*good*	*good*
Arrivals	**E-2**	**P-8**	**Helos**
VFR Piney Arrival (East/North flow)	60%	60%	50%
VFR Barren Arrival (West/South flow)	40%	40%	50%
	good	*good*	*good*

Closed Patterns: 5% of patterns are opposing side for P-8 and E-2

Key: VFR = visual flight rules.

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Operation Type Distribution

Operation	Type	P-3	C-12
Arrivals	Straight-in Arrival	100%	100%
	Overhead Break Arrival		
	Carrier Break Arrival		
	SFO Arrival		
	Straight-in to Slow Landing		
	Tactical - overhead break		
	Instrument approach		
		good	*good*
Departures	Military	100%	100%
	Afterburner Takeoff to Mil Climb		
	Short Takeoff to Mil Climb		
		good	*good*
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	60%	60%
	SFO Pattern		
	IFR Pattern or GCA Box	40%	40%
	Touch and Go to Slow Landing		
		good	*good*

Key: GCA = Ground Controlled Approach; SFO = Simulated Flame Out; VFR = visual flight rules.

VXS-1 Data Validation

FIST 10 year average VXS-1 Operations (These will be mo

Aircraft	*Sorties at Full Unit Strength*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
NP-3 Orion	104	365	35	Y	2	104	104	416	624
C-12	45	365	52	Y	3	45	45	270	360

Note: FIST data only had total sorties per month, so used pilot estimates for number of patterns per sortie

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NAS Pax River Directional Flow Patterns of Based Aircraft

See the Track Map .pdf file for details on the flight tracks.

Departures	P-3	C-12
East to 4006 (Barren)	57%	10%
North	5%	30%
South (Piney)	38%	60%
	good	*good*
Arrivals	**P-3**	**C-12**
Instrument Approach straight-in (6-7 NM final)	90%	
VFR from East (4006)	10%	10%
VFR from North		30%
VFR from South		60%
	good	*good*

Key: VFR = visual flight rules.

Operation Type Distribution

Operation	Type	E-6B
Arrivals	Straight-in Arrival	
	Overhead Break Arrival	
	Carrier Break Arrival	
	SFO Arrival	
	Straight-in to Slow Landing	
	Tactical - overhead break	
	Instrument approach	100%
		good
Departures	IFR Departure	100%
	Afterburner Takeoff to Mil Climb	
	Short Takeoff to Mil Climb	
		good
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	50%
	SFO Pattern	
	IFR Pattern or GCA Box	50%
	Touch and Go to Slow Landing	
		good

Key: GCA = Ground Controlled Approach; IFR = instrument flight rules; SFO = Simulated Flame Out; VFR = visual flight rules.

VQ-4 Data Validation

SHARP 10 year average VQ-4 Operations

Aircraft	*Sorties at Full Unit Strength*	*Unit / Description*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
707 (E-6B) Turbofans CFM-56	448	SHARP Data 10 year Average	365	52	Y	0.20	448	448	179	1075

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NAS Pax River Directional Flow Patterns of Based Aircraft
See the Track Map .pdf file for details on the flight tracks.

Departures	E-6B
IFR Salisbury-Six	66.7%
IFR Swaby-Eight	33.3%
	good

Arrivals	E-6B
IFR Straight-in	100%
	good

Key: IFR = instrument flight rules.

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Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

Operation Type Distribution

Operation	Type	MQ-25
Arrivals	VFR Course Rules Arrival	100%
	Overhead Break Arrival	
	Instrument approach	
		good
Departures	Military Departure	100%
	Afterburner Departure	
	Short Takeoff to Mil Climb	
		good
Patterns	Catapult Departure to Fullstop Arrival	23%
	Military Departure to Arrested Landing (5.5 deg glideslope)	77%
	IFR Pattern or GCA Box	
	Touch and Go to Slow Landing	

Key: GCA = Ground Controlled Approach; VFR = visual flight rules.

MQ-25 Data Validation

Estimated MQ-25 Operations (starting FY22)

Aircraft	*Sorties at Full Unit Strength*	*Unit / Description*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
MQ-25 (modeled as C-21)	120	FY 2022	100	20	Y	0.65	120	120	156	396

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Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

NAS Pax River Directional Flow Patterns of Based Aircraft

See the Track Map .pdf file for details on the flight tracks.

Departures	MQ-25
Course Rules Depart East/North (Barren)	60%
Course Rules Depart South/West (Piney)	40%
	good

Arrivals	MQ-25
VFR Piney Arrival (East/North flow)	60%
VFR Barren Arrival (West/South flow)	40%
	good

Key: VFR = visual flight rules.

UX-24 and MDARNG Data Validation

FIST 10 year average UX-24 Operations (These will be modeled)

Group	*Sorties at Full Unit Strength*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
UH-1 (surrogate for MQ-8)	151	240	48	Y	0.30	151	151	91	393
GASEPF (surrogate for RQ-21 and RQ-26A)	139	240	48	Y	1.40	139	139	389	667

note: GASEPF is General Aviation Single Engine Fixed Propeller

note: Maryland Air National Guard operates the RQ-7A/B: 56 annual sorties were added to the 83 annual RQ-21 and RQ-26 to make a total of 139 annual combined sorties of RQ-7/RQ-21/RQ-26

Key: MDARNG = Maryland Army National Guard.

Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

Operation	Type	UH-1	GASEPF
Arrivals	Straight-in Arrival	100%	100%
	Overhead Break Arrival		
	Carrier Break Arrival		
	SFO Arrival		
	Straight-in to Slow Landing		
	Tactical - overhead break		
	Instrument approach		
		good	*good*
Departures	Military	100%	100%
	Afterburner Takeoff to Mil Climb		
	Short Takeoff to Mil Climb		
		good	*good*
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	100%	100%
	SFO Pattern		
	IFR Pattern or GCA Box		
	Touch and Go to Slow Landing		
		good	*good*

Key: SFO = Simulated Flame Out; VFR = visual flight rules; GCA = Ground Controlled Approach.

NAS Pax River Directional Flow Patterns of Based Aircraft

See the Track Map .pdf file for details on the flight tracks.

Departures	UH-1	GASEPF
Spot 1 North	45.0%	
Spot 1 South	7.5%	
Spot 1 Southwest	22.5%	
Spot 2 East	2.5%	
Spot 2 South	7.5%	
Spot 2 West	15.0%	
Route A		75.0%
Route B		12.5%
Route C		12.5%
	good	*good*

Arrivals	UH-1	GASEPF
Spot 1 North	45.0%	
Spot 1 South	7.5%	
Spot 1 Southwest	22.5%	
Spot 2 East	2.5%	
Spot 2 South	7.5%	
Spot 2 West	15.0%	
Route A		75.0%
Route B		12.5%
Route C		12.5%
	good	*good*

Aircraft Noise Study to Support the EIS for the Patuxent River Complex – June 2019

Transient Aircraft Data Validation

Total Transient Ops (FIST data plus PPR Logs):									
Aircraft	*Sorties*	*# of Flying Days*	*# of Flying Weeks per Year*	*Basis of Sorties (# of days)*	*Patterns per Sortie*	*Annual Departures*	*Annual Arrivals*	*Annual Closed Pattern Operations*	*Total Annual Operations*
C-12	46	365	52	Y	1.3	46	46	120	212
C-130	52	365	52	Y	0.6	52	52	62	166
C-21	26	365	52	Y	0.6	26	26	31	83
F-18E/F	37	365	52	Y	0.8	37	37	59	133
F-35C	25	365	52	Y	0.5	25	25	25	75
GASEPF	62	365	52	Y	1.3	62	62	161	285
H-60	96	365	52	Y	2.2	96	96	422	614
MV-22	24	365	52	Y	2.2	24	24	106	154
P-3	38	365	52	Y	0.6	38	38	46	122
P-8	38	365	52	Y	0.6	38	38	46	122
T-38	27	365	52	Y	0.8	27	27	43	97
Totals:	**471**					**471**	**471**	**1121**	**2063**

Operation Type Distrubution		
Operation	**Type**	**Transients**
Arrivals	Straight-in Arrival	100%
	Overhead Break Arrival	
	Carrier Break Arrival	
	SFO Arrival	
	Straight-in to Slow Landing	
	Tactical - overhead break	
	Instrument approach	
		good
Departures	Military	100%
	Afterburner Takeoff to Mil Climb	
	Short Takeoff to Mil Climb	
		good
Patterns	VFR Touch and Go Pattern (or Low Approach Pattern)	30%
	SFO Pattern	
	IFR Pattern or GCA Box	70%
	Touch and Go to Slow Landing	
		good

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NAS Pax River Directional Flow Patterns of Transient Aircraft		
See the Track Map .pdf file for details on the flight tracks.		
Departures	**Fixed Wing Transients**	**Helicopter Transients**
Depart East/North (Barren)	60%	50%
Depart South/West (Piney)	40%	50%
	good	*good*
Arrivals	**Fixed Wing Transients**	**Helicopter Transients**
VFR Piney Arrival (East/North flow)	60%	50%
VFR Barren Arrival (West/South flow)	40%	50%
IFR Straight-in	0%	0%
	good	*good*

Key: VFR = visual flight rules; IFR = instrument flight rules.

Appendix B: Squadron and Aircraft Specific Flight Tracks

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Appendix C: Squadron and Aircraft Specific Representative Flight Profiles

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Appendix D
Air Quality Calculations

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List of Tables

Abbreviations and Acronyms

Acronym	***Definition***
<	less than
≤	less than or equal to
≥	greater than or equal to
AESO	Aircraft Environmental Support Office
AGL	above ground level
BT	bow thruster
cal	caliber
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
cyl	cylinder
DODIC	Department of Defense Identification Code
EFC&FC	Engine Fuel Consumption & Emission Calculator
ft	feet
g/HP-hr	gallons per horsepower-hour
gal	gallons
gal/hr	gallons per hour
GSE	ground support equipment
HC	hydrocarbons
Helo OPAREA	Helicopter Operating Area
HP	horsepower
HP-hr	horsepower hour
hrs	hours
HSMST	High-Speed Maneuvering Surface Target
Hyd	hydraulic
ID	identification
in	inches
kW	kilowatts
lbs	pounds
L	liter
LANT	Atlantic
lbs-ft	pound-foot
LTO	landing and takeoff
MEM	military expended materials
mm	millimeter
MPDE	main propulsion diesel engine
MPGE	main propulsion gasoline engine
MSC	Military Sealift Command
MT/yr	metric tons per year
MTU	Motor and Turbine Union
NA	not applicable
NAVAIR	Naval Air Systems Command
NAVFAC	Naval Facilities Engineering Command
NAVSEA	Naval Sea Systems Command
Navy	U.S. Department of the Navy
$NMHC+NO_x$	nonmethane hydrocarbons plus nitrogen oxides
No.	Number
NO_x	nitrogen oxides
OAETC	Open-Air Engine Test Cell
PM	particulate matter
PM_{10}	particulate matter less than or equal to 10 microns in diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in diameter
PRC	Patuxent River Complex
RONA	Record of Non-Applicability
SDST	Ship-Deployable Surface Target
SO_2	sulfur dioxide
SO_x	sulfur oxides
SSDG	ship-side diesel generator
SVHO	Super Vortex High Output
tpy	tons per year
UAS	unmanned aerial systems
U.S.	United States
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

This appendix discusses emission factor development and calculations including assumptions employed in the analysis presented in Section 3.2 (Air Quality) of Chapter 3 (Affected Environment and Environmental Consequences).

D.1 Air Quality Example Calculations

D.1.1 Aircraft Activities Emissions

The Proposed Action testing and training consists of various activities associated with manned and unmanned fixed-wing and rotary-wing aircraft. Aircraft activities of concern are those that occur from ground level up to 3,000 feet above ground level (AGL). The 3,000 feet AGL ceiling is the default atmospheric mixing height above which any pollutant generated would not contribute to increased pollutant concentrations at ground level (known as the mixing zone). All pollutant emissions from aircraft generated at greater than 3,000 feet AGL are excluded from this analysis. The pollutant emission rate is a function of the engine's operating mode, the fuel flow rate, and the engine's overall efficiency. Emissions for one complete flight for a particular aircraft are calculated using the specific engine pollutant emission factors for each mode of operation.

For this Environmental Impact Statement, emission factors for aircraft engines were obtained from the United States (U.S.) Department of the Navy's (the Navy) Aircraft Environmental Support Office (AESO) memoranda. For aircraft where engine data from AESO was unavailable, an appropriate surrogate aircraft's AESO emission factors were used.

Because operations in the Patuxent River Complex (PRC) Study Area include primarily testing operations, by nature, the numbers and types of operations vary greatly. To account for this, a conservative approach was used in which representative aircraft were chosen for each of four airframe classes: fixed-wing jet, fixed-wing propeller, rotary-wing, and unmanned aerial systems (UAS). Representative aircraft were selected based on their predominance of operations below 3,000 feet AGL (Table D-1).

Table D-1 Representative Airframes and Emission Factor Sources

Airframe Type	*Representative Aircraft*	*Emission Factors Source*
Fixed-wing Jet	F/A-18	Aircraft Emission Estimates: F/A-18 Landing and Takeoff Cycle and In-Frame Maintenance Testing Using JP-5, AESO Report 9815I (Navy, 2017)
Fixed-wing propeller	C-12	Aircraft Emission Estimates: C-12 Landing and Takeoff Cycle and In-Frame Maintenance Testing Using JP-5, AESO Report 9910D (Navy, 2015)
Rotary-wing	H-60	Aircraft Emission Estimates: H-60 Landing and Takeoff Cycle, Cruise Time and In-Frame Maintenance Testing Using JP-5, AESO Report 9929C (Navy, 2016)
Unmanned Aerial Systems (UAS)	T-34	Aircraft Emission Estimates: T-34C Landing and Takeoff Cycle and In-Frame Maintenance Testing Using JP-5, AESO Report 9921D (Navy, 2019)

A portion of flight operations would occur in the Calvert County ozone marginal nonattainment area. Of all flight operations, activities below 3,000 feet AGL represent approximately 41 percent of operations under the No Action Alternative and 51 percent under Alternatives 1 and 2. Of that, approximately half of operations occur in the West Helicopter Operating Area (Helo OPAREA) and 0.83 percent occur in R-4007. Approximately 25 percent of R-4007 and West Helo OPAREA airspaces overlap Calvert County (nonattainment area); therefore, emissions were weighted, based on those factors, to estimate the portion of emissions occurring in the nonattainment area as follows:

West Helo OPAREA

Table 3.0-14 (Current and Proposed Annual Flight Hours by PRC Airspace) indicates the number of flights in the Helo OPAREAs. The hours were then further adjusted by the fraction that are below 3,000 AGL for each alternative (i.e., 41 percent for the No Action Alternative, 51 percent each for Alternatives 1 and 2). Section 3.0.2.3.4.1 (Air-Based Assets) indicates that about half of the flight hours flown in the Helo OPAREAs are conducted in the West Helo OPAREA. Therefore, it was estimated:

- No Action Alternative = 4,020 hours (hrs) x .41 below 3,000 AGL x .50 in West Helo OPAREA = 824.1 hrs
- Alternative 1 = 4,680 hrs x .51 below 3,000 AGL x .50 in West Helo OPAREA = 1,193.4 hrs
- Alternative 2 = 5,200 hrs x .51 below 3,000 AGL x .50 in West Helo OPAREA = 1,326 hrs

R-4007

Figure 3.0-2 (Sorties Conducted in PRC Restricted Airspace) provides the 10-year average sorties for each PRC restricted area. The total sorties is 11,281 and R-4007 is 94 (or 0.83 percent).

Similar to the Helo OPAREA calculation, Table 3.0-14 (Current and Proposed Annual Flight Hours by PRC Airspace) provides the restricted area values for each alternative.

- No Action = 16,080 hrs x .41 below 3,000 AGL x .0083 in R-4007 = 54.7 hrs
- Alternative 1 = 18,720 hrs x .51 below 3,000 AGL x .0083 in R-4007 = 79.2 hrs
- Alternative 2 = 20,800 hrs x .51 below 3,000 AGL x .0083 in R-4007 = 88 hrs

Adding operations in the West Helo OPAREA and R-4007 together results in the following (Table D-2):

Table D-2 Nonattainment Area Flight Operations

	No Action Alternative	*Alternative 1*	*Alternative 2*
Total hours for West Helo OPAREA and R-4007	878.8	1,272.6	1,414
Percentage Distribution of Representative Aircraft			
Fixed-wing jet	24.16%	20.95%	20.95%
Fixed-wing prop	23.87%	14.73%	14.73%
Rotary-wing	48.17%	57.85%	57.85%
UAS	3.81%	6.48%	6.47%
Total Hours for West Helo OPAREA and R-4007 by Aircraft Type			
Fixed-wing jet	212.3	266.6	296.2
Fixed-wing prop	209.7	187.5	208.3
Rotary-wing	423.3	736.2	818
UAS	33.5	82.4	91.5

Key: Helo OPAREA = Helicopter Operating Area; R- = restricted area; UAS = unmanned aerial systems.

No low-level flights are anticipated in the portion of the PRC Study Area overlapping the nonattainment area in Sussex County, Delaware, and thus there are no concerns with respect to General Conformity, which is not addressed further.

Using these data, pollutant emissions for each aircraft and activity were calculated by applying the equation below. Time-in-mode below 3,000 feet AGL was obtained using the data from the *Aircraft*

Noise Study to Support the Environmental Impact Statement for the Patuxent River Complex (Blue Ridge Research and Consulting, LLC, 2019) (Appendix C, Noise Study).

Total minutes per landing and takeoff (LTO) and emission factors are from AESO's emission estimate reports, except the minutes-per-LTO was reduced by the total time for ground operation. This was done to match the time for noise profiles, as normally noise profiles do not include ground operations. However, the LTO emission factors do include the emissions from ground operations. Therefore, ground operations were included in AESO's calculations.

Emissions = TIM/MINxLTO-EF

Where:

Emissions = Aircraft Emissions (pounds per activity)

TIM = Time-in-mode below 3,000 feet AGL per noise study

MIN = Minutes per LTO cycle (minus the time for ground operations)

EF = Emission factor for one specific airframe LTO cycle, including emissions from ground operations associated with the LTO cycle

As the equation indicates, emissions were determined by estimating the total number of LTOs per airframe and then applying the appropriate AESO LTO emissions factors for the specified airframe.

Lead emissions were estimated by looking at actual usage of aviation gas at PRC over a five-year period. According to an aviation gas material safety data sheet from Shell, lead content is approximately 0.56 grams/liter (Shell Trading Company, 2020).

D.1.2 Aircraft In-Frame Maintenance

Emissions are generated by aircraft conducting routine in-frame maintenance runs. During tests, pilots operate engines at a range of operating modes while on the ground. Emissions associated with aircraft in-frame maintenance were estimated based on emission factors in AESO Memorandum Report No. 2020-14 *Averaged In-frame Maintenance Emission Rates for F/A-18, C-12, H-60, and T-34* (Aircraft Environmental Support Office, 2020). Emission factors are provided below in Table D-3.

Table D-3 Aircraft In-Frame Maintenance Emissions Factors

Airframe	*Averaged Fuel Usage (lb/hr)*	*Averaged In-Frame Maintenance Emission Rates (lb/hr)*						
		CO_2	*CO*	*THC*	*VOC*	*NO_X*	*$PM_{2.5}$*	*PM_{10}*
F/A-18	2,344.60	6,868.40	327.84	64.73	74.4395	24.45	14.66	14.66
C-12	355.70	1,133.80	5.84	1.44	1.656	1.80	1.49	1.49
H-60	266.00	847.00	6.09	0.76	0.874	1.23	0.84	0.84
T-34	126.50	399.80	1.93	0.15	0.1725	0.56	0.02	0.02

Key: AC = aircraft; CO = carbon monoxide; CO_2e = carbon dioxide equivalent; hr = hour; lb = pounds; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; THC = total hydrocarbons; VOC = volatile organic compound.

Emissions were then calculated as follows, based on the total annual in-frame maintenance hours for each representative airframe.

Emissions = OPSxEF

Where:

Emissions = Aircraft In-frame Maintenance Emissions

OPS = Total annual in-frame maintenance hours

EF = Averaged emission factor for specific airframe in-frame maintenance (lbs/hr)

D.1.3 Open-Air Engine Test Cell Facility

Emissions are generated by aircraft engine testing at the Open-Air Engine Test Cell (OAETC) facility. During tests, engines are operated approximately half of the time at idle and half at high power. Further, OAETC test activities are conducted intermittently, with many days of no activity. Because these are stationary sources, these emissions are tracked and reported annually in the Emissions Certification Reports submitted to the Maryland Department of the Environment. Table D-4 shows the reported emissions for the years available at the time this document was prepared (2013-2017) and the five-year average emissions. The five-year average is considered the baseline emissions for the OAETC. Under Alternative 1, the emissions are not projected to change from baseline levels. Alternative 2 emissions represent a 10 percent increase in operations from the baseline and Alternative 1. The majority of emissions are generated by the Jet Engine Test Instrumentation (JETI) test cells. However, emissions are minimal and operating hours are well below levels permitted under the Title V Air Operating Permit (Part 70 Operating Permit 24-037-0017).

D.1.4 Surface Vessel Activities Emissions

Surface activities consist of activities associated with vessel traffic. PRC Study Area Navy vessels including range support boats, combatant and patrol craft, motorized surface targets, and unmanned surface vehicles. Larger vessels also have generators operating onboard to provide electricity for non-propulsion functions and may also have separate bow thruster engines used in berthing. Each of these vessels incorporates different propulsion methods such as marine outboard engines, diesel engines, and gas turbines. Calculations are based on the combustion of fossil fuels (primarily diesel) in these engines and the time they run.

The Naval Sea Systems Command (NAVSEA) has compiled a database of all ships within their inventory and associated emissions factors for air pollutants produced from the vessel inboard and outboard gasoline and diesel engines. These engines are operated on a variety of vessels involved in testing and training activities. Emission factors were obtained from the NAVSEA Navy and Military Sealift Command (MSC) Marine Engine Fuel Consumption & Emission Calculator documentation for compression ignition and spark ignition engines. These vessels vary greatly in size, engine power, fuel consumption, and associated emissions. Therefore, vessels were classified by their length as being either small (less than 50 feet), medium (50 to 100 feet), or large (greater than 100 feet but less than 400 feet). Then, for each category, a representative vessel, based on greatest historical use, was selected to provide conservative emission factors and estimates.

Table D-4 Five-Year OAETC Emissions

Reporting Year	Engine Test Cell Type	Registration No.	Pollutant (tpy)						CO_2e (MT/yr)
			CO	NO_X	PM_{10}	SO_2	VOC	CO_2e	
2013	Jet Engine Test Cells	037-9-0038	11.40	4.37	0.81	0.39	1.11	707	641
	Helicopter Engine Test Cell	037-9-0039	0.21	0.26	0.08	0.05	0.02	120	109
	Turboshaft Engine Test Cell	037-9-0101	0.00	0.00	0.00	0.00	0.00	0	0
2014	Jet Engine Test Cells	037-9-0038	6.73	6.06	1.02	0.81	0.89	2,213	2,008
	Helicopter Engine Test Cell	037-9-0039	0.03	0.02	0.01	0.01	0.00	9	8
	Turboshaft Engine Test Cell	037-9-0101	0.10	0.22	0.00	0.01	0.03	15	14
2015	Jet Engine Test Cells	037-9-0038	4.37	6.34	0.96	0.68	0.64	921	836
	Helicopter Engine Test Cell	037-9-0039	0.01	0.01	0.00	0.00	0.00	6	5
	Turboshaft Engine Test Cell	037-9-0101	0.17	0.58	0.00	0.04	0.03	89	81
2016	Jet Engine Test Cells	037-9-0038	9.60	6.85	1.14	0.72	0.85	1237	1,122
	Helicopter Engine Test Bays	037-9-0039	0.02	0.01	0.00	0.00	0.00	6	5
	Turboshaft Engine Test Cell	037-9-0101	0.00	0.00	0.00	0.00	0.00	0	0
2017	Jet Engine Test Cells	037-9-0038	4.69	6.75	0.46	0.71	0.71	1578	1,432
	Helicopter Engine Test Cell	037-9-0039	0.06	0.08	0.02	0.01	0.01	35	32
	Turboshaft Engine Test Cell	037-9-0101	0.00	0.00	0.00	0.00	0.00	0	0
Five-Year Average	Jet Engine Test Cells	037-9-0038	7.36	6.07	0.88	0.66	0.84	1,333	1,209
	Helicopter Engine Test Cell	037-9-0039	0.07	0.08	0.02	0.02	0.01	35	32
	Helicopter Engine Test Cell	037-9-0086	0.00	0.00	0.00	0.00	0.00	0	0
	Turboshaft Engine Test Cell	037-9-0101	0.05	0.16	0.00	0.01	0.01	21	19
	OAETC Total Emissions		**7.48**	**6.31**	**0.90**	**0.68**	**0.86**	**1,389**	**1,260**

Key: CO = carbon monoxide; CO = carbon monoxide; CO_2e = carbon dioxide equivalents; MT/yr = metric tons per year; No. = number; NO_x = nitrogen oxides; OAETC = Open-Air Engine Test Cell; PM_{10} = particulate matter less than or equal to 10 microns in diameter; SO_2 = sulfur dioxide; tpy = tons per year; VOC = volatile organic compound.

Note: Total values shown may appear to differ slightly from additive sums due to rounding.

Table D-5 shows the representative vessels selected along with relevant engine data and associated emission factors. Detailed characteristics of these representatives are also provided in Appendix A (Patuxent River Complex Activity and Asset Descriptions).

The Navy and MSC Marine Engine Fuel Consumption & Emission Calculator is a database program that allows a registered user to determine (1) the amount of various pollutants given off by a Navy vessel or, alternatively, an engine of the type used aboard Navy vessels, and (2) the amount of fuel consumed by a Navy vessel over a period of time. The purpose of this program is to consolidate existing Navy vessel exhaust emission data into a single database, thereby allowing users to access this database via the Internet in order to calculate vessel exhaust emissions and fuel consumption for their particular needs (such as for Environmental Impact Statements or fleet fuel estimates). Currently, the pollutants that this application tracks are: nitrogen oxides (NO_x), sulfur oxides (SO_x), carbon monoxide (CO), carbon dioxide (CO_2), hydrocarbons (HC), and particulate matter (PM).

Emissions estimates for surface vessels were calculated using factors obtained from NAVSEA, multiplied by the engine horsepower and hours of operation.

Emissions = HP×HR/YR×EF×ENG
Where:
Emissions = Surface craft Emissions (pound per year)
HP = Horsepower (reflective of a particular load factor/engine power setting)
HR/YR = Hours per year
EF = Emission factor for specific engine type ENG = Number of engine

To determine the entire testing and training activity emissions, a calculation was conducted for each surface vessel type and for each pollutant and converted to tons. The baseline is defined as the level of testing and training activities identified in the No Action Alternative. These values were summed according to the appropriate pollutant to provide the cumulative emissions associated with surface vessel emissions activities.

Lead emissions were calculated as a fraction of the particulate matter less than or equal to 10 microns in diameter (PM_{10}) per the U.S. Environmental Protection Agency hazardous air pollutant profiles for marine vessels using distillate fuels. This assumes that lead emissions are 0.00015 weight fraction of the PM_{10} for category 1 and 2 engines (U.S. Environmental Protection Agency, 2020).

D.1.5 Ground Support Equipment Emissions

Ground support equipment (GSE) includes various gasoline or diesel equipment to support aircraft operations. Test stands, tow tractors, generators, loaders, and trucks are examples of equipment used regularly. Table D-6 shows the various types of GSE used along with the estimated hours of operation and relevant engine details. Details such as manufacturer, horsepower, fuel type, etc., were provided by the operators of Naval Air Station Patuxent River tenant squadrons. Parts-specific emission factors were not available; therefore, U.S. Environmental Protection Agency standard diesel emissions for the age-appropriate tier for the part (Tier 1 or Tier 2) were used to estimate emissions. Tier 1 and Tier 2 emission factors are provided in Table D-7.

Table D-5 Representative Vessels and Emission Factors

Vessel Size Class	Vessel Representative Type	NAVSEA EFC&FC Vessel ID Used	Engine Usage	Fuel Type	Engine Manufacturer	Engine Model	No. of Engines	Engine Rating (HP)	Emission Factors (lbs/HP-hr)[1]						
									CO	NO_x	PM_{10}	$PM_{2.5}$	SO_2	VOC	CO_2e
Range Support Boats															
Small (Less than 50 ft)	Fountain Boat	33BP1001	MPGE	Gas	Mercury	Verado	3	300	1.24	0.02	0.00	0.00	0.00	0.51	1.08
Medium (50 ft - 100 ft)	Patrol Boat 777	65PB777	MPDE	Diesel	GM/Detroit Diesel	8V92/8V-71TI	3	650	0.01	0.02	0.00	0.00	0.00	0.00	1.20
Large (Greater than 100 ft)	Relentless[2]	YDT-17/YDT-18	MPDE	Diesel	Caterpillar	3508B	2	1000	0.01	0.02	0.00	0.00	0.00	0.00	1.25
	Relentless[2]	YDT-17/YDT-18	SSDG	Diesel	Caterpillar	3306	2	168	1.24	0.02	0.00	0.00	0.00	0.51	1.13
	Relentless[2]	YDT-17/YDT-18	BT	Diesel	Caterpillar	3304	1	54	0.01	0.02	0.00	0.00	0.00	0.00	1.31
Combatant and Patrol Vessels															
Small (Less than 50 ft)	Rigid Inflatable Craft	11MRB0302	MDPE	Diesel	Cummings	QSB5.9	2	380	0.01	0.01	0.00	0.00	0.00	0.00	1.19
Medium (50 ft - 100 ft)	Mark V Patrol Boat	82NS9604	MDPE	Diesel	MTU	12V-394 TE94	2	2285	0.01	0.02	0.00	0.00	0.00	0.00	1.18
Large (Greater than 100 ft)	Cyclone-Class Patrol Ship	PC2/PC14	MPDE	Diesel	Paxman	16RP200M	4	3350	0.00	0.01	0.00	0.00	0.00	0.00	0.58
	Cyclone-Class Patrol Ship	PC2/PC14	SSDG	Diesel	Caterpillar	3306B	2	200	0.00	0.01	0.00	0.00	0.00	0.00	0.65
Motorized Surface Targets															
Small motorized propeller (Less than 50 ft)	HSMST	HSMST	MPGE	Gas	Mercury	200	2	200	1.24	0.02	0.00	0.00	0.00	0.51	1.14
Medium motorized propeller (50 ft - 100 ft)	QST-35B Seaborne Powered Target	100NS7801	MPDE	Diesel	Detroit MTU	Series 60	2	740	0.01	0.02	0.00	0.00	0.00	0.00	1.14
Small motorized impeller (Less than 50 feet)	SDST	NA[3]	NA	Gas	FX 2015 Cruiser SVHO	Yamaha 1812cc	1	250	0.61	0.02	0.00	0.00	0.00	0.25	0.43
Unmanned Maritime Systems															
Unmanned Surface Vehicles	HSMST	HSMST	MPGE	Gas	Mercury	200	2	200	1.24	0.02	0.00	0.00	0.00	0.51	1.14

Key: BT = bow thruster; CO = carbon monoxide; CO_2e = carbon dioxide equivalents; EFC&FC = Engine Fuel Consumption & Emission Calculator; ft = feet; HP = horsepower; HP-hr = horsepower hour; HSMST = High Speed Maneuvering Surface Target; ID = identification; LANT = Atlantic; lbs = pounds; MPGE = main propulsion gasoline engine; MPDE = main propulsion diesel engine; MTU = Motor and Turbine Union; NA = not applicable; NAVSEA = Naval Sea Systems Command; No. = number; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; SDST = Ship Deployable Surface Target; SSDG = ship service diesel generator; SVHO = Super Vortex High Output; VOC = volatile organic compound.

Notes:

1. These data are generated using the NAVSEA EFC&EC software by Dave Coffin at Naval Facilities Engineering Command Atlantic (NAVFAC LANT).
2. Navy Vessel Relentless is a 145-foot ship, which has three operating diesel engines onboard as described under engine usage and in the key.
3. Emissions Factors Draft Environmental Assessment for Naval Special Operations Training In Western Washington State (2018).

Table D-6 Ground Support Equipment Details

Equipment Type	*No Action Alternative hours/year*	*Alternative 1 (+14.1%) hours/year*	*Alternative 2 (+22.7%) hours/year*	*Engine Manufacturer*	*Engine Model*	*Tier*
Test Stand, Hyd Portable, Diesel	2,271	2,591	2,786	Deutz	2012c Notes: 111 HP, 4-cyl turbocharges, tank capacity = 22 gal	Tier 2
Tow Tractor, Aircraft	9,918	11,316	12,169	Deutz	BF4M2011 88HP, 4-cyl, fuel capacity = 18.4gal	Tier 2
Power Plant, Mobile Electric	13,050	14,890	16,012	Detroit Diesel, General Motors Corp	Series 6-71 215 HP, 6-cyl, 2-cycle, fuel capacity = 30 gal	Tier 2
Loader, Air-Launched Weapons	1,253	1,429	1,537	Hatz	Model 2M40L/2M41Z-9353 40 HP, 2-cyl, 4-cycle direct injection air-cooled, tank capacity = 6 gal	Tier 2
MSU-200 NAVAIR Start Unit	10,962	12,508	13,450	(gas turbine powerhead) Hamilton Sundstrand	PH-47C4 396 HP consumes 37.4 gal/hr	Tier 2
Heavy-duty Land-based Tow Tractor	7,830	8,934	9,607	Cummins	QSB4.5 turbocharges 4-cylinder, tank capacity = 45 gal	Tier 2
Truck, Lift Aerial Stores	1,044	1,191	1,281	Deutz	F2L1011 26.1 HP, 2-cylinder, air-cooled, fuel tank capacity = 6 gal	Tier 2
Truck, Transport, Ammunition-Loading	1,566	1,787	1,921	Ford Motor Company	[1] Ford F-750 6.7L PowerStroke V8 diesel engine - 270 HP/675 lbs-ft	Tier 2
Total hours[2]	47,894	54,646	58,763	NA	NA	NA

Key: cyl = cylinder; gal = gallons; gal/hr = gallons per hour; HP = horsepower; Hyd = hydraulic; L = liter; lbs-ft = pound-foot; NA = not applicable; NAVAIR = Naval Air Systems Command.

Note:

1. Source: (Ford, 2019)
2. Total values shown may appear to differ slightly from additive sums due to rounding.

Table D-7 U.S. Environmental Protection Agency Tier 1 and Tier 2 Emission Factors (g/HP-hr)

Engine Power	*Tier*	*Year*	*CO*	*HC*	*NMHC+NO$_x$*	*NO$_x$*	*PM$_{10}$*	*PM$_{2.5}$*
kW < 8	Tier 1	2000	6	0	7.8	0	0.75	0.75
(HP < 11)	Tier 2	2005	6	0	5.6	0	0.6	0.6
8 ≤ kW < 19	Tier 1	2000	4.9	0	7.1	0	0.6	0.6
(11 ≤ HP < 25)	Tier 2	2005	4.9	0	5.6	0	0.6	0.6
19 ≤ kW < 37	Tier 1	1999	4.1	0	7.1	0	0.6	0.6
(25 ≤ HP < 50)	Tier 2	2004	4.1	0	5.6	0	0.45	0.45
37 ≤ kW < 75	Tier 1	1998	0	0	0	6.9	0	0
(50 ≤ HP < 100)	Tier 2	2004	3.7	0	5.6	0	0.3	0.3
75 ≤ kW < 130	Tier 1	1997	0	0	0	6.9	0	0
(100 ≤ HP < 175)	Tier 2	2003	3.7	0	4.9	0	0.22	0.22
130 ≤ kW < 225	Tier 1	1996	8.5	1	0	6.9	0.4	0.4
(175 ≤ HP < 300)	Tier 2	2003	2.6	0	4.9	0	0.15	0.15
225 ≤ kW < 450	Tier 1	1996	8.5	1	0	6.9	0.4	0.4
(300 ≤ HP < 600)	Tier 2	2001	2.6	0	4.8	0	0.15	0.15
450 ≤ kW < 560	Tier 1	1996	8.5	1	0	6.9	0.4	0.4
(600 ≤ HP < 750)	Tier 2	2002	2.6	0	4.8	0	0.15	0.15
kW ≥ 560	Tier 1	2000	8.5	1	0	6.9	0.4	0.4
(HP ≥ 750)	Tier 2	2006	2.6	0	4.8	0	0.15	0.15

Key: ≥ = greater than or equal to; ≤ = less than or equal to; < = less than; CO = carbon monoxide; g/HP-hr = gallons per horsepower hour; HC = hydrocarbons; HP = horsepower; kW = kilowatts; NMHC+NO$_x$ = nonmethane hydrocarbons plus nitrogen oxides; NO$_x$ = nitrogen oxides; PM$_{10}$ = particulate matter less than or equal to 10 microns in diameter; PM$_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; U.S. = United States; VOC = volatile organic compound.

GSE emissions were calculated by multiplying the annual hours of operation by the horsepower of each piece of equipment by the appropriate tier and engine size emission factor. Emissions were then converted from grams to tons by applying a conversion factor.

Emissions = HP×HR/YR×EFxCF
Where:
Emissions = GSE Emissions (pound per year)
HP = Horsepower (reflective of a particular load factor/engine power setting)
HR/YR = Hours per year
EF = Emission factor for specific engine type, tier, and size
CF = Conversion Factor for grams to tons (1.10231e-6)

Lead emissions were calculated as a fraction of the PM$_{10}$ per the California Air Resource Board diesel fuel speciation profiles for the 2021 off-road diesel vehicle exhaust speciation. This assumes that lead emissions are 0.00001 weight fraction of the PM$_{10}$ (California Air Resource Board, 2020).

D.1.6 Munitions and Other Military Expended Materials Emissions

A wide variety of munitions and other military expended materials (MEM) are employed during testing and training activities in PRC Study Area. MEM were grouped by type, and a representative was chosen for each type based on the highest historical use and/or for which associated constituents were available. Emissions were only calculated for those munitions or MEM that generate emissions (e.g., those that are live-fired, contain a spotting charge, utilize combusted propellants, etc.). All munitions and MEM discussed in Section 3.0.2.3.3.4 (Non-explosive Munitions and Other Military Expended Materials), including aerial target jet-assisted takeoff bottles were included in the analysis, though all do not appear in the table, because they were grouped with another representative munition/MEM for emissions analysis.

Emission factors for representative surrogate munitions and other MEM were provided by Navy Ordnance Safety and Security Operation (NOSSA) from the U.S. Environmental Protection Agency's AP-42 compilations of emission factors from various sources. Emission factors are provided in Table D-8.

Available emissions factors (AP-42, Compilation of Air Pollutant Emission Factors) were utilized. These factors were then multiplied by the net weight of the explosive (or a conversion factor for pounds per item) and the number of times that the munition was used during baseline fiscal years 2008 through 2017. This calculation provided annual pounds per year of emissions, which were converted to tons per year for comparison purposes.

Emissions = EXP/YR×EF
Where:
Emissions = Ordnance Emissions (pounds per year)
EXP/YR = Explosives, propellants, and pyrotechnics used per year EF = Emissions factor

Table D-8 U.S. Representative Munitions and Other MEM Emission Factors

Type	*Category*	*DODIC ID*	*Emission Factor (lbs/item)*								*Emission Factor Source References*
			CO_2	*CO*	*NO_x*	*VOC*	*SO_2*	*PM_{10}*	*$PM_{2.5}$*	*Pb*	
.50 cal blank	Small cal	A598	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	USEPA, 2008 AP-42 15.1.29 A598, M1A1 .50 Caliber Blank Cartridge
25 mm	Medium cal	M793	0.043	0.085	0.002	0.000	0.000	0.003	0.002	0.000	USEPA, 2008 AP-42 15.1.32 A976, M793 25-mm Target Practice Tracer Cartridge
2.75-in Rocket (Practice)	Rocket	H974	4.800	0.530	0.000	0.000	0.000	0.160	0.170	0.070	USEPA, 2008 AP-42 15.6.7 H974, 2.75-inch M267 Practice Warhead, MK66 Mod 3 Motor
Floating Smoke Pot	Marine Marker	K867	0.530	0.890	0.003	0.022	0.003	30.000	23.000	0.016	USEPA, 2008 AP-42 15.7.7 K867, M4A2 Floating Type HC Smoke Pot
Flare	Counter-measure Flare	L410	0.011	0.001	0.000	0.000	0.000	0.006	0.006	0.000	USEPA, 2008 AP-42 15.8.16 L410, M206 Aircraft Countermeasure Flare
Flare	Illumination Flare	L311	0.140	0.011	0.003	0.000	0.000	0.120	0.120	0.000	USEPA, 2008 AP-42 15.8.4 L311, M126A1 Red Star Parachute Signal Flare
2.75-in Rocket Flechette	Rocket	H459	2.400	1.500	0.026	0.000	0.000	0.110	0.100	0.051	USEPA, 2008 AP-42 15.6.1 H459, 2.75-inch Flechette, MK40 Mod 3 Motor
Simulant Launcher Grenade	Launchers/ Pods	G978	0.015	0.012	0.000	0.000	0.000	0.053	0.029	0.000	USEPA, 2008 AP-42 15.5.11 G978, M82 Simulant Screening Smoke Launcher Grenade

Key: AP-42 = Air Pollutant Emissions Factors; cal = caliber; CO = carbon monoxide; CO_2 = carbon dioxide; DODIC = Department of Defense Identification Code; ID = identification; in = inches; lbs = pound; MEM = military expended materials; mm = millimeter; NO_x = nitrogen oxides; Pb = lead; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; U.S. = United States; VOC = volatile organic compound; USEPA = U.S. Environmental Protection Agency.

Note:
1. Emission Factors from USEPA AP-42 Section 15 (various dates)

D.2 Emissions Estimates Tables

The following tables (Table D-9 through Table D-14) contain data used for the emissions calculations for aircraft, aircraft in-frame maintenance, OAETC runs, GSE, vessels, and munitions and other MEM, respectively. These tables were converted from Microsoft Excel spreadsheets.

Table D-9 Total Annual Aircraft Flight Operations Emissions

Source	*Annual Pollutant Emissions (tons per year)*							*CO_2e (MT/yr)*
	CO	*VOC*	*NO_x*	*$PM_{2.5}$*	*PM_{10}*	*SO_2*	*CO_2e*	
No Action Alternative								
F-18	2,439	737	286	167	167	30	176,620	160,227
C-12	25.55	7.16	7.13	6.43	6.43	1.92	10,101	9,163
H-60	163	20.84	44.63	31	31	10.96	39,056	35,431
UAS (T-34)	0.52	0.05	0.13	0	0	0.03	295	267
TOTAL A/C	**2,628**	**765**	**338**	**205**	**205**	**43**	**226,071**	**205,088**
Alternative 1								
F-18	3,033	916	355	208	208	37	176,943	160,520
C-12	28.4	7.96	7.92	7.15	7.15	2.13	8,532	7,740
H-60	285	36.32	77.76	54.02	54.02	19.1	61,579	55,863
UAS (T-34)	2.3	0.21	0.56	0.02	0.02	0.15	704	638
TOTAL A/C	**3,349**	**961**	**441**	**269**	**269**	**59.38**	**247,758**	**224,762**
Alternative 2								
F-18	3,371	1,018	395	231	231	41	196,638	178,387
C-12	31.56	8.85	8.8	7.94	7.94	2.37	9,480	8,600
H-60	316	40.35	86.4	60.02	60.02	21.23	68,423	62,073
UAS (T-34)	2.36	0.21	0.57	0.02	0.02	0.15	752	682
TOTAL A/C	**3,721**	**1,068**	**491**	**299**	**299**	**65**	**275,293**	**249,742**

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 (or 2.5) microns in diameter; SO_2 = sulfur dioxide; UAS = unmanned aerial systems; VOC = volatile organic compound.

Note: Total values shown may appear to differ slightly from additive sums due to rounding.

Table D-10 Aircraft In-Frame Maintenance Emissions

Source	Annual Pollutant Emissions (tons per year)							CO_2e (MT)
	CO	VOC	NO_x	$PM_{2.5}$	PM_{10}	SO_2	CO_2	
No Action Alternative								
F/A-18	143	32.56	10.69	6.41	6.41	1.28	3,004	2,725
C-12	2.52	0.72	0.78	0.64	0.64	0.19	490	444
H-60	5.31	0.76	1.07	0.73	0.73	0.29	738	669
T-34	0.13	0.01	0.04	0.00	0.00	0.01	27	25
Total Emissions	**151**	**34.05**	**12.58**	**7.79**	**7.79**	**1.77**	**4,259**	**3,864**
Alternative 1								
F/A-18	145	32.83	10.78	6.47	6.47	1.29	3,029	2,748
C-12	1.81	0.51	0.56	0.46	0.46	0.14	352	319
H-60	7.42	1.07	1.50	1.02	1.02	0.41	1,032	936
T-34	0.26	0.02	0.08	0.00	0.00	0.02	54	49
Total Emissions	**154**	**34.43**	**12.92**	**7.95**	**7.95**	**1.86**	**4,467**	**4,053**
Alternative 2								
F/A-18	161	36.51	11.99	7.19	7.19	1.44	3,369	3,056
C-12	2.01	0.57	0.62	0.51	0.51	0.15	391	355
H-60	8.24	1.18	1.66	1.14	1.14	0.45	1,146	1,040
T-34	0.29	0.03	0.08	0.00	0.00	0.02	60	55
Total Emissions	**171**	**38.29**	**14.36**	**8.84**	**8.84**	**2.06**	**4,967**	**4,506**

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 (or 2.5) microns in diameter; SO_2 = sulfur dioxide; UAS = unmanned aerial systems; VOC = volatile organic compound.

Note: Total values shown may appear to differ slightly from additive sums due to rounding.

Table D-11 Annual OAETC Operations Emissions

Source	Annual Pollutant Emissions (tons per year)						CO_2e (MT/yr)
	CO	NO_x	PM	SO_2	VOC	CO_2e	
No Action Alternative							
Jet Engine Test Cells	7.36	6.07	0.88	0.66	0.84	1,333	1,209
Helicopter Engine Test Bays	0.07	0.08	0.02	0.02	0.01	35	32
Helicopter Engine Test Cell	0	0	0	0	0	0	0
Turboshaft Engine Test Cell	0.05	0.16	0	0.01	0.01	21	19
OAETC Total Emissions	**7.48**	**6.31**	**0.9**	**0.69**	**0.86**	**1,389**	**1,260**
Alternative 1							
Jet Engine Test Cells	7.36	6.07	0.88	0.66	0.84	1,333	1,209
Helicopter Engine Test Bays	0.07	0.08	0.02	0.02	0.01	35	32
Helicopter Engine Test Cell	0	0	0	0	0	0	0
Turboshaft Engine Test Cell	0.05	0.16	0	0.01	0.01	21	19
OAETC Total Emissions	**7.48**	**6.31**	**0.9**	**0.69**	**0.86**	**1,389**	**1,260**
Alternative 2							
Jet Engine Test Cells	8.09	6.68	0.96	0.73	0.92	1,466	1,330
Helicopter Engine Test Bays	0.07	0.08	0.03	0.02	0.01	39	35
Helicopter Engine Test Cell	0	0	0	0	0	0	0
Turboshaft Engine Test Cell	0.06	0.18	0	0.01	0.01	23	21
OAETC Total Emissions	**8.23**	**6.94**	**0.99**	**0.75**	**0.94**	**1,528**	**1,386**

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NO_x = nitrogen oxides; OAETC = Open-Air Engine Test Cell; PM_{10} = particulate matter less than or equal to 10 (or 2.5) microns in diameter; SO_2 = sulfur dioxide; UAS = unmanned aerial systems; VOC = volatile organic compound.

Note: Total values shown may appear to differ slightly from additive sums due to rounding.

