Atlantic Fleet Training and Testing Final Environmental Impact Statement / Overseas Environmental Impact Statement

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Lead Agency
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Cooperating Agency
National Marine Fisheries Service

Action Proponents
United States Fleet Forces
Naval Air Systems Command
Naval Sea Systems Command
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FINAL ENVIRONMENTAL IMPACT STATEMENT/ OVERSEAS ENVIRONMENTAL IMPACT STATEMENT for ATLANTIC FLEET TRAINING AND TESTING

Lead Agency:	United States Department of the Navy
Cooperating Agency:	National Marine Fisheries Service
Title of the Proposed Action:	Atlantic Fleet Training and Testing
Designation:	Final Environmental Impact Statement/Overseas Environmental Impact Statement

Abstract

The Navy prepared this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to comply with the National Environmental Policy Act (NEPA) and Executive Order (EO) 12114. The Navy identified its need to support and conduct current, emerging, and future training and testing activities in the Atlantic Fleet Training and Testing (AFTT) Study Area, located in the western Atlantic Ocean, off the eastern coast of the United States, in the Gulf of Mexico, and in portions of the Caribbean Sea. Three alternatives were analyzed:

- The No Action Alternative included current and historic levels of activity based on previously completed Navy NEPA/EO 12114 analysis. The No Action Alternative did not include any changes to current training and testing levels.
- Alternative 1 included the activities addressed in the No Action Alternative, expansion of the Study Area, and adjustments to types and levels of training and testing activities.
- Alternative 2 (Preferred Alternative) included all elements of Alternative 1 plus established new range capabilities, modified existing capabilities, and adjusted the type and levels of training and testing.

In this EIS/OEIS, the Navy analyzed potential impacts on environmental resources resulting from activities under the alternatives. Evaluated resources included sediments and water quality, air quality, marine habitats, marine mammals, sea turtles and other marine reptiles, birds, marine vegetation, marine invertebrates, fish, cultural resources, socioeconomic resources, and public health and safety.

In accordance with its At-Sea Policy, the Navy developed a programmatic approach to environmental compliance for ranges and operating areas within its areas of responsibility. The Study Area combined the geographic scope of the range complexes on the east coast of the United States and in the Gulf of Mexico and includes additional areas where training and testing activities historically occur; this EIS/OEIS also included new platforms and weapon systems not previously addressed.

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FOREWORD

The Draft Atlantic Fleet Training and Testing (AFTT) Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) was released for public review and comment 25 May 2012 through 10 July 2012. Changes in this Final EIS/OEIS reflect all substantive comments made on the Draft EIS/OEIS during the public comment period and Navy refinements to the Proposed Action. Additionally, the analysis has been refined to more accurately quantify the expected acoustic effects on marine mammals, taking into consideration animal avoidance or movement and Navy mitigations. Public comments are summarized and responded to in Appendix E, Public Comments and Responses.

While most sections in the EIS/OEIS were changed in some manner between the draft and final versions, many of those changes entailed minor modifications to improve wording. The key changes between the AFTT Draft EIS/OEIS and Final EIS/OEIS follow.

- Chapter 2 (Description of Proposed Action and Alternatives):

  Annual levels of certain activities and resulting quantities of associated military expended materials were adjusted to reflect more accurate estimates of future training and testing needs and to correct errors. The general types and locations of training and testing did not change. Tables 1 through 8 identify the changes between the Draft EIS/OEIS and Final EIS/OEIS for sonar and explosive usage during training and testing by alternative.

  Some of these changes affected the modeled marine mammal exposure results, such that modeled exposures decreased overall for training, and modeled behavioral exposures increased overall for testing activities. These changes are presented in Appendix B to the Determination of Acoustic Effects on Marine Mammals and Sea Turtles for the Atlantic Fleet Training and Testing Environmental Impact Statement/Overseas Environmental Impact Statement Technical Report, available at http://www.aftteis.com. Specifically, the modeled activities for the No Action Alternative for training increased in the FEIS because the number of hull-mounted sonar hours were underestimated in the DEIS model inputs, resulting in an overall increase in estimated marine mammal exposures for the No Action Alternative in the FEIS. For training, activities hours for Alternatives 1 and 2 increased overall, partly due to an increase in estimated sonar usage for the mine detection and classification sonar after publication of the DEIS. For testing, the number of countermeasure testing activities in the DEIS was over estimated for Alternatives 1 and 2, resulting in an overestimation of marine mammal exposures, particularly with regards to temporary threshold shift (TTS) and permanent threshold shift (PTS) in the DEIS, resulting in a corresponding decrease in modeled TTS and PTS exposures when remodeled for the FEIS. Additionally, the requirements for the anti-submarine warfare ASW2 source class testing, mid-frequency sonobuoys, increased following the publication of the DEIS, resulting in an increase in modeled behavioral response exposures. The remainder of the source class changes resulted in only minor modeled exposure changes due primarily to the types of sources and the minimal potential impact they have.