Table D-12 Ground Support Equipment Emissions

Source	HP	Tier	Annual Pollutant Emissions (tons per year)									CO_2 (MT)
			CO	VOC	NMHC +NO_x	NO_x	PM_{10}	$PM_{2.5}$	SO_2	Pb	CO_2	
No Action Alternative												
Test Stand, Hydraulic Portable, Diesel	111	2	1.03	0.07	1.36	1.29	0.06	0.06	0.00	0.00	50	45
Tow Tractor, Aircraft	88	2	3.56	0.27	5.39	5.12	0.29	0.29	0.01	0.00	274	248
Power Plant, Mobile Electric	215	2	8.04	0.76	15.15	14.40	0.46	0.46	0.02	0.00	554	503
Loader, Air-Launched Weapons	40	2	0.23	0.02	0.31	0.29	0.02	0.02	0.00	0.00	10	9
MSU-200 NAVAIR Start Unit	396	2	12.44	1.15	22.97	21.82	0.72	0.72	0.03	0.00	858	778
Test Stand, Hydraulic, Portable (Diesel)	154	1	0.00	0.00	0.00	9.17	0.00	0.00	0.01	0.00	238	216
Truck, Lift Aerial Stores	26.1	2	0.12	0.01	0.17	0.16	0.01	0.01	0.00	0.00	5	5
Truck, Transport, Ammunition-Loading	270	2	1.21	0.11	2.28	2.17	0.07	0.07	0.00	0.00	84	76
GSE Total Emissions			**26.63**	**2.38**	**47.63**	**54.42**	**1.64**	**1.64**	**0.06**	**0.00**	**2,072**	**1,880**
Alternative 1												
Test Stand, Hydraulic Portable, Diesel	111	2	1.17	0.08	1.55	1.48	0.07	0.07	0.00	0.00	57	52
Tow Tractor, Aircraft	88	2	4.06	0.31	6.15	5.84	0.33	0.33	0.01	0.00	312	283
Power Plant, Mobile Electric	215	2	9.18	0.86	17.29	16.43	0.53	0.53	0.02	0.00	632	574
Loader, Air-Launched Weapons	40	2	0.26	0.02	0.35	0.34	0.03	0.03	0.00	0.00	11	10
MSU-200 NAVAIR Start Unit	396	2	14.20	1.31	26.21	24.90	0.82	0.82	0.03	0.00	978	888
Test Stand, Hydraulic, Portable (Diesel)	154	1	0.00	0.00	0.00	10.46	0.00	0.00	0.01	0.00	272	247
Truck, Lift Aerial Stores	26.1	2	0.14	0.01	0.19	0.18	0.02	0.02	0.00	0.00	6	6
Truck, Transport, Ammunition-Loading	270	2	1.38	0.13	2.61	2.48	0.08	0.08	0.00	0.00	95	86
GSE Total Emissions			**30.39**	**2.72**	**54.35**	**62.10**	**1.87**	**1.87**	**0.07**	**0.00**	**2,365**	**2,145**
Alternative 2												
Test Stand, Hydraulic Portable, Diesel	111	2	1.26	0.08	1.67	1.59	0.07	0.07	0.00	0.00	61	55
Tow Tractor, Aircraft	88	2	4.37	0.33	6.61	6.28	0.35	0.35	0.01	0.00	336	305
Power Plant, Mobile Electric	215	2	9.87	0.93	18.59	17.67	0.57	0.57	0.02	0.00	680	617
Loader, Air-Launched Weapons	40	2	0.28	0.02	0.38	0.36	0.03	0.03	0.00	0.00	12	11
MSU-200 NAVAIR Start Unit	396	2	15.27	1.41	28.18	26.77	0.88	0.88	0.03	0.00	1,052	955
Test Stand, Hydraulic, Portable (Diesel)	154	1	0.00	0.00	0.00	11.25	0.00	0.00	0.01	0.00	292	265
Truck, Lift Aerial Stores	26.1	2	0.15	0.01	0.21	0.20	0.02	0.02	0.00	0.00	7	6
Truck, Transport, Ammunition-Loading	270	2	1.49	0.14	2.80	2.66	0.09	0.09	0.00	0.00	102	93
GSE Total Emissions			**32.68**	**2.92**	**58.45**	**66.78**	**2.01**	**2.01**	**0.07**	**0.00**	**2,543**	**2,307**

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Note: Total values shown may appear to differ slightly from additive sums due to rounding.

Table D-13 Annual Vessel Operations Emissions

Source	*Annual Pollutant Emissions (tons per year)*								*CO_2e (MT/yr)*
	CO	*NO_x*	*PM_{10}*	*$PM_{2.5}$*	*SO_2*	*VOCs*	*Pb*	*CO_2e*	
No Action Alternative									
Range Support Vessels	631.00	33.41	1.48	1.48	3.28	258.00	0.00	2,170.00	1,969.00
Combatant and Patrol Craft	1.92	3.64	0.12	0.12	0.70	0.31	0.00	348.00	316.00
Motorized Surface Targets	232.00	23.92	1.05	1.05	2.54	94.34	0.00	1,486.00	1,348.00
Unmanned Surface Vessels	0.01	0.11	0.00	0.00	0.01	0.00	0.00	6.28	5.70
Vessel Total Emissions	**865.41**	**61.08**	**2.65**	**2.65**	**6.53**	**352.61**	**0.00**	**4,010.66**	**3,638.41**
Alternative 1									
Range Support Vessels	631.00	33.41	1.48	1.48	3.28	258.00	0.00	2,170.00	1,969.00
Combatant and Patrol Craft	2.02	4.30	0.16	0.16	0.70	0.31	0.00	359.00	326.00
Motorized Surface Targets	233.00	23.94	1.05	1.05	2.54	94.65	0.00	1,487.00	1,349.00
Unmanned Surface Vessels	0.09	0.85	0.02	0.02	0.12	0.03	0.00	50.25	45.59
Vessel Total Emissions	**866.35**	**62.50**	**2.71**	**2.71**	**6.63**	**352.96**	**0.00**	**4,066.44**	**3,689.02**
Alternative 2									
Range Support Vessels	695.00	36.77	1.63	1.63	3.61	284.00	0.00	2,388.00	2,166.00
Combatant and Patrol Craft	2.22	4.72	0.17	0.17	0.77	0.34	0.00	394.00	358.00
Motorized Surface Targets	257.00	26.35	1.16	1.16	2.79	104.00	0.00	1,636.00	1,484.00
Unmanned Surface Vessels	0.10	0.94	0.02	0.02	0.13	0.04	0.00	55.28	50.15
Vessel Total Emissions	**953.86**	**68.77**	**2.98**	**2.98**	**7.30**	**388.62**	**0.00**	**4,473.39**	**4,058.19**

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; MT/yr = metric tons per year; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Note: Total values shown may appear to differ slightly from additive sums due to rounding.

Table D-14 Munitions and Other MEM Annual Emissions

Source	***Category***	***Quantity***	***Annual Emissions (tons per year)***								
			CO_2	***CO_2 (MT/yr)***	***CO***	***NO_x***	***VOC***	***SO_2***	***PM_{10}***	***$PM_{2.5}$***	***Pb***
No Action Alternative											
.50 cal Blank	Small-Caliber	56,077	0.06	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00
25 mm	Medium-Caliber	11,391	0.24	0.22	0.48	0.01	0.00	0.00	0.02	0.01	0.00
2.75-in Rocket (Practice)	Rocket	923	2.22	2.01	0.24	0.00	0.00	0.00	0.07	0.08	0.03
Floating Smoke Pot	Marine Marker	22	0.01	0.01	0.01	0.00	0.00	0.00	0.33	0.25	0.00
Flare	Countermeasure Flare	332	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flare	Illumination Flare	51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.75-in Rocket Flechette	Rocket	33	0.04	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Simulant Launcher Grenade	Launchers/Pods	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
No Action Alternative Total			**2.57**	**2.33**	**0.80**	**0.01**	**0.00**	**0.00**	**0.42**	**0.34**	**0.03**
Alternative 1											
.50 cal Blank	Small-Caliber	74,396	0.08	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00
25 mm	Medium-Caliber	19,702	0.42	0.38	0.84	0.01	0.00	0.00	0.03	0.02	0.00
2.75-in Rocket (Practice)	Rocket	1,139	2.73	2.48	0.30	0.00	0.00	0.00	0.09	0.10	0.04
Floating Smoke Pot	Marine Marker	34	0.01	0.01	0.02	0.00	0.00	0.00	0.51	0.39	0.00
Flare	Countermeasure Flare	267	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flare	Illumination Flare	40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.75-in Rocket Flechette	Rocket	46	0.06	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Simulant Launcher Grenade	Launchers/Pods	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alternative 1 Total Munitions and Other MEM Emissions			**3.30**	**2.99**	**1.26**	**0.01**	**0.00**	**0.00**	**0.63**	**0.51**	**0.04**
Alternative 2											
.50 cal Blank	Small-Caliber	81,836	0.09	0.08	0.07	0.00	0.00	0.00	0.00	0.00	0.00
25 mm	Medium-Caliber	21,672	0.47	0.42	0.92	0.02	0.00	0.00	0.04	0.02	0.00
2.75-in Rocket (Practice)	Rocket	1,253	3.01	2.73	0.33	0.00	0.00	0.00	0.10	0.11	0.04
Floating Smoke Pot	Marine Marker	37	0.01	0.01	0.02	0.00	0.00	0.00	0.56	0.43	0.00
Flare	Countermeasure Flare	294	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flare	Illumination Flare	44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.75-in Rocket Flechette	Rocket	51	0.06	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Simulant Launcher Grenade	Launchers/Pods	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alternative 2 Total Munitions and Other MEM Emissions			**3.64**	**3.30**	**1.38**	**0.02**	**0.00**	**0.00**	**0.70**	**0.56**	**0.05**

Key: CO = carbon monoxide; CO_2 = carbon dioxide; in = inches; mm = millimeter; NO_x = nitrogen oxides; PM_{10} = particulate matter less than or equal to 10 microns in diameter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; Pb = Lead; SO_2 = sulfur dioxide; VOC = volatile organic compound.

Note: Emissions are rounded to the nearest hundredths place. Therefore, because the quantities are small, the table may show zero emissions where there are actually small amounts emitted. Also, total values shown may appear to differ slightly from additive sums due to rounding.

D.3 Record of Non-Applicability (RONA)

RECORD OF NON-APPLICABILITY

Navy Record of Non-Applicability (RONA) for Clean Air Act Conformity

The Proposed Action falls under the RONA category and is documented with this RONA.

Proposed Action

Action Proponent: U.S. Department of the Navy

Location: Patuxent River Complex, Portions over Calvert County, Maryland; Kent and Sussex Counties, Delaware; and Charles City, James City, Gloucester, and York Counties, Virginia

Proposed Action: Patuxent River Complex Testing and Training

Proposed Action and Emissions Summary: The Proposed Action (Preferred Alternative, Alternative 2) involves operation of military aircraft, aircraft in-frame maintenance, open-air engine test cells, ground support equipment, vessels, and non-explosive munitions and other military expended materials (MEM) in order to achieve requisite training and testing requirements. Aircraft would be in operation below 3,000 feet above ground level within the mixing layer in airspace overflying the Calvert County, Maryland, marginal nonattainment area for ozone. However, no low-level flight operations (below 3,000 feet above ground level) occur in the Kent or Sussex County, Delaware, portion of the Study Area, nor do any flights occur below 3,000 feet in Charles City, James City, Gloucester, or York County, Virginia, portions of the Study Area. Thus, no criteria pollutants are emitted in the Kent or Sussex County, Delaware, nonattainment area nor the Charles City, James City, Gloucester, or York County, Virginia, portions of the maintenance area. Proposed Action emissions were evaluated to assess compliance with the General Conformity Rule *de minimis* thresholds, as shown in the table below.

Proposed Action Ozone Precursor (NO_x and VOC) Emissions Compared to General Conformity Rule *De Minimis* Thresholds (Tons per Year)

Annual Emissions	*NO_x*	*VOC*
Baseline PRC Emissions in Calvert County, Maryland	9.61	22
Proposed Action Emissions in Calvert County, Maryland	13.99	30.94
Net Change from Baseline Emissions	4.38	8.94
de minimis Threshold	100	50
Potential Exceedance	No	No
Baseline PRC Emissions in Sussex County, Delaware	0	0
Proposed Action Emissions in Sussex County, Delaware	0	0
Net Change from Baseline Emissions	0	0
de minimis Threshold	100	50
Potential Exceedance	No	No
Baseline PRC Emissions in Kent County, Delaware	0	0
Proposed Action Emissions in Kent County, Delaware	0	0
Net Change from Baseline Emissions	0	0
de minimis Threshold	100	50
Potential Exceedance	No	No
Baseline PRC Emissions in Charles City County, Virginia	0	0
Proposed Action Emissions in Charles City County, Virginia	0	0
Net Change from Baseline Emissions	0	0
de minimis Threshold	100	50
Potential Exceedance	No	No

Proposed Action Ozone Precursor (NO_x and VOC) Emissions
Compared to General Conformity Rule *De Minimis* Thresholds (Tons per Year) (continued)

Annual Emissions	*NO_x*	*VOC*
Baseline PRC Emissions in James City County, Virginia	0	0
Proposed Action Emissions in James City County, Virginia	0	0
Net Change from Baseline Emissions	0	0
de minimis Threshold	100	50
Potential Exceedance	No	No
Baseline PRC Emissions in Gloucester County, Virginia	0	0
Proposed Action Emissions in Gloucester County, Virginia	0	0
Net Change from Baseline Emissions	0	0
de minimis Threshold	100	50
Potential Exceedance	No	No
Baseline PRC Emissions in York County, Virginia	0	0
Proposed Action Emissions in York County, Virginia	0	0
Net Change from Baseline Emissions	0	0
de minimis Threshold	100	50
Potential Exceedance	No	No

Key: NO_x = nitrogen oxides; PRC = Patuxent River Complex; VOC = volatile organic compound.

Affected Air Basins: Calvert County, Maryland, marginal ozone nonattainment area; Sussex County, Delaware, marginal ozone nonattainment area; Kent County, Delaware, moderate ozone maintenance area; Charles City County, Virginia, marginal ozone maintenance area; Gloucester County, Virginia, marginal ozone maintenance area; James City, Virginia, marginal ozone maintenance area; and York County, Virginia, marginal ozone maintenance area

Date RONA Prepared: March 17, 2021

RONA Prepared By: Brad Boykin, Leidos

Proposed Action Exemptions

The Proposed Action is exempt from the General Conformity Rule requirements based on the determination that the emissions are below the *de minimis* threshold for ozone precursors, nitrogen oxides (NO_x) and volatile organic compounds (VOCs).

Emissions Evaluation Conclusion

The Navy concludes that *de minimis* thresholds for ozone precursors (NO_x and VOC) would not be exceeded as a result of implementation of the Proposed Action. The emissions data supporting that conclusion is shown in the table above. The calculations, methodology, data, and references are contained in Section 3.2 (Air Quality) and Appendix D (Air Quality Calculations) of the Patuxent River Complex Environmental Impact Statement. Therefore, the Navy concludes that further formal Conformity Determination procedures are not required, resulting in this RONA.

RONA Approval:

Signature: MCDANIEL.LANCE.E.1204352972 Digitally signed by MCDANIEL.LANCE.E.1204352972 Date: 2021.03.22 12:59:34 -04'00'

Date: 22MAR21

Name: Lance E. McDaniel

Command: NAS PAtuxent River

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Appendix E
Military Expended Materials and Physical Disturbance and Strike Analysis

List of Tables

Abbreviations and Acronyms

Acronym	***Definition***
AGM	air-to-ground missile
AIM	air intercept missile
AMNS	Airborne Mine Neutralization System
AMRAAM	Advanced Medium-Range Air-to-Air Missile
ATA	Armament Test Area
cal	caliber
CBWR	Chesapeake Bay Water Range
GBU	guided bomb unit
JATO	jet-assisted take off
LAU	launch adapter unit
LUU	illumination unit
MEM	military expended materials
mm	millimeters
PRC	Patuxent River Complex
SAR	search and rescue
SDZ	surface danger zone
SLAM-ER	Standoff Land Attack Missile-Expanded Response
sq ft	square feet
SS	Supersonic
UAS	unmanned aerial systems

This appendix discusses the methods and results for quantifying the disturbance/strike footprint of military expended materials (MEM) on benthic habitats of the Chesapeake Bay and Patuxent River during peaks of activity. The purpose of this appendix is not to evaluate the footprints in terms of environmental impacts. The footprint is based on the peak annual quantity and dimensions of MEM categories representing the range of materials that are planned with the Proposed Action alternatives. The metrics resulting from this analysis include: (1) total 2-dimensional footprint of MEM relative to ordnance concentration areas (Figure 2.1-3, Chesapeake Bay Water Range Munition Concentration Areas) and elsewhere, and (2) total area of benthic habitat types (e.g., oyster beds) (Figure 3.3-3, Characterization of Chesapeake Bay Water Range Bottom Types).

The analysis requires four data elements: (1) number and location of MEM associated with each action alternative (Table 2.3-2, Annual PRC Operational Tempo per Alternative: Number of Munitions, Other MEM, and Directed Energy Weapon Systems), (2) the recovery rate, dimensions, and impact multiplier for each MEM (Table E-1), (3) area of benthic habitat types by study area locations (Table E-2), and (4) historic distribution of MEM types among munition concentration areas and elsewhere (Table E-3). The information for data element 2 is organized by material category and includes accessories, recovery rate, material dimensions, impact multiplier, and 2-dimensional impact footprint for analysis. The information for data element 4 includes an assumption that 5 percent of the footprint targeting a munition concentration area fall elsewhere within the Chesapeake Bay Water Range.

The 2-dimensional impact footprint of individual materials is calculated according to their dimensions multiplied by impact multipliers, to account for some initial lateral movement and/or overlapping separation during settlement. The impact multiplier is typically × 2, but can be higher to reflect that separating components overlap (e.g., bullets and bullet casings). Any subsequent movement of the typically heavy materials would be slow and likely only shift the impact to a slightly different location. Lighter materials, such as plastic, are not a primary constituent of any MEM except some accessories (e.g., small decelerator/parachutes, endcaps, compression pads, flare O-rings). The number of MEM and MEM accessories are then multiplied by the portion not recovered (1-proportion recovered) and their 2-dimensional impact footprint to get the annual total impact footprint of MEM by alternative to the total bottom area where it is typically expended (Table E-3 and Table E-4). However, the peak impact areas presented herein are much higher than a typical year of proposed activities, due to the highly variable nature of testing. The historic distribution of MEM types among munition concentration areas may also change under future scenarios.

In summary, the total footprint of MEM for each alternative is projected to be 10,485.67 (No Action alternative), 19,000.39 (Alternative 1), and 21,194.40 (Alternative 2) square feet per year. However, the percentage of munition concentration area impacted annually by MEM under a peak scenario (Alternative 2) ranges from less than 0.0001 to 0.0125 percent, with the Hannibal Target Area impacted by the highest percent coverage of MEM. The next highest percent coverage was for Hooper Target Complex, at 0.0047 percent of the munition concentration area.

Table E-1 Analysis Specifications for Various Expended Materials Planned with the Proposed Action Alternatives

MEM Category	*MEM Subcategory*	*Representative(s)*	*Accessories*	*Proportion Recovered*	*Diameter (inches)*	*Length (inches)*	*Multiplier*	*Footprint (sq ft)*
Live-Fired Munitions	Medium-Caliber Gun Ammunition	20 mm	None	0.00	0.787	6.600	2.50	0.09
		30 mm	None	0.00	1.18	11.50	2.50	0.24
	Rockets	2.75-inch. Hydra w/ MK-6 Motor and MK-149 Flechette Warhead (WDU4)	None	0.00	2.75	41.70	2.00	1.59
		2.75-inch. Hydra w/ MK-66 Motor	None	0.00	2.75	41.70	2.00	1.59
		2.75-inch. Hydra w/ MK-66 Motor (ATA Launched)	None	0.00	2.75	41.70	2.00	1.59
	Small-Caliber Gun Ammunition	.50 cal	None	0.00	0.51	5.45	2.50	0.05
		7.62 mm	None	0.00	0.31	2.75	2.50	0.01
Other Non-Explosive Munitions	Airborne Neutralization System (AMNS)	AMNS Neutralizer	Fiber-optic Cable	0.00	15.30	52.00	2.00	11.05
	Bombs	GBU-24 (Guided Bomb)	None	0.00	18.00	172.76	2.00	43.19
		MK-76 (Practice Bomb)	None	0.00	4.00	24.64	2.00	1.37
	Mines	MK-56	None	0.00	22.40	114.30	2.00	35.56
		MK-62	None	0.00	15.10	89.00	2.00	18.66
	Missiles	AGM-84K SLAM-ER	Small Decelerator/ Parachute	0.55	13.50	172.00	2.00	32.25
		AIM-120 AMRAAM	None	0.00	7.00	144.00	2.00	14.00
	Torpedoes	MK-54	Lightweight Torpedo Accessories, Small Decelerator/ Parachute	0.95	12.59	112.99	2.00	19.76
Other MEM	Aerial Targets	Small UAS Target – Fragments (only Alternatives 1 and 2)	None	0.40	24.00	24.00	2.00	8.00

Table E-1 Analysis Specifications for Various Expended Materials Planned with the Proposed Action Alternatives, Continued

MEM Category	*MEM Subcategory*	*Representative(s)*	*Accessories*	*Proportion Recovered*	*Diameter (inches)*	*Length (inches)*	*Multiplier*	*Footprint (sq ft)*
Other MEM	Chaff	Chaff	Endcap - Chaff, Chaff-Air Cartridge	0.00	0.00	0.00	0.00	0.00
	Flares	B5 (Decoy/Countermeasure)	Endcap - Flare, Compression Pad/Piston, Flare O-ring	0.00	1.40	5.80	2.00	0.11
		LUU-2 (Illumination)	Parachute (Medium)	1.00	5.00	36.00	2.00	2.50
	Miscellaneous Items	I-Beam	None	0.00	14.13	480.00	2.00	94.19
	Launchers	LAU-61	None	0.00	16.00	83.20	2.00	18.49
	Marine Marker	MK-58	None	0.00	4.90	21.70	2.00	1.48
	Search and Rescue	SAR Raft and Kit	None	1.00	-	-	-	-
	Sonobuoys	Sonobuoys (Active/Passive)	Sonobuoy Wires, Small Decelerator/ Parachute	0.00	4.50	36.00	0.00	0.00
	Spotting Charges	Spotting Charge	None	0.00	3.40	11.18	2.00	0.53
	Surface Targets	Towed Surface Target – Fragments	None	0.95	180.00	180.00	2.00	449.97
Accessory	Air Targets	JATO Bottle	None	0.00	6.60	26.40	2.00	2.42
		Parachute (Large)	None	1.00	531.74	531.74	2.00	3,926.80
	AMNS	Fiber-optic Cable	None	0.00	0.00	0.00	0.00	0.00
	Chaff	Chaff-Air Cartridge	None	0.00	1.40	5.80	2.00	0.11
		Endcap - Chaff	None	0.00	1.40	0.56	2.00	0.01
		Piston-Chaff	None	0.00	1.40	0.56	2.00	0.01
	Flares	Compression Pad or Plastic Piston	None	0.00	1.40	0.56	2.00	0.01
		Endcap - Flare	None	0.00	1.40	0.56	2.00	0.01
		Flare O-ring	None	0.00	1.40	1.40	2.00	0.03
		Parachute (Medium)	None	1.00	188.02	188.02	2.00	490.96
	Mines	Anchor - Mines	None	0.00	36.00	36.00	2.00	18.00
	Missiles	Small Decelerator/Parachute	None	0.95	36.00	36.00	2.00	18.00

Table E-1 Analysis Specifications for Various Expended Materials Planned with the Proposed Action Alternatives, Continued

MEM Category	*MEM Subcategory*	*Representative(s)*	*Accessories*	*Proportion Recovered*	*Diameter (inches)*	*Length (inches)*	*Multiplier*	*Footprint (sq ft)*
Accessory	Sonobuoys	Small Decelerator/Parachute	None	0.00	36.00	36.00	2.00	18.00
		Sonobuoy Wires	None	0.00	0.00	0.00	0.00	0.00
	Torpedoes	Lightweight Torpedo Accessories	None	0.00	12.06	12.06	2.00	2.02
		Small Decelerator/Parachute	None	0.95	36.00	36.00	2.00	18.00

Key: AGM = air-to-ground missile; AIM = air intercept missile; AMNS = Airborne Mine Neutralization System; AMRAAM = Advanced Medium-Range Air-to-Air Missile; ATA = Armament Test Area; cal = caliber; GBU = guided bomb unit; JATO = jet-assisted take off; LAU = launch adapter unit; LUU = illumination unit; MEM = military expended materials; mm = millimeters; SAR = search and rescue; SLAM-ER = Standoff Land Attack Missile-Expanded Response; sq ft = square feet; UAS = unmanned aerial systems.

Table E-2 Substrate Composition of Patuxent River Complex Locations Where Military Expended Materials May Be Expended

Location	*Munition Concentration Area/Target*	*Abiotic Substrate Types (% Coverage)*						*Total Area (sq ft)*
		Artificial (Hard)	*Gravel*	*Mud*	*Sand*	*Shell Bottom*	*Unknown*	
Chesapeake Bay Water Range	Bay Forest	0.00%	0.00%	86.36%	2.24%	11.40%	0.00%	28,336,024
	Hannibal Target	0.00%	0.00%	2.94%	92.11%	4.95%	0.00%	55,436,897
	Hooper Target Complex	0.00%	0.00%	91.47%	8.45%	0.08%	0.00%	228,746,453
	Shoal	0.00%	0.00%	4.64%	5.05%	24.39%	65.91%	7,108,353
	Supersonic Aim Points	0.00%	0.00%	65.38%	34.62%	0.00%	0.00%	277,567,652
	Elsewhere	0.04%	0.00%	46.52%	41.82%	5.14%	6.49%	4,543,760,191
Chesapeake Bay Water Range (Anywhere Total)		*0.03%*	*0.00%*	*49.23%*	*40.22%*	*4.70%*	*5.83%*	*5,140,955,570*
Patuxent River Seaplane Area		*0.66%*	*0.48%*	*52.02%*	*16.76%*	*10.15%*	*19.92%*	*86,610,209*
Bloodsworth Island Range SDZ (Water Area)		*0.00%*	*0.00%*	*5.15%*	*25.03%*	*5.49%*	*48.50%*	*1,002,851,040*

Key: GIS = geographic information system; SDZ = surface danger zone; sq ft = square feet.
Note: Refer Appendix M, Geographic Information System (GIS) References, for GIS data credits.

Table E-3 Typical Distribution of Non-explosive Munitions and Other Military Expended Materials in Munition Concentration Areas

MEM Category	*MEM Subcategory*	*Representatives*	*Percent Distribution within CBWR*							*Percent Distribution within Other Areas*		
			Bay Forest	*Hannibal*	*Hooper*	*Shoal*	*SS Aim Points*	*CBWR (Elsewhere)*	*CBWR (Anywhere)*	*Dip Points*	*Seaplane Area*	*Bloodsworth Island Range SDZ*
Live-Fired Munitions	Medium-Caliber Gun Ammunition	20 mm	-	93%	2%	-	-	5%	-	-	-	-
		30 mm	-	93%	2%	-	-	5%	-	-	-	-
	Rockets	2.75-inch. Hydra w/ MK-66 Motor (ATA Launched)	-	81%	14%	-	-	5%	-	-	-	-
		2.75-inch. Hydra w/ MK-6 Motor and MK-149 Flechette Warhead (WDU4)	-	81%	14%	-	-	5%	-	-	-	-
		2.75-inch. Hydra w/ MK-66 Motor	-	81%	14%	-	-	5%	-	-	-	-
	Small-Caliber Gun Ammunition	7.62 mm	-	90%	5%	-	-	5%	-	-	-	-
		.50 cal	-	90%	5%	-	-	5%	-	-	-	-
Other Non-Explosive Munitions	AMNS	AMNS Neutralizer	-	-	-	-	-	-	100%	-	-	-
	Bombs	GBU-24 (Guided Bomb)	5%	38%	38%	-	14%	5%	-	-	-	-
		MK-76 (Practice Bomb)	5%	38%	38%	-	14%	5%	-	-	-	-
	Mines	MK-62	-	-	95%	-	-	5%	-	-	-	-
		MK-56	-	-	95%	-	-	5%	-	-	-	-
	Missiles	AGM-84K SLAM-ER	-	-	95%	-	-	5%	-	-	-	-
		AIM-120 AMRAAM	-	-	95%	-	-	5%	-	-	-	-
	Torpedoes	MK-54	-	-	47%	47%	1%	5%	-	-	-	-
Other MEM	Aerial Targets	Small UAS Target – Fragments (Only Alternatives 1 and 2)	-	-	-	-	-	-	35%	-	-	10%
	Chaff	Chaff	28%	57%	10%	-	-	5%	-	-	-	-
	Flares	LUU-2 (Illumination)	-	28%	70%	-	-	5%	-	-	-	-
		B5 (Decoy/Countermeasure)	1%	28%	62%	-	4%	5%	-	-	-	-
	Miscellaneous Items	I-Beam	-	-	95%	-	-	5%	-	-	-	-
	Launchers	LAU-61	-	28%	67%	-	-	5%	-	-	-	-

Table E-3 Typical Distribution of Non-explosive Munitions and Other Military Expended Materials in Munition Concentration Areas, Continued

MEM Category	*MEM Subcategory*	*Representatives*	*Percent Distribution within CBWR*							*Percent Distribution within Other Areas*		
			Bay Forest	*Hannibal*	*Hooper*	*Shoal*	*SS Aim Points*	*CBWR (Elsewhere)*	*CBWR (Anywhere)*	*Dip Points*	*Seaplane Area*	*Bloodsworth Island Range SDZ*
Other MEM	Marine Marker	MK-58	10%	-	38%	-	-	5%	-	-	47%	-
	Search and Rescue	SAR Raft and Kit	-	-	-	-	-	-	100%	-	-	-
	Sonobuoys	Sonobuoys (Active)[1]	-	-	-	-	-	-	-	100%	-	-
		Sonobuoys (Passive)	-	-	95%	-	-	5%	-	-	-	-
	Spotting Charges	Spotting Charge	5%	38%	38%	-	14%	5%	-	-	-	-
	Surface Targets	Towed Surface Target - Fragments	-	-	-	-	-	-	100%	-	-	-

Key: AGM = air-to-ground missile; AIM = air intercept missile; AMNS = Airborne Mine Neutralization System; AMRAAM = Advanced Medium-Range Air-to-Air Missile; ATA = Armament Test Area; cal = caliber; CBWR = Chesapeake Bay Water Range; GBU = guided bomb unit; LAU = launch adapter unit ; LUU = illumination unit; MEM = military expended materials; mm = millimeters; SAR = search and rescue; SLAM-ER = Standoff Land Attack Missile-Expanded Response; SDZ = surface danger zone; SS = supersonic; UAS = unmanned aerial systems.

Note:

1. Released only around the dip points north of the Chesapeake Bay Water Range.

Table E-4 Annual Military Expended Material Footprints and Percent of Patuxent River Complex Locations/Bottom Areas

Location	*Munition Concentration Area/Target*	*No Action Alternative*		*Action Alternative 1*		*Action Alternative 2*	
		Square Feet	*Percent*	*Square Feet*	*Percent*	*Square Feet*	*Percent*
Chesapeake Bay Water Range	Bay Forest	229.52	0.0008%	315.11	0.0011%	346.94	0.0012%
	Hannibal Target	4130.29	0.0075%	6323.39	0.0114%	7,322.69	0.0125%
	Hooper Target Complex	4865.55	0.0021%	9829.39	0.0043%	11,342.56	0.0047%
	Shoal	52.30	0.0007%	52.30	0.0007%	61.66	0.0008%
	Supersonic Aim Points	615.38	0.0002%	855.11	0.0003%	1,006.59	0.0003%
	Elsewhere (Target Area Missed)	520.69	<0.0001%	936.52	<0.0001%	1004.50	<0.0001%
	Anywhere[1]	71.94	<0.0001%	278.86	<0.0001%	564.39	<0.0001%
Dip Points		0.00	N/A	410.37	N/A	467.97	N/A
Patuxent River Seaplane Area		0.00	0.0000%	8.33	<0.0001%	9.02	<0.0001%
Bloodsworth Island Range SDZ		0.00	0.0000%	71.99	<0.0001%	71.99	<0.0001%

Key: < = less than; N/A = not applicable; SDZ = surface danger zone.
Note:
1. Anywhere within the broader Chesapeake Bay Water Range area.

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Appendix F
Coastal Consistency Determination

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F.1 Coastal Consistency Determination for Maryland

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
22347 CEDAR POINT ROAD UNIT 6
PATUXENT RIVER MARYLAND 20670-1161

7594
Ser: 046.21
25 March 2021

From: Executive Director, Data Analytics, Infrastructure and Technology Advancement Group
To: Coastal Policy Coordinator, Chesapeake and Coastal Services, Maryland Department of Natural Resources, 580 Taylor Avenue E-2, Annapolis, MD 21401, Attn: Mr. Joseph Abe

Subj: FEDERAL CONSISTENCY DETERMINATION FOR TESTING AND TRAINING ACTIVITIES IN THE PATUXENT RIVER COMPLEX

Encl: (1) Public Release Version of 2021 PRC EIS (CD)
(2) Federal Consistency Determination

1. In accordance with the Coastal Zone Management Act (16 United States Code § 1456(c) and 15 Code of Federal Regulations Part 930, Subpart C), the United States Department of the Navy (Navy) requests concurrence with its Federal Consistency Determination for proposed activities in the Patuxent River Complex (PRC) Study Area. The Navy previously analyzed the potential environmental impacts of its testing and training activities in the PRC in a *1998 Final Environmental Impact Statement (EIS) for Increased Flight and Related Operations in the Patuxent River Complex*. The Navy also conducted a Coastal Zone Management Act (CZMA) consultation for these activities in 1998. The Navy has begun the next phase of PRC planning and has analyzed the potential environmental impacts of proposed testing and training activities in the *Testing and Training Activities in the Patuxent River Complex Draft EIS* found at http://www.prceis.com.

2. Activities for this latest iteration of PRC planning are similar to what was described in the 1998 PRC EIS, with some activities increasing in scope and others decreasing. Some of the activities have also been reclassified or differ slightly from the previous consultation. In addition, some testing and training activities have been proposed to occur in other Study Area locations that were not included in the scope of the 1998 CZMA consultation.

3. The enclosed Draft PRC EIS and the project website (http://www.prceis.com) contain detailed information and analyses of potential impacts. The Navy reviewed the Maryland Coastal Zone Management Program in preparation of the enclosed Federal Consistency Determination. Based on the analyses, the Navy has determined that the Proposed Action within the PRC Study Area will be consistent to the maximum extent practicable with the policies of the Maryland Coastal Zone Management Program.

FEDERAL CONSISTENCY DETERMINATION FOR TESTING AND TRAINING ACTIVITIES IN THE PATUXENT RIVER COMPLEX

4. We request that the Maryland Department of the Environment provide its concurrence on our findings within 60 days of receipt of this letter. If a response has not been received by that time, concurrence with this finding will be presumed. My point of contact for this matter is Ms. Crystal Ridgell who may be reached at 301-757-5282 or crystal.l.ridgell@navy.mil.

Amy J. Markowich

AMY J. MARKOWICH
Executive Director
Naval Air Warfare Center Aircraft Division, DAiTA

Copy to: Commander, Navy Region Mid-Atlantic

FEDERAL CONSISTENCY DETERMINATION
TESTING AND TRAINING ACTIVITIES IN THE PATUXENT RIVER COMPLEX

INTRODUCTION

This document provides the State of Maryland with the United States (U.S.) Department of the Navy's (Navy) Consistency Determination under section 307(c)(1) of the Coastal Zone Management Act (CZMA) of 1972, as amended, and 15 Code of Federal Regulations [CFR] part 930, subpart C, for the proposed activities in the Patuxent River Complex (PRC) Study Area (Study Area).

The Navy analyzed the potential environmental impacts of all of its testing and training activities in Maryland, Virginia and Delaware in the *Final Environmental Impact Statement (EIS) for Increased Flight and Related Operations in the Patuxent River Complex, Patuxent River, Maryland* (December 1998), with the Record of Decision signed on May 17, 1999 (hereinafter referred to as the "1998 PRC EIS"). Concurrent with the development of the 1998 PRC EIS, the Navy also completed a Federal Consistency Determination on the same activities[1].

The 1998 PRC EIS served as the basis for the Navy's Federal Consistency Determinations for Operational Workload II, which was the Preferred Alternative. The activities analyzed in the current 2021 Draft PRC EIS are similar to what was described in the 1998 PRC EIS, with some activities increasing in scope and others decreasing. Some of the activities have also been reclassified or differ slightly from the previous Consistency Determination. In addition, some testing and training activities have been proposed in locations that were not included in the scope of the 1998 Federal Consistency Determination. This Federal Consistency Determination supplements the 1998 Consistency Determination to account for changes in the Navy's proposed testing and training activities necessary to meet mission needs.

As most of the activities proposed in the 2021 Draft EIS constitute a continuation of activities consulted on in the 1998 EIS, the potential effects to coastal resources are expected to be similar to those captured in the previous consultation. The Navy recognizes that, pursuant to 15 CFR part 930.31(e), activities already reviewed by the State of Maryland may be modified such that the potential effects to coastal resources may be substantially different than those previously reviewed. Although the Navy does not predict effects that are substantially different, the Navy is, as a matter of comity, electing to consult on changes to activities from the 1998 PRC EIS even when potential effects are expected to be the same or minimally different. In addition, the Navy is consulting on any new activities not included in the 1998 PRC EIS Federal Consistency Determination.

REGULATORY BACKGROUND INFORMATION

The CZMA, codified in 16 U.S. Code (U.S.C.) section 1451 et seq. established a comprehensive regulatory scheme for effective management, beneficial use, protection, and development of the coastal zone and its natural resources. CZMA encourages coastal states and provides a mechanism for them to develop, obtain federal approval for, and implement a broad-based coastal management program (CMP).

CZMA section 307 provides that federal agency activities shall be carried out in a manner, which is consistent to the maximum extent practicable with the enforceable policies of approved state

[1] Concurrence with the Navy's consistency determination for actions covered in the 1998 PRC EIS was received from Maryland, Virginia and Delaware.

management programs. Section 307 applies to federal agency activity in a state's coastal zone and also to federal agency activity outside the coastal zone, if the activity affects a land or water use in, or natural resources of, the coastal zone. Federal agency activity includes activity performed by a federal agency, approved by a federal agency, or for which a federal agency provides financial assistance. Such activity, whether direct, indirect, or cumulative, must be demonstrated to be consistent with the enforceable policies of the state's CMP, unless full consistency is otherwise prohibited by federal law (per 15 CFR part 930.32, "consistent to the maximum extent practicable"). The Navy's Proposed Action constitutes a direct federal action.

Description of the Proposed Federal Agency Action

The Navy has prepared a Draft PRC EIS to assess the environmental impacts associated with the continued conduct of military research, development, test and evaluation (hereinafter referred to as "testing") and training activities in the PRC Study Area (Figure 1). These military readiness activities are generally consistent with those analyzed in the 1998 PRC EIS (completed in December 1998; Record of Decision signed May 17, 1999) and are representative of essential testing and training that the Navy has been conducting in the PRC Study Area for decades. The Navy's Preferred Alternative in the Draft PRC EIS, and the alternative subject to the following Federal Consistency Determination, is Alternative 2.

Proposed activities are broadly categorized as aircraft flight activities, ground-based activities, or surface vessel activities. As the Navy's premier aircraft test range, flight activities are the most frequent and foremost performed within the PRC. The Naval Air Warfare Center Aircraft Division (NAWCAD) Naval Test Wing Atlantic and other squadrons home-based at Naval Air Station (NAS) Patuxent River (referred to collectively as tenant squadrons) conduct the majority of aircraft flights. Transient aircraft, not stationed at NAS Patuxent River, also utilize PRC airspace but on a much less frequent basis. Aircraft flight activities are further described in Draft PRC EIS Section 2.1.1.1. Ground-based activities include those performed by aircraft on the ground that are related to aircraft flights or non-flight tests that are conducted in specialized ground test facilities and laboratories. Ground-based activities are further described in Draft PRC EIS Section 2.1.1.2. Surface vessel activities involve the use of the Chesapeake Bay Water Range and its fixed target areas. The safe use of the target areas is largely achieved by NAWCAD Atlantic Targets and Marine Operations Division range support boats. Range support boats account for the majority of surface activities conducted within PRC waters and provide the services required to safely accomplish a testing or training event. Surface vessel activities are further described in Draft PRC EIS Section 2.1.1.3. These flight, ground-based, and surface vessel activities are further described later in this Consistency Determination and in greater detail in the Draft PRC EIS.

Project Location

PRC is based at NAS Patuxent River, located in Southern Maryland approximately 60 miles southeast of Washington, D.C. The 1998 PRC EIS defined the PRC as NAS Patuxent River and Outlying Field Webster flight and ground test facilities and airfields along with the Atlantic Test Range restricted airspace, Chesapeake Bay Water Range, and fixed target areas. This 2021 Draft PRC EIS expands the PRC Study Area to include land, water, and airspace historically and currently used by NAWCAD that were not assessed in the previous 1998 PRC EIS. These include Bloodsworth Island Range, waters beneath the restricted airspace outside the Chesapeake Bay Water Range, and surrounding Federal Aviation Administration airspace including Helicopter Operating Areas and Chessie Air Traffic Control Assigned Airspace. The PRC Study Area components are shown in Figure 1.

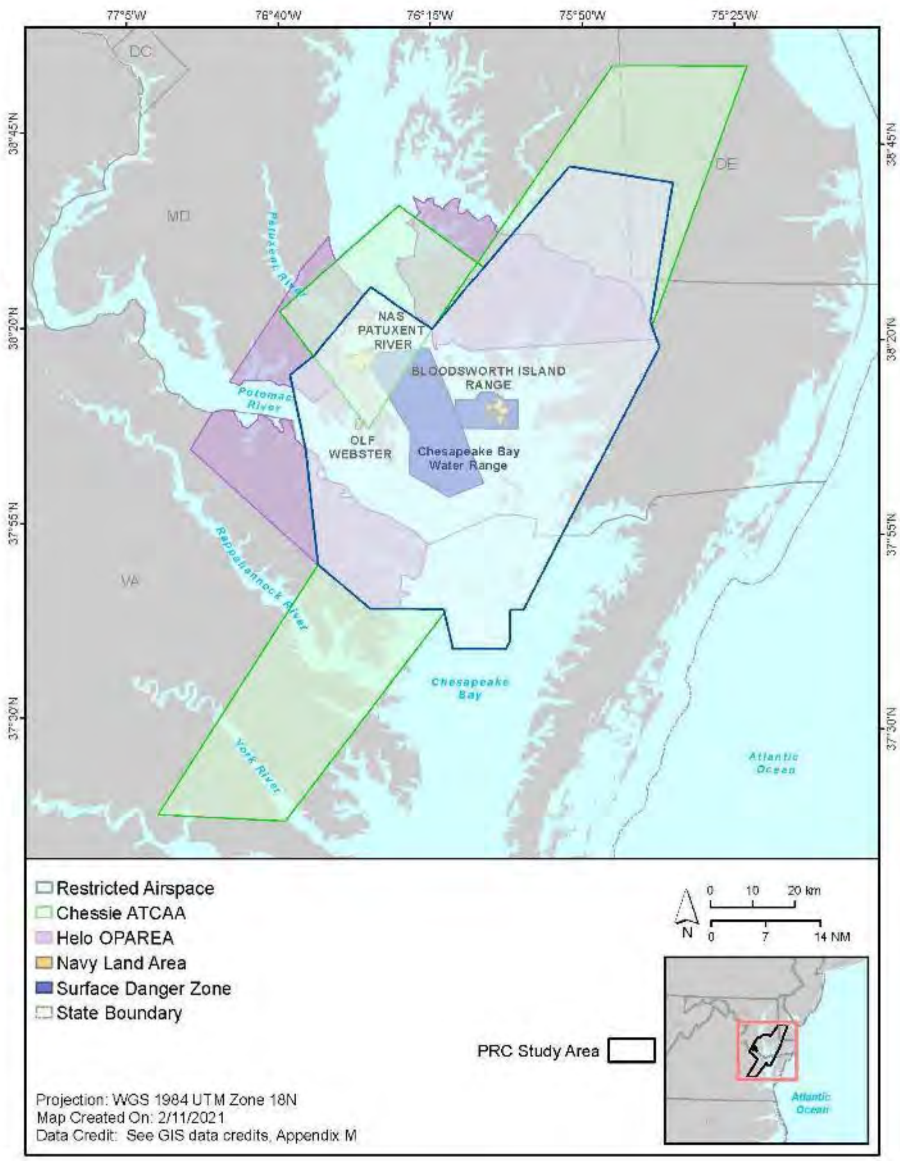

Figure 1 - Patuxent River Complex Study Area

Key: ATCAA = Air Traffic Control Assigned Airspace; OPAREA = Operating Area

Federal Consistency Determination for Maryland **Page 3**

To reflect the nature of Navy testing and training activities in the Study Area, the Navy identifies the locations of proposed activities. These activities and their locations are identified in Table 2.3-1 of Chapter 2 (Description of Proposed Action and Alternatives) of the Draft PRC EIS.

Testing and training activities would be conducted in areas appropriate for the type of activity based on operational and safety considerations. As noted and shown in Figure 1, the PRC Study Area spans across parts of the three states of Delaware, Virginia, and Maryland. To clarify which PRC testing and training activities occur within Maryland, the following is provided:

- All PRC testing and training activities which occur on land would occur in Maryland on the military installations of NAS Patuxent River and Outlying Field Webster.
- All PRC testing and training activities which occur on the water would occur in Maryland, primarily in the Chesapeake Bay Water Range and the waters offshore from NAS Patuxent River.
- Of the PRC testing and training activities which occur in special use airspace, approximately 90% would occur in the airspace over Maryland, and most of that restricted airspace is located over the Chesapeake Bay waters of Maryland.

DETERMINATION OF POTENTIAL EFFECTS

In accordance with 15 CFR part 930; subpart C, the Navy reviewed its Proposed Action and has determined that certain activities that will be conducted as part of the Proposed Action may have an effect on a coastal use or resource of the State of Maryland.

The Navy used a screening process to identify stressors[2] to environmental resources found in the PRC Study Area. Navy subject matter experts then studied the testing and training activities to identify specific stressors associated with each activity, which may have direct or indirect impacts on the environment. Not all stressors affect every resource, nor do all proposed Navy activities produce all stressors. Since the activities proposed are similar to the activities analyzed previously, the stressors considered are also similar. The analyses in the Draft PRC EIS were then used to determine if there would be effects to coastal zone resources.

Table 1 lists the environmental resources analyzed in the Draft PRC EIS and the stressors that could affect them. Details of the stressors associated with each of the proposed activities can be reviewed further in Section 3.0 (Introduction) of the Draft PRC EIS.

[2] Stressors are components of naval activities that could serve as stimuli or pose an opportunity to stress or otherwise affect different biological, physical, or human resources evaluated in the Draft EIS.

Table 1 - Stressors Analyzed in the Draft PRC EIS

Resource Areas	*Potential Stressors*						
	Acoustic	*Physical Disturbance and Strike*	*Pollutants*	*Public Interaction*	*Energy*	*Entanglement*	*Ingestion*
Ambient Airborne Noise	✓						
Air Quality			✓				
Water Quality and Sediments		✓	✓				
Biological Resources	✓	✓	✓		✓	✓	✓
Public Health and Safety	✓	✓		✓			
Land Use	✓						
Socioeconomics	✓			✓			
Environmental Justice	✓						
Cultural Resources	✓	✓					

Tables 2 and 3 list the annual operational tempo of proposed activities analyzed in the Draft PRC EIS by alternative (comparing the No Action Alternative and the Preferred Alternative under the 2021 Draft PRC EIS). Table 2 is organized by air activities (and air assets), land-based activities (and land-based assets), water-based activities (and water-based assets) according to the primary location in which they occur within the complex. The data categories include any new or expanded activities that were not included in the 1998 PRC EIS Consistency Determination and have the potential to affect coastal zone uses and resources as defined by the Maryland Coastal Zone Management Program.

Table 3 includes munitions, other military expended materials (MEM), and directed energy weapons systems by activity type for each of the alternatives. No explosive munitions are proposed under any alternative in the 2021 Draft PRC EIS.

Pursuant to guidance issued by the National Oceanographic and Atmospheric Administration, Navy activities that temporarily affect a coastal resource while that resource is outside of the coastal zone such that resource impacts are not felt within the coastal zone are not included. For Navy activities occurring outside the coastal zone, the likelihood that there will be an effect on resources of the coastal zone decreases with the distance of the activity from the coastal zone. An effect on a coastal resource has to be more than merely speculative, it must be reasonably foreseeable. Thus, even if certain activities have an effect on certain species, the distance of the activity from the coastal zone makes any effect to resources of the coastal zone highly speculative. The activities and locations where the activities typically occur are indicated in Tables 2 and 3. Testing and training activities would typically occur in portions of the PRC where they have historically occurred.

Table 2 - Annual PRC Operational Tempo per Alternative: Activities and Assets

Activity Name	*No Action Alternative*	*2021 Draft EIS Preferred Alternative (Alternative 2)*	*Location and Recovery Rate (as applicable)*
		Air-Based Activities	
Aircraft Flight Activities (# of Flight Hours)	20,100	26,000	*PRC Airspace* – restricted areas – 80%; Helicopter Operating Areas – 20%
Supersonic Activities (# of Events)	247	198	*PRC Airspace* – restricted areas – 98% R-4008 above 30,000 feet; greater than 2% below 30,000 feet weapons separation testing only; Chessie Air Traffic Control Assigned Airspace – 1 to 3 events per year
		Air-Based Assets	
Aerial (BQM) Targets (# of Targets)	3	6	*PRC Airspace* – launched from Armament Test Area; 100% recovered from CBWR
Unmanned Aerial Systems Targets[2] (# of Targets)	50	150	*PRC Airspace* – restricted areas – 65% over land areas; 35% over water areas (25% CBWR; 10% Bloodsworth Island Range Surface Danger Zone); 100% recovered from land; 40% recovered from water
		Land-Based Activities	
Aircraft Ground-Based Activities (# of Hours)	3,693	4,729	*PRC Land Areas and Facilities* – installation airfields flight line, taxiways, tarmacs, and hanger aprons
Outdoor Static Engine Runs (# of Events/Hours)	92	101	*PRC Land Areas and Facilities* – Open-Air Engine Test Cell Facility
Weapons Compatibility & Gun Fire Tests (# of Events)	11 gunfire 14 compatibility	13 gunfire 17 compatibility	*PRC Land Areas and Facilities* – Armament Test Area
		Land-Based Assets	
Ground Support Equipment (# of Hours)	47,894	58,763	*PRC Land Areas and Facilities* – on and around Installation airfields
Unmanned Ground Systems (# of Systems)	2	44	*PRC Land Areas and Facilities* – Installations (primarily Outlying Field Webster; previously disturbed approved areas)
		Water-Based Activities	
Anti-Submarine Warfare Systems Tests[2] (# of Events)	4 active 30 passive	39 active 35 passive	*PRC Water Areas* - sonar dip points

Table 2 - Annual PRC Operational Tempo per Alternative: Activities and Assets

Activity Name	*No Action Alternative*	*2021 Draft EIS Preferred Alternative (Alternative 2)*	*Location and Recovery Rate (as applicable)*
Mine Countermeasure Systems Tests[2] (# of Events)	22	26	*PRC Water Areas* – CBWR; installation surrounding waters
Water-Based Assets			
Vessels (# of Vessels)[1]	593	666	*PRC Water* Areas – CBWR – 85% to 90%; outside CBWR but still within PRC Study Area – 10% to 15%
Unmanned Maritime Systems (# of Systems)[3]	51	176	*PRC Water* Areas – primarily installation surrounding waters but also within the CBWR
Surface Targets (# of Targets)	476	539	*PRC Water* Areas – CBWR – 85% to 90%; Outside CBWR but still within PRC Study Area – 10% to 15%; mobile and stationary are 100% recovered; free floating or towed are 95% recovered
Subsurface Targets (# of Targets)	5	18	*PRC Water Areas* – CBWR; installation surrounding waters; 100% recovered

Key: CBWR = Chesapeake Bay Water Range; PRC = Patuxent River Complex.

Notes:

1. Includes one and two amphibious vehicles per alternative, respectively.
2. Associated aircraft flight hours are included in flight hour totals.
3. Includes one and two bottom crawlers or remotely operated vehicles per alternative, respectively; may rest or operate on seafloor bottom.

Table 3 - Annual PRC Operational Tempo per Alternative:
Number of Munitions, Other MEM, and Directed Energy Weapon Systems

Type	*No Action Alternative**	*2021 Draft EIS Preferred Alternative (Alternative 2)*	*Location and Recovery Rate (as applicable)*
		Test Flights	
Torpedoes	37	41	*PRC Water Areas* – CBWR; 80% recovered
Missiles	4	46	*PRC Water Areas* – CBWR; 55% recovered
Bombs	194	297	*PRC Water Areas* – CBWR; 0% recovered
Mines (Mine Laying)	16	202	
Rockets[1]	385	587	
Rockets (Flechette Warhead)	33	51	
Small-Caliber Gun Ammunition[1]	26,197	42,670	
Medium-Caliber Gun Ammunition[1]	8,539	17,922	
Chaff (Canisters [pounds])	96 (431)	217 (977)	
Flares (Decoys)	320	281	
Flares (Illumination)	47	41	
Dye Markers	37	41	
Launchers/Pods	7	15	
Signal Cartridges/ Spotting Charges	12	13	
Passive Sonobuoys	122	134	
Miscellaneous Items (Mass Equivalents and Fuel Tanks)	1	1	
Search & Rescue Rafts and Kits	2	17	*PRC Water Areas* – CBWR; 100% recovered
		Training Flights	
Bombs	2	3	*PRC Water Areas* – CBWR; 0% recovered
Chaff (Canisters [pounds])	25 (112)	54 (243)	
Flare (Illumination)	4	3	
Small-Caliber Gun Ammunition[1]	500	814	
		Other Flights	
Marine Markers	22**	37	*PRC Water Areas* – CBWR – 50%; Patuxent River Seaplane Area – 50%; 0% recovered
		Weapons Compatibility & Gun Fire Tests – Armament Test Area	
Chaff (# of Pounds)	81	94	Chaff are swept following events

Table 3 - Annual PRC Operational Tempo per Alternative:
Number of Munitions, Other MEM, and Directed Energy Weapon Systems

Type	*No Action Alternative**	*2021 Draft EIS Preferred Alternative (Alternative 2)*	*Location and Recovery Rate (as applicable)*
Cartridge Actuated Devices & Propellant Actuated Devices	513	593	100% recovered from ATA
Jet-Assisted Takeoff Bottles	6	12	*PRC Water Areas* – CBWR; 0% recovered
Rockets[1]	18	21	
Small-Caliber Gun Ammunition[1]	19,977	23,074	Expended into gun firing tunnel at ATA
Medium-Caliber Gun Ammunition[1]	2,430	2,807	
Surface and Subsurface Testing and Training			
Small-Caliber Gun Ammunition[1]	9,403	15,278	PRC Water Areas – CBWR; 0% recovered
Medium-Caliber Gun Ammunition[1]	422	943	
Mine Countermeasure Systems Tests			
Airborne Mine Neutralization System Neutralizers	2	5	*PRC Water Areas* – CBWR; 0% recovered
Anti-Submarine Warfare Systems Tests			
Active Sonobuoys	0	26	*PRC Water Areas* – sonar dip points; scuttled following events
Directed Energy Weapons Tests			
High-Energy Laser (# of Days)	0	50	*PRC Airspace, Land Areas, and Water Areas* – where hazard pattern can be contained within range and/or installation boundary and exclusive use airspace can be provided
High-Power Microwave (# of Days)	0	120	

Key: ATA = Armament Test Area; CBWR = Chesapeake Bay Water Range; DE = directed energy; MEM = military expended materials; PRC = Patuxent River Complex.

Notes:

1. Denotes live-fired non-explosive munition.

* No Action Alternative represents a 10-year average tempo (FY 2008-FY2017)

** Marine markers are 100% expended in the CBWR for No Action Alternative.

ASSESSMENT OF APPLICABILITY OF POLICIES OF THE MARYLAND COASTAL ZONE MANAGEMENT PROGRAM

The Maryland Coastal Zone Management Program is based on a network of agencies implementing a number of policies meant to protect and enhance the state's natural and economic resources. The Navy reviewed each of Maryland's enforceable policies and determined that ten are applicable to the Proposed Action. Table 4 presents the policies that the Navy has determined not to be applicable to the Navy's Proposed Action. Policies in Table 4 are not addressed further.

Table 4 - Enforceable Policies of Maryland's Coastal Area Management Program Not Applicable to the Proposed Action

Enforceable Policy	*Reason Policy is Not Applicable*
Core Policy 3. The unique ecological, geological, scenic, and contemplative aspects of State wild lands shall not be affected in a manner that would jeopardize the future use and enjoyment of those lands as wild.	The Proposed Action will not impact wild lands.
Core Policy 5. Any water appropriation must be reasonable in relation to the anticipated level of use and may not have an unreasonable adverse impact on water resources or other users of the waters of the State.	The Proposed Action does not require a groundwater appropriation or permit.
Core Policy 6. The natural character and scenic value of a river or waterway must be given full consideration before the development of any water or related land resources including construction of improvements, diversions, roadways, crossings, or channelization.	The Proposed Action does not involve development activities on rivers or waterways.
Core Policy 7. A dam or other structure that impedes the natural flow of a scenic or wild river may not be constructed, operated, or maintained, and channelization may not be undertaken	The Proposed Action does not include dam or structure development.
Core Policy 8. Permanent structures that do not have a clear environmental benefit are prohibited east of the dune line along the Atlantic Coast.	The Proposed Action does not include development of permanent structures.
Core Policy 9. Activities which will adversely affect the integrity and natural character of Assateague Island will be inconsistent with the State's Coastal Management Program, and will be prohibited.	The Proposed Action does not include activities that would affect Assateague Island and is not a prohibited activity as defined here.
Core Policy 10. An opportunity for a public hearing shall be provided for projects in non-tidal waters that dredge, fill, bulkhead, or change the shoreline; construct or reconstruct a dam; or create a waterway, except in emergency situations.	The Proposed Action does not include projects in non-tidal waters that will dredge, fill, bulkhead, or change the shoreline; construct or reconstruct a dam; or create a waterway.
Core Policy 11. Soil erosion shall be prevented to preserve natural resources and wildlife; control floods; prevent impairment of dams and reservoirs; maintain the navigability of rivers and harbors; protect the tax base, the public lands, and the health, safety and general welfare of the people of the State, and to enhance their living environment.	The Proposed Action does not include land-based projects and will not include soil erosion.
Core Policy 12. Controlled hazardous substances may not be stored, treated, dumped, discharged, abandoned, or otherwise disposed anywhere other than a permitted controlled hazardous substance facility or a facility that provides an equivalent level of environmental protection.	The Proposed Action does not include storing, treating, dumping, discharging, abandoning, or disposing controlled hazardous substances.
Core Policy 13. A person may not introduce in the Port of Baltimore any hazardous materials, unless the cargo is properly classed, described, packaged, marked, labeled, placarded, and approved for highway, rail, or water transportation.	The Proposed Action does not involve bringing cargo into the Port of Baltimore.

Enforceable Policy	*Reason Policy is Not Applicable*
Core Policy 14. Operations on the Outer Continental Shelf must be conducted in a safe manner by well trained personnel using technology, precautions, and techniques sufficient to prevent or minimize the likelihood of blowouts, loss of well control, fires, spillages, physical obstruction to other users of the waters or subsoil and seabed, or other occurrences which may cause damage to the environment or property, or which may endanger life or health.	The Proposed Action does not include oil and gas operations on the Outer Continental Shelf.
Water Quality Policy 3. The discharge of any pollutant, which will accumulate to toxic amounts during the expected life of aquatic organisms or produce deleterious behavioral effects on aquatic organisms is prohibited.	The Proposed Action does not involve effluent discharge as defined here.
Water Quality Policy 4. Before constructing, installing, modifying, extending, or altering an outlet or establishment that could cause or increase the discharge of pollutants into the waters of the State, the proponent must hold a discharge permit issued by the Department of the Environment or provide an equivalent level of water quality protection.	The Proposed Action does not include activities such as constructing, installing, modifying, extending, or altering an outlet or establishment.
Water Quality Policy 5. The use of best available technology is required for all permitted discharges into State waters	The Proposed Action does not include discharges as defined here.
Water Quality Policy 6. Thermal discharges shall be controlled so that the temperature outside the mixing zone (50 feet radially from the point of discharge) meets the applicable water quality criteria or discharges comply with the thermal mixing zone criteria.	The Proposed Action does not include thermal discharges.
Water Quality Policy 7. Pesticides shall be stored in an area located at least 50 feet from any water well or stored in secondary containment approved by the Department of the Environment.	The Proposed Action does not include pesticide use.
Water Quality Policy 8. Any development or redevelopment of land for residential, commercial, industrial, or institutional purposes shall use small-scale non-structural stormwater management practices and site planning that mimics natural hydrologic conditions, to the maximum extent practicable.	The Proposed Action does not include land-based development.
Water Quality Policy 9. Unless otherwise permitted, used oil may not be dumped into sewers, drainage systems, or any waters of the State or onto any public or private land.	The Proposed Action does not include dumping of oil.
Water Quality Policy 10. If material being dumped into Maryland waters or waters off Maryland's coastline has demonstrated actual toxicity or potential for being toxic, the discharger must perform biological or chemical monitoring to test for toxicity in the water.	The Proposed Action does not include dumping of toxic materials into Maryland waters.
Water Quality Policy 11. Public meetings and citizen education shall be encouraged as a necessary function of water quality regulation.	This policy is directed at a regulating body of the state.
Flood Hazard Policy 1. Projects in coastal tidal and non-tidal flood plains which would create additional flooding upstream or downstream, or which would have an adverse impact upon water quality or other environmental factors, are contrary to State policy.	The Proposed Action does not include relevant projects in coastal tidal or non-tidal flood plains which would impact flooding or water quality in the floodplain.

Enforceable Policy	*Reason Policy is Not Applicable*
Flood Hazard Policy 2. The following policies apply to projects in non-tidal waters and non-tidal floodplains, but not non-tidal wetlands. Proposed floodplain encroachments, except for roadways, culverts, and bridges, shall be designed to provide a minimum of 1 foot of freeboard above the elevation of the 100-year frequency flood event. In addition, the elevation of the lowest floor of all new or substantially improved residential, commercial, or industrial structures shall also be at least 1 foot above the elevation of the 100-year frequency flood event. Proposed unlined earth channels may not change the tractive force associated with the 2-year and the 10-year frequency flood events, by more than 10 percent, throughout their length unless it can be demonstrated that the stream channel will remain stable. Proposed lined channels may not change the tractive force associated with the 2-year and the 10-year frequency flood events, by more than 10 percent, at their downstream terminus unless it can be demonstrated that the stream channel will remain stable. Category II, III, or IV dams may not be built or allowed to impound water in any location where a failure is likely to result in the loss of human life or severe damage to streets, major roads, public utilities, or other high value property. Projects that increase the risk of flooding to other property owners are generally prohibited, unless the area subject to additional risk of flooding is purchased, placed in designated flood easement, or protected by other means acceptable to the Maryland Department of the Environment. The construction or substantial improvement of any residential, commercial, or industrial structures in the 100-year frequency floodplain and below the water surface elevation of the 100-year frequency flood may not be permitted. Minor maintenance and repair may be permitted. The modifications of existing structures for flood-proofing purposes may be permitted. Flood-proofing modifications shall be designed and constructed in accordance with specifications approved by the Maryland Department of the Environment. Channelization shall be the least favored flood control technique. Multiple purpose use shall be preferred over single purpose use, the proposed project shall achieve the purposes intended, and, at a minimum, project shall provide for a 50 percent reduction of the average annual flood damages.	The Proposed Action does not include relevant projects in coastal tidal and non-tidal flood plains.
Flood Hazard Policy 3. Development may not increase the downstream peak discharge for the 100-year frequency storm event in the following watersheds and all their tributaries: Gwynns Falls in Baltimore City and Baltimore County; and Jones Falls in Baltimore City and Baltimore County.	The Proposed Action does not include development activities.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 2. New facilities in the Critical Area shall not interfere with historic waterfowl concentration and staging areas.	The Proposed Action does not involve new facilities.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 3. Physical alterations to streams in the Critical Area shall not affect the movement of fish.	The Proposed Action does not involve physical alteration of streams.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 4. The installation or introduction of concrete riprap or other artificial surfaces onto the bottom of natural streams in the Critical Area is prohibited unless water quality and fisheries habitat will be improved.	The Proposed Action does not involve installation of rip rap or artificial surfaces in streams.

Enforceable Policy	*Reason Policy is Not Applicable*
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 5. The construction or placement of dams or other structures in the Critical Area that would interfere with or prevent the movement of spawning fish or larval forms in streams is prohibited.	The Proposed Action does not involve placement of dams or other structures in the Critical Area.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 6. Development may not cross or affect a stream in the Critical Area, unless there is no feasible alternative and the design and construction of the development prevents increases in flood frequency and severity that are attributable to development; retains tree canopy and maintains stream water temperature within normal variation; provides a natural substrate for affected streambeds; and minimizes adverse water quality and quantity impacts of stormwater.	The Proposed Action does not involve development.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 7. The construction, repair, or maintenance activities associated with bridges or other stream crossings or with utilities and roads, which involve disturbance within the buffer or which occur in stream are prohibited between March 1 and May 15.	The Proposed Action does not involve bridges or stream crossings.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 8. Roads, bridges, or utilities may not be constructed in any areas designated to protect habitat, including buffers, in the Critical Area, unless there is no feasible alternative and the road, bridge, or utility is located, designed, constructed, and maintained in a manner that maximizes erosion protection; minimizes negative impacts to wildlife, aquatic life, and their habitats; and maintains hydrologic processes and water quality.	The Proposed Action does not involve construction of road, bridges, or utilities.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 9. In the Critical Area, a minimum 100-foot vegetated buffer shall be maintained landward from the mean high water line of tidal waters, the edge of each bank of tributary streams, and the upland boundary of tidal wetlands. The buffer shall be expanded in sensitive areas in accordance with standards adopted by the Critical Area Commission. The buffer is not required for agricultural drainage ditches if the adjacent agricultural land has in place best management practices that protect water quality. The buffer is not required if existing patterns of development prevent the buffer from protecting ecological quality and functions, in which case, alternative means of protecting ecological quality and functions are required.	The Proposed Action does not involve land-based activities that would require a buffer.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 10. Disturbance to a buffer in the Critical Area is only authorized for a shore erosion control measure, new development, or redevelopment that is: water-dependent; meets a recognized private right or public need; minimizes the adverse effects on water quality and fish, plant, and wildlife habitat; and, insofar as possible, locates nonwater-dependent structures or operations associated with water-dependent projects or activities outside the buffer. Mitigation of impacts to the buffer and a buffer management plan must be developed in accordance with standards adopted by the Critical Area Commission when a development or redevelopment activity occurs within the buffer.	The Proposed Action does not involve land-based activities that would disturb buffers.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 11. If a development or redevelopment activity occurs on a lot or parcel that includes a buffer or if issuance of a permit, variance, or approval would disturb the buffer, the proponents of that activity must develop a buffer management plan that clearly indicates that all applicable planting standards developed by the Critical Area Commission will be met and that appropriate measures are in place for the long-term protection and maintenance of the buffer.	The Proposed Action does not involve development or redevelopment.

Enforceable Policy	*Reason Policy is Not Applicable*
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 12. Public beaches or other public water-oriented recreation or education areas including, but not limited to, publicly owned boat launching and docking facilities and fishing piers may be permitted in the buffer in portions of the Critical Area not designated as intensely developed areas only if adequate sanitary facilities exist; service facilities are, to the extent possible, located outside the Buffer; permeable surfaces are used to the extent practicable, if no degradation of ground water would result; and disturbance to natural vegetation is minimized.	The Proposed Action does not involve development.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 13. Water-dependent research facilities or activities may be permitted in the buffer, if nonwater-dependent structures or facilities associated with these projects are, to the extent possible, located outside the buffer.	The Proposed Action does not involve development.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 14. Industrial and port-related facilities may only be sited in the portions of areas of intense development that are exempted from buffer designation.	The Proposed Action does not involve industrial or port-related facilities.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 15. Agricultural activities are permitted in the buffer, if, as a minimum best management practice, a 25-foot vegetated filter strip measured landward from the mean high water line of tidal waters or tributary streams (excluding drainage ditches), or from the edge of tidal wetlands, whichever is further inland, is established in trees with a dense ground cover or a thick sod of grass.	The Proposed Action does not involve agricultural activities.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 16. The feeding or watering of livestock is not permitted within 50 feet of the mean high water line of tidal waters and tributaries.	The Proposed Action does not involve livestock.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 17. In the Critical Area, the creation of new agricultural lands shall not be accomplished by diking, draining, or filling of nontidal wetlands; by clearing of forests or woodland on soils with a slope greater than 15 percent or on soils with a "K" value greater than 0.35 and slope greater than 5 percent; by clearing that will adversely affect water quality or will destroy plant and wildlife habitat; or by clearing existing natural vegetation within the 100-foot buffer.	The Proposed Action does not involve agricultural activities.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 18. Agricultural activity permitted within the Critical Area shall use best management practices in accordance with a soil conservation and water quality plan approved or reviewed by the local soil conservation district.	The Proposed Action does not involve agricultural activities.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 19. Cutting or clearing of trees within the buffer is prohibited except that commercial harvesting of trees by selection or by the clearcutting of loblolly pine and tulip poplar may be permitted to within 50 feet of the landward edge of the mean high water line of tidal waters and perennial tributary streams, or the edge of tidal wetlands if the buffer is not subject to additional habitat protection. Commercial harvests must be in compliance with a buffer management plan that is prepared by a registered professional forester and is approved by the Department of Natural Resources.	The Proposed Action does not involve cutting or clearing trees.

Enforceable Policy	*Reason Policy is Not Applicable*
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 20. Commercial tree harvesting in the buffer may not involve the creation of logging roads and skid trails within the buffer and must avoid disturbing stream banks and shorelines as well as include replanting or allowing regeneration of the areas disturbed or cut in a manner that assures the availability of cover and breeding sites for wildlife and reestablishes the wildlife corridor function of the buffer.	The Proposed Action does not involve tree harvesting.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 21. Solid or hazardous waste collection or disposal facilities and sanitary landfills are not permitted in the Critical Area unless no environmentally acceptable alternative exists outside the Critical Area, and these facilities are needed in order to correct an existing water quality or wastewater management problem.	The Proposed Action does not involve waste collection or disposal.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 22. All available measures must be taken to protect the Critical Area from all sources of pollution from surface mining operations, including but not limited to sedimentation and siltation, chemical and petrochemical use and spillage, and storage or disposal of wastes, dusts, and spoils.	The Proposed Action does not involve surface mining.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 23. In the Critical Area, mining must be conducted in a way that allows the reclamation of the site as soon as possible and to the extent possible.	The Proposed Action does not involve mining.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 24. Sand and gravel operations shall not occur within 100 feet of the mean high water line of tidal waters or the edge of streams or in areas with scientific value, important natural resources such as threatened and endangered species, rare assemblages of species, or highly erodible soils. Sand and gravel operations also may not occur where the use of renewable resource lands would result in the substantial loss of forest and agricultural productivity for 25 years or more or would result in a degrading of water quality or a loss of vital habitat.	The Proposed Action does not involve sand and gravel operations.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 25. Wash plants including ponds, spoil piles, and equipment may not be located in the 100-foot buffer.	The Proposed Action does not involve wash plants.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 26. A soil erosion and sedimentation control plan shall be required whenever development within the Critical Area will involve any clearing, grading, transporting, or other form of disturbance to land by the movement of earth. This plan shall be appropriately designed to reduce adverse water quality impacts.	The Proposed Action does not involve development.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 27. All stormwater storage facilities shall be designed with sufficient capacity to eliminate all runoff caused by the development in excess of that which would have come from the site if it were in its predevelopment state.	The Proposed Action does not involve stormwater storage facilities.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 28. Intense development should be directed outside the Critical Area. Future intense development activities, when proposed in the Critical Area, shall be directed towards the intensely developed areas.	The Proposed Action does not involve development.

Enforceable Policy	*Reason Policy is Not Applicable*
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 29. The following development activities and facilities are not permitted in the Critical Area except in intensely developed areas and only after the activity or facility has demonstrated that there will be a net improvement in water quality to the adjacent body of water. Nonmaritime heavy industry Transportation facilities and utility transmission facilities, except those necessary to serve permitted uses, or where regional or interstate facilities must cross tidal waters Permanent sludge handling, storage, and disposal facilities, other than those associated with wastewater treatment facilities. However, agricultural or horticultural use of sludge when applied by an approved method at approved application rates may be permitted in the Critical Area, but not in the 100-foot Buffer.	The Proposed Action does not involve development.
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 30. The following policies apply in those areas of the Critical Area that are determined to be areas of intense development. To the extent possible, fish, wildlife, and plant habitats should be conserved. Development and redevelopment shall improve the quality of runoff from developed areas that enters the Chesapeake or Atlantic Coastal Bays or their tributary streams. At the time of development or redevelopment, appropriate actions must be taken to reduce stormwater pollution by 10%. Retrofitting measures are encouraged to address existing water quality and water quantity problems from stormwater. Development activities may cross or affect a stream only if there is no feasible alternative, and those activities must be constructed to prevent increases in flood frequency and severity attributable to development, retain tree canopy, maintain stream water temperatures within normal variation, and provide a natural substrate for affected streambeds. If practicable, permeable areas shall be established in vegetation. Areas of public access to the shoreline, such as foot paths, scenic drives, and other public recreational facilities, shall be maintained and, if possible, are encouraged to be established. Ports and industries which use water for transportation and derive economic benefits from shore access shall be located near existing port facilities or in areas identified by local jurisdictions for planned future port facility development and use if this use will provide significant economic benefit to the State or local jurisdiction. To the extent practicable, development shall be clustered to reduce lot coverage and maximize areas of natural vegetation. Development shall minimize the destruction of forest and woodland vegetation.	The Proposed Action does not involve land-based activities in areas of intense development.

Enforceable Policy	*Reason Policy is Not Applicable*
The Chesapeake and Atlantic Coastal Bays Critical Area Policy 31. The following policies apply in those portions of the Critical Area that are not areas of intense development. Development shall maintain, and if possible, improve the quality of runoff and ground water entering the Chesapeake and Coastal Bays. To the extent practicable, development shall maintain existing levels of natural habitat. All development sites shall incorporate a wildlife corridor system that connects undeveloped vegetated tracts onsite with undeveloped vegetated tracts offsite. All forests that are cleared or developed shall be replaced on not less than an equal area basis. If there are no forests on a proposed development site, the site shall be planted to provide a forest or developed woodland cover of at least 15 percent. Development on slopes equal to or greater than 15 percent, as measured before development, shall be prohibited unless the project is the only effective way to maintain the slope and is consistent with other policies. To the extent practicable, development shall be clustered to reduce lot coverage and maximize areas of natural vegetation. Lot coverage is limited to 15 percent of the site.	The Proposed Action does not include development activities.
Tidal Wetlands Policy 1. Any action which alters the natural character in, on, or over tidal wetlands; tidal marshes; and tidal waters of Chesapeake Bay and its tributaries, the coastal bays adjacent to Maryland's coastal barrier islands, and the Atlantic Ocean shall avoid dredging and filling, be water dependent, and provide appropriate mitigation for any necessary and unavoidable adverse impacts on these areas or the resources associated with these areas. MDE (B2) COMAR 26.24.01.01, COMAR 26.24.02.01, .03; COMAR 26.24.05.01.	The Proposed Action does not involve the alteration of tidal wetlands or the dredging or filling of a tidal wetland.
Non-Tidal Wetlands Policy 1. Removal, excavation, grading, dredging, dumping, or discharging of, or filling a non-tidal wetland with materials of any kind, including the driving of piles and placing of obstructions; changing existing drainage characteristics, sedimentation patterns, flow patterns, or flood retention characteristics; disturbing the water level or water table; or removing or destroying plant life that would alter the character of a non-tidal wetland is prohibited.	The Proposed Action does not involve removal, excavation, grading, dredging, dumping, or discharging of, or filling a non-tidal wetland with materials of any kind.
Forest Policies 1-6. Six forest policies identify measures established to ensure responsible forestry practices, preservation of existing forests, and timber plantings necessary to offset impacts from harvesting existing timber.	The Proposed Action does not involve forestry activities or impacts to forests.
Historical and Archaeological Sites Policy 3. Neither human remains nor funerary objects may be removed from a burial site or cemetery, unless permission is granted by the local State's Attorney. Funerary objects may not be willfully destroyed, damaged, or defaced.	The Proposed Action does not involve removal of human remains or funerary objects.
Living Aquatic Resources Policy 2. Fisheries shall be sustainably harvested.	The Proposed Action does not involve harvesting fish.
Living Aquatic Resources Policy 3. Any land or water resource acquired by the State to protect, propagate, or manage fish shall not be damaged.	The Proposed Action will not impact fish ponds or hatcheries.
Living Aquatic Resources Policy 4. No activity will be permitted that impedes or prevents the free passage of any finfish, migratory or resident, up or down stream.	The Proposed Action does not involve stream obstructions.

Enforceable Policy	*Reason Policy is Not Applicable*
Living Aquatic Resources Policy 5. All in-stream construction in non-tidal waters is prohibited from October through April, inclusive, for natural trout waters and from March through May, inclusive, for recreational trout waters. In addition, the construction of proposed projects, which may adversely affect anadromous fish spawning areas, shall be prohibited in non-tidal waters from March 15 through June 15, inclusive.	The Proposed Action does not involve in-stream construction.
Living Aquatic Resources Policy 6. Riparian forest buffers adjacent to waters that are suitable for the growth and propagation of self-sustaining trout populations shall be retained whenever possible.	The Proposed Action will not impact riparian forest buffers.
Living Aquatic Resources Policy 7. Projects in or adjacent to non-tidal waters shall not adversely affect aquatic or terrestrial habitat unless there is no reasonable alternative and mitigation is provided.	The Proposed Action will not impact non-tidal waters.
Living Aquatic Resources Policy 8. The harvest, cutting, or other removal or eradication of submerged aquatic vegetation may only occur in a strip up to 60 feet wide surrounding a pier, dock, ramp, utility crossing, or boat slip to point of ingress in a marina, otherwise the activity must receive the approval of the Department of Natural Resources. No chemical may be used for this purpose, and the timing and method of the activity shall minimize the adverse impact on water quality and on the growth and proliferation of fish and aquatic grasses.	The Proposed Action does not involve harvest, cutting, or other removal or eradication of submerged aquatic vegetation.
Living Aquatic Resources Policy 10. A person, other than the leaseholder, may not willfully and without authority catch oysters on any aquaculture or submerged land lease area, or willfully destroy or transfer oysters on this land in any manner.	The Proposed Action does not involve catching oysters.
Living Aquatic Resources Policy 11. An organism into which genetic material from another organism has been experimentally transferred so that the host acquires the genetic traits of the transferred genes may not be introduced into State waters.	The Proposed Action does not involve introducing organisms.
Living Aquatic Resources Policy 12. Vectors for the introduction of nonnative aquatic organisms must be appropriately controlled to prevent adverse impacts on aquatic ecosystems.	The Proposed Action does not involve introducing organisms.
Living Aquatic Resources Policy 13. Except as authorized by federal law, any live snakehead fish or viable eggs of snakehead fish of the Family Channidae may not be imported, transported, or introduced into the State.	The Proposed Action does not involve importing species.
Living Aquatic Resources Policy 14. Nonnative oysters may not be introduced into State waters.	The Proposed Action does not involve introducing species.
Mineral Extraction Policies 1-35. 35 policies are identified which limit the environmental, cultural, scenic, or recreational impacts that might occur as a result of mineral extraction activities.	The Proposed Action does not include any activities that involve mineral extraction.
Electrical Generation and Transmission Policies 1-5. Five policies are identified which limit the environmental, cultural, scenic, or recreational impacts that might occur as result of the construction of power plants and transmission lines. In addition, the construction of these facilities and appurtenances must consider ongoing operational costs post-construction and the impacts of overhead power lines on navigational interests.	The Proposed Action does not include any activities that involve electrical generation and transmission.
Tidal Shore Erosion Control Policies 1-7. Seven policies are identified which dictate the appropriate composition and type of fill material for shoreline erosion control structures along with best management practices to ensure stability of the structures.	The Proposed Action does not include tidal shore erosion control projects.

Enforceable Policy	*Reason Policy is Not Applicable*
Oil and Natural Gas Facilities Policies 1-6. Six policies are identified which detail standard practices targeted at preventing oil spills, providing financial assurances in case of spills, and limiting the transport of accidentally spilled oil into state waters.	The Proposed Action does not include oil and natural gas facilities.
Dredging and Disposal of Dredged Material Policies 1-13. 13 policies are identified which detail recommended protocols for designing dredging projects, time of year restrictions to avoid impacts to protected species and shellfish beds, and to properly reuse or dispose of dredged material.	The Proposed Action does not include dredging and disposal of dredged material.
Navigation Policy 1. Navigational access projects shall when possible be designed to use piers to reach deep waters rather than dredging.	The Proposed Action does not include navigational access projects.
Navigation Policy 2. Navigational access channels to serve individual or small groups of riparian landowners shall be designed to prevent unnecessary channels. A central access channel with short spur channels shall be considered over separate access channels for each landowner.	The Proposed Action does not include navigational access projects.
Navigation Policy 3. Navigational access channels shall be designed to minimize alteration of tidal wetlands and underwater topography.	The Proposed Action does not include navigational access projects.
Navigation Policy 4. New or expanded facilities for the mooring, docking, or storing of more than ten vessels on tidal navigable waters shall be located on waters with strong flushing characteristics and may not be located in areas where the natural depth is 4.5 feet or less at mean low water, and any of the following will be adversely affected: aquatic vegetation, productive macroinvertebrate communities, shellfish beds, fish spawning or nursery areas, rare, threatened, or endangered species, species in need of conservation, or historic waterfowl staging areas. Expansion of existing facilities is favored over new development.	The Proposed Action does not include new or expanded facilities for the mooring, docking, or storing of vessels.
Navigation Policy 5. The location of buoys for the mooring of boats shall not be located in designated private or public shellfish areas, cable-crossing areas, navigational channels, in other places in where general navigation would be impeded or obstructed, or public ship anchorage. The location of mooring buoys should not obstruct the riparian access of adjacent property owners or hinder the orderly access to or use of the waterways by the general public.	The Proposed Action does not include locating buoys for mooring boats.
Transportation Policies 1-5. Five policies are identified which seek to ensure public involvement in transportation project planning; consider social, environmental, and economic impacts of transportation projects; integrate consideration of different modes of transportation in order to ensure a unified regional transit system; and optimize access to and use of transportation facilities by pedestrians and bicycle riders.	The Proposed Action does not include transportation facilities projects or transportation development.
Agriculture Policies 1-5. Five policies are identified which seek to limit the amount of soil introduced into Maryland waters without proper planning; ensure implementation of best management practices to protect non-tidal wetlands and to limit livestock access to surface water; ensure utilization of chemical fertilizers, sludge, and animal manure in a manner that minimizes impacts on water quality; and to responsibly manage agricultural drainages.	The Proposed Action does not include agricultural or land management practices.
Development Policies 1-12. Twelve policies are identified with the general intent of minimizing erosion and sedimentation, to maintain water quality in surface and subsurface waters (including drinking water), to locate planned developments near existing or planned transit systems, and to protect community character and population centers.	The Proposed Action does not include any development or land-based projects.

Enforceable Policy	Reason Policy is Not Applicable
Sewage Treatment Policies 1-24. Twenty four policies are identified with the intent of protecting the quality of State waters from sewage discharges/treatment facilities for ecological and human health purposes.	These policies are specific to agricultural and silvicultural nonpoint source pollution, onsite sewage disposal systems, and underground storage tanks, which are not part of the Proposed Action.

Analysis of Enforceable Policies Applicable to the Proposed Action

The following policies of the Maryland Coastal Zone Management Program are applicable to the Proposed Action. The analysis of the policies below is only for those parts of the policies that are relevant to the Proposed Action. Furthermore, the analysis of each policy takes into consideration the Memorandum of Understanding between the State of Maryland and the U.S. Department of Defense (DoD), signed May 8, 2013. This agreement outlines protocols for treatment of certain issues dealing with compliance with the CZMA in Maryland.

Core Policy 1

It is State policy to maintain the degree of purity of the air necessary to protect the health, general welfare, and property of the people of the State. Maryland Department of the Environment (MDE) (C9) Maryland Code Annotated, Environment Article §§ 2-102 through 103.

Consistency Analysis

The proposed activities have the potential to result in minimal effects on air quality in the coastal zone from the use of non-explosive munition, surface vessel and aircraft activities. Aircraft and surface vessel emissions and byproducts of munitions could introduce contaminants into the air. Aircraft often conduct activities at altitudes that would not affect air quality in the coastal zone. Analysis in the Draft PRC EIS Section 3.2.3 (Environmental Consequences - Air Quality) concluded that changes in criteria air pollutant concentrations may be detectable but would not lead to a violation of air quality standards.

The Navy will be fully consistent with this policy.

Core Policy 2

The environment shall be free from noise which may jeopardize health, general welfare, or property, or which degrades the quality of life. MDE (C9) Code of Maryland Regulations (COMAR) 26.02.03.02, Environmental Noise Standards.

Consistency Analysis

The proposed activities have the potential to create noise in the coastal zone. Activities involving multiple or low-flying aircraft, multiple or nearshore vessels, and use of non-explosive munitions would generate noise of varying levels that have the potential to affect coastal zone uses and resources.

As written in Article II (Specific Maryland Enforceable Coastal Policies for the Purpose of Federal Consistency Determinations) Section 2.10 (General Policies: Core Policies – Noise) of the Memorandum of Understanding Between the State of Maryland and the U.S. DoD signed May 8, 2013, an agreement was entered to discount the noise of aircraft pertaining to this policy as stated below:

> "The DoD will demonstrate consistency with this Policy for new activities having a reasonably foreseeable effect on the Coastal Zone, other than aircraft operations. Compliance with internal

DoD and military service component noise abatement policies will be sufficient to demonstrate consistency with this Policy for such projects."

As the Memorandum of Understanding removes the requirement to analyze aircraft noise in this coastal consistency analysis, the discussions and findings presented below are those related to noise associated with surface vessel activities along with noise from the use of non-explosive munitions.

Section 3.7.3.3 (Socioeconomics, Alternative 2 [Preferred Alternative] Potential Impacts) of the Draft PRC EIS concluded that while noise interference could decrease public enjoyment of recreational activities, these disturbances would occur on a temporary basis when PRC vessel activities occur in support of testing and training. Since Navy activities in the Chesapeake Bay Water Range involving weapons firing would only occur when the Navy can confirm the area is clear of commercial and recreational boaters and other nonparticipants, there is a lessened likelihood that these activities involving vessel movements and non-explosive munitions would disturb the public. Furthermore, potential impacts to public health and safety are lessened by the Navy's standard operating procedures. The scheduling of testing and training activities is done in a manner in which interactions with commercial and recreational vessels and aircraft are avoided.

The Navy will be fully consistent with this policy.

Core Policy 4

The safety, order, and natural beauty of State parks and forests, State reserves, scenic preserves, parkways, historical monuments and recreational area shall be preserved. Maryland Department of Natural Resources (DNR) (B1) Maryland Code Annotated, Natural Resources Article § 5-209.

Consistency Analysis

On the occasions when the Navy plans activities that could conflict with public uses, the range is cleared prior to activities commencing. In this regard, the Navy adheres to standard operating procedures including procedures for range clearance and de-conflicting air and sea Space (See PRC EIS Table 2.5-1 Standard Operating Procedures). Activities occurring in the coastal zone would typically be of short duration (hours) and would only temporarily limit access to localized areas of the coastal zone to ensure public safety.

No State parks, forests, State reserves, scenic preserves, parkways, or historical monuments would be affected by the proposed activities.

The Navy will be fully consistent with this policy.

Historical and Archaeological Sites Policies 1 and 2

Unless permission is granted by the Maryland Historical Trust, activities that excavate, remove, destroy, injure, deface, or disturb submerged archaeological historic property, cave features, or archeological sites are generally prohibited. Maryland Department of Planning (C8) Maryland Code Annotated, State Finance and Procurement Article §§ 5A-341 through 343 and 333.

Consistency Analysis

The Navy routinely avoids locations of known obstructions, including submerged historic and cultural resources such as historic shipwrecks. Analysis in Section 3.9 (Cultural Resources) of the Draft PRC EIS concluded that testing and training activities with the potential to cause adverse effects to underwater cultural resources would be same as described in the 1998 PRC EIS. There are four non-target underwater cultural resources potentially eligible for the National Register of Historic Places (NRHP) in the Chesapeake Bay Water Range where vessel/target anchoring would occur and non-explosive munitions would be released and fall to the bay bottom. They include a World War II aircraft wreck (XF8F-1 Bearcat), Buoy 72A wreck, Cedar Point Schooner, and Cedar Point Barge. Although non-explosive MEM may potentially physically come in contact with in-water cultural resources such as shipwrecks, most non-explosive MEM are expended in the Chesapeake Bay Water Range and are focused around the munition concentration areas where there are no known cultural resources. Additionally, targets would not be placed in areas of in-water cultural resources, and therefore, continued use of the PRC Study Area would not affect underwater cultural resources that are potentially eligible for the NRHP. The Navy will consult with Maryland's State Historic Preservation Office to ensure compliance with Section 106 of the National Historic Preservation Act. If unrecorded submerged historic resources are discovered later, the Navy will reopen consultation.

Additionally, as written in Article II (Specific Maryland Enforceable Coastal Policies for the Purpose of Federal Consistency Determinations) Section 2.08 (Coastal Resources: Historical and Archaeological Sites) of the Memorandum of Understanding Between the State of Maryland and the U.S. DoD signed 8 May, 2013, an agreement was entered to state the following:

> "The DoD will continue to use procedures in accordance with the requirements of the National Historic Preservation Act that are consistent with Maryland's Historical Preservation Program. Maryland agrees that meeting the consultation requirement under the National Historic Preservation Act is sufficient to demonstrate consistency with Policies relating to historic preservation."

The Navy will be fully consistent with these policies.

Living Aquatic Resources Policy 1

Unless authorized by an Incidental Take Permit, no one may take a State-listed endangered or threatened species of fish or wildlife. DNR (A4) Maryland Code Annotated, Natural Resources Article §§ 4-2A-01 through 09; Maryland Code Annotated, Natural Resources Article §§ 10-2A-01 through 09.

Consistency Analysis

Navy activities must be conducted in accordance with applicable permits and authorizations granted under the federal Endangered Species Act (ESA) (16 U.S.C. section 1536) and Marine Mammal Protection Act (MMPA) (16 U.S.C. section 1371). Given established avoidance and mitigation measures described in the Draft PRC EIS Section 3.10 (Summary of Potential Impacts to Resources and Impact Avoidance and Minimization), the combined stressors of the Preferred Alternative will not result in the unintentional taking of one or more individual marine mammals that would require a take authorization pursuant to section 101(a)(5)(A) of the MMPA. No permits are required under the MMPA for this action. Pursuant to the ESA, the Navy is informally consulting with the U.S. Fish and Wildlife Service (USFWS) and formally consulting with the National Marine Fisheries Service (NMFS) with respect to species under their respective jurisdictions.

Thus, the Navy is consistent with this policy with respect to species also regulated by the ESA and MMPA. To the extent that state policies attempt to regulate the take of marine mammals protected by the MMPA, those policies are preempted by MMPA section 9(a), which explicitly prohibits any state from enforcing any law or regulation regarding the take of marine mammals. Additionally, the ESA does not contain a waiver of sovereign immunity, so states may not directly regulate federal activity via state laws protecting certain species. Furthermore, CZMA does not in and of itself authorize the application of state permit requirements to federal agencies. Based on the foregoing, the discussions below are provided for resources other than marine mammals.

Considering the aforementioned discussion regarding sovereign immunity and preemption, this Maryland CMP policy applies to state-listed or non-marine mammal species. Only those species upon which Navy activities may have a reasonably foreseeable effect should be considered with regard to this consultation.

There are 11 state-listed threatened or endangered plant species documented within the PRC installation boundaries. Of the state-listed threatened or endangered invertebrate species that may occur in the PRC Study Area, only the frosted elfin (*Incisalia irusirus*) (a butterfly) has actually been documented on PRC installations. The Proposed Action would have no effect on state-listed plant or invertebrate species.

The Navy has Integrated Natural Resources Management Plans (INRMPs) that cover NAS Patuxent River, Outlying Field Webster, and the Bloodsworth Island Range. The NAS Patuxent River Conservation Director is primarily responsible for implementing the INRMPs and coordinating with other personnel on the installation. The plans are reviewed in coordination with the U.S. Fish and Wildlife Service (USFWS) and the Maryland Department of Natural Resources (MDNR). Each year, the INRMPs and the projects contained within are reviewed and rated against established Navy metrics by the natural resources (NR) staff and State and Federal wildlife agencies.

There are no state-listed threatened or endangered fish species that are not also federally listed in the estuarine environment of the PRC Study Area, but there are some common state-managed species with commercial and/or recreational value (e.g., striped bass [*Morone saxatilus*], Atlantic menhaden [*Brevoortia tyrannus*], weakfish [*Cynoscion regalis*], Atlantic croaker [*Micropogonias undulatus*], spot [*Leiostomus xanthurus*], red drum [*Sciaenops ocellatus*], black drum [*Pogonias cromis*]).

State-listed amphibian species with the potential to be present in the PRC Study Area include the barking tree frog (*Hyla gratiosa*), eastern narrow-mouthed toad (*Gastrophryne carolinensis*), and the eastern tiger salamander (*Ambystoma tigrinum tigrinum*). Of these species, the eastern narrow-mouthed toad is confirmed present on NAS Patuxent River. None of the terrestrial reptiles and amphibians at this time have a federal ESA designation. There are no federally listed or state-listed terrestrial or freshwater mammals in the PRC Study Area.

The Navy testing and training activities under the Proposed Action would not result in purposeful take of state-listed species. Incidental take of state-listed species is not intended; however, it is not discountable. Due to the doctrine of Federal Sovereignty, the Navy is not obligated to obtain Maryland Incidental Take Permits. However, the Navy is consulting with the USFWS and NMFS regarding federally listed species (many of which are the same as the Maryland-listed species). Any best management practices or mitigations required or volunteered as a result of these consultations to reduce impacts would also apply to Maryland-listed species.

The Navy would reduce impacts to wildlife through adherence to standard operating procedures and mitigation measures. See PRC EIS Section 2.5 (Standard Operating Procedures included in the Proposed Action), specifically Table 2.5-1 Standard Operating Procedures; and Section 3.10 (Summary of Potential

Impacts to Resources and Impact Avoidance and Minimization), specifically Table 3.10-1 Impact Avoidance and Minimization Measures.

Based on the principles of sovereign immunity and preemption discussed earlier, the Navy will be consistent to the maximum extent practicable with Living Aquatic Resources Policy 1.

Living Aquatic Resources Policy 9

Natural oyster bars in the Chesapeake Bay shall not be destroyed, damaged, or injured.

Consistency Analysis

Navy testing and training activities in the PRC Study Area involve certain stressors which have the potential to affect natural oyster bars, including acoustic, physical disturbance and strike, pollutants, and ingestion stressors. Estuarine invertebrates including shellfish bed species (e.g., oysters, mussels) may detect low-frequency sounds generated by the proposed activities (e.g., weapons firing noise, sonic booms). Whereas responses of shellfish bed species to noise are not well documented, the highest intensity underwater noises they may experience could result in temporary shell closure, particular around Hannibal Target with weapons firing and supersonic weapons separation testing. Shellfish bed larvae looking for substrate may also prematurely settle in response to mid-frequency sonar sounds, but there are many factors weighing against any meaningful response. In either case, the exposure to potential acoustic stressors would be highly infrequent and localized. Other sources of underwater sounds, such as subsonic aircraft and vessel noise, are even less impactful on shellfish beds because they rise and fall slowly at lower intensities.

Impacts to shellfish bed essential fish habitat would be insignificant as they are highly unlikely to rise to the level of measurable impacts. Because impacts, if any, are expected to be minor and limited, no long-term consequences for the population of shellfish bed species present in the PRC Study Area are expected.

As with bottom substrates, physical disturbances and strikes of hard biotic habitat features by vessels or in-water devices would cause damage to the vessel and are avoided when possible. Natural oyster reefs are vulnerable to physical disturbance that may not be avoided using standard operating procedures; and the habitat could be damaged or disturbed during vessel operation without significant damage to a vessel. Whereas habitat areas set aside for restoration are often marked or located below navigation clearance, natural beds may not be visible and avoidable from the perspective of surface observers on a moving vessel. Whereas these shallow-water habitats would likely be avoided when transiting along established navigation corridors, they may not be avoidable during operation outside of established navigation channels.

The mostly intertidal oysters located very close to shore in the PRC Study Area are relatively unaffected by the unlikely event of vessel scarring or disturbance due to their location and hard/more resilient nature. Vessel scarring has also not been implicated in the primary stressors on oyster habitat: overharvesting and disease are far more pressing issues. Natural oyster or mussel habitats not marked as obstructions may be adversely impacted if vessel operations call for "nosing up" on a shoreline, but the vessels would be moving slower on approach and should be able to avoid structures that could damage the vessel. The oyster beds/reefs mapped in the study area are located relatively close to shore and a measureable adverse impact from transiting is therefore not expected. Submerged oyster and mussel beds associated with obstructions in the PRC Study Area should be relatively unaffected by vessel scarring or disturbance due to general avoidance of vessel damage and the absence of obstructions classified as dangerously "awash" or covered/uncovered with the tides.

Oysters, comprising most shellfish beds in the PRC Study Area, are filter-feeding organisms capable of collecting suspended material pieces that are very small or microscopic. For shellfish bed essential fish habitat, the only MEM of ingestible size for shellfish beds (other than microplastics) is microscopic fragments released as larger expended material degrades; chaff fibers were discounted as an impact on biological resources. The analysis regarding filter-feeding invertebrates in general supports a minimal and temporary adverse effect on shellfish bed essential fish habitat from ingestion stressors associated with the proposed activities; shellfish bed invertebrates may be affected by ingestible MEM fragments, but no population-level effects are anticipated.

The Navy will be consistent to the maximum extent practicable with Living Aquatic Resources Policy 9.