Table 1: Change in Annual Sonar and Other Active Acoustic Source Class Usage during Training Activities Analyzed in this FEIS Compared to the DEIS

For Annual Training Activities											
Source Class Category	Source Class	Units	Annual Usage								
			No Action Alternative			Alternative 1			Alternative 2		
			DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
Low-Frequency (LF) Sources that produce signals less than 1 kHz	LF3	Hours	0	0	–	0	0	–	0	0	–
	LF4	Hours	0	0	–	0	0	–	0	0	–
	LF5	Hours	0	0	–	0	0	–	0	0	–
	LF6	Hours	0	0	–	0	0	–	0	0	–
Mid-Frequency (MF) Tactical and nontactical sources that produce signals from 1 to 10 kHz	MF1	Hours	3,757	4,370	+613	9,805	9,844	+39	9,805	9,844	+39
	MF1K	Hours	156	156	–	163	163	–	163	163	–
	MF2	Hours	1,618	1,498	-120	3,140	3,150	+10	3,140	3,150	+10
	MF2K	Hours	59	59	–	61	61	–	61	61	–
	MF3	Hours	1,607	1,706	+99	2,054	2,058	+4	2,054	2,058	+4
	MF4	Hours	588	647	+59	925	927	+2	925	927	+2
	MF5	Count	7,740 (774)[1]	10,112	+2,372	14,472 (1,447)[1]	14,556	+84	14,472 (1,447)[1]	14,556	+84
	MF6	Count	0	0	–	0	0	–	0	0	–
	MF8	Hours	0	0	–	0	0	–	0	0	–
	MF9	Hours	0	0	–	0	0	–	0	0	–
	MF10	Hours	0	0	–	0	0	–	0	0	–
	MF11	Hours	0	0	–	800	800	–	800	800	–
	MF12	Hours	16	23	+7	687	687	–	687	687	–
High-Frequency (HF) Tactical and nontactical sources that produce signals greater than 10 kHz but less than 180 kHz	HF1	Hours	393	410	+17	1,676	1,676	–	1,676	1,676	–
	HF2	Hours	0	0	–	0	0	–	0	0	–
	HF3	Hours	0	0	–	0	0	–	0	0	–
	HF4	Hours	3,340	6,680	+3,340	4,388	8,464	+4,076	4,388	8,464	+4,076
	HF5	Hours	0	0	–	0	0	–	0	0	–
	HF6	Hours	0	0	–	0	0	–	0	0	–
	HF7	Hours	0	0	–	0	0	–	0	0	–
	HF8	Hours	0	0	–	0	0	–	0	0	–

DEIS: draft environmental impact statement; FEIS: final environmental impact statement; HF: high frequency; kHz: kilo hertz; LF: low frequency; MF: mid-frequency

[1] In the DEIS, source class MF5 was presented as hours of use (quantity in hours shown in parentheses). The equivalent count is shown here for comparison.

Table 1: Change in Annual Sonar and Other Active Acoustic Source Class Usage during Training Activities Analyzed in this FEIS Compared to the DEIS (Continued)

For Annual Training Activities											
Source Class Category	Source Class	Units	Annual Usage								
			No Action Alternative			Alternative 1			Alternative 2		
			DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
Anti-Submarine Warfare (ASW) Tactical sources used during anti-submarine warfare training and testing activities	ASW1	Hours	0	0	–	128	128	–	128	128	–
	ASW2[2]	Hours	436	0	-436	1,016	0	-1,016	1,016	0	-1,016
	ASW2[2]	Count	0	1450	+1450	0	2,620	+2,620	0	2,620	+2,620
	ASW3	Hours	3,671	5,202	+1,531	13,555	13,586	+31	13,555	13,586	+31
	ASW4	Count	211	1,006	+795	450	1,365	+915	450	1,365	+915
Doppler Sonar (DS) Sonar using Doppler effect to aid in navigation/collect oceanographic information	DS1	Hours	0	0	–	0	0	–	0	0	–
Acoustic Modems (M) Transmit data acoustically through the water	M3	Hours	0	0	–	0	0	–	0	0	–
Synthetic Aperture Sonar (SAS) Post-processed signals form high-resolution images of the seafloor	SAS1	Hours	0	0	–	0	0	–	0	0	–
	SAS2	Hours	0	0	–	0	0	–	0	0	–
	SAS3	Hours	0	0	–	0	0	–	0	0	–
Swimmer Detection Sonar (SD) Used to detect divers and submerged swimmers	SD1–SD2	Hours	0	0	–	0	0	–	0	0	–
Forward Looking Sonar (FLS) Forward or upward looking object-avoidance sonar.	FLS2–FLS3	Hours	0	0	–	0	0	–	0	0	–

ASW: anti-submarine warfare; DEIS: draft environmental impact statement; DS: Doppler sonar; FEIS: final environmental impact statement; FLS: forward looking sonar; M: acoustic modems; SAS: synthetic aperture sonar; SD: swimmer detection sonar

[2] The use of source class ASW2 proposed in Alternatives 1 and 2 is the same in both the DEIS and FEIS, although it was represented as hours in the DEIS and count in the FEIS.

Table 1: Change in Annual Sonar and Other Active Acoustic Source Class Usage during Training Activities Analyzed in this FEIS Compared to the DEIS (Continued)

For Annual Training Activities											
Source Class Category	Source Class	Units	Annual Usage								
			No Action Alternative			Alternative 1			Alternative 2		
			DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
Torpedoes (TORP) Source classes associated with active acoustic signals produced by torpedoes	TORP1	Count	29	42	+13	13	54	+41	13	54	+41
	TORP2	Count	23	93	+70	20	80	+60	20	80	+60

DEIS: draft environmental impact statement; FEIS: final environmental impact statement; HF: high frequency; kHz: kilo hertz; TORP: torpedoes

Table 2: Change in Non-Annual Sonar and Other Active Acoustic Source Class Usage during Training Activities Analyzed in this FEIS Compared to the DEIS

For Non-Annual Training Activities											
Source Class Category	Source Class	Units	Usage over a 5-Year Period								
			No Action Alternative			Alternative 1			Alternative 2		
			DEIS[1]	FEIS	Change	DEIS[1]	FEIS	Change	DEIS[1]	FEIS	Change
High-Frequency (HF) Tactical and nontactical sources that produce signals greater than 10 kHz but less than 180 kHz	HF4	Hours	0	0	–	96	192	+96	96	192	+96

DEIS: draft environmental impact statement; FEIS: final environmental impact statement; HF: high frequency; kHz: kilo hertz

[1] The table describing use of sonar and other active acoustic sources during non-annual activities was inadvertently left out of the AFTT Draft EIS/OEIS. The impacts due to these activities, however, were analyzed in the AFTT Draft EIS/OEIS.

Table 3: Change in Annual Sonar and Other Active Acoustic Source Class Usage during Testing Activities Analyzed in this FEIS Compared to the DEIS

For Annual Testing Activities											
Source Class Category	Source Class	Units	Annual Usage								
			No Action Alternative			Alternative 1			Alternative 2		
			DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
Low-Frequency (LF) Sources that produce signals less than 1 kHz	LF3	Hours	0	0	–	0	0	–	0	0	–
	LF4	Hours	100	100	–	218	218	–	254	254	–
	LF5	Hours	551	33	-518	453	325	-128	498	370	-128
	LF6	Hours	0	0	–	8	0	-8	12	0	-12
Mid-Frequency (MF) Tactical and nontactical sources that produce signals from 1 to 10 kHz	MF1	Hours	18	18	–	156	206	+50	170	220	+50
	MF1K	Hours	5	5	–	14	18	+4	15	19	+4
	MF2	Hours	0	0	–	20	36	+16	20	36	+16
	MF2K	Hours	0	0	–	0	0	–	0	0	–
	MF3	Hours	32	32	–	369	371	+2	433	434	+1
	MF4	Hours	87	126	+39	465	698	+233	510	776	+266
	MF5	Count [1]	1,070 (107)	1,099	+29	3,394 (339)	3,802	+408	3,763 (376)	4,184	+421
	MF6	Count	1	69	+68	2	255	+253	2	303	+301
	MF8	Hours	80	80	–	72	72	–	90	90	–
	MF9	Hours	1,334	299	-1,035	12,071	11,825	-246	13,280	13,034	-246
	MF10	Hours	17	12	-5	1,064	1,066	+2	1,065	1,067	+2
	MF11	Hours	0	0	–	0	0	–	0	0	–
	MF12	Hours	0	0	–	8	144	+136	12	144	+132
High-Frequency (HF) Tactical and nontactical sources that produce signals greater than 10 kHz but less than 180 kHz	HF1	Hours	26	26	–	1,099	1,104	+5	1,239	1,243	+4
	HF2	Hours	0	0	–	0	0	–	0	0	–
	HF3	Hours	26	26	–	307	307	–	387	384	-3
	HF4	Hours	692	692	–	1,340	4,841	+3,501	1,722	5,572	+3,850
	HF5	Hours	737	219	-518	1,188	1,135	-53	1,360	1,206	-154
	HF6	Hours	1,986	433	-1,553	2,138	1,754	-384	2,358	1,974	-384
	HF7	Hours	547	30	-517	449	321	-128	494	366	-128
	HF8	Hours	0	0	–	0	0	–	0	0	–