Navigation Policy 6

Vessels operated on State waters should not exceed a noise level of 90 A-weighted decibels (dBA). DNR (A1); COMAR 08.18.03.03.

Consistency Analysis

The proposed activities require that vessels transit the Maryland coastal zone. Vessels transiting through or conducting testing and training activities in the coastal zone have the potential to exceed a noise level of 90 dBA. Although this state law does not apply to federal public vessels, noise levels greater than 90 dBA could be generated by the propulsion of Navy vessels when in Maryland's waters. Proposed activities generating high levels of noise would be of short duration (hours). Analysis in the Draft PRC EIS Section 3.0.2.3.1.2 (Vessels and Other Water-Based Assets) describes vessel noise and noise generated in connection with other water-based assets in detail. Airborne noise generated by Navy vessel operations is similar to noise levels generated by civilian vessels, which operate regularly in the same water areas. Airborne vessel sound levels depend on vessel size and speed, but typically range from 59 to 73 decibels reference sound pressure 20 microPascals (dB re 20 μPa) at locations on the deck of the boat.

The Navy will be consistent to the maximum extent practicable with this policy.

Water Quality Policy 1

No one may add, introduce, leak, spill, or emit any liquid, gaseous, solid, or other substance that will pollute any waters of the State without State authorization. MDE (A5) Maryland Code Annotated, Environmental Article §§ 4-402, 9-101, 9-322.

Consistency Analysis

The proposed activities have the potential to impact water quality. Impacts could result from munitions use, and use of MEM. The proposed activities have the potential to impact water quality through the introduction of MEM constituents into the aquatic environment. Contaminants would remain near the release site and dilute within a short period of time, and would have no long-term effects on water quality. Analysis in Section 3.3 (Water Resources and Sediments) of the Draft PRC EIS concluded that the

Proposed Action would result in minor, localized, and short-term increases in turbidity associated with resuspended sediments from physical disturbances to bottom sediments. These physical disturbances could occur from initial impact and recovery of munitions and other MEM from the Bay floor as well as from anchor deployments and similar activities. In addition, proposed testing and training activities would result in a minor potential for releases of MEM constituents, but these releases are not expected to exceed water quality criteria or sediment guidelines. Pollutant stressors would not adversely affect designated beneficial use or pose unacceptable risks to human health or the environment.

The Navy will be fully consistent with this policy.

Water Quality Policy 2

All waters of the State shall be protected for water contact recreation, fish, and other aquatic life and wildlife. Shellfish harvesting and recreational trout waters and waters worthy of protection because of their unspoiled character shall receive additional protection. MDE (A1); COMAR 26.08.02.02.

Consistency Analysis

As discussed above in the analysis of Water Quality Policy 1, the Proposed Action would not violate federal water quality standards and any minor and temporary changes to water quality would not have indirect impacts on biological resources such as aquatic species or associated recreational pursuits.

The Navy will be fully consistent with this policy.

The Chesapeake and Atlantic Coastal Bays Critical Area Policy 1

Colonial water bird nesting sites in the Critical Area may not be disturbed during breeding season. CAC (C9) COMAR 27.01.09.04.

Consistency Analysis

There are no known rookeries at present on either NAS Patuxent River, Outlying Field Webster, or Naval Recreation Center Solomons. However, there are several colonial water bird nesting sites within the Critical Area portions of PRC Study Area (on Chesapeake Bay islands). These include a mixed heronry on Bloodsworth Island where Great Blue Herons, but also some Black-crowned Night-herons and Yellow-crowned Night-herons gather during breeding season. In past decades, the heronry also hosted Great Egrets, Snowy Egrets, Cattle Egrets, Little Blue Herons, Tricolored Herons, Green Herons, and Glossy Ibises. Additionally, there is a large nesting colony on Adam Island for Brown Pelicans, Double-crested Cormorants, Great Black-backed Gulls, and Herring Gulls. The Navy manages these properties in accordance with the INRMP for the Naval Air Station Patuxent River Complex, Bloodsworth Island Range, Maryland. The INRMP is prepared and reviewed in coordination with the U.S. Department of the Interior, Fish and Wildlife Service, and Maryland Department of Natural Resources.

The Navy continues to voluntarily cease land impact operations at Bloodsworth Island Range, including the dropping of live or non-explosive ordnance. The proposed testing and training activities which could have the potential to disturb the colonial water bird nesting sites (from noise) are those overflights by performed by military aircraft. Aircraft testing and training is conducted in the special use airspace overlying Bloodsworth Island Range. Range operations can include: aircraft performance evaluation tests, propulsion systems tests, aircrew system tests, mission system tests, electronic warfare, and flight crew proficiency tests. However, under existing mitigation measures implemented by the Atlantic Test Ranges Sustainability Office, potential impacts to colonial bird nesting sites are minimized. These measures include noise awareness briefings to educate aircrews of noise sensitive locations, and test plan environmental reviews. Additionally, heron sites are shown on INRMP maps and the depicted typical aircraft flight patterns avoid direct overhead flights of the heron sites.

The Navy will be consistent to the maximum extent practicable with this policy.

CONCLUSION

The Navy has reviewed Maryland's Coastal Zone Management Program and determined that ten policies are applicable to the Proposed Action, as analyzed above. As described in Table 4, all other policies do not apply to the proposed activities.

The Navy reviewed its proposed activities for how and to what degree the activities in or near the coastal zone could affect Maryland's coastal uses and resources. Potential impacts could result from activities occurring in the PRC Study Area. The Navy would reduce unavoidable impacts from proposed activities on coastal zone uses and resources by adhering to standard operating procedures (PRC EIS Table 2.5-1 Standard Operating Procedures) and implementing environmental mitigation measures (Table 3.10-1 of the Draft PRC EIS). Analysis in Chapter 3 (Affected Environment and Environmental Consequences) of the Draft PRC EIS addresses potential impacts on environmental resources in greater detail.

The Navy will be consistent to the maximum extent practicable with the policies of the Maryland Coastal Zone Management Program.

F.2 Coastal Consistency Determination for Virginia

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
22347 CEDAR POINT ROAD UNIT 6
PATUXENT RIVER MARYLAND 20670-1161

7594
Ser: 047.21
22 March 2021

From: Executive Director, Data Analytics, Infrastructure and Technology Advancement Group
To: Virginia Coastal Zone Management Program, Department of Environmental Quality, P.O. Box 1105, Richmond, VA, 23218, Attn: Ms. Bettina Rayfield

Subj: FEDERAL CONSISTENCY DETERMINATION FOR TESTING AND TRAINING ACTIVITIES IN THE PATUXENT RIVER COMPLEX

Encl: (1) Public Release Version of 2021 PRC EIS (CD)
(2) Federal Consistency Determination

1. In accordance with the Coastal Zone Management Act (16 United States Code § 1456(c) and 15 Code of Federal Regulations Part 930, Subpart C), the United States Department of the Navy (Navy) requests concurrence with its Federal Consistency Determination for proposed activities in the Patuxent River Complex (PRC) Study Area. The Navy previously analyzed the potential environmental impacts of its testing and training activities in the PRC in a 1998 *Final Environmental Impact Statement (EIS) for Increased Flight and Related Operations in the Patuxent River Complex*. The Navy also conducted a Coastal Zone Management Act (CZMA) consultation for these activities in 1998. The Navy has begun the next phase of PRC planning and has analyzed the potential environmental impacts of proposed testing and training activities in the *Testing and Training Activities in the Patuxent River Complex Draft EIS* found at http://www.prceis.com.

2. Activities for this latest iteration of PRC planning are similar to what was described in the 1998 PRC EIS, with some activities increasing in scope and others decreasing. Some of the activities have also been reclassified or differ slightly from the previous consultation. In addition, some testing and training activities have been proposed to occur in other Study Area locations that were not included in the scope of the 1998 CZMA consultation.

3. The enclosed Draft PRC EIS and the project website (http://www.prceis.com) contain detailed information and analyses of potential impacts. The Navy reviewed the Virginia Coastal Zone Management Program in preparation of the enclosed Federal Consistency Determination. Based on the analyses, the Navy has determined that the Proposed Action

FEDERAL CONSISTENCY DETERMINATION FOR TESTING AND TRAINING ACTIVITIES IN THE PATUXENT RIVER COMPLEX

within the PRC Study Area will be consistent to the maximum extent practicable with the policies of the Virginia Coastal Zone Management Program.

4. We request that the Virginia Department of Environmental Quality provide its concurrence on our findings within 60 days of receipt of this letter. If a response has not been received by that time, concurrence with this finding will be presumed. My point of contact for this matter is Ms. Crystal Ridgell who may be reached at 301-757-5282 or crystal.l.ridgell@navy.mil.

Amy J. Markowich

AMY J. MARKOWICH
Executive Director
Naval Air Warfare Center Aircraft Division, DAiTA

Copy to: Commander, Navy Region Mid-Atlantic

FEDERAL CONSISTENCY DETERMINATION
TESTING AND TRAINING ACTIVITIES IN THE PATUXENT RIVER COMPLEX

Introduction

This document provides the Commonwealth of Virginia with the United States (U.S.) Department of the Navy's (Navy) Consistency Determination under section 307(c)(1) of the Coastal Zone Management Act (CZMA) of 1972, as amended, and 15 Code of Federal Regulations [CFR] part 930, subpart C, for the proposed activities in the Patuxent River Complex (PRC) Study Area (Study Area).

The Navy analyzed the potential environmental impacts of all of its testing and training activities in Maryland, Virginia and Delaware in the *Final Environmental Impact Statement (EIS) for Increased Flight and Related Operations in the Patuxent River Complex, Patuxent River, Maryland* (December 1998), with the Record of Decision signed on May 17, 1999 (hereinafter referred to as the "1998 PRC EIS"). Concurrent with the development of the 1998 PRC EIS, the Navy also completed a Federal Consistency Determination on the same activities[1].

The 1998 PRC EIS served as the basis for the Navy's Federal Consistency Determinations for Operational Workload II, which was the Preferred Alternative. The activities analyzed in the current 2021 Draft PRC EIS are similar to what was described in the 1998 PRC EIS, with some activities increasing in scope and others decreasing. Some of the activities have also been reclassified or differ slightly from the previous Consistency Determination. In addition, some testing and training activities have been proposed in locations that were not included in the scope of the 1998 Federal Consistency Determination. This Federal Consistency Determination supplements the 1998 Consistency Determination to account for changes in the Navy's proposed testing and training activities necessary to meet mission needs.

As most of the activities proposed in the 2021 Draft EIS constitute a continuation of activities consulted on in the 1998 EIS, the potential effects to coastal resources are expected to be similar to those captured in the previous consultation. The Navy recognizes that, pursuant to 15 CFR part 930.31(e), activities already reviewed by the Commonwealth of Virginia may be modified such that the potential effects to coastal resources may be substantially different than those previously reviewed. Although the Navy does not predict effects that are substantially different, the Navy is, as a matter of comity, electing to consult on changes to activities from the 1998 PRC EIS even when potential effects are expected to be the same or minimally different. In addition, the Navy is consulting on any new activities not included in the 1998 PRC EIS Federal Consistency Determination.

The Navy is submitting a separate Federal Consistency Determination to the Maryland Department of the Environment for effects to Maryland coastal uses and resources. The Navy is submitting a separate Coastal Consistency Negative Determination to the Delaware Department of Natural Resources and Environmental Control. The proposed activities in Delaware will not have any reasonably foreseeable effects on Delaware's coastal uses or resources and is therefore consistent with the enforceable policies of the Delaware Coastal Management Program.

[1] Concurrence with the Navy's consistency determination for actions covered in the 1998 PRC EIS was received from Maryland, Virginia and Delaware.

Regulatory Background Information

The CZMA, codified in 16 U.S. Code (U.S.C.) section 1451 et seq. established a comprehensive regulatory scheme for effective management, beneficial use, protection, and development of the coastal zone and its natural resources. CZMA encourages coastal states and provides a mechanism for them to develop, obtain federal approval for, and implement a broad-based coastal management program (CMP).

CZMA section 307 provides that federal agency activities shall be carried out in a manner, which is consistent to the maximum extent practicable with the enforceable policies of approved state management programs. Section 307 applies to federal agency activity in a state's coastal zone and also to federal agency activity outside the coastal zone, if the activity affects a land or water use in or natural resources of the coastal zone. Federal agency activity includes activity performed by a federal agency, approved by a federal agency, or for which a federal agency provides financial assistance. Such activity, whether direct, indirect, or cumulative, must be demonstrated to be consistent with the enforceable policies of the state's CMP, unless full consistency is otherwise prohibited by federal law (per 15 CFR part 930.32, "consistent to the maximum extent practicable"). The Navy's Proposed Action constitutes a direct federal action.

Description of the Proposed Federal Agency Action

The Navy has prepared a Draft PRC EIS to assess the environmental impacts associated with the continued conduct of military research, development, test and evaluation (hereinafter referred to as "testing") and training activities in the PRC Study Area (Figure 1). The Navy's Preferred Alternative in the Draft EIS, and the alternative subject to the following Federal Consistency Determination, is Alternative 2. Proposed activities are broadly categorized as aircraft flight activities, ground-based activities, or surface vessel activities. As the Navy's premier aircraft test range, flight activities are the most frequent and foremost performed within the PRC. The Naval Air Warfare Center Aircraft Division (NAWCAD) Naval Test Wing Atlantic and other squadrons home-based at Naval Air Station (NAS) Patuxent River (referred to collectively as tenant squadrons) conduct the majority of aircraft flights. Transient aircraft, not stationed at NAS Patuxent River, also utilize PRC airspace but on a much less frequent basis. Aircraft flight activities are further described in Draft PRC EIS Section 2.1.1.1. Ground-based activities include those performed by aircraft on the ground that are related to aircraft flights or non-flight tests that are conducted in specialized ground test facilities and laboratories at NAS Patuxent River in Maryland. Ground-based activities are further described in Draft PRC EIS Section 2.1.1.2. Surface vessel activities involve the use of the Chesapeake Bay Water Range and its fixed target areas, also located in Maryland. The safe use of the target areas is largely achieved by NAWCAD Atlantic Targets and Marine Operations Division range support boats. Range support boats account for the majority of surface activities conducted within PRC waters and provide the services required to safely accomplish a testing or training event. Surface vessel activities are further described in Draft PRC EIS Section 2.1.1.3.

It is important to note that of the PRC testing and training activities, only aircraft flights are planned to occur over Virginia's designated Coastal Zone. The Navy considered all actions occurring outside of the Virginia coastal zone (e.g., in neighboring Maryland), and none of those activities (i.e., ground based activities at NAS Patuxent River and Outlying Field Webster; and water-based activities occurring in the

Chesapeake Bay Water Range in Maryland and points further north in the bay offshore from NAS Patuxent River) were considered to have a reasonably foreseeable effect on Virginia's coastal uses or resources.

Aircraft flight activities are further described in Tables 1 and 2 of this consistency determination and in detail in Chapter 2 of the Draft PRC EIS. Of the flight activities included in the Proposed Action, only a small fraction occur in the airspace over Virginia's coastal zone. Approximately 90% of all flight activities occur over Maryland. Aircraft overflights in Virginia's coastal zone include those by fixed wing and rotary wing aircraft. Sound generated during aircraft overflights are the focus of this CCD in terms of reasonable foreseeable effects on Virginia's coastal uses or resources.

Project Location

The PRC is based at NAS Patuxent River, located in Southern Maryland approximately 60 miles southeast of Washington, D.C. The 1998 PRC EIS defined the PRC as NAS Patuxent River and Outlying Field Webster flight and ground test facilities and airfields along with the Atlantic Test Ranges (ATR) restricted airspace, Chesapeake Bay Water Range, and fixed target areas. This 2021 Draft PRC EIS expands the PRC Study Area to include land, water, and airspace historically and currently used by NAWCAD that were not assessed in the previous 1998 PRC EIS. These include Bloodsworth Island Range, waters beneath the restricted airspace outside the Chesapeake Bay Water Range, and surrounding Federal Aviation Administration (FAA) airspace including Helicopter Operating Areas (Helo OPAREAs) and Chessie Air Traffic Control Assigned Airspace (ATCAA). The PRC Study Area components are shown in Figure 1.

NOTE: Of the Study Area components shown on Figure 1, only portions of the ATR restricted airspace, Helo OPAREAs, and the Chessie ATCAA overlay Virginia's designated Coastal Zone.

These areas are further described on the following pages.

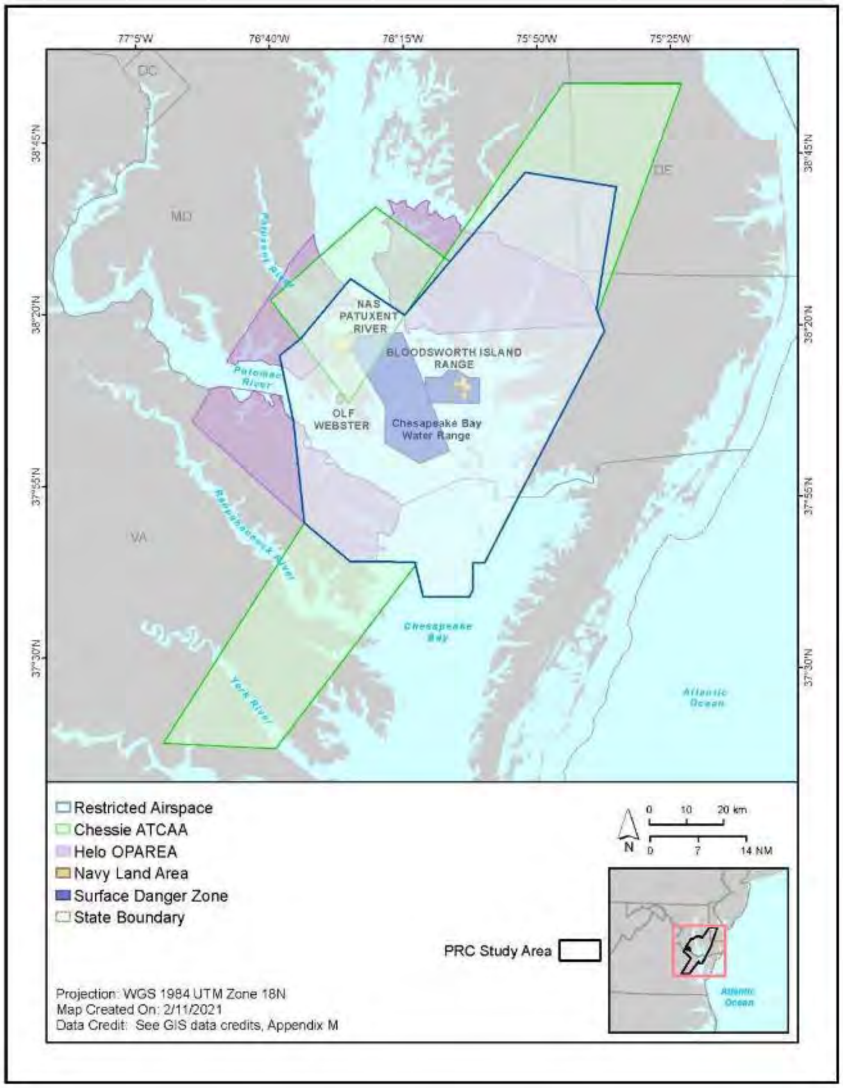

Figure 1 - PRC Study Area

Key: ATCAA = Air Traffic Control Assigned Airspace; OPAREA = Operating Area

To reflect the nature of Navy testing and training activities in the Study Area, the Navy identified the locations of proposed activities. These activities and their locations are identified in Table 2.3-1 of Chapter 2 (Description of Proposed Action and Alternatives) of the Draft EIS. Testing and training activities would be conducted in areas appropriate for the type of activity based on operational and safety considerations.

PRC Airspace

The FAA regulates and promotes safety of navigation for civil and military aircraft in U.S. airspace. Special Use Airspace (SUA) is designated by the FAA where activities must be confined because of their nature, where limitations are imposed upon aircraft that are not a part of those activities, or both. SUA is primarily established for military flight operations and may be used for commercial or general aviation when not reserved for military use. The proposed action does not involve any changes to the boundaries or dimensions of existing SUA.

Restricted airspace is a type of SUA within which the flight of aircraft, while not entirely prohibited, is subject to restriction. Restricted airspace is designated where operations are hazardous to nonparticipating aircraft and, when active; the nonparticipating aircraft are prohibited from entering unless the operator (or pilot) has advance permission from the controlling or using agency. For ATR restricted airspace, the FAA is the controlling agency that delegates permission to NAS Patuxent River Air Traffic Control (ATC) as the using agency. Figure 2 shows the PRC special use and shared airspace where the Navy conducts testing and training.

Restricted Airspace

ATR restricted airspace overlies approximately 2,352 square miles (1,800 square nautical miles) of Southern Maryland, the Eastern Shore of Maryland, the Northern Neck of Virginia, and southwest Delaware. Approximately 50 percent of the airspace is over the waters of the middle Chesapeake Bay while the remaining 50 percent is over land. The airspace comprises six restricted areas with a vertical extent spanning from surface level up to 85,000 feet with some overlapping in altitude. The specific restricted airspace units overlying Virginia are portions of R-4005, R-4006, R-4008, and R-6609. The Navy requests and receives permission from the FAA to use the restricted airspace daily. During the time the airspace is in use (i.e., activated), the ATR military radar unit, Baywatch, provides restricted area containment surveillance under the supervision of NAS Patuxent River ATC. Restricted airspace is typically activated between 7:00 a.m. to 11:00 p.m. on weekdays and 8:00 a.m. to 6:00 p.m. on weekends. When not activated, the airspace is released back to FAA for command and control and may be used for commercial or general aviation.

Helicopter Operating Areas

Adjacent to PRC restricted airspace are FAA Class E airspaces referred to in the *NAS Patuxent River Air Operations Manual* as the East, West, and South Helo OPAREAs. These areas are located over portions of the Eastern Shore of Maryland, Southern Maryland, and the Northern Neck of Virginia, respectively, with perimeters bound by the extent of the NAS Patuxent River Terminal Radar Approach Control and other geographic features. The one Helo OPAREA overlying Virginia is the South Helo OPAREA. Although called Helo OPAREAs for airspace management purposes, they are shared with private and commuter aircraft and used by Navy rotary wing as well as small, fixed-wing propeller aircraft to conduct lower altitude operations that do not require restricted airspace.

Chessie Air Traffic Control Assigned Airspace

Chessie ATCAA is a type of SUA that is part of the national FAA Class A airspace structure. The ATCAA was assigned to and developed exclusively for NAS Patuxent River ATC to provide air traffic segregation between Navy aircraft testing within this FAA airspace and other air traffic flying under instrument flight rules. Contiguous with PRC restricted airspace, Chessie is subdivided into A, B, and C, with Chessie A and B altitudes ranging 27,000 to 41,000 feet and Chessie C 18,000 to 50,000 feet. The one Chessie ATCAA overlying Virginia is Chessie B. The airspace accommodates flight tests that do not fit within the confines of the restricted airspace due to specific altitude and headings required to maximize tracking time and test points at supersonic speeds. Use of the ATCAA is infrequent and scheduling must be coordinated with the Washington Air Route Traffic Control Center.

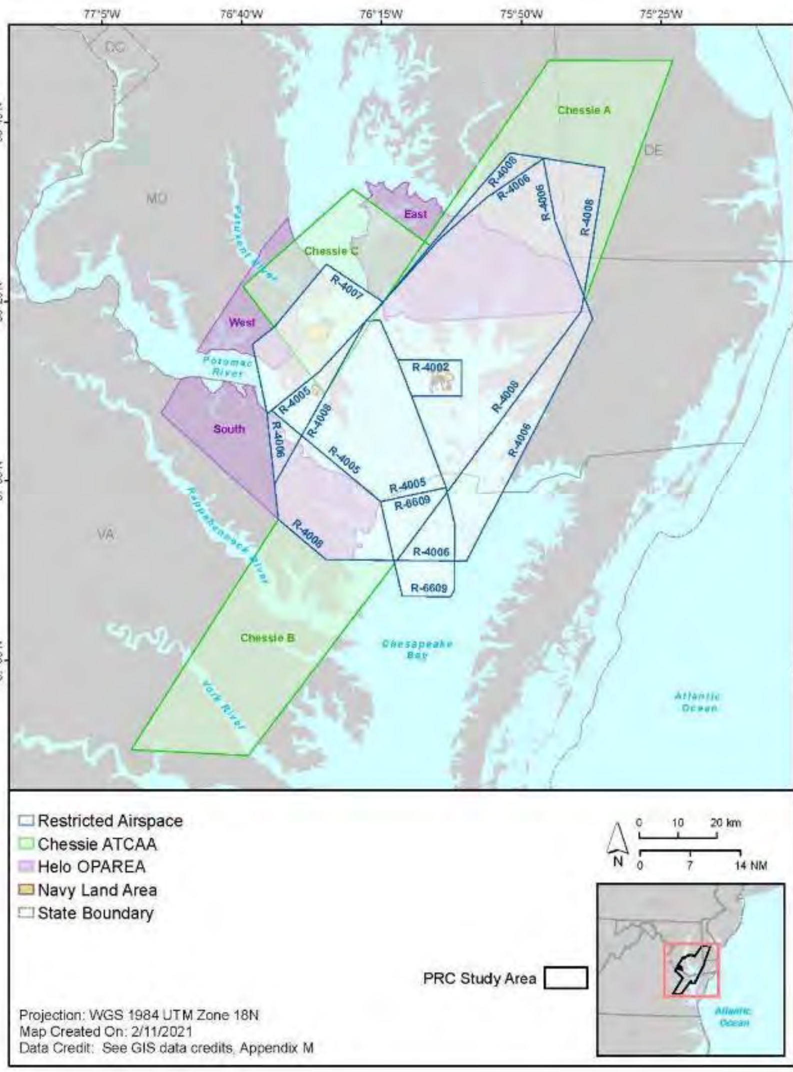

Figure 2 - PRC Airspace

Key: ATCAA = Air Traffic Control Assigned Airspace; OPAREA = Operating Area

DETERMINATION OF POTENTIAL EFFECTS

In accordance with 15 CFR part 930; subpart C, the Navy reviewed its Proposed Action and has determined that certain activities that will be conducted as part of the Proposed Action (i.e., flight activities) may have an effect on a coastal use or resource of the Commonwealth of Virginia. As set forth in the consistency analysis section of this determination, for Virginia, potential direct or indirect effects are limited to effects on wildlife related to airborne noise associated with aircraft overflight activities. Flight activities are further described below.

Aircraft Flight Activities

As previously mentioned, flight activities are the most frequent and foremost performed activity that occurs within the PRC. The NAWCAD Naval Test Wing Atlantic and other squadrons home-based at NAS Patuxent River conduct the majority of aircraft flights. Transient aircraft, not stationed at NAS Patuxent River, also utilize PRC airspace but on a much less frequent basis.

Flight activities occur daily and may involve the full spectrum of manned and unmanned, fixed- and rotary-wing aircraft. All aircraft flights originating or terminating in the PRC or utilizing PRC airspace are part of the Proposed Action. Aircraft flights include test flights, training flights, or other flights depending on the type of flight activity.

Table 1 provides a brief description of aircraft flight activities. Note that only overflights of the Virginia Coastal Zone would occur. There would be no landing practice or munitions or other military expended material (MEM) expenditures in Virginia as part of the Proposed Action. Table 2 provides the annual aircraft flight operational tempos of the alternatives that are included in the EIS. Note that only a small subset of aircraft flight activities shown in Table 2 would occur above the Virginia Coastal Zone.

Table 1 - Aircraft Flight Activities

Activity Name	*Activity Description*
	Test Flights
Air Vehicle Tests	Expose the airframe and aircrew to the full operational limits of altitude, speed, load factor, gross weight, environmental conditions, and operational situations experienced during Fleet operations. Tests include aeromechanics (including weapons compatibility and separation tests), air vehicle subsystems, structural tests, and crew systems. May involve the release of non-explosive munitions or other MEM. MEM will not be released in Virginia.
Carrier and Shipboard Suitability Tests	Evaluate aircraft compatibility with ship-based takeoff, approach, recovery equipment, and landing using special ground-based facilities designed to simulate a shipboard environment (e.g., TC-7 steam catapult, MK-7 arresting gear, and short takeoff vertical landing facility). Tests include fixed-wing, rotary-wing, and ships' air traffic and control and landing systems certification tests.

Table 1 - Aircraft Flight Activities (Continued)

Activity Name	***Activity Description***
	Test Flights
Mission Systems Tests	Evaluate the performance and operability of subsystems (e.g., electronics) that are integrated into cockpit displays and fire control systems of modern military aircraft (and ships). Both the operational functionality of the system (or subsystem) and interoperability with the aircraft and its systems are verified. Tests include communication (including lasers), navigation, information warfare, computers, armament control, sensors, electromagnetic environmental effects, laser designators and rangefinders, and ship and shore-based systems. Do not typically but may involve the release of non-explosive munitions or other MEM. MEM would not be released in Virginia
Electronic Warfare Tests	Evaluate U.S. military electronic combat systems against a wide variety of threat simulations, surrogates, and actual systems that represent real world threat scenarios. Tests include electronic attack (including directed energy and cyberwarfare), electronic protection, electronic warfare support, and radar cross section and infrared signature measurement. May involve the release of non-explosive munitions or other MEM related to electronic countermeasures (e.g., chaff, flares). MEM would not be released in Virginia.
Operational Tests	VX-1 operational aircraft test and evaluate airborne anti-submarine warfare and maritime anti-surface warfare weapon systems, airborne strategic weapons systems, as well as support systems, equipment, and materials.
	Training Flights
Aircrew Proficiency Flights*	Performed to maintain the flying skills of pilots and aircrew personnel.
Field Carrier Landing Practice*	Performed on a runway equipped to simulate an aircraft carrier flight deck to familiarize pilots with carrier landings. Flown in close proximity to the airfield and below 3,000 feet.
United States Naval Test Pilot School Flights	Train experienced pilots in the processes and techniques of aircraft systems test and evaluation to be aircraft test pilots.
Transient Training Flights	Train transient aircrew in unit level skills such as aircrew proficiency, field carrier landing practice, electronic warfare, weapons integration and separation, simulated air-to-air combat, and other tactical training tasks. May involve the release of non-explosive munitions or other MEM. MEM would not be released in Virginia.
	Other Flights
Support Flights	Naval Test Wing Atlantic aircraft provide support needed to successfully accomplish a testing or training event. Flights include in-flight refueling, safety/photo chase, logistics, cooperative target and threat simulation, range surveillance, or other unique services.
Cross-Country Flights	Flown to transport equipment, material, and/or personnel to and from the air station in support of testing, training, or base-keeping operations.
Functional Check Flights	Conducted to determine whether the airframe, propulsion, accessories, and equipment are functioning in accordance with predetermined standards when subjected to the intended operating environment.
Mission of State Flights	Unmanned aerial systems (e.g., MQ-4 Triton) perform post-hurricane surveillance involving high-altitude and meteorological surveys in support of post-disaster relief efforts.

Table 1 - Aircraft Flight Activities (Continued)

	Other Flights
Search and Rescue Flights	Search and rescue helicopters (MH-60) locate and recover military or civilian personnel injured or lost during a testing, training, or non-military event. May involve the release of marine markers as surface reference points to locate/mark survivors.
Strategic Communications Flights	VQ-4 aircraft (E-6B) conduct operational patrols to provide airborne command posts and strategic communications relays.
Scientific Development Flights	VXS-1 aircraft execute airborne science and technology projects such as bathymetry, electronic countermeasures, gravity mapping, and radar development.

Key: MEM = military expended materials; U.S. = United States.
Note: * = May also be performed by transients.

Table 2 - Annual PRC Aircraft Flight Operational Tempo per Alternative

Activity Name	*Baseline No Action Alternative*	*Proposed Action Alternative 1*	*Proposed Action Alternative 2*	*Location*
Air-Based Activities (Annual)				
Aircraft Flight Activities (# of Flight Hours)	20,100	23,400	26,000	*PRC Airspace* – restricted areas – 80%; Helo Operating Areas – 20%
Supersonic Activities (# of Events)	247	180	198	*PRC Airspace* – restricted areas – 98% R-4008 above 30,000 ft; >2% below 30,000 ft weapons separation testing only; Chessie Air Traffic Control Assigned Airspace – 1 to 3 events per year

Key: > = greater than; CBWR = Chesapeake Bay Water Range; ft = feet; Helo = Helicopter; PRC = Patuxent River Complex.

For a description of all proposed testing and training activities occurring throughout the entire PRC, see Chapter 2 of the *Testing and Training Activities in the Patuxent River Complex Draft EIS* available at www.PRCEIS.com.

Assessment of Applicability of Policies of the Virginia Coastal Zone Management Program and Consistency Analysis

The Navy reviewed each of Virginia's enforceable policies and determined applicability to the Proposed Action. As shown in Table 3 below, 11 of the 12 enforceable policies are not applicable to the Proposed Action. One enforceable policy is relevant and the consistency analysis for that policy is set forth after Table 3.

Table 3 - Enforceable Policy and Reasoning for Non-Applicability

Enforceable Policy	*Policy Text*	*Reason Policy is Not Applicable*
Tidal and Non-Tidal Wetlands § 28.2-1301 and -1308 and §§ 62.1-44.15:20 and -44.15:21	It is the policy of this Commonwealth to preserve the tidal wetlands, to prevent their despoliation and destruction, and to accommodate necessary economic development in a manner consistent with wetlands preservation. It is the policy of the Commonwealth to avoid or minimize the loss of tidal wetlands and the adverse ecological effects of all permitted activities. It is the Commonwealth's policy that non-tidal surface waters, including wetlands and streams, shall be protected. Development shall only be permitted in a manner consistent with the protection of wetland acreage and function and stream function. Impacts to wetlands and streams shall be avoided or minimized to the maximum extent practicable.	The proposed aircraft flight activities in Virginia do not have any effect on tidal or non-tidal wetlands.
Subaqueous Lands § 28.2-1200, -1203, -1204 and -1205	All decisions affecting subaqueous lands shall be guided by the Commonwealth's General Policy to conserve, develop, and utilize its natural resources, its public lands, and its historical sites and buildings and to protect its atmosphere, lands, and waters from pollution, impairment, or destruction, for the benefit, enjoyment, and general welfare of the people of the Commonwealth.	The proposed aircraft flight activities in Virginia do not have any effect on subaqueous lands, such as dredging, aquaculture, placement of wharves, bulkheads, or fill.
Dunes and Beaches §§ 28.2-1401 and -1408	It is the policy of the Commonwealth to preserve and protect coastal primary sand dunes and beaches, to prevent their despoliation and destruction, and whenever practical, to accommodate necessary economic development in a manner consistent with the protection of such features.	The proposed aircraft flight activities in Virginia would not involve any alteration of or construction upon coastal primary sand dunes and beaches.

Enforceable Policy	*Policy Text*	*Reason Policy is Not Applicable*
Chesapeake Bay Preservation Area §§28.2-104.1, 52.1-44. §15:24, -44.15:51, -44.15:67, -44.15:68, -44.15:69, -44.15:73, -44.15:74, and -44.15:78	It is the policy of the Commonwealth to protect and improve the water quality of the Chesapeake Bay, its tributaries, and other state waters by minimizing the effect of human activity upon these waters. To that end, the Commonwealth will ensure that land use and development performance criteria and standards are implemented in Chesapeake Bay Preservation Areas, which if improperly used or developed may result in substantial damage to the water quality of the Chesapeake Bay and its tributaries.	The proposed aircraft flight activities in Virginia do not involve any land use or development in Chesapeake Bay Preservation Areas.
Marine Fisheries §§ 28.2-101, -201, -203, -203.1, -225, -551, -600, -601, -603, -618, and -1103, -1203	It is the policy of the Commonwealth to conserve and promote the seafood and marine resources of the Commonwealth, including fish, shellfish and marine organisms, and manage the fisheries to maximize food production and recreational opportunities within the Commonwealth's territorial waters.	The proposed aircraft flight activities in Virginia do not effect marine resources. The action does not involve any of the following: overfishing; effects on Blue crab stock; effects on spawning stock, nursery areas and habitat; encroachment on oyster beds; propagation of oysters; nor encroachment on a lawful use and occupation of previously leased ground.
Plant Pests and Noxious Weeds § 3.2-700 and -703; § 3.2-712 and -804;	Once the Board of Agriculture and Consumer Services or the Commissioner of Agriculture and Consumer Services has established a quarantine for a pest, no person shall move any regulated article described in the quarantine or the pest against which the quarantine is established within, from, into, or through the Commonwealth in violation of the quarantine. No person shall sell, barter, offer for sale, move, transport, deliver, ship, or offer to ship into or within the Commonwealth any plant pests in any living stage, unless such plant pests are not injurious, are generally present already, or are for scientific purposes subject to specified safeguards. No person shall move, transport, deliver, ship, or offer for shipment into or within the Commonwealth any noxious weed, or part thereof, unless such noxious weed is generally present already or it is for scientific purposes subject to prescribed standards.	The proposed flight activities in Virginia do not involve the movement or transport of plant pests or noxious weeds.
Commonwealth Lands § 29.1-532 § 29.1-103(10) § 29.1-554 §§ 5-30-70 and -220	Various policies for Commonwealth Lands under management by: *Virginia Department of Game and Inland Fisheries* -Dams and Fish Passage	The proposed aircraft flight activities in Virginia do not have any effect on Commonwealth lands managed by the Virginia Department of Game and Inland

Enforceable Policy	*Policy Text*	*Reason Policy is Not Applicable*
§§ 5-30-240 to -250 § 5-30-422 §§ 5-30-190, -290, and -330	-Back Bay -Damage to Boundary Enclosures and Entry to Refuges -Protection of Aquatic and Terrestrial Habitats Used or Owned by DGIF *Virginia Department of Conservation and Recreation* -Fire Prevention -Hunting and Fishing in State Parks -Feeding Wildlife in State Parks Prohibited -Boating and Vehicles in State Parks	Fisheries or Virginia Department of Conservation and Recreation.
Point Source Air Pollution § 10-1.1308	It is the policy of the Commonwealth, after observing the effects of air pollution, to abate, control, and prohibit air pollution throughout the Commonwealth. Additional specific policies are provided for asphalt paving operations, open burning, fugitive dust emissions, and state operating permits used to limit emissions of stationary sources contributing to a violation of any air quality standard.	The proposed aircraft flight activities in Virginia would not include installation or operation of a stationary emissions source, asphalt paving, open burning, or fugitive dust generation. No air permitting would be required.
Point Source Water Pollution § 62.1-44.2	It is the policy of the Commonwealth to protect existing high quality state waters and restore all other state waters to such condition of quality that any such waters will permit all reasonable public uses and will support the propagation and growth of all aquatic life, including game fish, which might reasonably be expected to inhabit them; safeguard the clean waters of the Commonwealth from pollution; prevent any increase in pollution; reduce existing pollution; promote and encourage the reclamation and reuse of wastewater in a manner protective of the environment and public health; and promote water resource conservation, management and distribution, and encourage water consumption reduction in order to provide for the health, safety, and welfare of the present and future citizens of the Commonwealth.	The proposed aircraft flight activities in Virginia would not result in new point source pollutant discharges, or effect water quality in Virginia.
Nonpoint Source Water Pollution § 62.1-44.15:25, 62.1-44.15:52	It is the policy of the Commonwealth to control stormwater runoff to protect the quality and quantity of state waters from the potential harm of unmanaged stormwater; to control soil erosion and sediment deposition in order to prevent unreasonable degradation of properties, stream	The proposed aircraft flight activities in Virginia would not have any effect on stormwater runoff, soil erosion, or nonpoint source water pollution.

Federal Consistency Determination for Virginia Page 13

Enforceable Policy	Policy Text	Reason Policy is Not Applicable
	channels, state waters, and other natural resources; and to otherwise act to control nonpoint source water pollution to ensure the general health, safety, and welfare of the citizens of the Commonwealth.	
Shoreline Sanitation § 32.1-12 and -164	It is the policy of the Commonwealth for sewage to be disposed of in a safe and sanitary manner that protects the public health and welfare and the environment	The proposed aircraft flight activities in Virginia would not involve any sewage disposal or discharge.

Analysis of Enforceable Policies Applicable to the Proposed Action

The following policy of the Virginia Coastal Zone Management Program is partly applicable to the Proposed Action.

Enforceable Policy - Wildlife and Inland Fisheries

See Va. Code Ann. §§ 29.1-501, -564, -566, -567, and -568; 4 Va. Admin. Code §§ 15-20-130 and -140

Parts of the policy are <u>not</u> applicable and the reasons for non-applicability include:

- The proposed activities would not involve the administration of drugs to any vertebrate wildlife;
- The proposed activities would not involve the import, possession, sale or liberation of any predatory, undesirable, or non-indigenous species;
- The proposed activities in Virginia would not involve the import, export, taking, pursuit, killing or possessing of any fish or wildlife, or stock of any species of fish.

Consistency Analysis

Virginia's enforceable policy states in part that no person shall harass, harm, hunt, shoot, wound, kill, trap, capture, possess, collect, transport, sell or offer to sell, or attempt to do so, any species of fish or wildlife listed as threatened or endangered by the Board of Game and inland Fisheries. Species designated as threatened or endangered by Virginia Board of Game and Inland Fisheries are likely occur in the Virginia portions of the PRC Study Area where aircraft overflights occur. Aircraft overflights produce noise that might incidentally harass special status species (e.g., cause a startle reaction), however, these events would be temporary, infrequent, and would not result in adverse effects.

Regarding compliance with the federal Endangered Species Act (ESA) and species under the jurisdiction of the U.S. Fish and Wildlife Service, the Navy has determined that acoustic stressors associated with the proposed activities may affect, but would not likely adversely affect the eastern black rail, northeastern beach tiger beetle, puritan tiger beetle, red knot, and West Indian manatee. Acoustic stressors associated with the proposed activities would have no effect on the Northern long-eared bat. With the release of the Draft PRC EIS, the Navy is consulting with the U.S. Fish and Wildlife Service under ESA Section 7.

Regarding compliance with the federal ESA and species under the jurisdiction of the National Marine Fisheries Service, the Navy has determined that acoustic stressors associated with the proposed activities may affect, but would not likely adversely affect the Atlantic sturgeon (Carolina DPS, Chesapeake Bay DPS, New York Bight DPS), green sea turtle, Kemp's Ridley sea turtle, leatherback sea turtle, loggerhead sea turtle, and shortnose sturgeon. With the release of the Draft PRC EIS, the Navy is consulting with the National Marine Fisheries Service under ESA Section 7.

The Navy is consistent with this policy with respect to species also regulated by the ESA. The ESA does not contain a waiver of sovereign immunity, so states may not directly regulate federal activity via state laws protecting certain species. Furthermore, CZMA does not in and of itself authorize the application of state permit requirements to federal agencies.

Aircraft overflights would have no negative effects on the Commonwealth's fish and wildlife conservation efforts. Therefore, the Proposed Action would be consistent to the maximum extent practicable with this policy. Potential effects to fish and wildlife are fully analyzed in the Draft PRC EIS.

Conclusion

The Navy has determined that the proposed federal agency action in airspace overlying Virginia (aircraft overflights) may affect certain natural resources of the Commonwealth of Virginia's coastal zone pursuant to the CZMA. However, the Navy will implement the Proposed Action in a manner that is consistent to the maximum extent practicable with the applicable enforceable policies of the Virginia CZMP.

F.3 Coastal Consistency Determination for Delaware

DCMP Fed Con Form v.2.0

Delaware Department of Natural Resources and Environmental Control
Delaware Coastal Management Program

Initial Review: ________
Updated On: ________
Complete: ________
Official Use Only

Coastal Zone Management Act Federal Consistency Form

This document provides the Delaware Coastal Management Program (DCMP) with a Federal Consistency Determination or Certification for activities regulated under the Coastal Zone Management Act of 1972, as amended, and NOAA's Federal Consistency Regulations, 15 C.F.R. Part 930. Federal agencies and other applicants for federal consistency are not required to use this form; it is provided to applicants to facilitate the submission of a Consistency Determination or Consistency Certification. In addition, federal agencies and applicants are only required to provide the information required by NOAA's Federal Consistency Regulations.

Project/Activity Name:	Navy Testing and Training Activities in the Patuxent River Complex

I. Federal Agency or Non-Federal Applicant Contact Information:

Contact Name/Title: Crystal Ridgell / Environmental Scientist

Federal Agency Contractor Name (if applicable): ________

Federal Agency: Naval Air Warfare Center, Aircraft Division
(either the federal agency proposing an action or the federal agency issuing a federal license/permit or financial assistance to a non-federal applicant)

Mailing Address: 23013 Cedar Point Road, Building 2118

City: Patuxent River State: MD Zip Code: 20670

E-mail: Crystal.L.Ridgell@navy.mil Telephone #: (301) 757-5282

II. Federal Consistency Category:

- (●) Federal Activity or Development Project (15 C.F.R. Part 930, Subpart C)
- ( ) Outer Continental Shelf Activity (15 C.F.R. Part 930, Subpart E)
- ( ) Federal Financial Assistance (15 C.F.R. Part 930, Subpart F)
- ( ) Federal License or Permit Activity (15 C.F.R. Part 930, Subpart D)
- ( ) Federal License or Permit Activity which occurs wholly in another state (interstate consistency activities identified in DCMP's Policy document)

III. Detailed Project Description (attach additional sheets if necessary):

The Proposed Action is to continue conducting military testing and training activities within the Patuxent River Complex (PRC) to meet current and projected military readiness requirements. The PRC is primarily located in Maryland, but portions of special use airspace extend over portions of Virginia and Delaware. Proposed activities in Delaware are limited to high altitude testing and training flights. These flights would occur in existing special use airspace units (i.e., R-4008 [25,000 ft to 85,000 ft] and the Chessie Air Traffic Control Assigned Airspace Unit A [27,000 ft to 41,000 ft]). See attached Figure. Use of the Chessie ATCAA is infrequent and scheduling is coordinated with the Washington Air Route Traffic Control Center. Based on low use frequency and high altitude, proposed aircraft flight activity is not expected to affect Delaware coastal uses or resources, as set forth in Sections IV and V below.

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DCMP Fed Con Form v.2.0

IV. General Analysis of Coastal Effects (attach additional sheets if necessary)

The proposed federal activity will not have any reasonably foreseeable effects on a Delaware coastal use or resource.

V. Detailed Analysis of Consistency with DCMP Enforceable Policies (attach additional sheets if necessary):

Policy 5.1: Wetlands Management

The proposed action does not include construction or landscape modification activity that may encroach upon wetlands. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.2: Beach Management

The proposed action does not include construction of facilities, operation of vehicles on beaches, or restrictions to public beaches. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.3: Coastal Waters Management (includes wells, water supply, and stormwater management. Attach additional sheets if necessary)

The proposed action does not include actions that take place in or affect coastal waters and water resources of Delaware. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.4: Subaqueous Land and Coastal Strip Management

The proposed action does not include actions that take place in submerged lands or tidelands of Delaware. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.5: Public Lands Management

The proposed action does not include operations restricting public access to Delaware state lands. Therefore, the provisions under this policy are not applicable to the proposed action.

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Policy 5.6: Natural Lands Management

The proposed action consists of utilizing airspace for overflights of aircraft. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.7: Flood Hazard Areas Management

The proposed action will not take place in area identified by the Federal Emergency Management Act (FEMA) as a Flood Hazard Area. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.8: Port of Wilmington

The proposed action will have no actions that take place near or interfere with operations of the Port of Wilmington. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.9: Woodlands and Agricultural Lands Management

The proposed action will not involve the removal of trees or take place in agricultural lands. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.10: Historic and Cultural Areas Management

The proposed action will not have an adverse effect on historic properties in Delaware. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.11: Living Resources

The proposed action will not have an adverse environmental effect on living resources of Delaware. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.12 Mineral Resources Management

The proposed action will not include extraction and production of minerals. Therefore, the provisions under this policy are not applicable to the proposed action.

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Policy 5.13: State Owned Coastal Recreation and Conservation

The proposed action will not include altering of state owned lands where natural condition or present state of use would maintain or enhance the conservation of natural, cultural, or historic resources of Delaware. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.14: Public Trust Doctrine

The proposed action will not have an effect on the public's right of navigation and fishery on streams where the tide ebbs and flows. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.15: Energy Facilities

The proposed action will not include development or modification of energy facilities. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.16: Public Investment

The proposed action will not impact items that pertain to the public's investment interest. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.17: Recreation and Tourism

The proposed action does not include an impact to recreation and tourism of resources in Delaware. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.18: National Defense and Aerospace Facilities

The proposed action does not include siting of National Defense and Aerospace Facilities. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.19: Transportation Facilities

The proposed action does not include development or expansion of any transportation facilities. Therefore, the provisions under this policy are not applicable to the proposed action.