DEIS: draft environmental impact statement; FEIS: final environmental impact statement; HF: high frequency; kHz: kilo hertz; LF: low frequency; MF: mid-frequency

[1] In the DEIS, source class MF5 was presented as hours of use (quantity in hours shown in parentheses). The equivalent count is shown here for comparison.

Table 3: Change in Annual Sonar and Other Active Acoustic Source Class Usage during Testing Activities Analyzed in this FEIS Compared to the DEIS (Continued)

For Annual Testing Activities											
Source Class Category	Source Class	Units	Annual Usage								
			No Action Alternative			Alternative 1			Alternative 2		
			DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
Anti-Submarine Warfare (ASW) Tactical sources used during anti-submarine warfare training and testing activities	ASW1	Hours	0	0	–	0	96	+96	0	96	+96
	ASW2[2]	Hours	434	0	-434	936	200	-736	1,047	274	-773
	ASW2[2]	Count	0	1,115	+1,115	0	2,378	+2,378	0	2,743	+2,743
	ASW3	Hours	89	89	–	822	901	+79	1,002	948	-54
	ASW4	Count	48	144	+96	133	400	+267	161	483	+322
Doppler Sonar (DS) Sonar using Doppler effect to aid in navigation/collect oceanographic information	DS1	Hours	0	0	–	0	0	–	0	0	–
Acoustic Modems (M) Transmit data acoustically through the water	M3	Hours	46	46	–	344	392	+48	414	461	+47
Synthetic Aperture Sonar (SAS) Post-processed signals form high-resolution images of the seafloor	SAS1	Hours	1,665	5	-1,552	3,432	6	-384	3,814	6	-384
	SAS2	Hours		108			3,042			3,424	
	SAS3	Hours	0	0	–	0	0	–	0	0	–
Swimmer Detection Sonar (SD) Used to detect divers and submerged swimmers	SD1–SD2	Hours	80	80	–	200	200	–	230	230	–

ASW: anti-submarine warfare; DEIS: draft environmental impact statement; DS: Doppler sonar; FEIS: final environmental impact statement; FLS: forward looking sonar; M: acoustic modems; SAS: synthetic aperture sonar; SD: swimmer detection sonar

[1] The use of source class ASW2 proposed in Alternatives 1 and 2 is the same in both the DEIS and FEIS, although it was represented as hours in the DEIS and count in the FEIS.

Table 3: Change in Annual Sonar and Other Active Acoustic Source Class Usage during Testing Activities Analyzed in this FEIS Compared to the DEIS (Continued)

For Annual Testing Activities											
Source Class Category	Source Class	Units	Annual Usage								
			No Action Alternative			Alternative 1			Alternative 2		
			DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
Forward Looking Sonar (FLS) Forward or upward looking object avoidance sonar.	FLS2–FLS3	Hours	0	30	+30	448	320	-128	493	365	-128
Torpedoes (TORP) Source classes associated with active acoustic signals produced by torpedoes	TORP1	Count	20	86	+66	145	540	+395	166	581	+415
	TORP2	Count	35	43	+8	100	464	+364	113	521	+408

FLS: forward looking sonar; DEIS: draft environmental impact statement; FEIS: final environmental impact statement; TORP: torpedoes

Table 4: Change in Non-Annual Sonar and Other Active Acoustic Source Class Usage during Testing Activities Analyzed in this FEIS Compared to the DEIS

For Annual Testing Activities											
Source Class Category	Source Class	Units	Usage Over a 5-Year Period								
			No Action Alternative			Alternative 1			Alternative 2		
			DEIS[1]	FEIS	Change	DEIS[1]	FEIS	Change	DEIS[1]	FEIS	Change
Low-Frequency (LF) Sources that produce low-frequency (less than 1 kHz) signals	LF5	Hours	517	129	-388	128	240	+112	128	240	+112
Mid-Frequency (MF) Tactical and nontactical sources that produce mid-frequency (1 to 10 kHz) signals	MF9	Hours	1,034	259	-775	256	480	+224	256	480	+224
High-Frequency (HF) Tactical and nontactical sources that produce high-frequency (greater than 10 kHz but less than 180 kHz) signals	HF5	Hours	517	129	-388	128	240	+112	128	240	+112
	HF6	Hours	1,552	388	-1,164	384	720	+336	384	720	+336
	HF7	Hours	517	129	-388	128	240	+112	128	240	+112
Synthetic Aperture Sonar (SAS) Sonar in which active acoustic signals are post-processed to form high-resolution images of the seafloor	SAS2	Hours	1,552	388	-1,164	384	720	+336	384	720	+336
Forward Looking Sonar (FLS) Forward or upward looking object avoidance sonar.	FLS2–FLS3	Hours	0	129	+129	128	240	+112	128	240	+112

lb.: pound; DEIS: draft environmental impact statement; FEIS: final environmental impact statement; FLS: forward looking sonar; HF: high frequency; kHz: kilo hertz; LF: low frequency; MF: mid-frequency; SAS: synthetic aperture sonar

[1] The table describing use of sonar and other active acoustic sources during non-annual activities was inadvertently left out of the AFTT Draft EIS/OEIS. The impacts due to these activities, however, were analyzed in the AFTT Draft EIS/OEIS.

Table 5: Change in Annual Explosive Usage during Training Activities Analyzed in this FEIS Compared to the DEIS

For Annual Training Activities									
Source Class (Net Explosive Weight)	Number of Explosives								
	No Action Alternative			Alternative 1			Alternative 2		
	DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
E1 (0.1 – 0.25 lb.)	394	103	-291	123,112	124,552	+1,440	123,112	124,552	+1,440
E2 (0.26 – 0.5 lb.)	68	32	-36	858	856	-2	858	856	-2
E3 (0.6 – 2.5 lb.)	0	100	+100	3,132	3,132	–	3,132	3,132	–
E4 (2.6 – 5 lb.)	2,214	2,130	-84	2,180	2,190	+10	2,180	2,190	+10
E5 (6 – 10 lb.)	5,090	1,400	-3,690	14,370	14,370	–	14,370	14,370	–
E6 (11 – 20 lb.)	143	140	-3	440	500	+60	440	500	+60
E7 (21 – 60 lb.)	0	30	+30	316	322	+6	316	322	+6
E8 (61 – 100 lb.)	54	54	–	77	77	–	77	77	–
E9 (101 – 250 lb.)	7	7	–	2	2	–	2	2	–
E10 (251 – 500 lb.)	5	5	–	8	8	–	8	8	–
E11 (501 – 650 lb.)	4	4	–	1	1	–	1	1	–
E12 (651 – 1,000 lb.)	27	27	–	133	133	–	133	133	–
E13 (1,001 – 1,740 lb.)	0	0	–	0	0	–	0	0	–
E14 (1,741 – 3,625 lb.)	0	0	–	0	0	–	0	0	–

lb.: pound; DEIS: draft environmental impact statement; FEIS: final environmental impact statement

Table 6: Change in Non-Annual Explosive Usage during Training Activities Analyzed in this FEIS Compared to the DEIS

For Non-Annual[1] Training Activities									
Source Class (Net Explosive Weight)	Number of Explosives								
	No Action Alternative			Alternative 1			Alternative 2		
	DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
E2 (0.26 – 0.5 lb.)	0	0	–	2	2	–	2	2	–
E4 (2.6 – 5 lb.)	0	0	–	2	2	–	2	2	–

lb.: pound; DEIS: draft environmental impact statement; FEIS: final environmental impact statement

[1] The table describing use of explosives during non-annual activities was inadvertently left out of the AFTT Draft EIS/OEIS. The impacts due to these activities, however, were analyzed in the AFTT Draft EIS/OEIS.