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Policy 5.20: Air Quality Management

The proposed action does not establish or operate an air source in the State of Delaware. Aircraft traversing Delaware airspace will emit pollutants, however it will be at an altitude where pollutants would be dispersed and would not mix with or affect ground-level air quality. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.21: Water Supply Management

The proposed action does not include impacts to the state's water supply management. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.22: Waste Disposal Management

The proposed action does not include impacts to the state's waste disposal management. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.23: Development

The proposed action does not include development of new facilities or construction of infrastructure in the project area. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.24: Pollution Prevention

The proposed action does not include generation of wastes. Therefore, the provisions under this policy are not applicable to the proposed action.

Policy 5.25: Coastal Management Coordination

The proposed action is a federal action. Therefore, the provisions under this policy are not applicable to the proposed action. In compliance with the National Environmental Policy Act, the Navy will provide state, federal, and other interested parties an opportunity to review and comment on the proposed action.

VI. JPP and RAS Review (Check all that apply):

Has the project been reviewed in a monthly Joint Permit Processing and/or Regulatory Advisory Service meeting?

☐ JPP ☐ RAS ■ None

*If yes, provide the date of the meeting(s): ______________________

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DCMP Fed Con Form v.2.0

VII. Statement of Certification/Determination and Signature (Check one and sign below):

☐ **FEDERAL AGENCY CONSISTENCY DETERMINATION.** Based upon the information, data, and analysis included herein, the federal agency, or its contracted agent, listed in (I) above, finds that this proposed activity is consistent to the maximum extent practicable with the enforceable policies of the Delaware Coastal Management Program.

OR

☒ **FEDERAL AGENCY NEGATIVE DETERMINATION.** Based upon the information, data, and analysis included herein, the federal agency, or its contracted agent, listed in (I) above, finds that this proposed activity will not have any reasonably foreseeable effects on Delaware's coastal uses or resources (Negative Determination) and is therefore consistent with the enforceable policies of the Delaware Coastal Management Program.

OR

☐ **NON-FEDERAL APPLICANT'S CONSISTENCY CERTIFICATION.** Based upon the information, data, and analysis included herein, the non-federal applicant for a federal license or permit, or state or local government agency applying for federal funding, listed in (I) above, finds that this proposed activity complies with the enforceable policies of the Delaware Coastal Management Program and will be conducted in a manner consistent with such program.

Signature:	MARKOWICH.AMY.J.1232247904 Digitally signed by MARKOWICH.AMY.J.1232247904 Date: 2021.03.25 09:06:33 -04'00'		
Printed Name:	Amy J. Markowich	Date:	03/25/2021

Pursuant to 15 C.F.R. Part 930, the Delaware Coastal Management Program must provide its concurrence with or objection to this consistency determination or consistency certification in accordance with the deadlines listed below. Concurrence will be presumed if the state's response is not received within the allowable timeframe.

Federal Consistency Review Deadlines:

Federal Activity or Development Project (15 C.F.R. Part 930, Subpart C)	60 days with option to extend an additional 15 days or stay review (15 C.F.R. § 930.41)
Federal License or Permit (15 C.F.R. Part 930, Subpart D)	Six months, with a status letter at three months. The six month review period can be stayed by mutual agreement. (15 C.F.R. § 930.63)
Outer Continental Shelf Activity (15 C.F.R. Part 930, Subpart E)	Six months, with a status letter at three months. If three month status letter not issued, then concurrence presumed. The six month review period can be stayed by mutual agreement. (15 C.F.R. § 930.78)
Federal Financial Assistance to State or Local Governments (15 C.F.R. Part 930, Subpart F)	State Clearinghouse schedule

OFFICIAL USE ONLY:

Reviewed By:	Fed Con ID:	Date Received:
Public notice dates: to	Comments Received: ☐ NO ☐ YES *[attach comments]*	
Decision type: (objections or conditions attach details)	Decision Date:	

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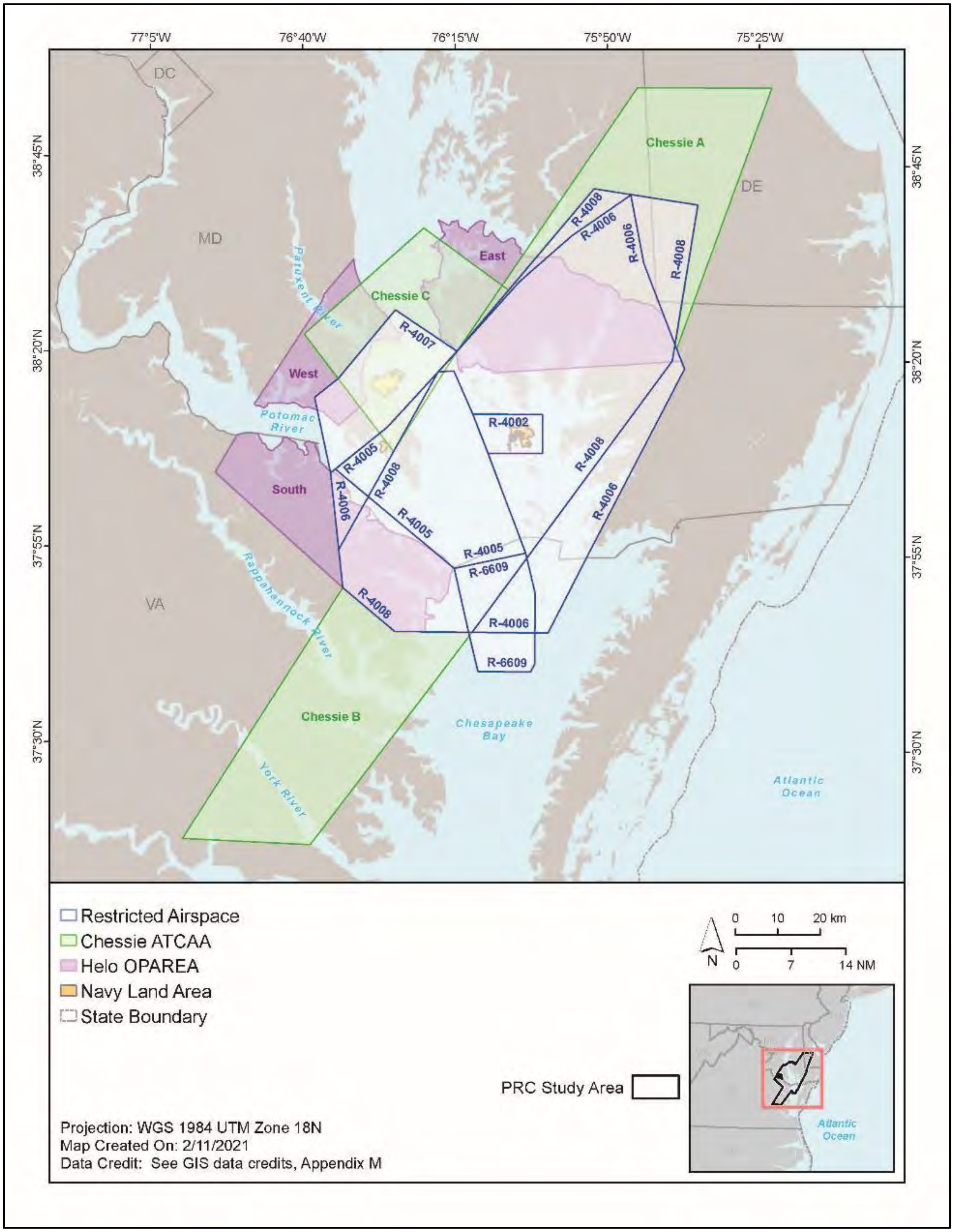
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Chessie C
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South
Patuxent River
Potomac River
Rappahannock River
York River
Chesapeake Bay
Atlantic Ocean
R-4002
R-4005
R-4006
R-4007
R-4008
R-6609
Restricted Airspace
Chessie ATCAA
Helo OPAREA
Navy Land Area
State Boundary
PRC Study Area
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Projection: WGS 1984 UTM Zone 18N
Map Created On: 2/11/2021
Data Credit: See GIS data credits, Appendix M

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Appendix G
Public Involvement

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List of Figures

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G.1 Published Notice of Intent

Federal Register / Vol. 84, No. 32 / Friday, February 15, 2019 / Notices 4457

be treated as public documents and will be made available for public inspection, including, but not limited to, being posted on the RFPB's website.

Dated: February 12, 2019.

Shelly E. Finke,

Alternate OSD Federal Register Liaison Officer, Department of Defense.

[FR Doc. 2019–02538 Filed 2–14–19; 8:45 am]

BILLING CODE 5001–06–P

DEPARTMENT OF DEFENSE

Department of the Navy

Notice of Intent To Prepare an Environmental Impact Statement for Patuxent River Complex Testing and Training and To Announce Public Scoping Meetings

AGENCY: Department of the Navy, DoD.

ACTION: Notice.

SUMMARY: Pursuant to section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969, as implemented by the Council on Environmental Quality, the Department of the Navy (Navy) announces its intent to prepare an Environmental Impact Statement (EIS) for Research, Development, Test and Evaluation (hereinafter referred to as "testing") and training activities within the Patuxent River Complex (PRC), Naval Air Station Patuxent River, MD. The proposed action is to continue conducting military testing and training activities within the PRC to meet current and projected military readiness requirements. The proposed action includes testing and training activities analyzed in the Naval Air Systems Command, Naval Air Warfare Center Aircraft Division (NAWCAD) December 1998 PRC Final EIS and subsequent Environmental Assessments, plus adjustments to current testing and training activities required to support projected Navy military readiness requirements into the foreseeable future.

DATES: The 45-day public scoping comment period begins February 15, 2019 and ends April 1, 2019. Public scoping meetings will be held on March 4, 5, 6 and 7, 2019. All public comments are due by April 1, 2019.

ADDRESSES: The meetings will be held at the following locations:

1. March 4, 2019, 4:00 p.m. to 7:00 p.m., Light of Christ Anglican Church, 9500 Northumberland Highway, Heathsville, VA 22473–0609.

2. March 5, 2019, 4:00 p.m. to 7:00 p.m., Southern Maryland Higher Education Center, Building 1 Multi-Purpose Room, 44219 Airport Road, California, MD 20619–2010.

3. March 6, 2019, 4:00 p.m. to 7:00 p.m., University of Maryland, Eastern Shore, Richard A. Henson Center Ballroom, 30690 University Blvd. S, Princess Anne, MD 21853–1295.

4. March 7, 2019, 4:00 p.m. to 7:00 p.m., St. Paul's United Methodist Church, Parish Hall, 205 Maryland Avenue, Cambridge, MD 21613–1924.

The Navy invites public comments on the scope of the analysis, including potential environmental issues and viable alternatives to be considered during the development of the Draft EIS. Comments may be provided at the public scoping meetings, by mail, and through the EIS website at: *http://www.prceis.com.* Comments must be postmarked or received online by April 1, 2019. Mailed comments must be sent to the address in the **FOR FURTHER INFORMATION CONTACT** section for consideration in the Draft EIS preparation.

The scoping meetings will consist of informal, open house sessions with informational poster stations staffed by Navy representatives. Meeting details will be announced in local area newspapers. Additional information on the public scoping meetings will be available on the EIS website at: *http://www.prceis.com.*

FOR FURTHER INFORMATION CONTACT: Naval Air Warfare Center Aircraft Division Range Sustainability Office, Atlantic Test Range, Building 2118, 23013 Cedar Point Road, Patuxent River, MD 20670–1183, Attn: Ms. Crystal Ridgell, EIS Project Manager, 301–342–9902 or project website: *http://www.prceis.com.*

SUPPLEMENTARY INFORMATION: NAWCAD is the Navy's action proponent for activities in the PRC, and is based at Naval Air Station (NAS) Patuxent River, Maryland approximately 60 miles southeast of Washington, DC. The PRC is a Major Range and Test Facility Base with the mission of testing Navy and Marine Corps aircraft, aircraft systems, and inert weapons in the military restricted and surrounding airspace that overlies the middle Chesapeake Bay water range, the southern end of the Potomac and Patuxent Rivers, as well as lands in Maryland, Virginia, and Delaware. The PRC is critical to supporting NAWCAD's mission to deliver high quality, affordable aircraft products and services in support of Navy and Marine Corps military readiness. Navy pilots also conduct training flights within the PRC.

The proposed action is to continue conducting military testing and training activities within the PRC to meet current and projected military readiness requirements. The proposed action includes testing and training activities analyzed in the 1998 PRC Final EIS and subsequent environmental assessments, as well as adjustments to current testing and training activities to support projected Navy readiness requirements into the foreseeable future.

The purpose of the proposed action is to provide Sailors and Marines with equipment and technology that operates effectively and safely to support current and projected future military readiness requirements.

The need for the proposed action is to maintain military readiness of naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas, now and into the future, consistent with Title 10, Section 5062, of the United States Code.

The Navy will evaluate the potential environmental impacts from a No Action Alternative and action alternatives, and will analyze potential impacts on environmental resources from activities included in the alternatives. These environmental resources include, but are not limited to: Biological resources (e.g., aquatic and terrestrial protected species); water resources and sediments; air quality; airborne noise; cultural resources; socioeconomics; land use; public health and safety; hazardous material and waste; and environmental justice.

The scoping process is helpful in identifying public concerns and local issues to be considered during the development of the Draft EIS. Federal, state, and local agencies; federally recognized tribes; and interested persons are encouraged to provide substantive comments to the Navy on environmental resources and issue areas of concern that the commenter believes the Navy should consider. All comments, provided orally or in writing at the scoping meetings, submitted via the EIS website, or mailed, will be taken into consideration during the development of the Draft EIS.

Dated: February 15, 2019.

M.S. Werner,

Commander, Judge Advocate General's Corps, U.S. Navy, Federal Register Liaison Officer.

[FR Doc. 2019–02325 Filed 2–14–19; 8:45 am]

BILLING CODE 3810–FF–P

G.2 Scoping Material

G.2.1 Scoping Notification Letter and Distribution

Table G-1 Entities that Received the Scoping Notification Letter

Federal Elected Officials	***State Elected Officials***
U.S. Senators (Maryland, Delaware, and Virginia)	Office of the Governor (Maryland, Delaware, and Virginia)
U.S. Representatives (Maryland, Delaware, and Virginia)	Maryland House of Delegates
	Virginia House of Delegates
	Delaware House of Representatives
	Senate of Delaware
	Senate of Maryland
	Virginia Senate
Federal Agencies	***State Agencies***
Federal Aviation Administration Eastern Region	Maryland Department of the Environment
National Marine Fisheries Service Greater Atlantic Region	Maryland Historical Trust
U.S. Fish and Wildlife Service Chesapeake Bay Field Office	Delaware Department of Natural Resources and Environmental Control
Chesapeake Marshlands National Wildlife Refuge	Delaware Division of Historical and Cultural Affairs
Harriet Tubman Underground Railroad National Historical Park	Virginia Department of Aviation
	Virginia Department of Conservation and Recreation
U.S. Coast Guard Sector Baltimore	Virginia Department of Environmental Quality
	Virginia Department of Historic Resources
	Virginia Department of Game and Inland Fisheries
Federally Recognized Tribes	***Local Officials***
Catawba Indian Tribe	Cambridge City Council
Cherokee Nation	Crisfield City Council
Chickahominy Indian Tribe	Federalsburg Town Council
Delaware Nation	Hurlock Town Council
Delaware Tribe of Indians	Leonardtown Town Council
Eastern Band of Cherokee Indians	Mardela Springs Town Board
Eastern Chickahominy	Town of Montross
Eastern Shawnee Tribe of Oklahoma	Princess Anne Town Council
Monacan Nation	Salisbury City Council
Muscogee (Creek) Nation	Seaford City Council
Nansemond Indian Nation	Sharptown Town Commission
Pamunkey Indian Tribe	Vienna Town Council
Rappahannock Tribe	Accomack Board of Supervisors
Seneca-Cayuga Nation	Calvert County Commission
Tuscarora Nation	County Commissioners of Caroline County
United Keetoowah Band of Cherokee Indians in Oklahoma	Dorchester County Council
	Lancaster County Board of Supervisors

Table G-1 Entities that Received the Scoping Notification Letter

Upper Mattaponi Tribe	Northumberland Board of Supervisors
Non-Federally Recognized Tribes	Richmond County Board of Supervisors
Piscataway Conoy Tribe	Somerset County Commission
Piscataway Indian Nation	St. Mary's County Commission
Other Local Entities	Sussex County Council
Dominion Energy Cove Point Liquid Natural Gas Terminal	Westmoreland Board of Supervisors
	Wicomico County Commission
Chesapeake Biological Laboratory	Northern Neck Planning District Commission
Smith Island United	Tri-County Council for Southern Maryland
	Midshore Regional Council
	Tri-County Council for the Lower Eastern Shore

Key: U.S. = United States.

Figure G-1 Stakeholder Scoping Notification Letter

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
22347 CEDAR POINT ROAD, UNIT 6
PATUXENT RIVER, MARYLAND 20670-1161

5090
Ser 000000A/047
February 7, 2019

Dear Sir or Madam:

The Department of the Navy is in the beginning stages of preparing an Environmental Impact Statement to address the continued conduct of military research, development, test, and evaluation (hereinafter referred to as "testing"), and training operations within the Patuxent River Complex (PRC) Study Area to meet current and projected military readiness requirements.

The Navy's Proposed Action includes testing and training operations analyzed in the increased flight and related operations in the PRC Final Environmental Impact Statement from December 1998 and subsequent environmental assessments, as well as adjustments in testing and training activities from current types and tempos required to support projected Navy military readiness requirements into the foreseeable future.

The purpose of the proposed action is to provide Sailors and Marines with equipment and technology that operates effectively and safely to support current and projected future military readiness requirements. The need for the proposed action is to maintain military readiness of naval forces capable of winning wars; deterring aggression; and maintaining freedom of the seas, now and into the future, consistent with Title 10, Section 5062, of the United States Code.

An essential part of the process is public involvement. The Navy is requesting your comments on the proposed action, alternatives, and resources to be considered during preparation of the PRC EIS. There are multiple ways to get involved:

a. Visit the website www.prceis.com to learn about the project, review materials, join the mailing list, and/or submit comments.

b. Attend a Scoping Meeting. A series of open-house style public meetings will be held.

Date	Time	Location
March 4, 2019	1600 - 1900	Light of Christ Anglican Church 9500 Northumberland Highway Heathsville, VA 22473
March 5, 2019	1600 - 1900	Southern Maryland Higher Education Center Building 1 Multi-Purpose Room 44219 Airport Road California, MD 20619

Date	Time	Location
March 6, 2019	1600 - 1900	University of Maryland, Eastern Shore Richard A. Henson Center Ballroom 30690 University Boulevard South Princess Anne, MD 21853
March 7, 2019	1600 - 1900	St. Paul's United Methodist Church Parish Hall 205 Maryland Avenue Cambridge, Maryland 21613

c. Provide Comments. Comments may be provided at public scoping meetings, by mail, and/or through the EIS website. Mailed comments must be postmarked no later than April 1, 2019 and mailed to:

Naval Air Warfare Center Aircraft Division
NAVAIR Ranges Sustainability Office
ATTN: EIS Project Manager
23013 Cedar Point Road
Patuxent River, MD, 20670

We appreciate your time and interest and look forward to hearing from you. My point of contact for this matter is the Naval Air Warfare Center Aircraft Division Range Sustainability Office, which may be reached via phone at (301) 342-9902.

Sincerely,

John S. Lemmon
Rear Admiral, United States Navy

Enclosure: 1. PRC EIS Project Description and Study Area Map

2

PATUXENT RIVER COMPLEX (PRC) TESTING AND TRAINING

ENVIRONMENTAL IMPACT STATEMENT (EIS)

PROJECT DESCRIPTION AND STUDY AREA MAP

PRC Testing and Training EIS Proposed Action and Alternatives:

The Department of the Navy (Navy) proposes to continue conducting military Research, Development, Test and Evaluation (hereinafter referred to as "testing") and training activities within the Patuxent River Complex (PRC) Study Area to meet current and projected military readiness requirements. The Navy's Proposed Action includes testing and training activities that have been conducted within the PRC for decades and are consistent with those analyzed in the *Increased Flight and Related Operations in the Patuxent River Complex Final Environmental Impact Statement* (December 1998) and subsequent Environmental Assessments (EAs), plus adjustments to current testing and training activities in the PRC that include aircraft, aircraft systems and nonexplosive weapons required to support projected Navy military readiness requirements into the foreseeable future. The Navy will evaluate in the new EIS the potential environmental impacts on environmental resources from testing and training activities associated with a range of alternatives to the proposed action, including a No Action and action alternatives.

Environmental Analysis:

Resource areas that will be addressed include, but are not limited to: biological resources (including aquatic and terrestrial protected species); water resources and sediments; air quality; airborne noise; cultural resources; socioeconomics; land use; public health and safety; hazardous material and waste; and environmental justice.

PRC Testing and Training EIS Study Area:

The PRC is one of our nation's Major Range and Test Facility Base (MRTFB) assets that provides the flight and ground test facilities, airfields, and instrumented range as well as the airspace and water space critical to supporting NAWCAD's mission of testing aircraft, aircraft systems and nonexplosive weapons so that Sailors and Marines have aircraft and equipment that will operate safely and effectively. Naval Air Warfare Center Aircraft Division (NAWCAD), the Navy's action proponent for activities in the PRC, is based at Naval Air Station (NAS) Patuxent River, Maryland approximately 60 miles southeast of Washington, D.C. Navy land and facilities, in the PRC, also include nearby Outlying Landing Field (OLF) Webster in St. Inigoes, Maryland and the Bloodsworth Island Range, in the Chesapeake Bay.

The PRC Testing and Training EIS will assess the potential environmental impacts from aircraft testing and training activities conducted in the PRC Study Area (Figure 1). The geographic scope of the PRC Study Area includes the military restricted airspace and surrounding shared Visual Flight Rule (VFR) airspace that is within NAS Patuxent River's Air Traffic Control (ATC) approach control and the Class A airspace, Chessie ATC Assigned Airspace (ATCAA), as well as the underlying Chesapeake Bay Navy water range (including fixed targets, aim points and recovery areas for high value assets), the southern end of the Potomac and Patuxent Rivers, and lands in Maryland, Virginia, and Delaware.

Enclosure (1)

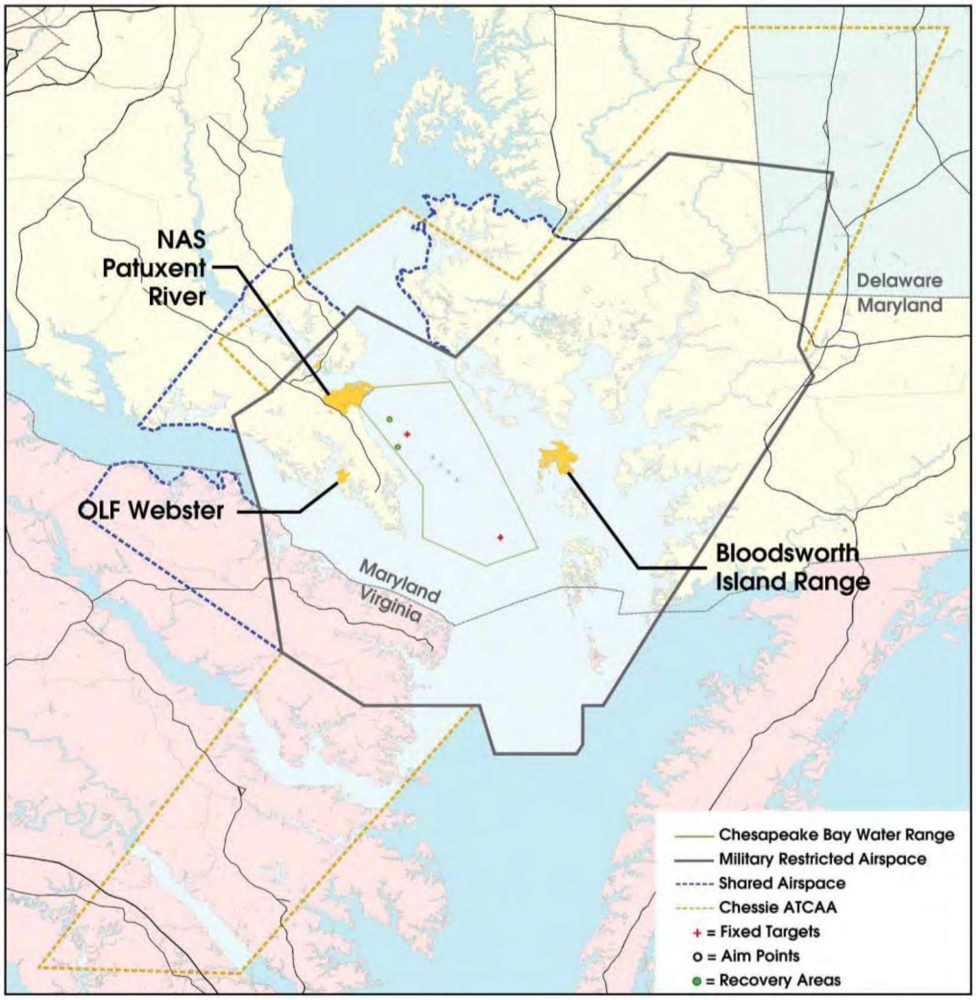


Figure 1: Patuxent River Complex (PRC) Testing and Training Environmental Impact Statement (EIS) Study Area

Enclosure (1)

G.2.2 Scoping Meeting Postcard Mailers

Patuxent River Complex (PRC) Testing and Training Environmental Impact Statement (EIS)

The Navy invites you to participate in the National Environmental Policy Act process for the Patuxent River Complex (PRC) Testing and Training Environmental Impact Statement (EIS). We are at the very beginning of the EIS process. The Navy is requesting your comments on the scope of analysis, including the alternatives and resources to be considered during development of the Draft EIS.

Open House Public Scoping Meetings 4 p.m. to 7 p.m.

March 4, 2019
Light of Christ Anglican Church
9500 Northumberland Highway
Heathsville, VA 22473

March 5, 2019
Southern Maryland Higher Education Center
Building 1 Multi-Purpose Room
44219 Airport Road
California, MD 20619

March 6, 2019
University of Maryland, Eastern Shore
Richard A. Henson Center Ballroom
30690 University Boulevard South
Princess Anne, MD 21853

March 7, 2019
St. Paul's United Methodist Church
Parish Hall
205 Maryland Avenue
Cambridge, MD 21613

The Navy Requests Your Input!

You can participate in several ways:

- Visit www.PRCEIS.com to learn more about the project, review materials, join the mailing list, and/or submit comments.
- Attend a scoping meeting open house and speak with project representatives and submit comments.
- Mail written comments by **April 1, 2019** to:

Naval Air Warfare Center
Aircraft Division
Attn: EIS Project Manager
NAVAIR Ranges Sustainability Office
Atlantic Test Ranges, Building 2118
23013 Cedar Point Road
Patuxent River, MD 20670-1183

Proposed Action

The Navy proposes to continue conducting research, development, test, and evaluation and training activities on naval aircraft, non-explosive weapons, and aircraft systems within the PRC to meet current and future projected military readiness requirements. Proposed testing and training activities and annual tempo are similar to that which has occurred in the PRC Study Area for decades.

The purpose of the Proposed Action is to provide Sailors and Marines with equipment and technology that operate effectively and safely to support current and projected future military readiness requirements. The need for the Proposed Action is to maintain military readiness of naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas, now and into the future.

Visit: www.PRCEIS.com to learn more or to submit comments online.

Naval Air Warfare Center Aircraft Division
Attn: EIS Project Manager
NAVAIR Ranges Sustainability Office
Atlantic Test Ranges, Building 2118
23013 Cedar Point Road
Patuxent River, MD 20670-1183

Leidos
Attn: Paisley Gunter
301 Laboratory Road
Oak Ridge, TN 37830

Figure G-2 Postcard Mailer (Front and Back)

G.2.3 Scoping Meeting Newspaper Advertisement

Table G-2 Newspaper Publications of NOI and Scoping Meetings

Newspaper	*Coverage*	*Publication Dates*
Northern Neck News	Northern Neck, VA	February 20, 27, 2019
Crisfield-Somerset Times	Somerset County, MD, and Tangier Island, VA	February 20, 27, 2019
Calvert Recorder	Calvert County, MD	February 20, 22, 27, 2019 March 1, 2019
The Tester	NAS Patuxent River	February 21, 28, 2019
The Enterprise	St. Mary's County, MD	February 15, 20, 22, 2019 March 1, 2019
BayNet	St. Mary's County, MD (electronic only)	Week of February 25, 2019
The Daily Times	Eastern Shore, MD	February 15, 16, 17, 2019 March 5, 2019
Dorchester Star	Eastern Shore, MD	February 22, 2019 March 1, 2019

Key: MD = Maryland; NAS = Naval Air Station; NOI = Notice of Intent; VA = Virginia.

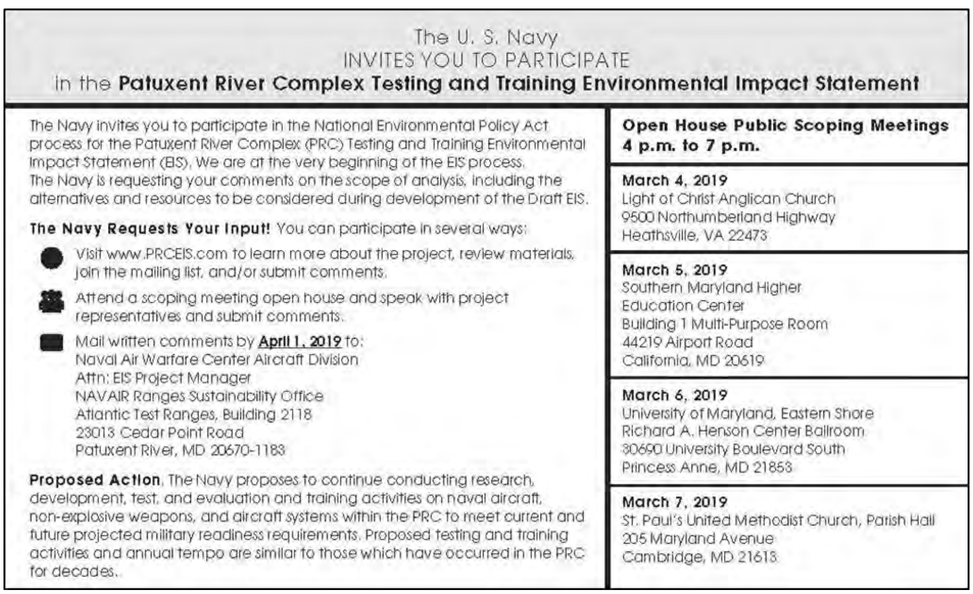


Figure G-3 Example Newspaper Advertisement

G.2.4 Scoping Press Release

NEWS RELEASE
NAVAL AIR STATION PATUXENT RIVER
PUBLIC AFFAIRS OFFICE
DESK: 301-757-3343
MOBILE: 301-247-8872

RELEASE #190301 **March 1, 2019**

Navy to Hold Public Meetings March 4 to March 7 Regarding Patuxent River Testing and Training Environmental Impact Statement

PATUXENT RIVER NAVAL AIR STATION, MD – The U.S. Navy is holding a series of public meetings between March 4 and 7 regarding the Patuxent River Complex Testing and Training Environmental Impact Statement, or EIS.

This EIS will assess community and environmental impacts from continued military testing and training activities within the Patuxent River Complex. It will include testing and training activities addressed in the 1998 EIS and subsequent Environmental Assessments, current and projected military readiness requirements, and new technology, science, policy, and regulations that warrant new analysis.

The opening step in a multi-year process, these meetings will consist of informal, open-house sessions with informational poster stations staffed by U.S. Navy representatives. They will help the U.S. Navy to identify areas of public interest that should be considered in the preparation of the EIS, including resources to be studied, potential environmental issues and viable alternatives.

Open-House Public Scoping Meetings
All meetings will be held 4 p.m. to 7 p.m.

March 4, 2019
Light of Christ Anglican Church
9500 Northumberland Highway
Heathsville, VA 22473

March 5, 2019
Southern Maryland Higher Education Center
Building 1 Multi-Purpose Room
44219 Airport Road
California, MD 20619

March 6, 2019
University of Maryland, Eastern Shore
Richard A. Henson Center Ballroom
30690 University Boulevard South
Princess Anne, MD 21853

March 7, 2019
St. Paul's United Methodist Church, Parish Hall
205 Maryland Avenue
Cambridge, MD 21613

The Patuxent River Complex includes Naval Air Station Patuxent River, Webster Outlying Field, Bloodsworth Island Range, and the water and airspace where the Navy conducts aircraft testing and training in Maryland, Virginia, and Delaware.

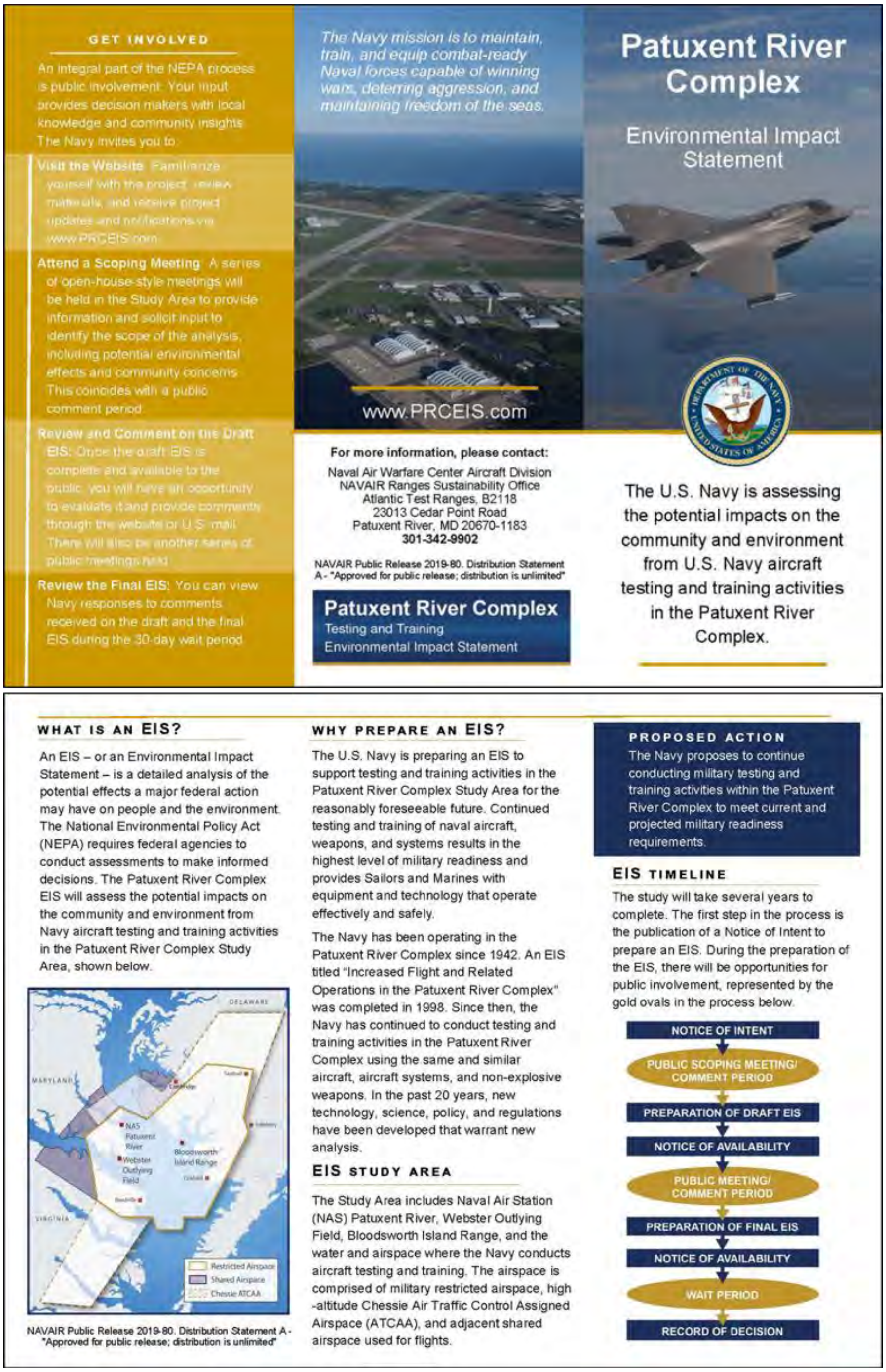
Written comments are being accepted until April 1, 2019, through U.S. mail, the EIS website at www.PRCEIS.com or at any of the public meetings.

If you have questions about the meetings or would like more information, please visit www.PRCEIS.com or contact the NAVAIR Ranges Sustainability Office at (301) 342-9902.

– 30 –

Figure G-4 Public Scoping News Release

G.2.5 Post-NOI Brochure



GET INVOLVED

An integral part of the NEPA process is public involvement. Your input provides decision makers with local knowledge and community insights. The Navy invites you to:

Visit the Website: Familiarize yourself with the project, review materials, and receive project updates and notifications via www.PRCEIS.com.

Attend a Scoping Meeting: A series of open-house-style meetings will be held in the Study Area to provide information and solicit input to identify the scope of the analysis, including potential environmental effects and community concerns. This coincides with a public comment period.

Review and Comment on the Draft EIS: Once the draft EIS is complete and available to the public, you will have an opportunity to evaluate it and provide comments through the website or U.S. mail. There will also be another series of public meetings held.

Review the Final EIS: You can view Navy responses to comments received on the draft and the final EIS during the 30-day wait period.

The Navy mission is to maintain, train, and equip combat-ready Naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas.

www.PRCEIS.com

For more information, please contact:

Naval Air Warfare Center Aircraft Division
NAVAIR Ranges Sustainability Office
Atlantic Test Ranges, B2118
23013 Cedar Point Road
Patuxent River, MD 20670-1183
301-342-9902

NAVAIR Public Release 2019-80. Distribution Statement A - "Approved for public release; distribution is unlimited"

Patuxent River Complex
Testing and Training
Environmental Impact Statement

Patuxent River Complex

Environmental Impact Statement

The U.S. Navy is assessing the potential impacts on the community and environment from U.S. Navy aircraft testing and training activities in the Patuxent River Complex.

WHAT IS AN EIS?

An EIS – or an Environmental Impact Statement – is a detailed analysis of the potential effects a major federal action may have on people and the environment. The National Environmental Policy Act (NEPA) requires federal agencies to conduct assessments to make informed decisions. The Patuxent River Complex EIS will assess the potential impacts on the community and environment from Navy aircraft testing and training activities in the Patuxent River Complex Study Area, shown below.

NAVAIR Public Release 2019-80. Distribution Statement A - "Approved for public release; distribution is unlimited"

WHY PREPARE AN EIS?

The U.S. Navy is preparing an EIS to support testing and training activities in the Patuxent River Complex Study Area for the reasonably foreseeable future. Continued testing and training of naval aircraft, weapons, and systems results in the highest level of military readiness and provides Sailors and Marines with equipment and technology that operate effectively and safely.

The Navy has been operating in the Patuxent River Complex since 1942. An EIS titled "Increased Flight and Related Operations in the Patuxent River Complex" was completed in 1998. Since then, the Navy has continued to conduct testing and training activities in the Patuxent River Complex using the same and similar aircraft, aircraft systems, and non-explosive weapons. In the past 20 years, new technology, science, policy, and regulations have been developed that warrant new analysis.

EIS STUDY AREA

The Study Area includes Naval Air Station (NAS) Patuxent River, Webster Outlying Field, Bloodsworth Island Range, and the water and airspace where the Navy conducts aircraft testing and training. The airspace is comprised of military restricted airspace, high -altitude Chessie Air Traffic Control Assigned Airspace (ATCAA), and adjacent shared airspace used for flights.

PROPOSED ACTION

The Navy proposes to continue conducting military testing and training activities within the Patuxent River Complex to meet current and projected military readiness requirements.

EIS TIMELINE

The study will take several years to complete. The first step in the process is the publication of a Notice of Intent to prepare an EIS. During the preparation of the EIS, there will be opportunities for public involvement, represented by the gold ovals in the process below.

NOTICE OF INTENT
PUBLIC SCOPING MEETING/ COMMENT PERIOD
PREPARATION OF DRAFT EIS
NOTICE OF AVAILABILITY
PUBLIC MEETING/ COMMENT PERIOD
PREPARATION OF FINAL EIS
NOTICE OF AVAILABILITY
WAIT PERIOD
RECORD OF DECISION

Figure G-5 Post-NOI Brochure

G.2.6 Scoping Factsheet Booklet and Comment Guide

Patuxent River Complex Testing and Training Environmental Impact Statement

Public Scoping Meeting Guide

Open House Public Scoping Meeting Schedule

DATE	LOCATION	TIME
March 4, 2019	Light of Christ Anglican Church 9500 Northumberland Highway Heathsville, VA 22473	4:00 - 7:00 pm
March 5, 2019	Southern Maryland Higher Education Center Building 1 Multi-Purpose Room 44219 Airport Road California, MD 20619	4:00 - 7:00 pm
March 6, 2019	University of Maryland, Eastern Shore Richard A. Henson Center Ballroom 30690 University Boulevard South Princess Anne, MD 21853	4:00 - 7:00 pm
March 7, 2019	St. Paul's United Methodist Church, Parish Hall 205 Maryland Avenue Cambridge, MD 21613	4:00 - 7:00 pm

Please Check In!

Scoping is your opportunity to provide comments to help us focus our analysis.
Please visit the project website at www.PRCEIS.com

NAVAIR Public Release 2019-80, Distribution Statement A - "Approved for public release; distribution is unlimited"

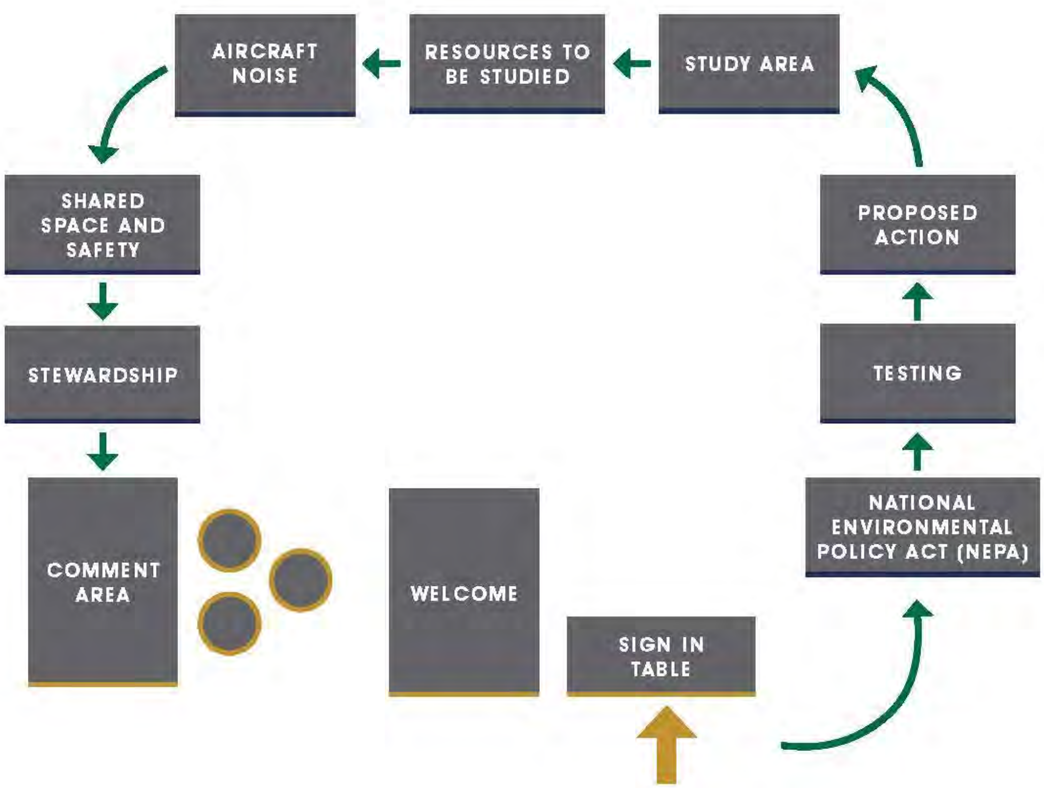
If you have questions or would like more information about the PRC EIS process, please contact NAVAIR Ranges Sustainability Office at (301) 342-9902. Note, comments will not be accepted via the telephone.

Please visit the project website at www.PRCEIS.com

Welcome

Welcome to the U.S. Navy's public meetings for the Patuxent River Complex (PRC) Testing and Training Environmental Impact Statement (EIS). The Navy is preparing an EIS to assess the potential impacts on the community and environment from conducting ongoing and new research, development, acquisition, testing, and evaluation ("testing") and training activities in the PRC.

The public meetings are open-house format. Please take your time to review the displays, talk to project staff, and provide comments. We are in the early stages of the EIS process and appreciate your time and interest.



Please visit the project website at www.PRCEIS.com

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NEPA

What is NEPA?

The National Environmental Policy Act (NEPA) of 1969 is environmental legislation that requires federal agencies to assess the environmental effects of their proposed actions prior to making decisions. Citizens are invited to participate in the process.

The Navy invites you to participate in the Environmental Impact Statement process.

What is an EIS?

An Environmental Impact Statement (EIS) is a detailed public document providing an assessment of the potential effects a major federal action may have on the human, natural, and cultural environment.
An EIS:

- Is a report prepared by a multidisciplinary team
- Considers alternative ways to accomplish the proposed action
- Includes an evaluation of existing resources
- Assesses the impact of the proposed action and alternatives on the environment
- Evaluates best management practices and mitigation measures to reduce environmental impacts

A typical EIS contains the following sections:

1. Introduction and Purpose and Need – project objectives and why the proposed action is needed
2. Proposed Action and Alternatives – what the Navy wants to do and alternatives that can meet their needs
3. Affected Environment – description of the existing environment or baseline conditions
4. Environmental Consequences – analysis of affected environmental resource areas associated with implementation of each alternative
5. Cumulative Impacts – effects of the proposed action considered along with other projects occurring in the same area
6. Mitigation Measures – best management practices and measures that could lessen environmental impacts

*Gold ovals represent public involvement opportunities

Please visit the project website at www.PRCEIS.com

What is Scoping?

Scoping occurs at the beginning of the NEPA process to help understand community-specific concerns regarding the scope of analysis. It encourages the participation of other federal, state, and local agencies, as well as citizens. Scoping helps determine what should be studied in the EIS and alternatives to be analyzed.

Get Involved

There are several opportunities where your participation is encouraged. The schedule highlights in gold the steps where you can get involved. During the scoping step, engaging the public in an early and open process helps identify, define, and prioritize resources to be evaluated in the Draft EIS. Once the Draft EIS is released, the Navy invites citizens to review and comment on the analysis. The release of the Draft EIS and the opening of the Draft EIS comment period will be announced in newspapers, and additional public meetings will be held to receive comments on the report. The Navy then prepares a Final EIS, considering the comments received on the Draft EIS. Once the Final EIS is complete, a Notice of Availability is published in the *Federal Register* and local newspapers. This is followed by a 30-day wait period. The final decision will then be published in the *Federal Register* as a Record of Decision.

Please visit the project website at www.PRCEIS.com

NAVAIR Public Release 2019-80. Distribution Statement A – "Approved for public release; distribution is unlimited"

TESTING

Testing ensures that aircraft, systems, and equipment meet the needs of our Sailors and Marines.

Importance of the Patuxent River Complex (PRC)

The PRC is a national asset for aircraft testing and training for all branches of the U.S. military. Testing at the PRC has been occurring since 1943. All types of Navy and Marine Corps aircraft are tested in the PRC. The PRC is unique in that it provides the facilities, military restricted airspace, instrumentation, and people with the technical expertise to support aircraft, aviation systems, and non-explosive weapons integration testing. All Navy aircraft, systems, and equipment must be tested to ensure proper functioning before delivery to the U.S. military for use. Testing activities conducted in the PRC are important for maintaining readiness. Research and development of new technologies by the U.S. Department of Defense occurs continually to ensure that the U.S. military can counter new and emerging threats.

Proposed Navy testing and training activities are similar to the types of activities that have been occurring in the PRC for decades.

What is Testing?

Testing at the PRC includes: aircraft, aviation systems, non-explosive weapons, and their ability to operate on aircraft carriers and other ships. Testing explores the capabilities of aircraft and equipment at various speeds, altitudes, maneuvers, and weapons configurations, using systematic methods to work safely from the known towards the unknown.

Please visit the project website at www.PRCEIS.com

- **Test Activities** – testing activities include:
  - Air Vehicle Testing – tests during flights to expose the airframe and aircrew to varying altitude, speed, load factor, weight, and other conditions
  - Carrier and Shipboard Suitability Testing – tests conducted in ground-based facilities designed to simulate a ship
  - Mission Systems Testing – tests to evaluate the performance and operability of electronic, computer, communications, and control systems including, black boxes, avionics, and aircraft electronics
  - Electronic Warfare Testing – tests to evaluate electronic systems designed to interrupt enemy electronic systems
  - Weapons Integration Testing – tests to evaluate the integration of non-explosive weapons with aircraft and associated systems
- **Training Activities** – training of Naval Air Station Patuxent River and other military aircrew
  - U.S. Navy Test Pilot School training for new test pilots
  - Aircrew proficiency and Field Carrier Landing Practice
  - Air Force, Army, and National Guard training in support of national defense
- **Support Activities** – aircraft flights and surface vessels that provide support to testing or training missions
- **Ground Activities** – ground-based activities related to aircraft flight activities. Examples include: aircraft pre- and post-flight checks, ground taxiing, and static engine tests

Please visit the project website at www.PRCEIS.com

What is the Navy Proposing?

The Navy conducts testing and training on aircraft and weapons to ensure service members are equipped to be successful in their mission of national defense.

Proposed Action

The Navy proposes to continue conducting military testing and training activities within the Patuxent River Complex (PRC) to meet current and projected military readiness requirements.

U.S. Sailors and Marines:

- Protect and defend the United States against enemies
- Protect rights to move freely on the oceans
- Provide humanitarian assistance

Purpose

To provide Sailors and Marines with equipment and technology that operate effectively and safely to support current and projected future military readiness requirements

Need

To meet the Navy's requirement to maintain military readiness of naval forces to win wars, deter aggression, and maintain freedom of the seas, now and into the future

Alternatives

The Navy is developing a range of alternatives that take into consideration the Navy's operational needs for the foreseeable future as well as public input received during scoping.

Considerations in Developing Alternatives

- Continued testing and training during all seasons, day and night, in the PRC
- Annual capacity to meet current and future military readiness requirements
- Annual capacity to meet emergent military readiness requirements in response to increased global conflict

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The proposed action includes testing and training activities analyzed in the 1998 PRC Final Environmental Impact Statement (EIS) and subsequent Environmental Assessments, as well as adjustments in testing and training activities from current types and tempos required to support projected Navy military readiness requirements into the foreseeable future.

Updated environmental impact analysis is warranted due to changes in:

Technology: The EIS will address new aircraft, test activities, and changes in the number of non-explosive weapons. All aircraft, non-explosive weapons, and test activities are very similar to those conducted and used for the past 20 years.

Environment: The EIS will address the natural and cultural resources of the PRC Study Area. The PRC Study Area (a map is provided on the Study Area fact sheet) includes supporting land areas (Naval Air Station Patuxent River, Outlying Landing Field Webster, and the Bloodsworth Island Range), water areas (e.g., Chesapeake Bay, lower Potomac, St. Mary's, and lower Patuxent Rivers), airspace, and Atlantic Test Ranges assets (e.g., fixed targets, aim points, recovery areas, and instrumentation sites).

Science: The EIS will use the best available science. Since 1998, there have been changes in the natural and cultural resources within the PRC that are documented in new published scientific studies. New methodologies and studies will be used to update the analysis of potential environmental impacts from ongoing and proposed testing and training activities.

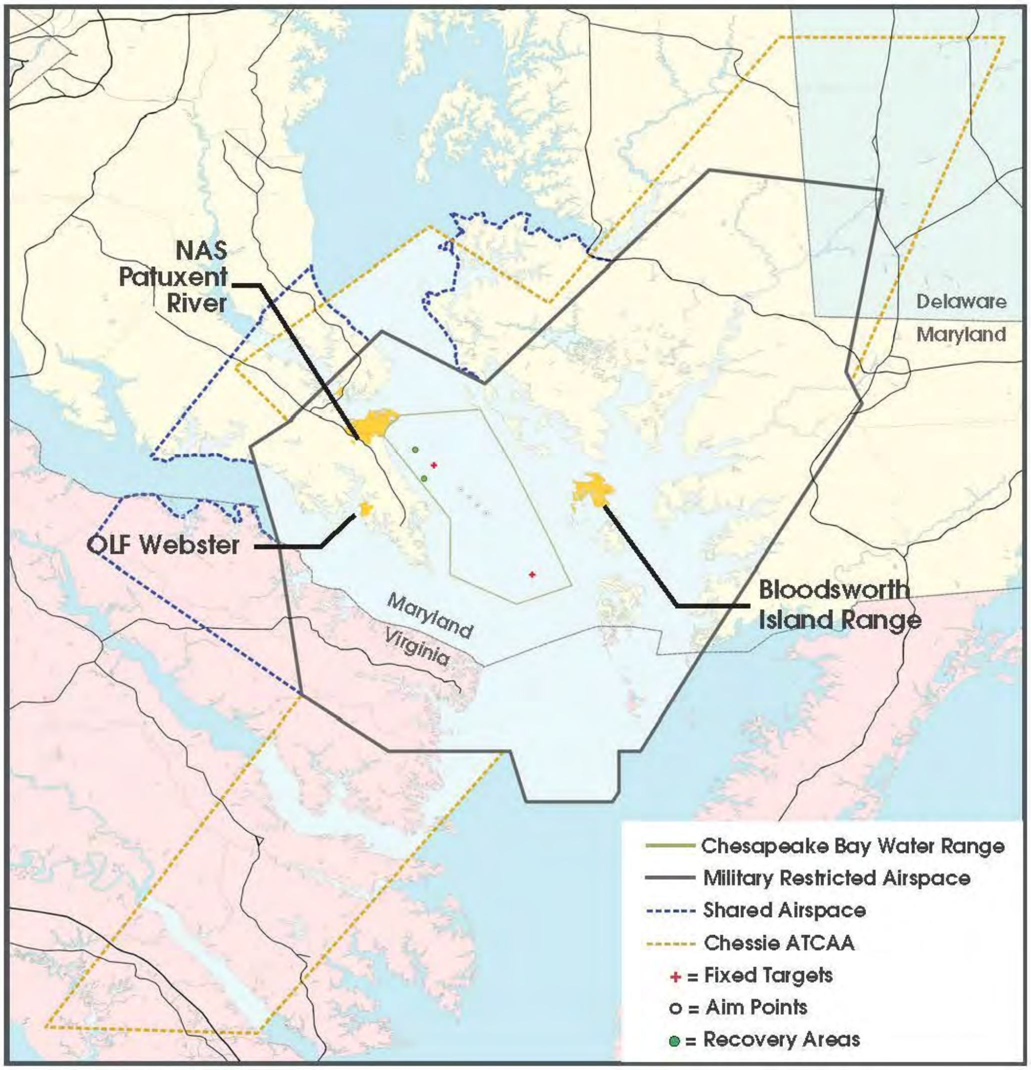
Navy Policy and Regulations: The EIS will use the most current standards for conducting environmental impact analysis, incorporate multiple Navy National Environmental Policy Act (NEPA) documents into a single EIS document, and address new environmental regulatory requirements (e.g., new protected species).

The Navy invites you to provide input on what to consider in the development of the alternatives to be evaluated in the EIS.

Please visit the project website at www.PRCEIS.com

Study Area

The Study Area is presented in the map below.



NAS -Naval Air Station

OLF - Outlying Landing Field

ATCAA - Air Traffic Control Assigned Airspace

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Land Areas

- **Naval Air Station (NAS) Patuxent River:** Covers 6,304 acres in St. Mary's County, and contains the main airfield, two runways, control tower, and the majority of aircraft and aircraft systems testing facilities.
- **Outlying Landing Field (OLF) Webster:** An annex to NAS Patuxent River, OLF Webster covers 852 acres along the eastern shore of the St. Mary's River, with St. Inigoes Creek and Molls Cove forming the northern boundary, and is primarily used for unmanned aircraft research, development, testing, and evaluation.
- **Bloodsworth Island Range:** The range covers 4,738 acres, located 25 miles southeast of NAS Patuxent River in the Chesapeake Bay. The Navy conducts aviation-related testing activities within the military restricted airspace that overlies the Bloodsworth Island Range.

Water Areas

- **Chesapeake Bay Water Range:** Located in the middle Chesapeake Bay between the mouth of the Patuxent River and the mouth of the Potomac River, this Range supports aircraft testing and training activities, including the release of non-explosive weapons to ensure safe release from aircraft.
- **Patuxent River Seaplane Area:** A designated area historically used for seaplane takeoffs and landings.
- **Potomac and St. Mary's Rivers surrounding OLF Webster:** These waters are used for non-impact testing activities, including aircraft overflights, surface vessels, and unmanned underwater vehicles.

Airspace

- **Military Restricted Airspace:** Designated airspace that provides a safe and controlled area for aircraft testing and evaluation.
- **Adjacent Shared Airspace:** Adjacent airspace shared by other users, including private and commercial aircraft.
- **Chessie Air Traffic Control Assigned Airspace (ATCAA):** High-altitude airspace that can be assigned to the military to accommodate flight activities that require additional space beyond the boundaries of the military restricted airspace.

Atlantic Test Ranges (ATR) Assets

- **Fixed Targets, Aim Points, and Recovery Areas:** Used as reference points for non-explosive weapons and mission systems.
- **Instrumentation Sites:** ATR is a fully instrumented range with shore-based radars, telemetry, optical, and communications systems.

Please visit the project website at www.PRCEIS.com

What resources will be studied in the Environmental Impact Statement?

The Navy will be studying potential impacts on the following representative resource areas within the Patuxent River Complex (PRC). The scoping process helps to identify which resources will be studied.

Resource Area

Airspace and Airfield Activities	• Aircraft testing and evaluation in military restricted airspace • Use of adjacent shared airspace • Flight activities in high-altitude airspace • Number of aircraft flight hours
Noise	• Types and sources of noise • Sensitive receptors
Public Health and Safety	• Flight safety • Bird/Animal aircraft strike hazard • Range safety • Hazardous materials and wastes
Shared Space	• Land use compatibility • Recreation • Environmental justice
Air Quality	• Air emissions from aircraft maintenance, testing, and training • Greenhouse gases
Biological Resources	• Terrestrial vegetation and wildlife • Marine resources • Protected species • Essential fish habitat
Water Resources and Sediments	• Surface waters, including the Chesapeake Bay • Wetlands • Sediments
Cultural Resources	• Archaeological resources • Architectural resources • Traditional cultural properties

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Aircraft Noise

Aircraft flying in the Patuxent River Complex (PRC) generate noise, and the Navy is preparing a noise assessment as part of this Environmental Impact Statement (EIS).

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and are sensed by the human ear. Sound is all around us. The perception and evaluation of sound involves three basic physical characteristics:

- **Intensity –** the acoustic energy, which is expressed in terms of sound pressure, in decibels (dB)
- **Frequency –** the number of cycles per second the air vibrates, in hertz
- **Duration –** the length of time the sound can be detected

What is Noise?

Noise is considered to be unwanted sound that interferes with normal activities or otherwise diminishes the quality of the environment.

The response of different individuals to similar noise events is diverse and is influenced by many factors including: the type of noise, interference with activity, time of day, how long the noise lasts, how many times it occurs, background or ambient noise levels, previous experiences within the community, and individual sensitivity to noise.

Aircraft noise is the predominant noise source at the PRC. Noise is generated from testing and training activities at Naval Air Station (NAS) Patuxent River and Outlying Landing Field (OLF) Webster and in the water and airspace.

How is Noise Assessed?

The U.S. Environmental Protection Agency (EPA), Federal Aviation Administration (FAA), and Department of Defense (DoD) use the Day-Night Average Sound Level (DNL) as the primary metric to measure long-term community noise exposure and assess noise impacts on the natural and human environment.

DNL represents the average sound energy of events over a 24-hour period, with a 10-dB adjustment added to nighttime activities (10:00 p.m. to 7:00 a.m.). This 10-dB adjustment accounts for the added intrusiveness of noise when background noise levels are low and noise-sensitive activities such as sleep take place. DNL is depicted as noise contours, a continuous line around a noise source (e.g., 65 dB DNL, 70 dB DNL), connecting points of equal noise levels. DNL takes into account the factors that influence the perception of noise by people (loudness, number and duration of events, and time of day) and includes them in one metric that is used to identify land uses that are compatible with specific noise levels.

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Less than 60 dB DNL is generally considered an area of low exposure.

60 to 75 dB DNL is an area where some land use controls are needed due to noise levels.

Greater than 75 dB DNL needs the greatest degree of land use controls due to noise levels.

Supplemental metrics are used to assess specific types of noise impacts, such as interference with sleep, speech, and classroom learning.

This EIS will include a comprehensive noise study of the PRC. The study will use the latest approved DoD environmental noise computer models to quantify and assess noise at the airfields and in the water and airspace for the baseline conditions and the operational alternatives. The following noise metrics will be included in the PRC noise study:

A-Weighted Day-Night Average Sound Level (ADNL)	• Used for evaluating community response to aircraft noise and land use compatibility • 24-hour cumulative noise metric • 10 dB added to events occurring between 10 p.m. and 7 a.m. to account for nighttime noise disturbance • A-weighted dB levels are used to represent human hearing frequency
C-Weighted DNL (CDNL)	• Used to describe sonic boom and impulsive noise • C-weighted dB levels best describe noise that can be felt as well as heard
A-Weighted Monthly Onset Rate DNL (Ldnmr)	• Used for evaluating community response to aircraft noise and land use compatibility • A monthly average calculated based on the number of daily flights and the number of flying days in a month with the highest tempo
A-Weighted Sound Exposure Level (SEL)	• Used to compare relative noise levels of various flights • Used to estimate the potential for sleep disturbance • Noise exposure of a single event (e.g., flyover) as if it occurs in 1 second
Maximum A-Weighted Sound Level (Lmax)	• Used to estimate the potential for task interference and classroom interruptions • Maximum sound level that humans can hear during an overflight event
Unweighted Peak Sound Level (dBP)	• Used to estimate the likelihood of complaints associated with large-arms firing • Highest instantaneous sound level generated by weapon firing

Please visit the project website at www.PRCEIS.com

How is Noise Modeled?

The DoD uses environmental noise models to predict and compare noise levels of current conditions and future operational alternatives. Noise model input includes aircraft types, number of activities, flight tracks, engine power settings, aircraft speed, terrain, temperature, and relative humidity. Engine maintenance testing is also included in the models. The output of noise models is presented on land use maps in the form of noise contours.

Noise Management:

The Navy has a comprehensive noise management program for the PRC including:

- Noise response system with a toll-free noise hotline to report noise disturbances
- Annual aircrew awareness briefings
  "Be Safe, Be Smart, and Be Sensitive"
- Sonic boom monitors throughout the PRC
- Noise management instructions to reduce noise impacts
- Monitoring and tracking of activities
- Community noise advisories
- Real estate disclosure clause to notify prospective buyers of potential impacts from nearby military installations
- Noise zones to promote compatible development

Noise Hotline 866-819-9028

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Shared Space and Safety

The water and airspace within the Patuxent River Complex (PRC) are used by many people for commercial and recreational purposes. The Navy shares the water and airspace with the community and recognizes the importance of public access.

The Navy ensures public safety during testing and training activities by:

- Making sure any watermen or recreational users are clear of impact areas and targets before testing begins
- Canceling or delaying activities if public or personnel safety is a concern
- Communicating via radio to local watermen and recreational users of the location, date, and time of range closures
- Implementing temporary access restrictions to testing and training areas
- Designating restricted airspace for multiple, high-speed, military aircraft
- Limiting the number of aircraft within restricted airspace
- Using a Military Radar Unit, named BayWatch, for surveillance when the restricted area is activated

Communication is Key
The Navy uses marine very high frequency (VHF) Channels 81 and 82

Thorough environmental and safety reviews are conducted for all tests.

PUBLIC NOTIFICATION

Noise advisories are posted to inform the public of dates and times when noise-generating activities are scheduled.

Temporary access limitations (usually lasting several hours) can occur during testing and training activities for the safety of commercial and recreational users.

The Navy conducts diverse testing and training in the PRC.

Some access restrictions must occur for public safety.

The safety measures implemented before and during testing and training, along with the cooperation of the public, commercial, and recreational users of the air and sea spaces, enable safe testing and training.

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Stewardship

Programs

The Navy's stewardship programs contribute to both the success of the mission and the protection of the Chesapeake Bay for future generations.

Naval Air Station (NAS) Patuxent River manages robust community service and environmental stewardship programs. Multiple partnerships with the private sector and government agencies have been successful in advancing environmental compliance, conservation, and education.

Initiatives include:

- Wildlife habitat protection and enhancement
- Rare, threatened, and endangered species monitoring
- Archaeological surveys and site protection
- Marine mammal surveillance
- Overflight restrictions to minimize wildlife disturbance

For example, the Navy works with the College of William and Mary to study bald eagle nesting success on NAS Patuxent River (top right) and archaeologists have excavated a test pit showing a brick foundation dating to the 1800s (bottom right).

NAS Patuxent River did the first test flight of the Green Hornet, a bio-fueled F/A-18 jet.

Partnering

- The Navy partners with nonprofit organizations and local, state, and federal agencies to manage lands for uses such as agriculture, recreation, and natural habitat. Over 8,000 acres of land have been protected as conservation areas or easements.
- NAS Patuxent River partners with the University of Maryland to develop creative solutions to protect native terrapin (top right). Natural resource experts found that prime terrapin nesting sites overlapped with an established helicopter landing zone. Working with the pilots, an acceptable alternative landing zone site was identified. Through an agricultural outlease, farmers cleared excess vegetation on the new site, and a terrapin exclusion fence was installed.
- Navy experts built heron nesting platforms at Bloodsworth Island Range (bottom right).
- The Navy participates in the North American Waterfowl Management Plan along with the U.S. Fish and Wildlife Service and Maryland Department of Natural Resources.

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How to Provide Comments:

Complete a comment form tonight
and place it in the comment box.

By mail:
Naval Air Warfare Center Aircraft Division
Attn: EIS Project Manager
NAVAIR Ranges Sustainability Office
Atlantic Test Ranges, Building 2118
23013 Cedar Point Road
Patuxent River, MD 20670-1183

Electronically via the project website:
www.PRCEIS.com

If you have questions or would like more information about the PRC EIS process, please contact the NAVAIR Ranges Sustainability Office at (301) 342-9902. Note, comments will not be accepted via the telephone.

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NOTES:

Please visit the project website at www.PRCEIS.com

We are in the early stages of the EIS process and appreciate your time and interest.

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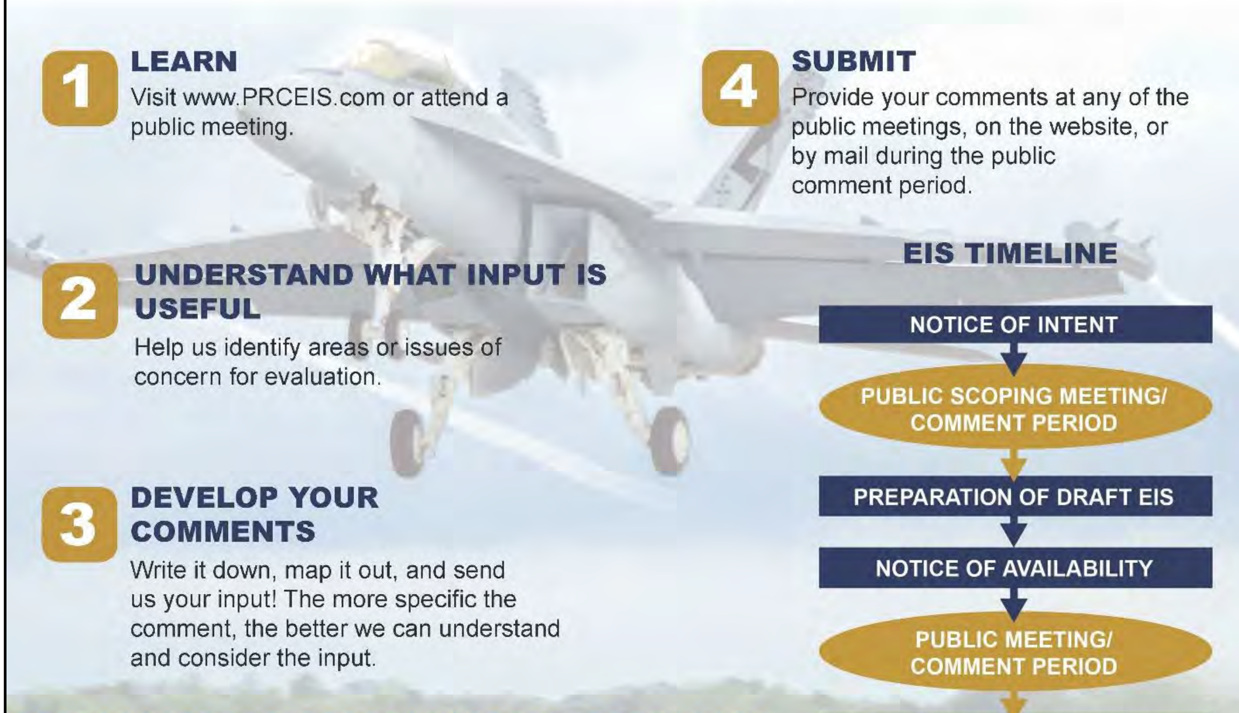
A GUIDE TO PROVIDING COMMENTS

Patuxent River Complex Testing and Training Environmental Impact Statement (EIS)

The Navy is hosting a series of public meetings to provide information on the Patuxent River Complex EIS, which coincide with a public comment period. The Navy is asking stakeholders to help identify areas or issues of concern for evaluation.

Your input is important to us and provides decision makers with local knowledge and community insight.

This is your opportunity to provide input on what will be studied and considered before the analysis begins.



1 LEARN

Visit www.PRCEIS.com or attend a public meeting.

2 UNDERSTAND WHAT INPUT IS USEFUL

Help us identify areas or issues of concern for evaluation.

3 DEVELOP YOUR COMMENTS

Write it down, map it out, and send us your input! The more specific the comment, the better we can understand and consider the input.

4 SUBMIT

Provide your comments at any of the public meetings, on the website, or by mail during the public comment period.

EIS TIMELINE

- NOTICE OF INTENT
- PUBLIC SCOPING MEETING/ COMMENT PERIOD
- PREPARATION OF DRAFT EIS
- NOTICE OF AVAILABILITY
- PUBLIC MEETING/ COMMENT PERIOD
- PREPARATION OF FINAL EIS
- NOTICE OF AVAILABILITY
- WAIT PERIOD
- RECORD OF DECISION

Place Stamp Here

Naval Air Warfare Center Aircraft Division
Attn: EIS Project Manager
NAVAIR Ranges Sustainability Office
Atlantic Test Ranges, Building 2118
23013 Cedar Point Road
Patuxent River, MD 20670-1183

www.PRCEIS.com

HOW TO LEARN MORE
and Submit Comments

VISIT THE EIS WEBSITE

Familiarize yourself with the project, review materials, and sign up to receive project updates and notifications at www.PRCEIS.com.

SUBMIT YOUR COMMENTS

1 ONLINE

Follow the instructions at www.PRCEIS.com.

2 BY MAIL

Submit your written comments via U.S. mail; you can fill out, detach, and mail the post card below.

3 PUBLIC MEETINGS

Comment forms will be available for your use at the public meetings.

ATTEND A PUBLIC MEETING

Public meetings will be an open-house format to facilitate one-on-one conversations and to provide information. To find a meeting near you, please visit www.PRCEIS.com.

MAIL COMMENTS

Mail comments to:

Naval Air Warfare Center Aircraft Division
Attn: EIS Project Manager
NAVAIR Ranges Sustainability Office
Atlantic Test Ranges, Building 2118
23013 Cedar Point Road
Patuxent River, MD 20670-1183

FOR MORE INFORMATION

For more information on the Patuxent River Complex EIS, please contact:

Naval Air Warfare Center Aircraft Division
NAVAIR Ranges Sustainability Office
301-342-9902

PUBLIC COMMENTS WILL BE ACCEPTED FROM 15 FEBRUARY TO 1 APRIL 2019.

www.PRCEIS.com

G.2.7 Scoping Comment Summary

Table G-3 Summary of Comments Received During the Scoping Period

Comment Method	***Code***	***Summary***
Comment Forms		
Comment Form	Noise	Would like an app to inform the community about aircraft operations.
Comment Form	Airspace, Stewardship	Shared airspace with general aviation, stewardship (County partnership to buy Shannon Farm), and wants to be a good neighbor (Cedar Cove).
Comment Form	Shared Space	Recommends a fact sheet for new boat registrations and fishing/crabbing/oysters to make people aware of the water restricted areas.
Comment Form	General	Presentations were informational and interesting.
Comment Form	General	Add to mailing list. Very informative presentations.
Letters		
Letter	Water	No comments since the Patuxent River Complex (PRC) is outside of area of Tidewater, Virginia, localities that are subject to the Chesapeake Bay Preservation Area Designation and Management Regulations. Regulations do not apply.
Letter	Cultural Resources	The Department of Historic Resources believes that the proposed undertaking has the potential to affect historic properties listed in or eligible for listing in the National Register of Historic Places. Please continue to consult with the Department of Historic Resources on the undertaking pursuant to the National Environmental Policy Act and Section 106 of the National Historic Preservation Act.
Letter	Purpose and Need	The purpose or objective of the proposal should be defined in relationship to the need of the action. Need should identify and describe underlying deficiency, facts and analyses supporting the deficiency, and context.
	Alternatives	The Environmental Impact Statement (EIS) should have clear comparison of alternatives text, rationale for selection of the preferred alternative, and reasons alternatives were eliminated.
	Land Use	The EIS should contain the type and acreage of land or water impacted and include a description of the permits, laws, and regulations.
	Water Resources	The EIS should address water quality including surface water, groundwater, drinking water, stormwater management, wastewater management, wetlands, oceans and watersheds. Identify all water bodies including target locations that may be impacted by the Navy's operations. Also address submerged aquatic vegetation, Chesapeake Bay Protection and Restoration, and the Chesapeake Bay watershed.
	Biological (Threatened and Endangered Species)	The EIS should provide a description of terrestrial, wildlife, and aquatic species. Include threatened or endangered species and critical habitat. Describe the potential project impacts to these species as well as mitigation measures to minimize/avoid impacts. The most recent state and federal threatened and endangered species coordination letters should be appended

Table G-3 Summary of Comments Received During the Scoping Period, Continued

Comment Method	*Code*	*Summary*
		to the EIS. In addition, appropriate state and federal agencies should be contacted annually.
	Marine Mammal Protection Act	The EIS should discuss testing/training operations impact on marine life. Monitoring of activities and impacts on marine life should be tracked and coordinated with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). Include USFWS and NMFS on the Distribution List.
	Essential Fish Habitat	Proposed Action should not involve the alteration of essential fish habitats or reduce the productive capacity of any fish stock. Operations should not alter essential fish habitats. Coordinate with the National Oceanic and Atmospheric Administration (NOAA) on possible impacts to fish habitats and include NOAA in the Distribution List.
	Environmental Justice	Environmental Justice analysis to include maps with Census tracts and/or block groups and meaningful public outreach. Include the methodology and outreach efforts. Use EJSCREEN.
	Human Health	In the EIS, discuss the human health risks associated with operations at the PRC including contaminants.
	Executive Order 13045, Children's Health	The EIS should address Executive Order (EO) 13045. Environmental health and safety risks are defined as "risks to health or to safety that are attributable to products or substances that the child is likely to come in contact with or ingest".
	Leadership in Energy and Environmental Design	If the Proposed Action would require renovation of existing facilities and construction of new facilities, the Navy should consider Leadership in Energy and Environmental Design in project planning.
	Distribution List	Include the distribution list in the EIS.
	Cultural Resources	Consult with the Maryland State Historic Preservation Officer (SHPO) to identify historic properties/districts, etc. that may potentially be affected and to seek ways to resolve potential adverse effects. Include a description of the affected sites and potential impacts, Military Operating Area, and include correspondence. Coordination with the Maryland Historic Trust is recommended.
	EO 13693, Planning for Federal Sustainability in the Next Decade	Note: this EO has been revoked. Include in the EIS how the Navy will reduce energy use and costs, increase efficiency, and build resiliency into project design.
	Cumulative Impacts	The EIS should assess cumulative and indirect (secondary) impacts specific to resources. Use a trend analysis for resources that may be adversely affected by the proposed alternatives. Manage and link proposed projects to overall water quality and habitat on a sub-basin and sub watershed

Table G-3 Summary of Comments Received During the Scoping Period, Continued

Comment Method	*Code*	*Summary*
		basis, as well as allow for a full evaluation of community impacts that need to be evaluated.
	Hazardous Waste	Discuss if a Hazardous Waste Management Plan and a Hazardous Waste Minimization Plan are in place. Identify known hazardous materials, legacy chemical warfare materials, biological warfare materials, radiological materials, munitions and explosives of concern (MEC) as well as asbestos-containing materials (ACM), lead-based paint (LBP), and oil and other hazardous materials located within the study area. The status of the materials should be discussed as well as alternative remedial methods described in addition to providing a detailed plan for proper disposal.
	Noise	The EIS should discuss noise impacts. Describe health problems related to noise including stress-related illnesses, high blood pressure, speech interference, hearing loss, sleep disruption, and lost productivity.
	Socio-economics	The EIS should discuss the socioeconomic and cultural status of those within and/or affected by the Proposed Action, including the number of people, employees and/or jobs impacted as a result of the Navy's operations. The EIS should address the decrease or increase of people/employees /jobs in relation to its effect on tax base, local housing, job markets, schools, utilities, businesses, etc.
	Traffic and Transportation	If the Proposed Action will have no impacts on traffic and transportation, please indicate this and state why in the EIS.
	Water - Wetlands	Wetlands present on, or within the study area should be delineated according to the 1987 Federal Manual. Impacts to wetlands should be avoided or minimized whenever possible. The total size of the wetlands should be provided, in addition to the size of wetlands in the study area and size of the direct impact. The EIS must analyze the size and functional values of all impacted wetlands and develop a mitigation plan for their protection.
	Water – Stormwater and Sedimentation	The Energy Independence and Security Act (EISA) requires federal agencies to reduce stormwater runoff from development projects to protect water resources. Discuss the Navy's operations in relation to sediment impact (specific to target locations, sensitive areas, Chesapeake Bay, etc.).
	Physiography	The physical and natural resources of the project area should be described in the EIS including physiographic provinces, topography, climate and geologic setting. Soils should be mapped.
	Biological Resources	The EIS should provide a complete description of the terrestrial habitat resources in the study area. Complete species lists for mammals, birds, amphibians, reptiles, and plants present in the study area should be provided. The composition and characteristics of each community type should be summarized, and the functions and total acreage indicated. Discuss potential

Table G-3 Summary of Comments Received During the Scoping Period, Continued

Comment Method	*Code*	*Summary*
		impacts to these communities as a result the Navy's operations and possible mitigation measures to minimize/avoid impacts.
	Air Quality	Conduct a General Conformity rule analysis. Evaluate both temporary and National Ambient Air Quality Standards impacts.
Letter	Noise and Health	Noise and heath, vibration from ground testing, fumes, noise monitor, and mitigation measures.
Web		
Web	General, Coastal Consistency Determination (CCD)	Department of Environmental Quality does not participate in scoping but lists other agencies that may provide comments, CCD submission, and database assistance (GIS, GEMS, DHR, DCR, DGIF, and EPA sites).
Web	Airspace, Noise	Please consider the community surrounding the Tappahannock-Essex county, Virginia airport (KXSA). It is requested that you completely eliminate or, at the very least, minimize KXSA as a training destination for your aircraft. Particularly your helicopter aircraft and osprey, fixed winged aircraft. Our community is constantly abused by helicopter/osprey aircraft from multiple locations and the citizens here are beginning to feel negatively towards our military because of it.
Web	Airspace, Noise	Supports keeping fighting Airmen trained. However, lives in rural Dunnsville, Virginia, close to the Tappahannock Airport that the folks here did not want. No problem with your Ospreys using this airport during the day but nighttime activities need to stop. There are other areas for your fly boys to train nearby such as AP Hill and the West Point airport. This is not an airport set up for this kind of training. I hope you will respect our wishes and night train somewhere else.
Web	Health and Safety	Safety hazard to boaters: 4 poles in the Chesapeake Bay near the Naval Ranges Theodolite Radar Station in Dameron, Maryland. Also at the Radar Station an underground large stiff black rubber piece of tubing extends 20 to 30 feet out onto the beach and directly into the Chesapeake Bay. Request removal.
Web	General – Public Involvement	Is there a way to obtain minutes from the scoping meeting held at the Higher Education Center on Airport Road on March 5?
Web	Airspace	Shared airspace between St. Mary’s County Airport and Naval Air Station Patuxent River. There seems to be some ambiguity.
Web	General and Stewardship (Land Use)	Requests word searchable EIS, section that describes differences between 1998 and current EIS, more information on land preservation initiatives.
Web	General	Support for Navy testing and training. Lives on the Little Wicomico in Northumberland County near Smith Point. Naval aircraft pass overhead almost every day. They usually look to be F-18s, but they’re so high and fast that it’s hard to tell for sure. Very rarely is there a sonic boom, certainly nothing objectionable. I for one am happy to have the Navy training and testing as much as it needs to do so. When America needs

Table G-3 Summary of Comments Received During the Scoping Period, Continued

Comment Method	*Code*	*Summary*
		those aerial warfighters it will need them badly and want them to be highly trained. Go Navy.
Web	Proposed Action and Health and Safety	Tank removal near Bloodsworth Island Range–hazard to navigation thus needing an exclusion zone.
Web	Land Use – CCD	No comments; Delaware Coastal Management Program.
Web	Land Use and Cultural Resources	List National Park Service resources that are located in the project vicinity designed since the previous EIS: Captain John Smith Chesapeake National Historic Trail, Star Spangled Banner Trail, Potomac Heritage National Scenic Trail, and Harriet Tubman Underground Railroad National Historic Park.
Web	Land Use and Cultural Resources	Attachment to National Park Service letter: Foundation Document Potomac Heritage National Scenic Trail, October 2014.
Web	Biological Resources, Noise	Tracking and modeling of dolphin distribution in and around the Chesapeake Bay. Not just an occasional visitor. Requests that the noise effects on bottlenose dolphins be assessed.
Web	Biological Resources: Natural Heritage Resources, State Threatened/ Endangered	Natural Area Preserves (Bush Mill, Dameron Marsh, Hickory Hollow, and Hughlett Point) are located within 2 miles; however, Virginia Department of Conservation and Recreation does not anticipate impacts to these areas. The Proposed Action will not affect any documented state-listed plants and insects.
Email		
Email	Biological	The USFWS does not have scoping comments but will be able to assist in identifying fish and wildlife resources.
Phone		
Phone	General	Media had questions about the Notice of Intent.
Phone	Airspace	Received a question from the Aircraft Owners & Pilots Association (AOPA) asking if the PRC EIS would result in an expansion of military airspace. He will communicate to AOPA that no airspace expansion is planned and all activities will continue in existing military airspace.
Phone	Public Involvement	Received postcard in the mail. Asked if he could share the information about the scoping meetings with the community and if the community could attend the meetings.
Phone	Public Involvement, Noise	Had trouble with the web site comment feature and could not find a phone number. Said that it has been quiet lately and requested the Public Affairs Office web site with the noise advisories.
Phone	Public Involvement	Enterprise (newspaper). Information on the format of the public meetings (e.g., provide testimony).

Table G-3 Summary of Comments Received During the Scoping Period, Continued

Comment Method	*Code*	*Summary*
Phone	Cultural resources	Project is outside of Cherokee Nation and they do not want to receive further information.
Phone	Public Involvement	Wanted additional copies of the scoping meeting brochures.
Phone	Public Involvement	Wanted someone from the Navy to attend a Civic Association meeting on April 8, 2019, and give a brief overview of the EIS.
Phone	Tanks	Wanted to know the number of tanks near Bloodsworth Island Range.

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Appendix H
Endangered Species Act Documentation

Table of Contents

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H.1 U.S. Fish and Wildlife Service – Endangered Species Act Section 7 Correspondence

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
22347 CEDAR POINT ROAD UNIT 6
PATUXENT RIVER MARYLAND 20670-1161

7594
Ser:
01 March 2021

To: http://ecos.fws.gov/ipac/
United States Fish and Wildlife Service (USFWS), Chesapeake Bay Field Office

SUBJECT: ENDANGERED SPECIES ACT SECTION 7 CONSULTATION FOR NAVAL AIR STATION PATUXENT RIVER COMPLEX TESTING AND TRAINING ACTIVITIES

In accordance with section 7 of the Endangered Species Act, the United States Navy (Navy) requests concurrence on our determination that Naval Air Station Patuxent River Complex (PRC) proposed activities in the middle Chesapeake Bay may affect, but are not likely to adversely affect listed species. The Proposed Action includes testing and training activities analyzed in the 1998 PRC Environmental Impact Statement (EIS) and subsequent Environmental Assessments, as well as adjustments to current testing and training activities required to support projected Navy military readiness requirements into the foreseeable future and in the event of increased global conflict. The incidental effects of the proposed action result from exposure to acoustic, physical disturbance, and other environmental stressors associated with military readiness activities that do not include use of explosives. Section 3.4.4.2 (Federal Threatened and Endangered Species Act – USFWS Jurisdiction) of the 2021 PRC EIS provides the required information pursuant to 50 C.F.R. §402.12(±) and is enclosed for your convenience.

We request concurrence on our may affect, not likely to adversely affect determinations for: eastern black rail (*Laterallus j. jamaicensis*), northeastern beach tiger beetle (*Cicindela d. dorsalis*), Puritan tiger beetle (*Cicindela puritan*), red knot (*Calidris canatus rufa*), and West Indian manatee (*Trichechus manatus*).

Although sea turtles occur within the PRC action area, there is no nesting expected within the action area; therefore, we are consulting on sea turtles with only the National Marine Fisheries Service.

We appreciate your continued support in helping the Navy meet its environmental responsibilities. You may contact Mrs. Crystal Ridgell (301-757-5282 or

crystal.l.ridgell@navy.mil) should you have additional questions.

AMY J. MARKOWICH
Executive Director
Data Analytics, Infrastructure and
Technology Advancement Group

Copy to: Chief of Naval Operations (N45)
Naval Sea Systems Command

Enclosures (1) – Public Release Version of 2021 PRC EIS (CD)

H.2 National Marine Fisheries Service – Endangered Species Act Section 7 Correspondence

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
22347 CEDAR POINT ROAD UNIT 6
PATUXENT RIVER MARYLAND 20670-1161

7594
Ser:
01 March 2021

To: nmfs.gar.esa.section7@noaa.gov
National Marine Fisheries Service (NMFS), Greater Atlantic Region

Dear Section 7 Coordinator:

In accordance with section 7 of the Endangered Species Act, the United States Navy (Navy) requests concurrence on our determination that Naval Air Station Patuxent River Complex (PRC) proposed activities in the middle Chesapeake Bay may adversely affect listed species. The Proposed Action includes testing and training activities analyzed in the 1998 PRC Environmental Impact Statement (EIS) and subsequent Environmental Assessments, as well as adjustments to current testing and training activities required to support projected Navy military readiness requirements into the foreseeable future and in the event of increased global conflict. The incidental effects of the proposed action result from exposure to acoustic, physical disturbance, and other environmental stressors associated with military readiness activities that do not include use of explosives. Section 3.4.4.1 (Federal Threatened and Endangered Species Act – NMFS Jurisdiction) of the 2021 PRC EIS provides the required information pursuant to 50 C.F.R. §402.12(±) and is enclosed for your convenience.

Based on the Navy's may affect, likely to adversely affect determinations, we are requesting formal consultation on: Atlantic sturgeon (*Acipenser oxyrinchus oxyrhynchus*) Chesapeake Bay DPS, shortnose sturgeon (*Acipenser brevirostrum*), green sea turtle (*Chelonia mydas*), Kemp's ridley sea turtle (*Chelonia mydas*), loggerhead sea turtle (*Caretta caretta*), and leatherback sea turtle (*Dermochelys coriacea*).

Although sea turtles occur within the PRC action area, there is no nesting expected within the action area; therefore, we will not be consulting on sea turtles with the United States Fish and Wildlife Service.

We request concurrence on our may affect, not likely to adversely affect determinations for: Atlantic sturgeon (*Acipenser oxyrinchus oxyrhynchus*) Carolina and New York Bight DPS, and critical habitat.

We appreciate your continued support in helping the Navy meet its environmental responsibilities. You may contact Mrs. Crystal Ridgell (301-757-5282 or

crystal.l.ridgell@navy.mil) should you have additional questions.

AMY J. MARKOWICH
Executive Director
Data Analytics, Infrastructure and
Technology Advancement Group

Copy to: Chief of Naval Operations (N45)
Naval Sea Systems Command

Enclosures (1) – Public Release Version of 2021 PRC EIS (CD)

Appendix I
Essential Fish Habitat Documentation

Table of Contents

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I.1 National Marine Fisheries Service Essential Fish Habitat Assessment Correspondence

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
22347 CEDAR POINT ROAD UNIT 6
PATUXENT RIVER MARYLAND 20670-1161

7594
Ser:
01 March 2021

Ms. Karen Greene
Mid-Atlantic Field Office Supervisor and EFH Coordinator
Greater Atlantic Regional Fisheries Office
55 Great Republic Drive
Gloucester, MA 09130

Dear Ms. Greene,

In accordance with the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the United States Navy (Navy) has prepared an Essential Fish Habitat (EFH) assessment for Naval Air Station Patuxent River Complex (PRC) proposed activities occurring in the middle Chesapeake Bay. The Proposed Action includes testing and training activities analyzed in the 1998 PRC Environmental Impact Statement (EIS) and subsequent Environmental Assessments, as well as adjustments to current testing and training activities required to support projected Navy military readiness requirements into the foreseeable future and in the event of increased global conflict. The Navy's assessment concludes that EFH may be adversely affected by the proposed military testing and training activities and requests initiation of the MSA's EFH consultation process. The incidental effects of the proposed action result from exposure to acoustic, physical disturbance, and other environmental stressors associated with military readiness activities that do not include use of explosives.

The PRC EFH assessment is contained within the 2021 PRC EIS Section 3.4.7 (Magnuson-Stevens Fishery Conservation and Management Act – Essential Fish Habitat Assessment) and enclosed for your convenience. The classification-based approach to the assessment is very similar to that of the Phase III Atlantic Fleet Training and Testing Essential Fish Habitat Assessment (Final Version 12 February 2018) previously reviewed by your office.

We appreciate your continued support in helping the Navy meet its environmental responsibilities. You may contact Mrs. Crystal Ridgell (301-757-5282 or

crystal.l.ridgell@navy.mil) should you have additional questions.

AMY J. MARKOWICH
Executive Director
Data Analytics, Infrastructure and
Technology Advancement Group

Copy to: Chief of Naval Operations (N45)
Naval Sea Systems Command

Enclosures (1) - Public Release Version of 2021 PRC EIS (CD)

Appendix J
National Historic Preservation Act Documentation

Table of Contents

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J.1 Maryland Historical Trust Correspondence

DEPARTMENT OF THE NAVY
NAVAL AIR STATION
22268 CEDAR POINT ROAD
PATUXENT RIVER, MARYLAND 20670-1154

5090
Ser N45/308
March 3, 2021

Ms. Beth Cole
State Historic Preservation Office
Maryland Historical Trust
100 Community Place
Crownsville, MD 21032-2023

Dear Ms. Cole:

SUBJECT: PATUXENT RIVER COMPLEX (PRC) TESTING AND TRAINING, RENEWAL OF SECTION 106 CONSULTATION

The purpose of this letter is to renew Section 106 consultation, per the National Historic Preservation Act of 1966, for a Department of the Navy (Navy) undertaking of continued testing and training in the Patuxent River Complex (PRC), St. Mary's County, Maryland. The Navy is preparing an updated Environmental Impact Statement (EIS) to evaluate the potential effects of increasing aircraft flight, ground-based, and surface/subsurface activities within the PRC Study Area.

Project Description. The Proposed Action is to continue conducting military testing and training activities within the PRC to meet current and projected military readiness requirements. This action includes testing and training activities analyzed in the 1998 PRC EIS and subsequent Environmental Assessments, as well as adjustments to current testing and training activities required to support projected Navy military readiness requirements into the foreseeable future and in the event of increased global conflict. The EIS consolidates the testing and training activities analyzed in these previous documents and addresses the following adjustments to current testing and training:

- Additional aircraft flight hours and adjustments in aircraft mix (e.g., increased unmanned aerial system [UAS] platforms).
- Additional use of non-explosive munitions and other military expended materials (MEM).
- Additional surface vessel and subsurface vehicle traffic in PRC waters.
- Adjustments in the types of mission systems being integrated and tested in aircraft and surface and subsurface platforms (e.g., anti-submarine warfare [ASW] and mine countermeasure [MCM] systems).
- Expanded use of the Patuxent River Seaplane Area.

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Ser N45/308
March 3, 2021

- Addition of active sonobuoy testing in conjunction with helicopter dipping sonar tests.
- Testing of new technologies to address new and emerging threats (e.g., directed energy weapons systems).

The 1998 PRC EIS defined the PRC as Naval Air Station (NAS) Patuxent River and Outlying Field Webster flight and ground test facilities and airfields along with the Atlantic Test Ranges restricted airspace, Chesapeake Bay Water Range, and fixed target areas. This Proposed Action expands the PRC Study Area to include land, water, and airspace historically and currently used by the Navy that were not assessed in the previous EIS. These include Bloodsworth Island Range, waters beneath the restricted airspace outside the Chesapeake Bay Water Range, and surrounding Federal Aviation Administration airspace including Helicopter Operating Areas (Helo OPAREAs) and Chessie Air Traffic Control Assigned Airspace.

Area of Potential Effect. The Navy has defined the Area of Potential Effect (APE) to include the entire PRC and the visible view shed surrounding the complex. Maps of the PRC and the APE are enclosed.

Identified Historic Properties - Archaeological Sites. For all the Proposed Action alternatives, no ground-disturbing activities will occur in soils not previously disturbed. Therefore, land-based archaeological resources will not be affected by the undertaking. In addition, there are no identified traditional cultural properties or sacred sites at any of the installations under NAS Patuxent River jurisdiction that are in the APE.

The only possible disturbance to archaeological sites may come from non-explosive MEM which may disturb in-water cultural resources such as shipwrecks. However, most MEM in the Chesapeake Bay Water Range will be focused around current munition concentration areas (Enclosure 2, Chesapeake Bay Water Range Munition Concentration Areas). These areas have been targeted through the decades, and it is very unlikely that any intact deposits would still survive today. While none of the underwater cultural resources in the Chesapeake Bay Water Range are determined to be eligible for the National Register of Historic Places (NRHP), they have yet to be evaluated. As targets will not be placed near recorded sites, this undertaking will not impact underwater cultural resources that may be eligible for the NRHP.

Underwater Cultural Resources within the Chesapeake Bay Water Range

Site Number	*Type*	*Description*	*NRHP Status*
18ST847	Aircraft Wreck	WWII aircraft wreck, XF8F-1 Bearcat	Not Evaluated
N/A	Shipwreck	Hannibal (former direct-impact target)	Not Evaluated
N/A	Shipwreck	American Mariner (current direct-impact target)	Not Evaluated
18ST869	Shipwreck	NAS Patuxent River Target Barge	Not Evaluated

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18ST870	Shipwreck	NAS Target West Buoy Wreck	Not Evaluated
18DO494	Shipwreck	Buoy 72A wreck	Not Evaluated
18ST892	Shipwreck	Cedar Point Schooner	Not Evaluated
18ST893	Shipwreck	Cedar Point Barge	Not Evaluated

Sources: (Maryland Historical Trust, 2019)
Key: N/A = not available; NAS = Naval Air Station; NRHP = National Register of Historic Places; WWII = World War II.

Identified Historic Properties - Architectural Resources. The APE touches six counties of Maryland, in which 117 properties are listed or eligible for inclusion to the NHRP located within the APE. While the APE is quite broad, few will notice the impacts caused by the proposed increased activity. As the undertaking does not include construction or demolition, the most severe impact to the built environment would be noise. The results of our noise and vibration studies lead us to believe the overpressures generated by supersonic overflight will be well below established damage thresholds to sites and structures. Therefore, subsonic noise and sonic booms associated with continuation of existing testing and training activities will not be of sufficient magnitude to impact historic properties under the airspace.

High or irregular noise levels can undermine the quality of life at a historic property and interfere with learning. The current baseline noise levels beneath the PRC Study Area airspace are between less than 35 A-weighted sound level (dBA) and 52.9 dBA. Under Alternative 1, subsonic noise levels would increase by between 0.5 dBA to 1.8 dBA, with the greatest increase in the West Helo OPAREA, from 44.3 dBA to 46.1 dBA in PRC airspace areas. With Alternative 2, increased aircraft testing and training activities would be incrementally higher than Alternative 1, and noise levels would increase over existing conditions by between 1 dBA to 2.3 dBA, with the greatest increase in the West Helo OPAREA from 44.3 dBA to 46.6 dBA. For most people, changes in A-weighted noise levels of less than 2 dBA would not be noticeable.

Finding of Effect: The Proposed Action alternatives do not involve impacts related to construction or demolition. The only new impact to the built environment would be related to aircraft noise. The incremental increase in overflights over any of the historic resources would be infrequent and of short duration, resulting in a fleeting and minor change to the historic setting. We find that the minimal increase in visual or audible elements would not diminish the integrity of the properties' historical attributes or alter the characteristics that qualify them for inclusion in the NRHP. Therefore, we find that all alternatives in the proposed undertaking will have a no adverse effect on historical properties.