Table 7: Change in Annual Explosive Usage during Testing Activities Analyzed in this FEIS Compared to the DEIS

For Annual Testing Activities									
Source Class (Net Explosive Weight)	Number of Explosives								
	No Action Alternative			Alternative 1			Alternative 2		
	DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
E1 (0.1 – 0.25 lb.)	7,000	7,000	–	20,600	22,802	+2,202	22,600	25,501	+2,901
E2 (0.26 – 0.5 lb.)	0	0	–	0	0	–	0	0	–
E3 (0.6 – 2.5 lb.)	892	734	-158	2,848	2,128	-720	3,589	2,912	-677
E4 (2.6 – 5 lb.)	462	479	+17	1,053	1,143	+90	1,266	1,432	+166
E5 (6 – 10 lb.)	94	94	–	448	448	–	495	495	–
E6 (11 – 20 lb.)	7	8	+1	36	49	+13	41	54	+13
E7 (21 – 60 lb.)	0	0	–	0	0	–	0	0	–
E8 (61 – 100 lb.)	4	4	–	10	10	–	11	11	–
E9 (101 – 250 lb.)	0	0	–	0	0	–	0	0	–
E10 (251 – 500 lb.)	0	0	–	0	8	+8	0	10	+10
E11 (501 – 650 lb.)	32	20	-12	25	25	–	27	27	–
E12 (651 – 1,000 lb.)	0	0	–	0	0	–	0	0	–
E13 (1,001 – 1,740 lb.)	0	0	–	0	0	–	0	0	–
E14 (1,741 – 3,625 lb.)	3	3	–	3	3	–	4	4	–

lb.: pound; DEIS: draft environmental impact statement; FEIS: final environmental impact statement

Table 8: Change in Non-Annual Explosive Usage during Testing Activities Analyzed in this FEIS Compared to the DEIS

For Non-Annual[1] Testing Activities									
Source Class (Net Explosive Weight)	Number of Explosives								
	No Action Alternative			Alternative 1			Alternative 2		
	DEIS	FEIS	Change	DEIS	FEIS	Change	DEIS	FEIS	Change
E1 (0.1 – 0.25 lb.)	0	0	–	600	600	–	600	600	–
E16 (7,251 – 14,500 lb.)	0	0	–	12	12	–	12	12	–
E17 (14,501 – 58,000 lb.)	0	0	–	4	4	–	4	4	–

lb.: pound; DEIS: draft environmental impact statement; FEIS: final environmental impact statement

[1] The table describing use of explosives during non-annual activities was inadvertently left out of the AFTT Draft EIS/OEIS (the table describing explosives used during ship shock trials, source classes E16 and E17, was included in the DEIS). The impacts due to these activities, however, were analyzed in the AFTT Draft EIS/OEIS.

- Section 3.0 (Introduction to Affected Environment and Environmental Consequences):

  Tables were updated to reflect different annual levels of certain activities and resulting quantities of associated military expended materials based on changes to Chapter 2 (Description of Proposed Action and Alternatives). Changes in the number of activities proposed also prompted updates to the tables describing the level of use of acoustic sources.

- Section 3.1 (Sediments and Water Quality):

  Changes in quantities of military expended materials were adjusted based on changes made to Chapter 2 (Description of Proposed Action and Alternatives) and military expended material numbers in Section 3.0 (Introduction). Additional detail was added on the chemical and biological simulant testing activities. The analyses of impacts on water quality and sediments as a result of these changes were modified accordingly.

- Section 3.2 (Air Quality):

  The analyses of impacts on air quality as a result of changes to annual levels of certain activities, as detailed in Chapter 2 (Description of Proposed Action and Alternatives), were modified accordingly. In addition, updates to text were made to capture recent regulatory changes.

- Section 3.3 (Marine Habitats):

  Changes in quantities of explosives on or near the bottom and military expended materials were adjusted based on changes made to Chapter 2 (Description of Proposed Action and Alternatives) and tables in Section 3.0.5.3 (Identification of Stressors for Analysis). The analyses of impacts on marine habitats as a result of these changes were modified accordingly. In addition, the definition of hard bottom substrate was clarified and a new source of hard bottom data was referenced for training and testing locations in the Gulf of Mexico. Updates were made to Essential Fish Habitat findings to match those contained in the AFTT Essential Fish Habitat Assessment Final Report.

- Section 3.4 (Marine Mammals):

  The analyses of impacts on marine mammals as a result of changes to annual levels of certain activities, as detailed in Chapter 2 (Description of Proposed Action and Alternatives) and tables in Section 3.0.5.3 (Identification of Stressors for Analysis) were modified accordingly. The acoustic analysis was revised to more accurately quantify the expected acoustic effects on marine mammals, taking into consideration animal avoidance or movement and standard Navy mitigations.