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Ser N45/308
March 3, 2021

If you have any questions, please contact Craig Lukezic, Cultural Resources Program Manager, by telephone at (301) 757-4774 or by email at craig.lukezic@navy.mil.

Sincerely,

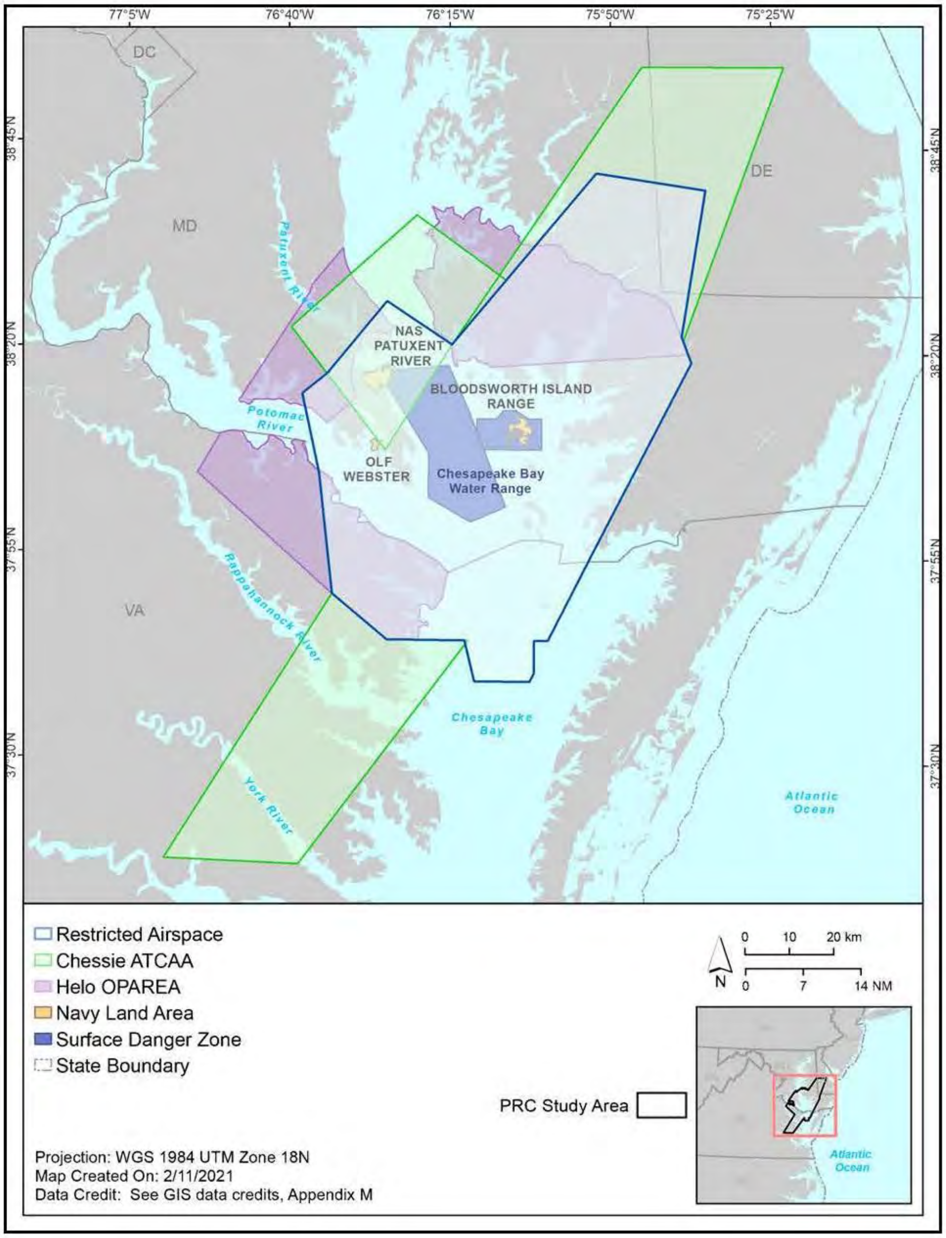
MCDANIEL.LANCE.E.1204352972 Digitally signed by MCDANIEL.LANCE.E.1204352972 Date: 2021.03.03 13:08:55 -05'00'

L. E. McDANIEL
Installation Environmental Director
By direction
of the Commanding Officer

Enclosures: 1. Location Map and Area of Potential Effect
2. Chesapeake Bay Water Range Munition Concentration Areas

4

Enclosure 1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37°55'N
37°30'N
DC
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DE
VA
Patuxent River
Potomac River
Rappahannock River
York River
NAS PATUXENT RIVER
BLOODSWORTH ISLAND RANGE
OLF WEBSTER
Chesapeake Bay Water Range
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Atlantic Ocean
Restricted Airspace
Chessie ATCAA
Helo OPAREA
Navy Land Area
Surface Danger Zone
State Boundary
PRC Study Area
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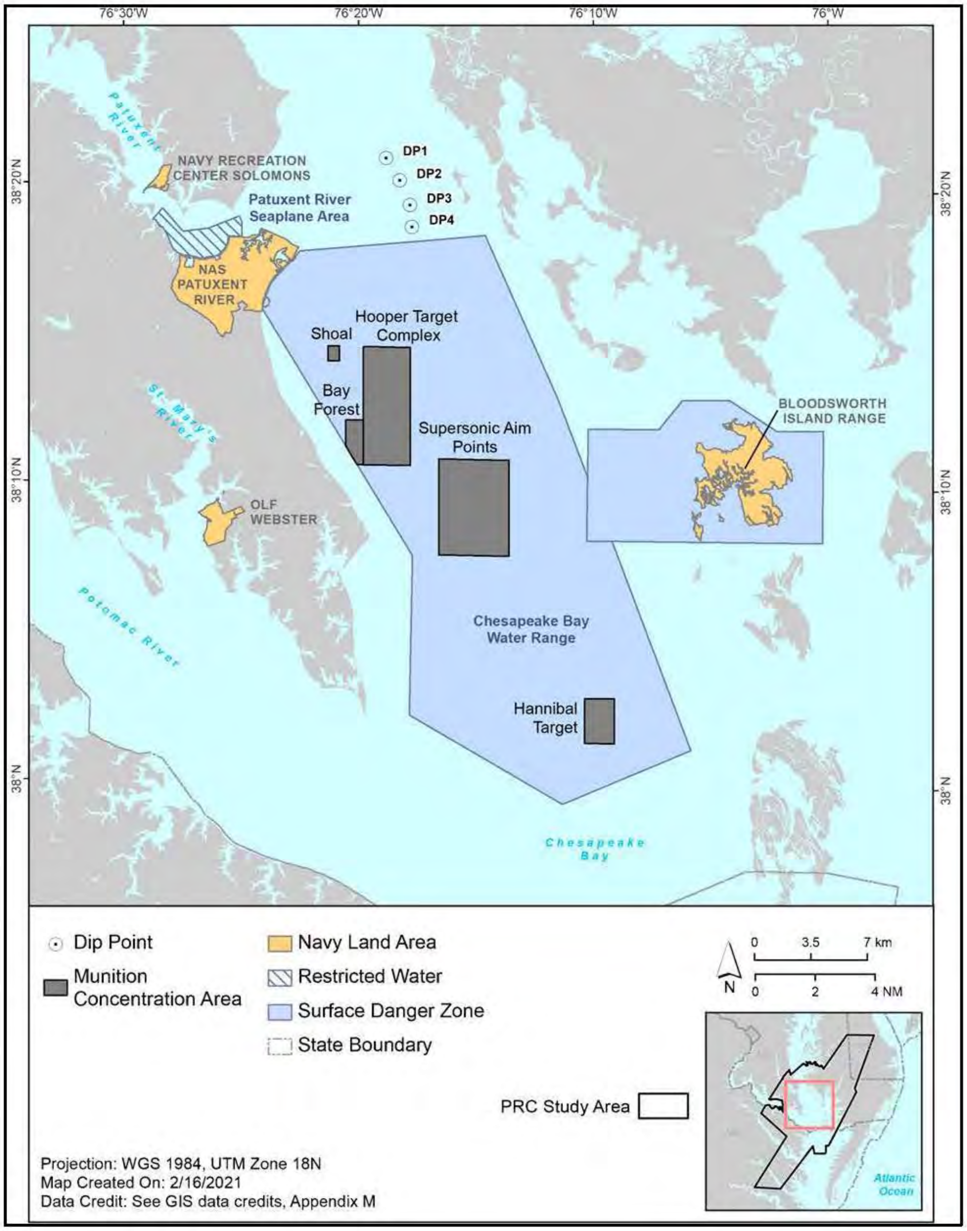
Projection: WGS 1984 UTM Zone 18N
Map Created On: 2/11/2021
Data Credit: See GIS data credits, Appendix M

Enclosure 2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38°20'N
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Patuxent River
NAVY RECREATION CENTER SOLOMONS
Patuxent River Seaplane Area
DP1
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PRC Study Area
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0 2 4 NM
Atlantic Ocean
Projection: WGS 1984, UTM Zone 18N
Map Created On: 2/16/2021
Data Credit: See GIS data credits, Appendix M

J.2 Virginia Department of Historic Resources Correspondence

DEPARTMENT OF THE NAVY
NAVAL AIR STATION
22268 CEDAR POINT ROAD
PATUXENT RIVER, MARYLAND 20670-1154

5090
Ser N45/308
March 3, 2021

Ms. Rodger Kirchen
Director, Division of Review and Compliance
Virginia Department of Historic Resources
2801 Kensington Avenue
Richmond, VA 23221

Dear Mr. Kirchen:
SUBJECT: PATUXENT RIVER COMPLEX (PRC) TESTING AND TRAINING, RENEWAL OF SECTION 106 CONSULTATION

The purpose of this letter is to renew Section 106 consultation, per the National Historic Preservation Act of 1966, for a Department of the Navy (Navy) undertaking of continued testing and training in the Patuxent River Complex (PRC), St. Mary's County, Maryland. The Navy is preparing an updated Environmental Impact Statement (EIS) to evaluate the potential effects of increasing aircraft flight, ground-based, and surface/subsurface activities within the PRC Study Area.

Project Description. The Proposed Action is to continue conducting military testing and training activities within the PRC to meet current and projected military readiness requirements. This action includes testing and training activities analyzed in the 1998 PRC EIS and subsequent Environmental Assessments, as well as adjustments to current testing and training activities required to support projected Navy military readiness requirements into the foreseeable future and in the event of increased global conflict. The EIS consolidates the testing and training activities analyzed in these previous documents and addresses the following adjustments to current testing and training:

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- Adjustments in the types of mission systems being integrated and tested in aircraft and surface and subsurface platforms (e.g., anti-submarine warfare [ASW] and mine countermeasure [MCM] systems).
- Expanded use of the Patuxent River Seaplane Area.
- Addition of active sonobuoy testing in conjunction with helicopter dipping sonar tests.

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March 3, 2021

- Testing of new technologies to address new and emerging threats (e.g., directed energy weapons systems).

The 1998 PRC EIS defined the PRC as Naval Air Station (NAS) Patuxent River and Outlying Field Webster flight and ground test facilities and airfields along with the Atlantic Test Ranges restricted airspace, Chesapeake Bay Water Range, and fixed target areas. This Proposed Action expands the PRC Study Area to include land, water, and airspace historically and currently used by the Navy that were not assessed in the previous EIS. These include Bloodsworth Island Range, waters beneath the restricted airspace outside the Chesapeake Bay Water Range, and surrounding Federal Aviation Administration airspace including Helicopter Operating Areas (Helo OPAREAs) and Chessie Air Traffic Control Assigned Airspace.

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Identified Historic Properties - Archaeological Sites. For all the Proposed Action alternatives, no ground-disturbing activities will occur in soils not previously disturbed. Therefore, land-based archaeological resources will not be affected by the undertaking. In addition, there are no identified traditional cultural properties or sacred sites at any of the installations under NAS Patuxent River jurisdiction that are in the APE.

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2

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Ser N45/310
March 3, 2021

18DO494	Shipwreck	Buoy 72A wreck	Not Evaluated
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Sources: (Maryland Historical Trust, 2019)
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Finding of Effect: The Proposed Action alternatives do not involve impacts related to construction or demolition. The only new impact to the built environment would be related to aircraft noise. The incremental increase in overflights over any of the historic resources would be infrequent and of short duration, resulting in a fleeting and minor change to the historic setting. We find that the minimal increase in visual or audible elements would not diminish the integrity of the properties' historical attributes or alter the characteristics that qualify them for inclusion in the NRHP. Therefore, we find that all alternatives in the proposed undertaking will have a no adverse effect on historical properties.

3

5090
Ser N45/310
March 3, 2021

If you have any questions, please contact Craig Lukezic, Cultural Resources Program Manager, by telephone at (301) 757-4774 or by email at craig.lukezic@navy.mil.

Sincerely,

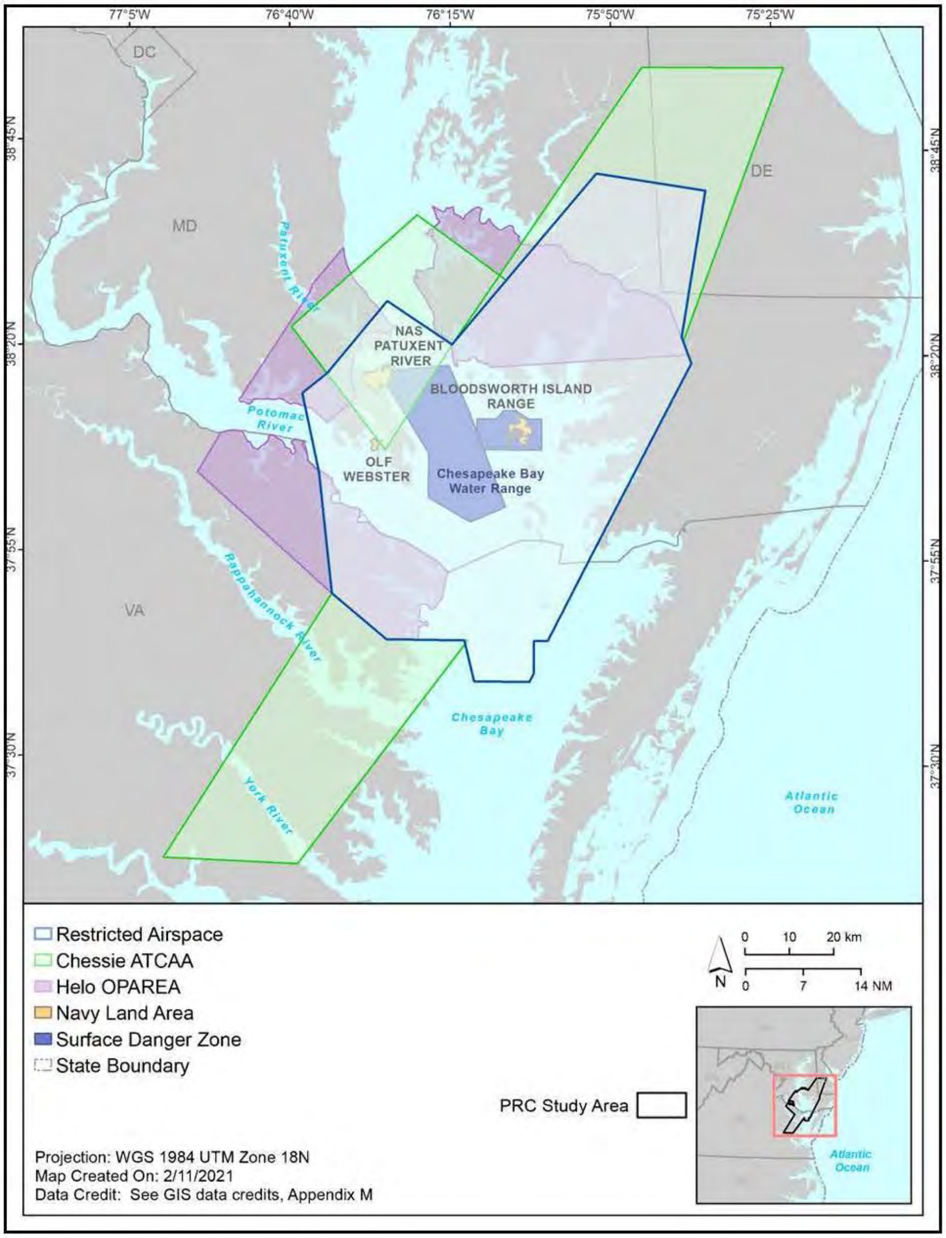
MCDANIEL.LANCE.E.1204352972 Digitally signed by MCDANIEL.LANCE.E.1204352972 Date: 2021.03.03 13:10:05 -05'00'

L. E. McDANIEL
Installation Environmental Director
By direction
of the Commanding Officer

Enclosures: 1. Location Map and Area of Potential Effect
2. Chesapeake Bay Water Range Munition Concentration Areas

4

Enclosure 1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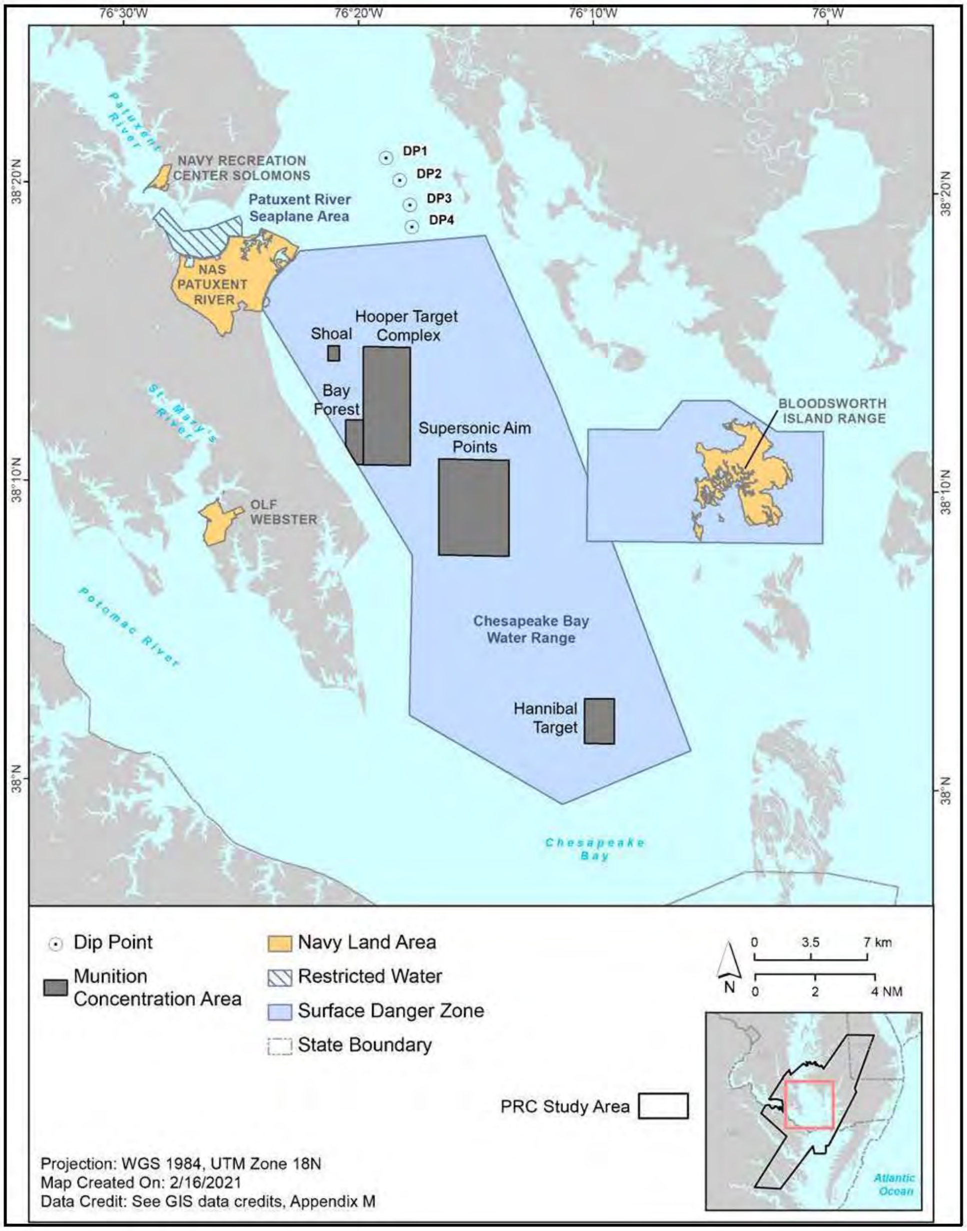
Projection: WGS 1984 UTM Zone 18N
Map Created On: 2/11/2021
Data Credit: See GIS data credits, Appendix M

Enclosure 2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Atlantic Ocean
Projection: WGS 1984, UTM Zone 18N
Map Created On: 2/16/2021
Data Credit: See GIS data credits, Appendix M

J.3 Delaware Division of Historical and Cultural Affairs Correspondence

DEPARTMENT OF THE NAVY

NAVAL AIR STATION
22268 CEDAR POINT ROAD
PATUXENT RIVER, MARYLAND 20670-1154

5090
Ser N45/308
March 3, 2021

Ms. Gwyneth Davis
State Historic Preservation Office
Division of Historical and Cultural Affairs
21 The Green
Dover, DE 19901

Dear Ms. Davis:

SUBJECT: PATUXENT RIVER COMPLEX (PRC) TESTING AND TRAINING, RENEWAL OF SECTION 106 CONSULTATION

The purpose of this letter is to renew Section 106 consultation, per the National Historic Preservation Act of 1966, for a Department of the Navy (Navy) undertaking of continued testing and training in the Patuxent River Complex (PRC), St. Mary's County, Maryland. The Navy is preparing an updated Environmental Impact Statement (EIS) to evaluate the potential effects of increasing aircraft flight, ground-based, and surface/subsurface activities within the PRC Study Area.

Project Description. The Proposed Action is to continue conducting military testing and training activities within the PRC to meet current and projected military readiness requirements. This action includes testing and training activities analyzed in the 1998 PRC EIS and subsequent Environmental Assessments, as well as adjustments to current testing and training activities required to support projected Navy military readiness requirements into the foreseeable future and in the event of increased global conflict. The EIS consolidates the testing and training activities analyzed in these previous documents and addresses the following adjustments to current testing and training:

- Additional aircraft flight hours and adjustments in aircraft mix (e.g., increased unmanned aerial system [UAS] platforms).
- Additional use of non-explosive munitions and other military expended materials (MEM).
- Additional surface vessel and subsurface vehicle traffic in PRC waters.
- Adjustments in the types of mission systems being integrated and tested in aircraft and surface and subsurface platforms (e.g., anti-submarine warfare [ASW] and mine countermeasure [MCM] systems).
- Expanded use of the Patuxent River Seaplane Area.

5090
Ser N45/ 009
March 3, 2021

- Addition of active sonobuoy testing in conjunction with helicopter dipping sonar tests.
- Testing of new technologies to address new and emerging threats (e.g., directed energy weapons systems).

The 1998 PRC EIS defined the PRC as Naval Air Station (NAS) Patuxent River and Outlying Field Webster flight and ground test facilities and airfields along with the Atlantic Test Ranges restricted airspace, Chesapeake Bay Water Range, and fixed target areas. This Proposed Action expands the PRC Study Area to include land, water, and airspace historically and currently used by the Navy that were not assessed in the previous EIS. These include Bloodsworth Island Range, waters beneath the restricted airspace outside the Chesapeake Bay Water Range, and surrounding Federal Aviation Administration airspace including Helicopter Operating Areas (Helo OPAREAs) and Chessie Air Traffic Control Assigned Airspace.

Area of Potential Effect. The Navy has defined the Area of Potential Effect (APE) to include the entire PRC and the visible view shed surrounding the complex. Maps of the PRC and the APE are enclosed.

Identified Historic Properties - Archaeological Sites. For all the Proposed Action alternatives, no ground-disturbing activities will occur in soils not previously disturbed. Therefore, land-based archaeological resources will not be affected by the undertaking. In addition, there are no identified traditional cultural properties or sacred sites at any of the installations under NAS Patuxent River jurisdiction that are in the APE.

The only possible disturbance to archaeological sites may come from non-explosive MEM which may disturb in-water cultural resources such as shipwrecks. However, most MEM in the Chesapeake Bay Water Range will be focused around current munition concentration areas (Enclosure 2, Chesapeake Bay Water Range Munition Concentration Areas). These areas have been targeted through the decades, and it is very unlikely that any intact deposits would still survive today. While none of the underwater cultural resources in the Chesapeake Bay Water Range are determined to be eligible for the National Register of Historic Places (NRHP), they have yet to be evaluated. As targets will not be placed near recorded sites, this undertaking will not impact underwater cultural resources that may be eligible for the NRHP.

Underwater Cultural Resources within the Chesapeake Bay Water Range

Site Number	*Type*	*Description*	*NRHP Status*
18ST847	Aircraft Wreck	WWII aircraft wreck, XF8F-1 Bearcat	Not Evaluated
N/A	Shipwreck	Hannibal (former direct-impact target)	Not Evaluated
N/A	Shipwreck	American Mariner (current direct-impact target)	Not Evaluated
18ST869	Shipwreck	NAS Patuxent River Target Barge	Not Evaluated

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18ST870	Shipwreck	NAS Target West Buoy Wreck	Not Evaluated
18DO494	Shipwreck	Buoy 72A wreck	Not Evaluated
18ST892	Shipwreck	Cedar Point Schooner	Not Evaluated
18ST893	Shipwreck	Cedar Point Barge	Not Evaluated

Sources: (Maryland Historical Trust, 2019)
Key: N/A = not available; NAS = Naval Air Station; NRHP = National Register of Historic Places; WWII = World War II.

Identified Historic Properties - Architectural Resources. The APE touches six counties of Maryland, in which 117 properties are listed or eligible for inclusion to the NHRP located within the APE. While the APE is quite broad, few will notice the impacts caused by the proposed increased activity. As the undertaking does not include construction or demolition, the most severe impact to the built environment would be noise. The results of our noise and vibration studies lead us to believe the overpressures generated by supersonic overflight will be well below established damage thresholds to sites and structures. Therefore, subsonic noise and sonic booms associated with continuation of existing testing and training activities will not be of sufficient magnitude to impact historic properties under the airspace.

High or irregular noise levels can undermine the quality of life at a historic property and interfere with learning. The current baseline noise levels beneath the PRC Study Area airspace are between less than 35 A-weighted sound level (dBA) and 52.9 dBA. Under Alternative 1, subsonic noise levels would increase by between 0.5 dBA to 1.8 dBA, with the greatest increase in the West Helo OPAREA, from 44.3 dBA to 46.1 dBA in PRC airspace areas. With Alternative 2, increased aircraft testing and training activities would be incrementally higher than Alternative 1, and noise levels would increase over existing conditions by between 1 dBA to 2.3 dBA, with the greatest increase in the West Helo OPAREA from 44.3 dBA to 46.6 dBA. For most people, changes in A-weighted noise levels of less than 2 dBA would not be noticeable.

Finding of Effect: The Proposed Action alternatives do not involve impacts related to construction or demolition. The only new impact to the built environment would be related to aircraft noise. The incremental increase in overflights over any of the historic resources would be infrequent and of short duration, resulting in a fleeting and minor change to the historic setting. We find that the minimal increase in visual or audible elements would not diminish the integrity of the properties' historical attributes or alter the characteristics that qualify them for inclusion in the NRHP. Therefore, we find that all alternatives in the proposed undertaking will have a no adverse effect on historical properties.

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Ser N45/ 009
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If you have any questions, please contact Craig Lukezic, Cultural Resources Program Manager, by telephone at (301) 757-4774 or by email at craig.lukezic@navy.mil.

Sincerely,

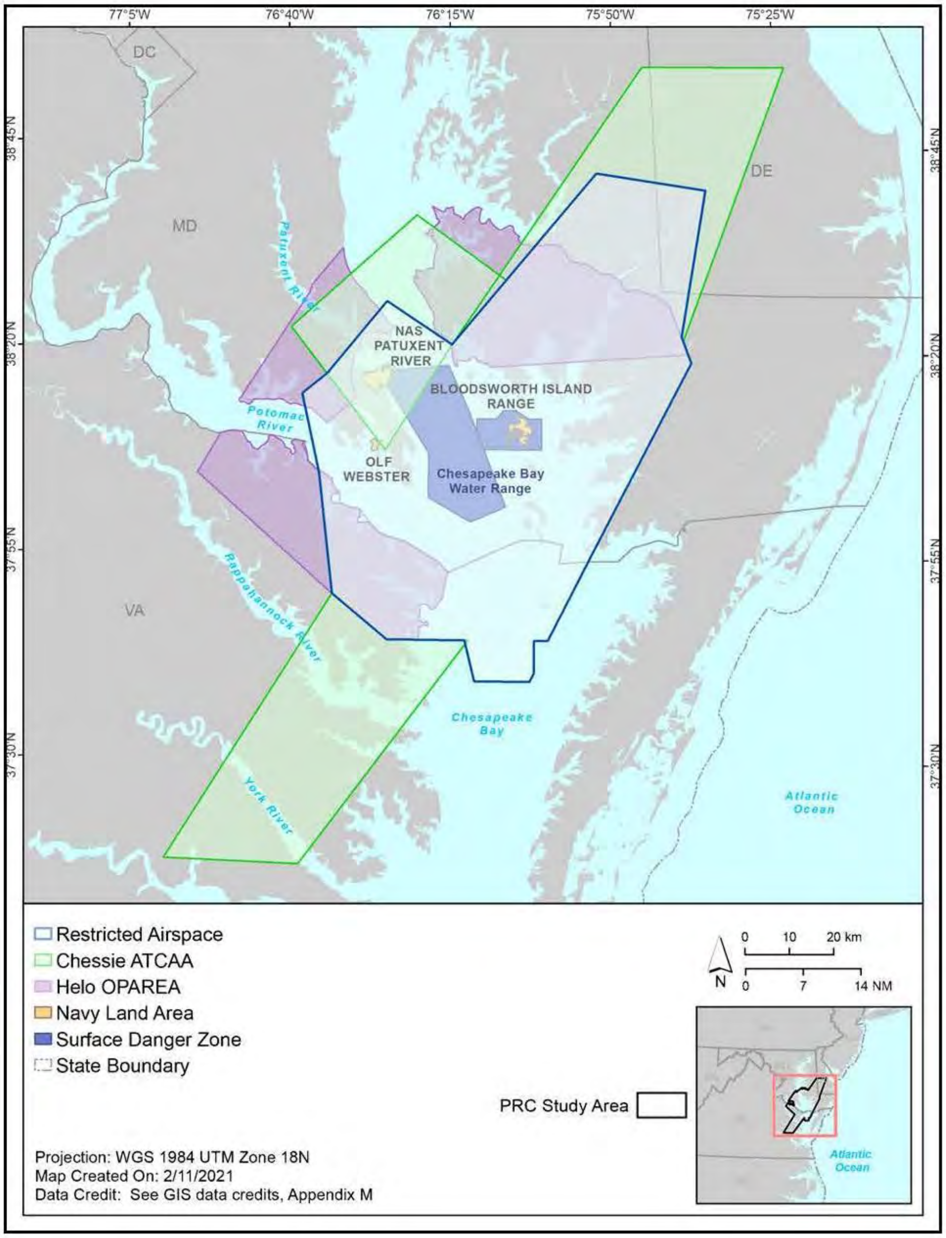
MCDANIEL.LANCE.E.1204352972 Digitally signed by MCDANIEL.LANCE.E.1204352972 Date: 2021.03.03 13:07:55 -05'00'

L. E. McDANIEL
Installation Environmental Director
By direction
of the Commanding Officer

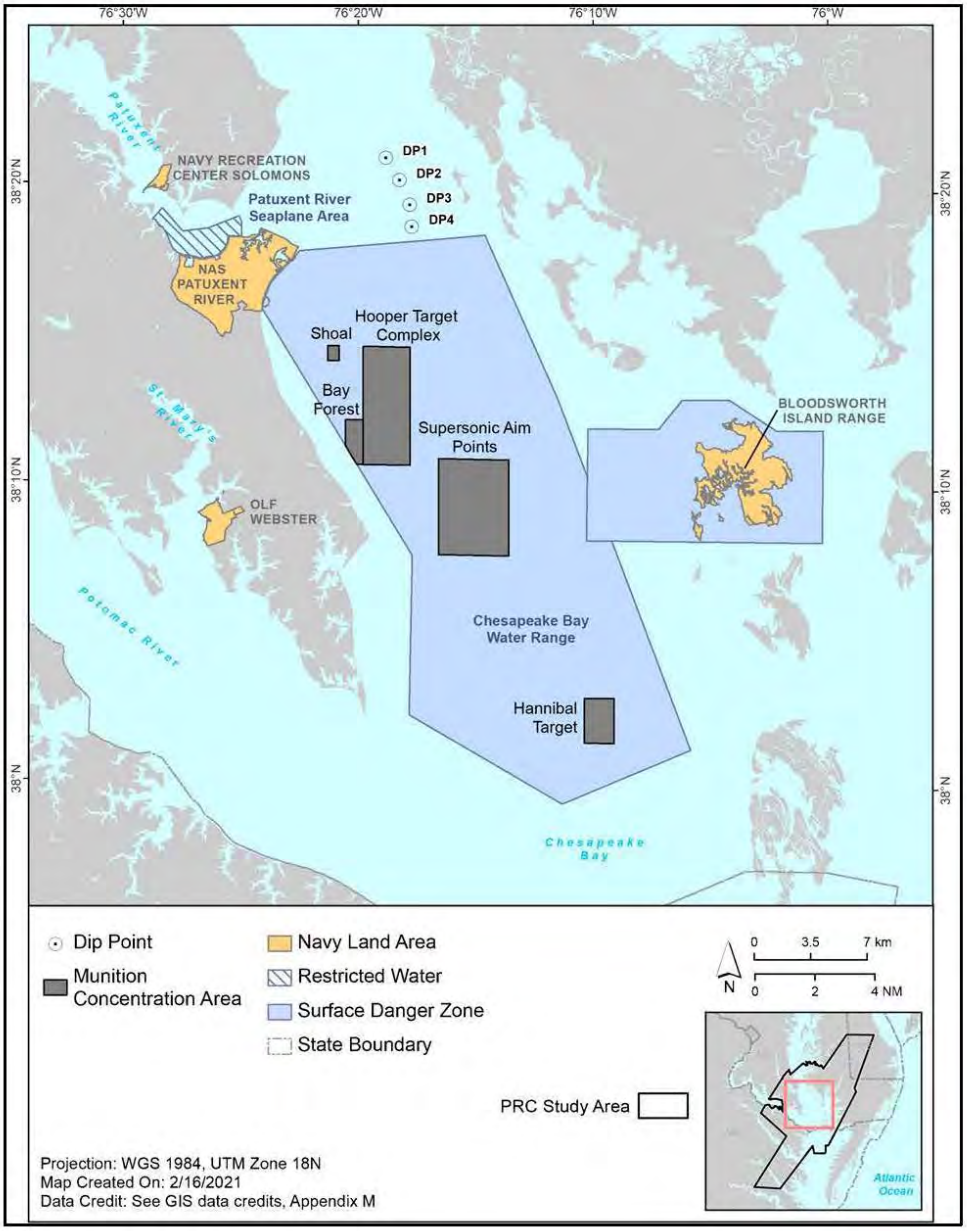
Enclosures: 1. Location Map and Area of Potential Effect
2. Chesapeake Bay Water Range Munition Concentration Areas

4

Enclosure 1


77°5'W
76°40'W
76°15'W
75°50'W
75°25'W
38°45'N
38°20'N
37°55'N
37°30'N
DC
MD
DE
VA
Patuxent River
Potomac River
Rappahannock River
York River
NAS PATUXENT RIVER
BLOODSWORTH ISLAND RANGE
OLF WEBSTER
Chesapeake Bay Water Range
Chesapeake Bay
Atlantic Ocean
Restricted Airspace
Chessie ATCAA
Helo OPAREA
Navy Land Area
Surface Danger Zone
State Boundary
PRC Study Area
0 10 20 km
0 7 14 NM
N
Projection: WGS 1984 UTM Zone 18N
Map Created On: 2/11/2021
Data Credit: See GIS data credits, Appendix M

Enclosure 2


76°30'W
76°20'W
76°10'W
76°W
38°20'N
38°10'N
38°N
Patuxent River
NAVY RECREATION CENTER SOLOMONS
Patuxent River Seaplane Area
DP1
DP2
DP3
DP4
NAS PATUXENT RIVER
Hooper Target Complex
Shoal
Bay Forest
Supersonic Aim Points
BLOODSWORTH ISLAND RANGE
St. Mary's River
OLF WEBSTER
Potomac River
Chesapeake Bay Water Range
Hannibal Target
Chesapeake Bay
Dip Point
Munition Concentration Area
Navy Land Area
Restricted Water
Surface Danger Zone
State Boundary
PRC Study Area
0 3.5 7 km
0 2 4 NM
N
Atlantic Ocean
Projection: WGS 1984, UTM Zone 18N
Map Created On: 2/16/2021
Data Credit: See GIS data credits, Appendix M

Appendix K
Tribal Government to Government Documentation

Table of Contents

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K.1 Tribal Entities that Received the Scoping Notification Letter

K.1.1 Federally Recognized Tribal Distribution List

Title	*First Name*	*Last Name*	*Title*	*Tribal Entity*	*Address*	*City*	*State*
Dr.	Wenonah G.	Haire	THPO	Catawba Indian Tribe	1536 Tom Steven Rd	Rock Hill	SC
Principal Chief	Bill John	Baker	THPO	Cherokee Nation	PO Box 948	Tahlequah	OK
Chief	Stephen	Adkins	Chief	Chickahominy Indian Tribe	7240 Adkins Rd	Charles City	VA
Ms.	Deborah	Dotson	President	Delaware Nation	P.O. Box 825	Anadarko	OK
Chief	Chester	Brooks	Chief	Delaware Tribe of Indians	5100 Tuxedo Blvd	Bartlesville	OK
Mr.	Russell Townsend, THPO	Townsend	THPO	Eastern Band of Cherokee Indians	Qualla Boundary Reservation PO Box 455	Cherokee	NC
Chief	Gene W.	Adkins	Chief	Eastern Chickahominy	3120 Mount PleasantRd	Providence Forge	VA
Chief	Glenna	Wallace	Chief	Eastern Shawnee Tribe of Oklahoma	PO Box 350	Seneca	MO
Chief	Dean	Branham	Chief	Monacan Nation	104 Walnut Place	Lynchburg	VA
Principal Chief	James	Floyd	Principal Chief	Muscogee (Creek) Nation	PO Box 580	Okmulgee	OK
Chief	Lee	Lockamy	Chief	Nansemond Indian Nation	1001 Pembroke Ln	Suffolk	VA
Chief	Robert	Gray	Chief	Pamunkey Indian Tribe	1054 Pocahontas Trail	Joseph King mayor	VA
Chief	G. Anne	Richardson	Chief	Rappahannock Tribe	5036 Indian Neck Rd	Indian Neck	VA
Chief	William	Fisher	Chief	Seneca-Cayuga Nation	PO Box 453220	Grove	OK
Mr.	Bryan	Printup		Tuscarora Nation	5226 Walmore Rd	Lewiston	NY
Chief	Joe	Bunch	Chief	United Keetoowah Band of Cherokee Indians in Oklahoma	P.O. Box 746	Tahlequah	OK
Chief	W. Frank	Adams	Chief	Upper Mattaponi Tribe	5932 East River Rd	King William	VA

K.1.2 Non-Federally Recognized Tribal Distribution List

Title	***First Name***	***Last Name***	***Title***	***Tribal Entity***	***Address***	***City***	***State***
Tribal Chair	Francis	Gray	Tribal Chair	Piscataway Conoy Tribe	PO Box 638	Bryans Road	MD
Chief	Billy (RedWing)	Tayac	Chief	Piscataway Indian Nation	P.O. Box 312	Port Tobacco	MD

K.2 Scoping Notification Letter

DEPARTMENT OF THE NAVY
NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION
22347 CEDAR POINT ROAD, UNIT 6
PATUXENT RIVER, MARYLAND 20670-1161

5090
Ser 000000A/047
February 7, 2019

Dear Sir or Madam:

The Department of the Navy is in the beginning stages of preparing an Environmental Impact Statement to address the continued conduct of military research, development, test, and evaluation (hereinafter referred to as "testing"), and training operations within the Patuxent River Complex (PRC) Study Area to meet current and projected military readiness requirements.

The Navy's Proposed Action includes testing and training operations analyzed in the increased flight and related operations in the PRC Final Environmental Impact Statement from December 1998 and subsequent environmental assessments, as well as adjustments in testing and training activities from current types and tempos required to support projected Navy military readiness requirements into the foreseeable future.

The purpose of the proposed action is to provide Sailors and Marines with equipment and technology that operates effectively and safely to support current and projected future military readiness requirements. The need for the proposed action is to maintain military readiness of naval forces capable of winning wars; deterring aggression; and maintaining freedom of the seas, now and into the future, consistent with Title 10, Section 5062, of the United States Code.

An essential part of the process is public involvement. The Navy is requesting your comments on the proposed action, alternatives, and resources to be considered during preparation of the PRC EIS. There are multiple ways to get involved:

a. Visit the website www.prceis.com to learn about the project, review materials, join the mailing list, and/or submit comments.

b. Attend a Scoping Meeting. A series of open-house style public meetings will be held.

Date	Time	Location
March 4, 2019	1600 - 1900	Light of Christ Anglican Church 9500 Northumberland Highway Heathsville, VA 22473
March 5, 2019	1600 - 1900	Southern Maryland Higher Education Center Building 1 Multi-Purpose Room 44219 Airport Road California, MD 20619

Date	Time	Location
March 6, 2019	1600 - 1900	University of Maryland, Eastern Shore Richard A. Henson Center Ballroom 30690 University Boulevard South Princess Anne, MD 21853
March 7, 2019	1600 - 1900	St. Paul's United Methodist Church Parish Hall 205 Maryland Avenue Cambridge, Maryland 21613

c. Provide Comments. Comments may be provided at public scoping meetings, by mail, and/or through the EIS website. Mailed comments must be postmarked no later than April 1, 2019 and mailed to:

Naval Air Warfare Center Aircraft Division
NAVAIR Ranges Sustainability Office
ATTN: EIS Project Manager
23013 Cedar Point Road
Patuxent River, MD, 20670

We appreciate your time and interest and look forward to hearing from you. My point of contact for this matter is the Naval Air Warfare Center Aircraft Division Range Sustainability Office, which may be reached via phone at (301) 342-9902.

Sincerely,

John S. Lemmon
Rear Admiral, United States Navy

Enclosure: 1. PRC EIS Project Description and Study Area Map

2

PATUXENT RIVER COMPLEX (PRC) TESTING AND TRAINING

ENVIRONMENTAL IMPACT STATEMENT (EIS)

PROJECT DESCRIPTION AND STUDY AREA MAP

PRC Testing and Training EIS Proposed Action and Alternatives:

The Department of the Navy (Navy) proposes to continue conducting military Research, Development, Test and Evaluation (hereinafter referred to as "testing") and training activities within the Patuxent River Complex (PRC) Study Area to meet current and projected military readiness requirements. The Navy's Proposed Action includes testing and training activities that have been conducted within the PRC for decades and are consistent with those analyzed in the *Increased Flight and Related Operations in the Patuxent River Complex Final Environmental Impact Statement* (December 1998) and subsequent Environmental Assessments (EAs), plus adjustments to current testing and training activities in the PRC that include aircraft, aircraft systems and nonexplosive weapons required to support projected Navy military readiness requirements into the foreseeable future. The Navy will evaluate in the new EIS the potential environmental impacts on environmental resources from testing and training activities associated with a range of alternatives to the proposed action, including a No Action and action alternatives.

Environmental Analysis:

Resource areas that will be addressed include, but are not limited to: biological resources (including aquatic and terrestrial protected species); water resources and sediments; air quality; airborne noise; cultural resources; socioeconomics; land use; public health and safety; hazardous material and waste; and environmental justice.

PRC Testing and Training EIS Study Area:

The PRC is one of our nation's Major Range and Test Facility Base (MRTFB) assets that provides the flight and ground test facilities, airfields, and instrumented range as well as the airspace and water space critical to supporting NAWCAD's mission of testing aircraft, aircraft systems and nonexplosive weapons so that Sailors and Marines have aircraft and equipment that will operate safely and effectively. Naval Air Warfare Center Aircraft Division (NAWCAD), the Navy's action proponent for activities in the PRC, is based at Naval Air Station (NAS) Patuxent River, Maryland approximately 60 miles southeast of Washington, D.C. Navy land and facilities, in the PRC, also include nearby Outlying Landing Field (OLF) Webster in St. Inigoes, Maryland and the Bloodsworth Island Range, in the Chesapeake Bay.

The PRC Testing and Training EIS will assess the potential environmental impacts from aircraft testing and training activities conducted in the PRC Study Area (Figure 1). The geographic scope of the PRC Study Area includes the military restricted airspace and surrounding shared Visual Flight Rule (VFR) airspace that is within NAS Patuxent River's Air Traffic Control (ATC) approach control and the Class A airspace, Chessie ATC Assigned Airspace (ATCAA), as well as the underlying Chesapeake Bay Navy water range (including fixed targets, aim points and recovery areas for high value assets), the southern end of the Potomac and Patuxent Rivers, and lands in Maryland, Virginia, and Delaware.

Enclosure (1)

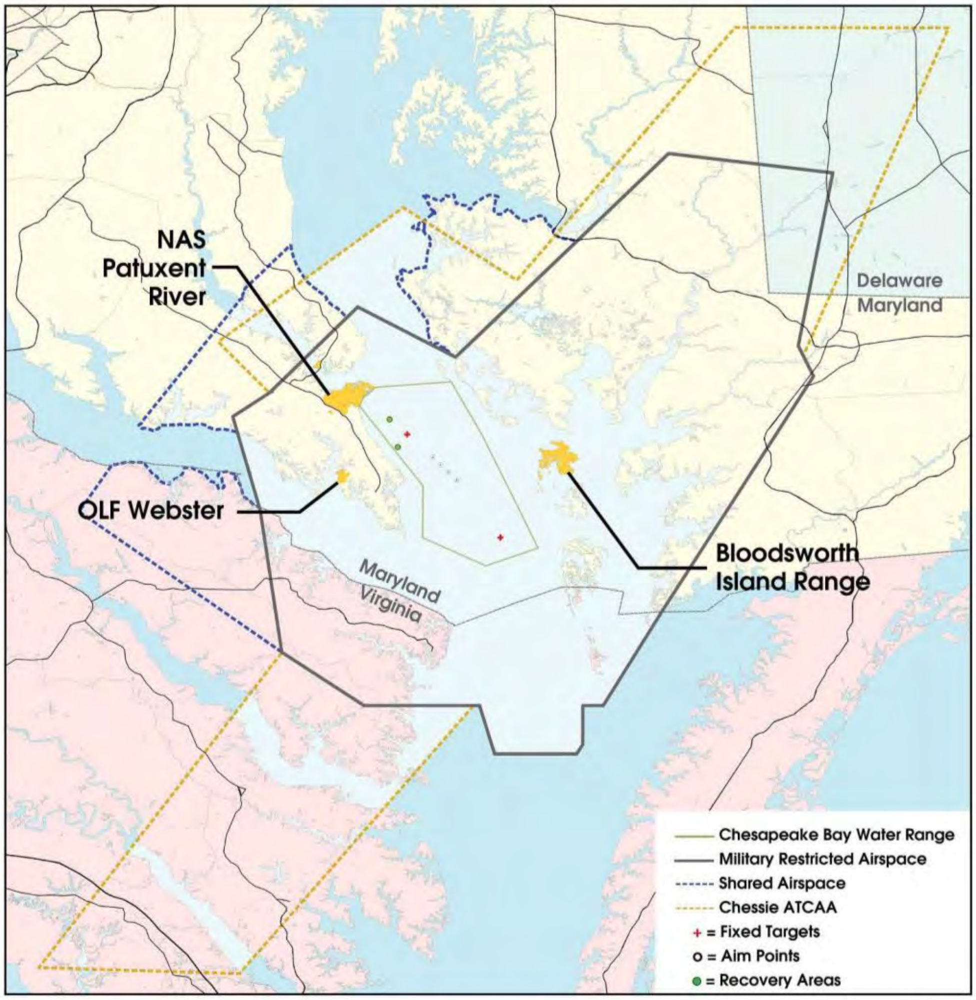

Figure 1: Patuxent River Complex (PRC) Testing and Training Environmental Impact Statement (EIS) Study Area

Enclosure (1)

Appendix L
Geographic Information System (GIS) References

Item Name in Figure Legend	Basic Metadata Credits
Acoustic Telemetry Receivers	Compilation of the following unpublished data sources: (1) Hager, C. (2016). Operation of the Navy's Telemetry Array in the Lower Chesapeake Bay: Annual Progress Report for 2015. Final Report. Williamsburg, VA: Chesapeake Scientific. (2) Ogburn, M. and R. Anguilar (2018, October). Personal communication with Carter Watterson, NAVFAC Atlantic, regarding Atlantic sturgeon presence in the Patuxent River and Tangier Sound based on telemetry data. Source affiliation: Smithsonian Environmental Research Institute. (3) Secor, D. and M. O'Brien. (2018, November). Personal communication with Carter Watterson, NAVFAC Atlantic, regarding Atlantic sturgeon presence in the Maryland waters of the Chesapeake Bay and the Potomac River based on telemetry data. Source affiliation: University of Maryland, Chesapeake Biological Laboratory. (4) Stence, C. (2018, October). Personal communication with Carter Watterson, NAVFAC Atlantic, regarding Atlantic sturgeon presence in the Nanticoke River and Marshyhope Creek based on telemetry data. Source affiliation: Maryland Department of Natural Resources.
Aim Point	Government furnished information
Airfield Runway	Government furnished information
Benthic Areas/ Substrate	NOAA Chesapeake Bay Program [CBP] (2011-2017). Benthic Habitat Integration for Chesapeake Bay. Processing Notes: Combination of 2017 NOAA CBP integration including only sonar-based classifications and the 2011 NOAA CBP integration including other, less precise, mapping methods.
Bloodsworth Island Range SDZ	Government furnished information
Building	Government furnished information
Chesapeake Bay Water Range	Government furnished information
Chessie ATCAA	Government furnished information
Depth (m)	Maryland iMAP [Original File Name: Maryland_Chesapeake_Bay_Bathymetry_Contours]
Dip Point	Government furnished information
Dissolved Oxygen (mg/l) Minimums	Maryland iMAP/Chesapeake Bay Program [Original File Name: Maryland_Chesapeake_Bay_Dead_Zones__Chesapeake_Bay_Dead_Zones]
Fixed Target	Government furnished information
Helo OPAREAs	Government furnished information
Helo Pads	Government furnished information
Impact & Recovery Area	Government furnished information

Item Name in Figure Legend	Basic Metadata Credits
Installation Road	Government furnished information
Land-use/Land-cover	National Land Cover Dataset (2011) [Original File Name: nlcd2011.img]
Low Altitude Airspace (>0 ft Altitude)	Government furnished information. Processing notes: Combination of restricted airspace (0-3,500 ft) and shared airspace
Munition Concentration Areas	Government furnished information. Processing notes: Digitized ordnance concentration areas from 2013 Patuxent River Complex Water Range Condition Assessment (U.S. Department of the Navy, 2013c)
Navy Installation/ Navy Land Area	Government furnished information
PRC Study Area	Government furnished information
Regulatory Designations - Artificial Reefs	Maryland iMAP [Original File Name: MD_Artificial_Reefs]
Regulatory Designations - Oyster Sanctuary	Maryland iMAP [Original File Name: BIOT_OysterSanctuaries_DNR]
Restricted Airspace	Government furnished information
Shoreline Habitats (Low Tide)	NOAA Office of Response and Restoration (2016) Chesapeake Bay Environmental Sensitivity Index ["Lines" feature class]
State Boundary	US Census Bureau 2018
Streams	Maryland iMAP [Original File Name: NHD_H_Maryland State Shape]
Summer Salinity (psu)	NOAA Chesapeake Bay Program [Original File Name: summer_sal]
Surface Danger Zones	Government furnished information
Target Prohibited Area (1000 yard)	Government furnished information
Water Features - Seagrass	Virginia Institute of Marine Science (2016) Seagrass Mapping Program
Wrecks and Obstructions	NOAA Automated Wreck and Obstruction Avoidance System (2015)
Census Block Groups and Tracts	U.S. Department of Commerce, U.S. Census Bureau, Geography Division, “TIGER/Line Shapefiles" (2018)
Vessel Traffic Density	“Vessel Density”. Office for Coastal Management (OCM). Published 2020. https://marinecadastre.gov/data/
Land Use	MD Department of Planning 2018 “Parcel dataset, St. Mary’s County”. December 2018. Geospatial digital data. Downloaded from

Item Name in Figure Legend	Basic Metadata Credits
	https://planning.maryland.gov/Pages/OurProducts/DownloadFiles.aspx. Last downloaded 11/20/2019.
Delaware Natural Areas	DNREC Division of Parks and Recreation. 2020. "Natural Areas Inventory". http://opendata.firstmap.delaware.gov/datasets/delaware-natural-areas/
Delaware Public Protected Lands	DNREC Division of Parks and Recreation. 2019. "Delaware Public Protected Lands". http://opendata.firstmap.delaware.gov/datasets/delaware-public-protected-lands
Maryland Protected Lands - Local Protected Lands	MD iMAP "Maryland Protected Lands - Local Protected Lands" https://geodata.md.gov/imap/rest/services/Environment/MD_ProtectedLands/FeatureServer/5 last accessed 11/13/2019
Delaware Park Facilities	DNREC Division of Parks and Recreation. "Park Facilities" https://firstmap.delaware.gov/arcgis/rest/services/Society/DE_Park_Facilities/FeatureServer. last accessed 11/13/2019.
Virginia Conservation Lands	VA-DCR, Natural Heritage. 2020. "Statewide GIS coverage of Conservation Lands in Virginia" http://www.dcr.virginia.gov/natural_heritage/cldownload.shtml. Downloaded 2/21/2019
Maryland Protected Lands - DNR Owned Properties and Conservation Easements	MD iMAP. 2020. "Maryland Protected Lands - DNR Owned Properties and Conservation Easements" https://geodata.md.gov/imap/rest/services/Environment/MD_ProtectedLands/FeatureServer/0
Maryland Historical Trust 2019	Maryland Historical Trust. (2019, October 23). Medusa, Maryland's Cultural Resource Information System. Retrieved from https://mht.maryland.gov/secure/Medusa/
U.S. Fish and Wildlife Service Interests	U.S. Fish and Wildlife Service. 2020. "FWS Interest shapefile". https://www.fws.gov/gis/data/CadastralDB/links_cadastral.html
National Park Service Boundaries.	National Park Service. 2020. "Boundaries". https://public-nps.opendata.arcgis.com/datasets/nps-boundary-1
National Park Service 2019	National Park Service. (2019, July 9). *NPS.gov*. Retrieved from National Register of Historic Places: www.nps.gov/subjects/nationalregister/data-downloads.htm
USGS Protected Areas Database of the United States	U.S. Geological Survey (USGS) Gap Analysis Project (GAP), 2018, Protected Areas Database of the United States (PAD-US): U.S. Geological Survey data release, https://doi.org/10.5066/P955KPLE.

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Appendix M
Bald and Golden Eagle Protection Act Documentation

NORTHEAST BALD EAGLE PROJECT SCREENING FORM

Welcome!

What is the purpose of this form? The U.S. Fish and Wildlife Service (Service) designed this form as a voluntary tool to help people comply with the Bald and Golden Eagle Protection Act (BGEPA) by planning activities in a manner that avoids disturbing nesting bald eagles. To disturb a bald eagle nest means to agitate or bother a bald eagle to a degree that causes, or is likely to cause, that eagle to abandon its nest, suffer injury, or be unable to perform activities necessary to its survival. While all guidance included in this form is voluntary, individuals and organizations that disturb eagles may be subject to fine and prosecution under BGEPA.

How is this form different from the National Bald Eagle Management Guidelines? The National Bald Eagle Management Guidelines (Guidelines) is a document published by the Service in 2007 that provides background information on the biology of bald eagles, explains the Federal laws and regulations protecting them, and lays out guidance for several categories of human activities that can affect their nesting. This form takes the Guideline's recommendations, fits them to the regional conditions of the Northeast, and offers them to you in an interactive and intuitive format. Because the form fits its assessments and recommendations to the needs and behaviors of nesting bald eagles in the Northeast, you may find that it differs from the Guidelines on certain details. Nonetheless, the ultimate goal remains the same: to keep project proponents in compliance with BGEPA, while also protecting nesting bald eagles from disturbance.

How this form works. To complete this form, first, find the category of activities that includes your proposed activity. Then, go to the page listed for that category to assess whether your project may risk disturbing nesting bald eagles. If the form identifies that your activities may disturb nesting bald eagles, follow the recommended avoidance measures. These measures will identify factors that could influence nesting eagles' sensitivity to your activities: distance, visibility, timing, and exposure to other human activities. Sign the self-certification that you have committed to implementing the appropriate measures. If your proposed activities fall into multiple categories, repeat this process for each category. Additionally, if your project has the potential to affect multiple nests, complete a separate form for each nest site.

What to do with your completed form. Once you have signed your self-certification, keep the form for your personal records. You do not need to submit your completed form to the Service. Keep the form and additional pages that may be helpful to your future planning and compliance. If a local, state, or federal authority asks for documentation that you are complying with the Service's regional guidance, you can present them with your completed and signed form.

INTRODUCTION

What to know before you start. You will need a few pieces of information to help you complete this form.

Breeding Season
For temporary activities that might be loud or very visible, one of the simplest and most effective ways to avoid disturbing a bald eagle nest is to time the activity when eagles are not nesting, that is, outside the bald eagle breeding season. Wildlife agencies often refer to this type of measure as a time-of-year restriction. The bald eagle breeding season lasts approximately seven to eight months and has many stages. Start and end dates to this season can vary by location, year, and breeding pair. For simplicity, general dates are often set at a statewide level. Consult Appendix A to find the breeding season in your area.

Visibility
For some categories of activities, this form will ask whether your project activities will be visible to the nest. There are two general approaches to answering this question, a desktop assessment and a site visit. A desktop assessment involves consulting online mapping resources, such as Google Maps or state nest maps (see Appendix B), which can display your project location and the nest location on satellite or aerial imagery. When viewing this imagery, look to see whether there are landscape features or structures that might screen the nest's view of your activities. Your assessment is only as good as your imagery. Make sure the imagery is current and accurately reflects visibility conditions on the ground.

The second option is to visit your project location. Assess from various points in your project footprint whether you can see the nest. Use binoculars (4X power or greater) or spotting scope to assist your viewing. If you plan to visit the project site during the breeding season, be aware that your presence could also disturb the nest. Maintain 330' feet between you and the nest, or at least as much distance as the nearest ongoing foot traffic at the nest site. You should only perform your site visit from property legally accessible to you.

Using both the field and desktop approach will give you your best answer. If there is need to select between the two options, a site visit will generally provide a better sense of visibility. In either approach, consider that your activities may become more visible during portions of the year when leaves are off trees and other vegetation.

Nest Location
To figure out how close or how visible your activities will be, you will need precise knowledge of the nest's location. If you do not already have this information, check Appendix B to see if any online or state resources are available. If you are unable to get this information from any of these sources, survey the site. As when assessing visibility, you should only perform your visit on property legally accessible to you. You should also avoid coming within 330 feet of a nest during the breeding season, unless you know that the eagles have previously tolerated people at whatever shorter distance you are planning to use. For descriptions and examples of bald eagle nests, and explanation of how they differ from other large bird nests, see "Appendix C – Guide to Nest Identification."

INTRODUCTION

If you feel unable to perform this search, consider employing the services of a wildlife biologist experienced in this type of surveying. Alternatively, consider contacting your state or local wildlife agency to see if they would be able to perform a site visit (please be aware that many state and local wildlife agencies are constrained in their resources and time and may not be able to offer this service). Be sensitive to sharing information about nest locations. Attracting public interest to a nest site can threaten the safety of that nest. Some states also continue to prohibit the release of nest locations.

It is possible that you will be unable to find a reported nest. While bald eagles commonly use nests across breeding seasons, nests do not always survive from one season to the next. Nests may fall apart of their own accord or be blown down by high winds. Bald eagles may also stop using a nest for one season or more, even if the nest as a structure still exists. In these scenarios, bald eagles may still reuse a former nest site in the following breeding seasons. The temporary absence of a nest or nesting eagles does not absolve you of your responsibilities to avoid disturbing future nesting at that site. The Service recommends implementing the measures included in this form for five years after the last breeding season eagles used a nest or, where the nest no longer exists, three years after the last breeding season in which the nest existed.

Similar Activities
One of the best indicators of what a nesting bald eagle pair will tolerate is what they have already tolerated. In certain places, this form will ask whether the nesting pair has experienced and tolerated similar activities at the nest location. To answer this question, you will need to know about previous human activity at that location. Was that activity similar in nature to what you propose? As close as or closer than what you propose to do? Did it occur at the same time of day? Time of year? Did it last as long? Was it as frequent? Was it as loud? Was it as visible? You will also need to know basic history about the nest. Did the nest exist before that previous activity? Was it ever used after that activity? If your answer to any of these questions is 'no,' you cannot answer 'yes' to the broader question of whether there is similar activity at that site. See "Appendix D – Similar Activity Example Exercise" for a demonstration of how to apply this principle.

Limitations
Know when and how you should be using this form. See "Appendix E – Limitations of this form."

Where to go for help. The Service understands that project proponents may occasionally need clarification on which assessments are relevant to them and how to implement certain avoidance and minimization measures. If you find you are unable to complete this form, you can contact your regional eagle coordinator (Tom Wittig) for assistance at

thomas_wittig@fws.gov – or - 413-253-8577

When emailing, please include in your subject line "BALD EAGLE SCREENING FORM QUESTION." If you are unable to connect with your regional eagle coordinator when calling, please leave a voice message that you are calling about this form and how best to reach you.

For explanation of technical terms used in this form, see "Appendix F – Glossary of Terms."

PROJECT INFORMATION

PROJECT INFORMATION

Project Name: Patuxent River Complex Testing and Training Activities

City: Patuxent River **County:** St. Mary's & Dorchester **State:** Maryland

Lat/Long (decimal degrees; ex. *38.418310, -76.001096*): 6 nests on 3 NAS PAX River properties

Find Lat/Long via map

Size: 11,969 acres\miles

PROJECT CONTACT INFORMATION

Name: Jackie Smith **Phone:** 301-757-0007

Address: 22445 Peary Road
Patuxent River, Maryland 20670-1603

Email: jacqueline.c.smith@navy.mil

If your project has a Federal (ex. U.S. Army Corps), state (ex. PNDI), or other ID number, please list here: ______

PROJECT ACTIVITY CATEGORY(S)

Place a check next to all activities you plan to perform.

- ☐ Construction and Development Activities → go to pages 5 - 7
- ☐ Maintenance and Restoration Activities → go to pages 8 - 9
- ☐ Timber Operation and Forestry Practices → go to page 10
- ■ Use of Helicopters and Fixed-wing Aircraft → go to page 11
- ■ Blasting and Other Loud, Intermittent Noises (including Fireworks) → go to page 12
- ☐ Recreational Activities → go to pages 13 – 14

Feedback? The Service is continuously looking to improve this form. If you have suggested changes, please feel free to email them to us at thomas_wittig@fws.gov. Include "Bald Eagle Project Screening Form – Feedback" in your subject line.

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CONSTRUCTION & DEVELOPMENT

Construction and Development Activities

Which specific construction activities do you plan to perform? (check all that apply)

- ☐ Building construction
- ☐ Tree and land clearing
- ☐ Construction of roads, trails, canals, power lines, pipelines and other linear utilities
- ☐ Agriculture or aquaculture – new or expanded operations
- ☐ Alteration of shorelines or wetlands
- ☐ Installation of docks, piers, or moorings (pile driving may qualify as loud noise, page 12)
- ☐ Water impoundment or withdrawal
- ☐ Mining
- ☐ Oil and natural gas drilling and refining
- ☐ Wind farm construction
- ☐ Installation or expansion of marinas with a capacity of 6 or more boats
- ☐ Communications tower construction (excluding maintenance and repairs)

Is your activity similar to an ongoing or previous activity that coincided with the breeding season <u>and</u> that bald eagles tolerated? Consider both construction and use/operation of your project.

Consider all of the following elements/factors in answering:

-duration	-time of season	-area/footprint
-frequency	-visibility	-magnitude
-time of day	-distance	-nature

- ☐ Yes → No avoidance measures recommended. Go to self-certification (page 7).
- ☐ No → Go to next question.

Will your activities be visible to the bald eagle nest(s)?

- ☐ Yes → Stop. Implement Avoidance Measures (AM) 2, 4, and 5 (see page 7)
- ☐ No → Go to the next question

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CONSTRUCTION & DEVELOPMENT

Which of these categories most closely matches your proposed project or activity?
(check all that apply)

☐ Building construction, 1 or 2 story, with a project footprint of ½ acre or less ☐ Construction of roads, trails, canals, power lines, or other linear utilities ☐ Agriculture or aquaculture – new or expanded operations ☐ Alteration of shorelines or wetlands ☐ Installation of docks or moorings ☐ Water impoundment or withdrawal ☐ Construction of communication towers **→ Implement AM 3, 4 and 5 (page 7)**	☐ Building construction or expansion, 3 or more stories ☐ Building construction or expansion, 1 or 2 story, with project footprint more than ½ acre ☐ Mining ☐ Oil and natural gas drilling and refining ☐ Installation or expansion of marinas with a capacity of 6 or more boats **→ Go to the next question**

Is there a similar activity within 1 mile of the nest?

☐ Yes → Implement AM 3, 4 and 5 (see page 7)

☐ No → Implement AM 1 and 5 (see page 7)

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CONSTRUCTION & DEVELOPMENT

AVOIDANCE MEASURES - Place a check mark next to each avoidance measure (AM) that this form instructed you to implement and that you can commit to following. The Service recommends you follow the applicable AMs to prevent your activities from disturbing nesting bald eagles.

☐ AM 1 – Maintain a distance buffer of at least 660 feet (200 meters) between all project activities and the nest.

☐ AM 2 – Maintain a distance buffer of at least 660 feet (200 meters) between all project activities and the nest. If there is an existing human-made feature (e.g., house, road, dock) similar to your project that is closer than 660 feet <u>and</u> tolerated by the nesting eagles, maintain a distance buffer equal to or greater than the distance separating that tolerated feature and the nest.

☐ AM 3 – Maintain a distance buffer of at least 330 feet (100 meters) year-round between all project activities and the nest. If a similar activity (i.e., similar in kind and size) is closer than 330 feet <u>and</u> has been tolerated by eagles, the distance buffer will be the same or greater than that of the existing tolerated activity.

☐ AM 4 – Do not perform disruptive project activities within 660 feet (200 meters) of the nest during the breeding season. This time-of-year restriction is in addition to your recommended distance buffer. Disruptive activities include, but are not limited to, external construction, excavation, use of heavy equipment, use of loud equipment or machinery, vegetation clearing, earth disturbance, planting, and landscaping.

☐ AM 5 – Maintain existing landscape buffers that visually screen the activity from the nest.

Do you commit to following all recommended avoidance measures?

☐ YES – I certify that I have completed this form to the best of my ability, answered all questions completely and accurately, and committed to implementing all applicable avoidance measures.

__________________________________ __________________

(signature) (date)

<u>U.S. Fish and Wildlife Service Determination</u>: Based on your responses and commitment to implementing all applicable avoidance measures, the Service has determined that your proposed activities are unlikely to disturb nesting bald eagles.

☐ NO – I am unable to follow one or more of the avoidance measures recommended by this form.

Go to page 15 for further instruction.

MAINTENANCE & RESTORATION

Maintenance and Restoration Activities

This category includes outdoor maintenance of existing structures or infrastructure, where the maintenance activity is temporary and obtrusive (e.g., requires use of heavy equipment or loud machinery), and within the previously disturbed footprint of the structure or infrastructure. If maintenance is proposed outside the previously disturbed footprint, see **Construction and Development Activities** (pages 5-7). This category also applies to the maintenance and restoration of natural habitats (e.g., wetlands, streams, rivers, non-forested uplands). This category does not include routine, ongoing activities to which bald eagles have already exhibited a tolerance (e.g., lawn mowing; plowing, planting or harvesting of agricultural fields; etc.).

Which maintenance or restoration activities do you plan to perform? (check all that apply)

☐ Maintenance of linear utilities (e.g., power lines, pipelines, water and sewer lines)

☐ Road, bridge, or culvert maintenance

☐ Trail, campground, or recreational area maintenance

☐ Maintenance of oil and gas wells, well pads, and storage tanks

☐ Maintenance of dams, levees, berms, canals and other water-control structures

☐ Pond, lake, or reservoir maintenance (draw downs, dredging)

☐ Stream or stream bank maintenance /restoration (e.g., stream bank fencing, stream bank stabilization, livestock crossings, in-stream habitat improvements, channel maintenance, dredging)

☐ Wetland maintenance / restoration (e.g., invasive plant control, restoration of hydrology)

☐ Prescribed burning for invasive control

☐ Upland habitat maintenance / restoration (e.g., planting or cutting of vegetation, invasive plant control, trash cleanup, abandoned mine lands restoration). This does not include activities in forests/woodlands (see **Timber Operation and Forestry Practices**) or in agricultural fields.

Is your activity similar to an ongoing or previous activity that coincided with the breeding season <u>and</u> that bald eagles tolerated? Consider both construction and use/operation of your project.

Consider all of the following elements/factors in answering:

-duration	-time of season	-area/footprint
-frequency	-visibility	-magnitude
-time of day	-distance	-nature

☐ Yes → No avoidance measures recommended. Go to self-certification.

☐ No → Go to Avoidance Measures.

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MAINTENANCE & RESTORATION

AVOIDANCE MEASURES - Place a check mark next to each AM that you can commit to following. The Service recommends you follow these AMs to prevent your activities from disturbing nesting bald eagles.

☐ AM 6 - Within 660 feet (200 meters) of the nest, perform all loud and intrusive maintenance and restoration work outside the breeding season. These activities include, but are not limited to, the following: construction, excavation, use of heavy equipment, use of loud equipment or machinery, vegetation clearing, earth disturbance, planting, landscaping, and habitat restoration activities.

☐ AM 7 - Maintain existing landscape buffers that visually screen the activity from the nest.

☐ AM 8 - Do not perform prescribed burning within 660 feet (200 meters) of the nest during the breeding season. If there is no practicable alternative to scheduling prescribed burning during the breeding season, only conduct burns when adult eagles and young are absent from the nest tree (i.e., at the beginning of, or end of, the breeding season, either before the particular nest is in use or after the young have fledged from that nest).

☐ AM 9 - When performing prescribed burning within the drip line of the nest tree, rake leaves, vines, and woody debris from around the base of the tree to prevent fire from climbing the tree. When burning within a patch of forest containing the nest tree, take precautions to prevent crown fire.

Do you commit to following all recommended avoidance measures?

☐ YES – I certify that I have completed this form to the best of my ability, answered all questions completely and accurately, and committed to implementing all applicable avoidance measures.

________________________________ _________________

(signature) (date)

U.S. Fish and Wildlife Service Determination: Based on your responses and commitment to implementing all applicable avoidance measures, the Service has determined that your proposed activities are unlikely to disturb nesting bald eagles.

☐ NO – I am unable to follow one or more of the avoidance measures recommended by this form.

Go to page 15 for further instruction.

TIMBER & FORESTRY

Timber Operation and Forestry Practices

AVOIDANCE MEASURES - Place a check mark next to each AM that you can commit to following. The Service recommends you follow these AMs to prevent your activities from disturbing nesting bald eagles.

☐ AM 10 – Do not perform clear-cutting or overstory tree removal within 330 feet (100 meters) of the nest at any time of the year.

☐ AM 11 - During the breeding season, do not perform timber harvesting, road construction, chain saw use, or yarding operations within 660 feet (200 meters) of the nest. Around alternate nests (including nests that were attended during the current breeding season but not used to raise young), you may reduce this distance to 330 feet (100 meters), provided the eggs laid in another nest within the nesting territory have hatched.

☐ AM 12 – Do not construct or operate log transfer facilities and in-water log storage areas within 330 feet (100 meters) of nests at any time of the year.

☐ AM 13 – Do not perform selective thinning, prescribed burning, or other similar silviculture practices for the enhancement or conservation of habitat within 660 feet (200 meters) of the nest during the breeding season. If there is no practicable alternative to scheduling prescribed burning during the breeding season, only conduct burns when adult eagles and young are absent from the nest tree (i.e., at the beginning of, or end of, the breeding season, either before the particular nest is active or after the young have fledged from that nest).

☐ AM 14 – When performing prescribed burning within the drip line of the nest tree, rake leaves, vines, and woody debris from around the base of the tree to prevent fire from climbing the tree. When burning within a patch of forest containing the nest tree, take precautions to prevent crown fire.

Do you commit to following all recommended avoidance measures?

☐ YES – I certify that I have completed this form to the best of my ability, answered all questions completely and accurately, and committed to implementing all applicable avoidance measures.

______________________________ __________________

(signature) (date)

<u>U.S. Fish and Wildlife Service Determination</u>: Based on your responses and commitment to implementing all applicable avoidance measures, the Service has determined that your proposed activities are unlikely to disturb nesting bald eagles.

☐ NO – I am unable to follow one or more of the avoidance measures recommended by this form.

Go to page 15 for further instruction.

AIRCRAFT OPERATION

Use of a Helicopter and Fixed-wing Aircraft

Is your activity similar to an ongoing or previous activity that coincided with the breeding season <u>and</u> that bald eagles tolerated?

Consider all of the following elements/factors in answering:

-duration	-time of season	-area/footprint
-frequency	-visibility	-magnitude
-time of day	-distance	-nature

☒ Yes → No avoidance measures recommended. Go to self-certification.

☐ No → Go to Avoidance Measures.

AVOIDANCE MEASURES - Place a check mark next to each AM that you can commit to following. The Service recommends you follow this AM to prevent your activities from disturbing nesting bald eagles.

☐ AM 15 - During the breeding season, do not fly within 1000 feet (305 meters) of bald eagle nests.

Do you commit to following all recommended avoidance measures?

☒ YES – I certify that I have completed this form to the best of my ability, answered all questions completely and accurately, and committed to implementing all applicable avoidance measures.

SMITH.JACQUELINE.C.1122828766 Digitally signed by SMITH.JACQUELINE.C.1122828766 Date: 2021.04.19 15:21:15 -04'00'

19APR2021

(signature) (date)

<u>U.S. Fish and Wildlife Service Determination</u>: Based on your responses and commitment to implementing all applicable avoidance measures, the Service has determined that your proposed activities are unlikely to disturb nesting bald eagles.

☐ NO – I am unable to follow one or more of the avoidance measures recommended by this form.

Go to page 15 for further instruction.

LOUD NOISE

Blasting and Other Loud, Intermittent Noises (including Fireworks)

Is your activity similar to an ongoing or previous activity that coincided with the breeding season and that bald eagles tolerated?

Consider all of the following elements/factors in answering:

-duration	-time of day	-distance
-frequency	-time of season	-volume

■ Yes → No avoidance measures recommended. Go to self-certification.

☐ No → Go to Avoidance Measures.

AVOIDANCE MEASURES - Place a check mark next to each AM that you can commit to following. The Service recommends you follow this AM to prevent your activities from disturbing nesting bald eagles.

☐ AM 16 - During the breeding season, do not perform blasting and other activities that produce extremely loud noises within 1/2 mile (800 meters) of in-use nests. This measure also applies to the use of fireworks classified by the Federal Department of Transportation as Class B explosives, which includes the larger fireworks intended for licensed public display.

Do you commit to following all recommended avoidance measures?

■ YES – I certify that I have completed this form to the best of my ability, answered all questions completely and accurately, and committed to implementing all applicable avoidance measures.

SMITH.JACQUELINE.C.1122828766 Digitally signed by SMITH.JACQUELINE.C.1122828766 Date: 2021.04.19 15:21:39 -04'00' 19APR2021

(signature) (date)

U.S. Fish and Wildlife Service Determination: Based on your responses and commitment to implementing all applicable avoidance measures, the Service has determined that your proposed activities are unlikely to disturb nesting bald eagles.

☐ NO – I am unable to follow one or more of the avoidance measures recommended by this form.

Go to page 15 for further instruction.

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RECREATION

Recreational Activities

Is your activity similar to an ongoing or previous activity that coincided with the breeding season and that bald eagles tolerated?

Consider all of the following elements/factors in answering:

-duration	-time of season	-area/footprint
-frequency	-visibility	-magnitude
-time of day	-distance	-nature

☐ Yes → No avoidance measures recommended. Go to self-certification.

☐ No → Go to next question

Will your recreation occur during the breeding season?

☐ Yes → Go to Avoidance Measures.

☐ No → No avoidance measures recommended. Go to self-certification.

AVOIDANCE MEASURES – For each applicable recreational subcategory, place a check mark next to the AMs you can commit to following. The Service recommends you follow the applicable AMs to prevent your activities from disturbing nesting bald eagles.

Non-motorized recreation and human entry (including hiking, camping, fishing, hunting, canoeing)

☐ AM 17 - Stay at least 330 feet (100 meters) from the nest if you walk, bike, canoe, camp, fish, or hunt near an eagle nest during the breeding season and your activity will be visible or can be heard from the nest.

Off-road vehicle use (including snowmobiles)

☐ AM 18 - Stay at least 330 feet (100 meters) from the nest. In open areas, where there is increased visibility and exposure to noise, stay at least 660 feet (200 meters) from the nest.

RECREATION

Motorized watercraft use (including jet skis/personal watercraft)

☐ AM 19 - Do not operate jet skis (personal watercraft) or airboats within 330 feet (100 meters) of the nest.

☐ AM 20 - Avoid concentrations of noisy vessels (e.g. commercial fishing boats and tour boats) within 330 feet (100 meters) of the nest, except where eagles have demonstrated tolerance for such activity.

☐ AM 21 - For all motorized boat traffic within 330 feet (100 meters) of the nest, minimize trips and avoid stopping in the area, particularly where eagles are unaccustomed to boat traffic.

Do you commit to following all recommended avoidance measures?

☐ YES – I certify that I have completed this form to the best of my ability, answered all questions completely and accurately, and committed to implementing all applicable avoidance measures.

________________________________ ________________

(signature) (date)

U.S. Fish and Wildlife Service Determination: Based on your responses and commitment to implementing all applicable avoidance measures, the Service has determined that your proposed activities are unlikely to disturb nesting bald eagles.

☐ NO – I am unable to follow one or more of the avoidance measures recommended by this form.

Go to page 15 for further instruction.

FURTHER GUIDANCE

-- SEEK FURTHER GUIDANCE --

You have indicated that you are unable to implement all the recommended avoidance measures. Without all avoidance measures, your activities may risk disturbing nesting bald eagles.

Consult with your regional eagle coordinator to determine the appropriate next steps. The Service will work with you to help develop alternate measures to avoid disturbance of nesting bald eagles. If there are no feasible alternate measures, the Service may advise that you obtain an eagle incidental take permit to relieve you of legal liability in the event that your activities unintentionally disturb nesting bald eagles.

Contact your regional eagle coordinator (Tom Wittig) for assistance at thomas_wittig@fws.gov

When emailing, please include in your subject line "[Your project name] – SCREENING FORM FURTHER GUIDANCE." In the body of your message, include

-a brief description of your project, including its location and when you plan to start;

-the activity category(s);

-the ID number(s) (e.g., AM 5) of the Avoidance Measure(s) you are unable to implement; and

-the nest location(s), if available.

To see the Service's eagle incidental take permit application form, go to

https://www.fws.gov/forms/3-200-71.pdf

For answers to Frequently Asked Questions on this form, go to

https://www.fws.gov/migratorybirds/pdf/policies-and-regulations/3-200-71FAQ.pdf

The Service advises you talk with your regional eagle coordinator before deciding to apply.

APPENDIX A

APPENDIX A

Bald Eagle Breeding Season by State

State	Breeding Season
VA	December 15 – July 15
DC	December 15 – July 15
WV	January 1 – June 30
MD	December 15 – June 30
DE	December 15 – June 30
PA	January 1 – July 31
NY	January 1 – September 30
NJ	January 1 – July 31
RI	January 1 – July 31
CT	January 1 – July 31
MA	January 1 – August 15
VT	February 1 – August 15
NH	February 1 – August 15
ME (coastal)	February 1 – August 15
ME (northern)	March 1 – August 30

APPENDIX B

APPENDIX B

State Mapping Resources

Connecticut
Contact state
Brian Hess, CT DEEP
Brian.Hess@ct.gov

Delaware
Contact state
Katie Kadlubar, Delaware Division of Fish & Wildlife
Kathryn.Kadlubar@delaware.gov

DC
Contact National Park Service
Mikaila Milton, NPS
mikaila_milton@nps.gov

Maine
https://www.arcgis.com/apps/webappviewer/index.html?id=796b7baa18de43b49f911fe82dc4a0f1

Maryland
https://marylandbirds.org/report-bald-eagle-nest/

Massachusetts
Contact state
Andrew Vitz, MassWildlife
Andrew.vitz@state.ma.us

New Hampshire
Contact state
https://www2.des.state.nh.us/nhb_datacheck/signin.aspx

New Jersey
Contact state
https://www.nj.gov/dep/parksandforests/natural/heritage/datareq.html

New York
Contact state
https://www.dec.ny.gov/animals/31181.html

Pennsylvania
https://fws.maps.arcgis.com/apps/webappviewer/index.html?id=87ac96536654495b9f4041d81f75d7a0

Rhode Island
Contact state
DEM.DFW@dem.ri.gov

Vermont
Contact state
https://vtfishandwildlife.com/conserve/development-review

Virginia
https://www.ccbbirds.org/maps/#eagles

West Virginia
Contact state
Rich Bailey, WVDNR
Richard.S.Bailey@wv.gov

Please note that maps are not exhaustive records of all nests within that state.

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APPENDIX C

Guide to Nest Identification

Is it a bald eagle nest? Because bald eagle populations have grown so rapidly in recent years, not every bald eagle nest is registered to an online map or known to wildlife management agencies. As a result, project screening form users may occasionally have to make their own assessment of whether the nest near their project or activity is a bald eagle nest. Users should be cautious in making these determinations. Bald eagle nests can easily be confused with nests of other large birds such as osprey.

This guide will help landowners and project proponents assess whether a nest belongs to bald eagles or another species. It describes for readers the most commonly encountered large nests in the Northeast, with several reference figures for bald eagle nests, and provides tips for telling nest types apart. Any user who reads this guide and still feels uncertain about what type of nest they have encountered should contact their regional eagle coordinator for further guidance.

Common types of large nests.

Bald Eagle

The most notable aspect to a bald eagle nest is generally its size. Bald eagles build some of the largest nests in the world, with most nests around 5 feet in diameter and 3 feet in height (Fig. 1). Nests can grow well beyond these dimensions (Fig. 2), as bald eagles tend to repair and expand their nests each year and can use individual nests for decades. Bald eagle nests are mainly composed of large interwoven sticks. Nests will also have a soft interior bowl made up of materials such as hay, cornhusks, and grass clippings. However, this portion of the nest is rarely visible to human observers. The shape of bald eagle nests varies; they can take the general form of flat discs, inverted cones, cylinders (Fig. 2), or spheres (Fig. 3).

Bald eagles typically place their nests in prominent trees that sit above the surrounding forest canopy. These nest trees will often be on hillsides, lake and ocean shorelines, riverbanks, and forest edges. Nests are generally in the top third of a tree, below the crown, secured in a prominent fork off the main trunk (Fig 4.). Bald eagle nests can be in living deciduous (Fig. 3-4) and coniferous trees (Fig. 1), or dead trees (snags; Fig. 5). Within the Northeastern U.S., bald eagles use a wide range of tree types, including white pines, loblolly pines, tulip poplars, sycamores, oaks, and cottonwoods. Despite their common perception as an emblem of wilderness, bald eagles are also increasingly nesting on human-made structures such as electric transmission towers (Fig. 6) and communication towers.

APPENDIX C

Osprey

Osprey build large stick nests that can look quite similar to bald eagle nests. In general, osprey nests are smaller, flatter, more disorganized, and more often composed of unnatural materials, such as bailing twine and plastic bags. Osprey also show a stronger preference than bald eagles for human made structures, regularly nesting on light polls, channel markers, and cell towers. When osprey do select a natural support for their nest, it tends to be the topmost part of dead trees, in contrast to bald eagles, which seek out slightly lower portions of trees.

The best clue to which species occupies a nest, osprey or bald eagles, is who shows up. Bald eagles arrive back at their nests earlier in the year than osprey, but by late spring, both species are usually attending their nests. At this time of year, watching a nest over a period of hours will generally reveal which species is using it. However, through fall and early winter, both species are usually away from their nests. During these seasons, the only immediate sources of information on nest will be the physical details described above and online mapping resources.

In addition to the state maps for bald eagles listed in Appendix C, Osprey Watch (http://www.osprey-watch.org/) provides a mapping database of osprey nest locations. As with the bald eagle mapping resources, this map is thorough, but does not represent all existing nests.

Red-Tailed Hawk/Red-Shouldered Hawk

Generally around 1.5 feet wide and 2 feet tall, nests of red-tailed hawks and red-shouldered hawks are less than one-half the size of bald eagle nests. The individual sticks in these hawk nests also tend to be smaller, with diameters of about 1-2 inches. Overall appearance of these nests can be slightly more frayed and chaotic than that of bald eagle nests. Like bald eagles, both hawk species show a tendency towards nesting in upper portions of prominent trees. Red-tailed hawks also share bald eagle's occasional preference for human made structures such as cell towers and transmission towers.

Common Raven

Common ravens construct stick nests that vary substantially in size, from 1.5 to 5 feet across and from little over 0.5 to 2 feet high. The sticks making up the main structure of these nests can be around 3 feet in length and 1 inch in diameter. Ravens place their nests in a variety of natural and developed settings. Raven nests are easily confused with bald eagle nests when located on cell towers, transmission towers, or in trees. When situated in trees, these nests are usually in the upper portion of the tree in a crotch of the main tree stem. The best means of telling raven and bald eagle nests apart are likely size and shape; raven nests are noted for occasionally being asymmetric, and even at their larger sizes, they still tend to be smaller than bald eagle nests.

APPENDIX C

Great Horned Owl
In addition to nesting in tree cavities, great horned owls also frequently use the former nests of other animals, including squirrels, ravens, crows, and herons. The size and nature of a great horned owl nest therefore depends on the nest's original creator. Red-tailed hawk may be the most common source of nests for great horned owls in the Northeast. However, great horned owls will also occasionally take over bald eagle nests.

Heron
Herons nest in colonies known as "rookeries" where many nests are present; individual heron nests are rare. Multiple nests can be present in one tree and some nests may be located relatively high up or far out on branches. Nest sites are usually near water. Heron nests are mainly composed of sticks, and are flat and broad, often resembling a thin platform. Nests used for several years may grow taller and wider. Heron nests can give off a general impression of messiness or flimsiness.

Squirrel
Squirrel nests can reach basketball size or larger. They are distinguished from bird nests mainly by their materials, which include leaves and other soft vegetation material (e.g., grasses), and very few sticks. They are usually round shaped, and often look messy.

Legal definitions and protections for eagle and migratory bird nests.

Eagle Nests
BGEPA protects eagle nests in same manner it protects eagles; they cannot be destroyed, possessed, or relocated without a permit from the Service, which the Service only provides under a limited set of circumstances. Regulation defines an eagle nest as "any assemblage of materials built, maintained, or used by bald eagles or golden eagles for the purpose of reproduction" (50 CFR 22.3). A nest is an eagle nest if it was built by or ever used by eagles, even if other species of birds played a role in the nest's history. For example, if osprey build a nest and eagles take that nest over, legally, the nest is an eagle nest. Alternatively, if great horned owls begin to use a nest originally built by eagles, that nest remains an eagle nest for as long as it exists. An eagle nest also retains protection regardless of where it was built, whether it was ever finished or successful, or when it was last used. Additionally, BGEPA's protections apply regardless of the nest's size andcondition.

Migratory Bird Nests
The Migratory Bird Treaty Act (MBTA) protects migratory bird nests in the many of the same ways that BGEPA protects eagle nests. Unless a permit is in place, migratory bird nests cannot be possessed or relocated at any time or intentionally destroyed while active. One notable difference between MBTA and BGEPA is MBTA's standard on inactive nests. If a migratory bird nest is inactive, meaning it does not contain viable eggs or chicks, it can be destroyed without a permit. (Note: the

terms 'active' and 'inactive' here are different from the 'in-use' and 'alternate' standards used for eagle nests [see Appendix E for definitions].) For more information, please read the Service's 2018 Nest Destruction Memo. Bird species protected under MBTA are listed under regulation at 50 CFR 10.13. Additional protections not described here apply to any migratory bird species listed under the Endangered Species Act. Tribal, state, and local laws may also place greater restrictions on the destruction of migratory bird nests.

APPENDIX C

Figure 1.

Figure 2.

APPENDIX C

Figure 3.

Figure 4.

APPENDIX C

Figure 5.

Figure 6.

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APPENDIX D

Similar Activity Example Exercise

What is the purpose of this appendix? This appendix provides project screening form users with an example of how to assess the similarity between two activities. By reading through this example, landowners and project proponents can develop a better sense of what factors they should consider when answering the question of whether their activity is similar to an ongoing or previous activity tolerated by eagles.

In the example scenario, a proposed residential construction project is compared to previous farming activity. The example starts with an overview of the historic farming activity, nest, and proposed project; then goes through a full assessment, set up in table format; and finally closes with a summary of the determination and explanation of how that determination would influence completion of the form.

What is the scenario?

Previous/Existing Activities

The project site is a large agricultural field that was farmed nearly every year for the past two decades. Human activity at the site was limited to occasional operation of heavy farm equipment. The broader area out to one mile includes other agricultural fields and medium density residential and commercial development.

Nest Location & History

Five years ago, a pair of bald eagles constructed a nest in a cottonwood located in the hedgerow bordering the agricultural field. The pair were unsuccessful in their first year, but fledged young from the nest each of the following four years up to present. Workers observed that the pair did not respond to operation of farming equipment, but became vigilant whenever an equipment operator stepped outside their vehicle.

Project Narrative

The proposed project will convert portions of the existing agricultural field to a residential development with 30 single-family homes, which places it under the screening form's Construction and Development category. Construction will require extending water, sewage, and electrical utilities and adding a small network of residential streets. Preparing each lot will involve grading, home and driveway construction, and landscaping. Ten acres of property near the nest will be signed over as a conservation easement.

APPENDIX D

Factor	Previous/Existing Activity: Farming	Proposed Activity: Construction	Similar?
NATURE	Heavy equipment preparing field, planting, and harvesting crop. Two-three workers, generally confined to closed cab tractors.	Twenty workers either in heavy equipment or on foot. Ground disturbance. Placement/extension of utilities. Landscaping. Construction of 20 homes.	No
HISTORY	Farming activity predated nesting and continued while eagles successfully fledged young from the nest. This success demonstrates the eagles tolerated the farming.	N/A	Yes
DISTANCE	Distance between farming activity and the nest tree was essentially 0 feet; the hedgerow in which the nest is located bounds the agricultural field.	Nearest lot boundary will be 400 feet from nest. Area between home and nest will be converted conservation easement and left in passive, natural state.	Yes
TIMING	Farming activity began in March and continued through October each year.	Proposed schedule is April through October.	Yes
DURATION	The field was generally worked for one to two days at time, from sunrise to sundown.	On days of construction activity, work will occur during standard business hours.	Yes
FREQUENCY	Intermittent. Farming occurred in stages (e.g., fertilizing, plowing, harvesting) and events were often separated by weeks or months.	Continuous. Work will occur most weekdays and occasionally on weekends.	No
NOISE	Farming equipment (e.g., tractor) generated loud noises within the range of 80 – 100 decibels.	Construction will not require blasting or pile driving. Construction equipment (e.g., backhoes) will generate loud noise within the range of 80 – 95 decibels.	Yes
VISBILITY	High. Because the field was flat and there was no vegetation other than the hedgerow, practically all farming activity was visible to the nest.	High. There will be no topography or vegetation screening view of construction. Visibility will only begin to lower once exterior walls are put up.	Yes

APPENDIX D

Final Assessment & Conclusion

The proposed construction activity is different from the historic farming activity in general nature and frequency. Construction will require more workers and more equipment, operating at greater intensity and higher frequency. Because of these differences, the construction cannot be considered similar to the historic farming activity, and it cannot be assumed that the breeding pair will tolerate the activity. Avoidance measures will be necessary to reduce the likelihood of disturbing the nest.

Having made these conclusions, the form user would mark 'No' to the question on page 5 of whether the activity was similar to an ongoing or previous activity. Then, at the next question the user would mark 'Yes' because the project would be visible to nest over the open intervening space. At that point, the form would direct them to implement AMs 2, 4, and 5. The project design, as proposed, would not meet AM 2, the 660-foot buffer. The user's options then would be to revise the project to eliminate the portions within 660 feet of the nest and sign the self-certification, or check no on the commitment to follow all recommended AMs and seek further guidance.

APPENDIX E

Limitations of This Form

This project screening form is not a permit or authorization to disturb bald eagles. It does not free you from legal liability under BGEPA. Rather, this form provides instruction on how to minimize the legal risk of disturbing nesting bald eagles.

The effectiveness of this form depends on the accuracy and completeness of your answers and your compliance with the avoidance measures. Using this form inappropriately may put you at risk of disturbing nesting bald eagles and violating BGEPA.

This form's recommendations are specific to the Northeast and may not be effective outside this region. If your project is in another area of the U.S., do not use this form. Instead, consult with your regional eagle biologist or migratory bird permit office for guidance matched to your locality.

This form only relates to managing activities near bald eagle nests. It does not provide direction on how to avoid disturbing bald eagle communal roosts and concentration areas, which, compared to nest sites, have different biological significance to eagles and present different sets of concerns. If you believe your activities have any potential to affect a communal roost or concentration area, consult the Guidelines document for guidance.

Conditions such as the location and existence of nests and surrounding habitat are subject to change between years. For this reason, the Service recommends revisiting your determinations every breeding season after completing this form until your project is complete. The more time that passes between when you complete this form and when you end your activities, the more likely it is that conditions will change enough that your original determinations no longer apply.

This form only addresses nesting bald eagles. To identify other USFWS-managed resources and suggested conservation measures for your project, go to https://ecos.fws.gov/ipac/.

Wind energy developers seeking to address potential take of eagles should use this form in conjunction with the Service's Eagle Conservation Plan Guidance. Use of this form alone will not assure wind projects' compliance with BGEPA's protections on disturbance or other take.

Certain states and localities have their own laws, regulations, and guidelines for protecting bald eagles and their nests. Completing this form does not guarantee that you are also in compliance with these other standards and/or regulations. If you are unfamiliar with your state and local standards, consult with the appropriate agencies and authorities.

You are responsible for ensuring that your activities comply with all applicable Federal, tribal, State, and local laws and regulations. This form will only help you in your compliance with BGEPA and its protections on the nesting activity of bald eagles.

APPENDIX F

Glossary of Terms

Alternate nest – one of potentially several nests within a nesting territory that is not an in-use nest at the current time. When there is no in-use nest, all nests in the territory are alternate nests. Also sometimes referred to as an inactive nest (e.g., in the Service's 2009 Eagle Rule).

Communal roost – an area where eagles gather repeatedly in the course of a season and shelter overnight and sometimes during the day in the event of inclement weather.

Disturb – to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

In addition to immediate impacts, this definition also covers impacts that result from human-caused alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle's return, such alterations agitate or bother an eagle to a degree that injures an eagle or substantially interferes with normal breeding, feeding, or sheltering habits and causes, or is likely to cause, a loss of productivity or nest abandonment.

Eagle nest – any assemblage of materials built, maintained, or used by bald eagles or golden eagles for the purpose of reproduction.

Fledge – to leave the nest and begin flying. For bald eagles, this normally occurs at 10-12 weeks of age.

In-use nest – a bald or golden eagle nest characterized by the presence of one or more eggs, dependent young, or adult eagles on the nest in the past 10 days during the breeding season. Also sometimes referred to as an active nest.

Landscape buffer – a natural or human-made landscape feature that screens eagles from human activity (e.g., strip of trees, hill, cliff, berm, sound wall).

Nest abandonment – nest abandonment occurs when adult eagles desert or stop attending a nest and do not subsequently return and successfully raise young in that nest for the duration of a breeding season. Nest abandonment can be caused by altering habitat near a nest, even if the alteration occurs prior to the breeding season. Whether the eagles migrate during the non-breeding season, or remain in the area throughout the non-breeding season, nest abandonment can occur at any point between the time the eagles return to the nesting site for the breeding season and the time when all progeny from the breeding season have dispersed.

Nesting territory – the area that contains one or more eagle nests within the home range of a mated pair of eagles, regardless of whether such nests were built by the current resident pair.

Northeast – Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Delaware, Virginia, West Virginia, and the District of Columbia.

Project footprint – the area of land (and water) temporarily or permanently altered by a project.

Tolerate – the acceptance of specific human activities by eagles at the nest site. Demonstrated in the eagles' continued ability to successfully feed, breed, and shelter, and the general absence of stress or agitation in their behavior.