- Section 3.5 (Sea Turtles and Other Marine Reptiles):

  The analyses of impacts on sea turtles and other marine reptiles as a result of changes to annual levels of certain activities, as detailed in Chapter 2 (Description of Proposed Action and Alternatives) and tables in Section 3.0.5.3 (Identification of Stressors for Analysis) were modified accordingly.

- Section 3.6 (Birds):

  Only minor clarifications to text were made with no substantial changes. Changes were made to text to account for the red knot (*Calidris canutus*) which is a candidate for listing under the Endangered Species Act (ESA).

- Section 3.7 (Marine Vegetation):

  Changes in quantities of explosives and military expended materials were adjusted based on changes made to Chapter 2 (Description of Proposed Action and Alternatives) and tables in Section 3.0.5.3 (Identification of Stressors for Analysis). The analyses of impacts on marine vegetation as a result of these changes were modified accordingly. In addition, updates were made to Essential Fish Habitat findings to reflect those contained in the AFTT Essential Fish Habitat Assessment Final Report.

- Section 3.8 (Marine Invertebrates):

  Table 3.8-2, Federally Managed Marine Invertebrate Species with Essential Fish Habitat within the Study Area Covered under Each Fishery Management Plan was modified. Changes were made to text to account for the proposed Endangered Species Act (ESA) listing of seven coral species and for the change in status from “threatened” to “endangered” for elkhorn and staghorn corals (*Acropora palmata and A. cervicornis).* Minor modifications were made to the analyses of impacts on corals at the South Florida Ocean Measurement Facility Testing Range as a result of these proposed ESA changes. In addition, information was added on the queen conch (*Lobatus gigas*), and Essential Fish Habitat findings were modified to match those found in the AFTT Essential Fish Habitat Assessment Final Report.

- Section 3.9 (Fish):

  Endangered Species Act findings for Atlantic salmon were clarified for entanglement and ingestion stressors. Critical habitat determinations for Gulf sturgeon were updated to correspond with textual discussion of impacts from military expended material strikes. Endangered Species Act findings for each acoustic substressor were separated for clarity. Table 3.9-1, Status and Presence of Endangered Species Act Endangered, Threatened, and Candidate Fish Species, and Species of Concern in the Study Area, was updated to reflect changing status of certain species and additions of species previously not listed. Additional information was added regarding the dwarf seahorse (*Hippocampus zosterae*) and detail was added to Section 3.9.2.2 (General Threats) regarding the *Deepwater Horizon* oil spill.

- Section 3.10 (Cultural Resources):

  The regulatory finding for Section 106 of the National Historic Preservation Act in the Final EIS/OEIS was adjusted to “no historic properties affected” due to mitigation measured employed (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). In the unlikely event that the Navy impacts a submerged historic property, consultation will commence with the appropriate state historic preservation officer.

- Section 3.11 (Socioeconomic Resources):

  Changes were made to the account for updated information, including recently released data.

- Chapter 4 (Cumulative Impacts):

  Updates were made to the status of ongoing projects. In addition, updates were made to reflect changes made to other chapters in the EIS/OEIS.

- Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring):

  In response to public comment, modifications were made to the discussion of how activities recommence after a marine mammal or sea turtle sighting, and to the Effectiveness and Operational Assessment discussions. Also as a result of public comment, modifications were made to improve consistency across mitigation measures wherever possible. Section 5.5 (Mitigation Measures Considered but Eliminated) was restructured, supplemented with additional discussion, and migrated into Section 5.3 (Mitigation Assessment). Additional information was added to Section 5.3.1.1 (Specialized Training) about the U.S. Navy Afloat Environmental Compliance Training Series. Ship shock trial mitigation measures were revised to clarify the recommended mitigation measures. The Effectiveness Assessment for Lookout Procedural Measures was modified to provide a Study-Area specific detection probability table (Table 5.3-1), additional mitigation areas were recommended for manatees (Section 5.3.3.1.2, West Indian Manatee). Discussion of seafloor habitats was modified (Section 5.3.3.2, Seafloor Resources). Table 5.4-1 (Summary of Recommended Mitigation Measures) was updated to reflect the changes made within the chapter.

- Chapter 6 (Additional Regulatory Considerations):

  To address public comments received, wording was modified in some areas to reflect exact regulatory language for Marine Protected Areas. In addition, language was clarified for Marine Protected Areas to indicate which Navy activities were and were not allowed to occur in those areas.

- Chapter 8 (Public Involvement and Distribution):

  A section was added to identify who was notified of the comment period for the National Marine Fisheries Service Marine Mammal Protection Act Proposed Rule.

- Appendix A (Navy Activities Descriptions):

  Changes were made to reflect modifications made to Chapter 2 (Description of Proposed Action and Alternatives) and to correct errors.

- Appendix C (Agency Correspondence):

  Agency correspondence received since the public release of the Draft EIS/OEIS.

- Appendix D (Air Quality Example of Emissions Calculations and Example Record of Non-Applicability):

  The example emissions calculations and Record of Non-Applicability were modified based on changes in numbers of annual events in Chapter 2 (Description of Proposed Action and Alternatives).

- Appendix E (Public Comments and Responses):

  Information regarding the public meetings held in conjunction with the release of the Draft EIS/OEIS, public comments received on the Draft EIS/OEIS, pertinent comments received on the National Marine Fisheries Service Proposed Rule, and the Navy's responses to comments were added.

- Appendix F (Training and Testing Activities Matrices):

  Changes were made to reflect corrections made to Chapter 2 (Description of Proposed Action and Alternatives) and to correct errors.

- Appendix H (Impacts Due To Atlantic Fleet Training and Testing Activities at the Undersea Warfare Training Range):

  This appendix was created to facilitate public understanding of impacts from the subset of AFTT activities that would occur on the Undersea Warfare Training Range.

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COMMONLY USED ABBREVIATED TERMS

AFTT	Atlantic Fleet Training and Testing
DoD	Department of Defense
DEIS	draft environmental impact statement
EIS	environmental impact statement
ESA	Endangered Species Act
FEIS	final environmental impact statement
MMPA	Marine Mammal Protection Act
Navy	U.S. Department of the Navy
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
OEIS	overseas environmental impact statement
OPAREA	operating area
USEPA	U.S. Environmental Protection Agency

EXECUTIVE SUMMARY

ES.1 INTRODUCTION

The U.S. Department of the Navy (Navy) prepared this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to comply with the National Environmental Policy Act (NEPA) and Executive Order (EO) 12114. The Navy also prepared this EIS/OEIS to assess the potential environmental impacts associated with two categories of military readiness activities: training and testing. Collectively, the at-sea areas in this EIS/OEIS are referred to as the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area) (Figure ES-1).

Major conflicts, terrorism, lawlessness, and natural disasters all have the potential to threaten the national security of the United States (U.S.). National security, prosperity, and vital interests are increasingly tied to other nations because of the close relationships between the United States and other national economies. The Navy carries out training and testing activities to be able to protect the United States against its enemies, to protect and defend the rights of the United States and its allies to move freely on the oceans, and to provide humanitarian assistance to failed states. Training and testing activities that prepare the Navy to fulfill its mission to protect and defend the United States and its allies potentially impact the environment. These activities may trigger legal requirements identified in many U.S. federal environmental laws, regulations, and executive orders.

After thoroughly reviewing its environmental compliance requirements, the Navy instituted a policy in the year 2000 designed to comprehensively address these requirements. That policy—the Navy's At-Sea Policy—resulted, in part, in a series of comprehensive analyses of training and testing activities on U.S. at-sea range complexes and operating areas (OPAREA). These analyses served as the basis for the National Oceanic and Atmospheric Administration to issue Marine Mammal Protection Act (MMPA) incidental take authorizations because of the potential effects of some training and testing activities on species protected by federal law. The first of these analyses and incidental take authorizations resulted in a series of documents, completed in 2008 and 2009, for which incidental take authorizations begin to expire in early 2014. This EIS/OEIS updates these analyses and supports issuance of new incidental take authorizations. This EIS/OEIS also furthers compliance with the Navy's policy for comprehensive analysis by expanding the geographic scope to include additional areas where training and testing activities have historically occurred.

The AFTT Draft EIS/OEIS was released for public review and comment 25 May 2012 through 10 July 2012. Changes in this Final EIS/OEIS reflect all substantive comments made on the Draft EIS/OEIS during the public comment period and Navy refinements to the Proposed Action. The key changes between the AFTT Draft EIS/OEIS and Final EIS/OEIS can be found in the Foreword.

ES.2 PURPOSE OF AND NEED FOR PROPOSED MILITARY READINESS TRAINING AND TESTING ACTIVITIES

The purpose of the Proposed Action is to conduct training and testing activities to ensure that the Navy meets its mission, which is to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is achieved in part by conducting training and testing within the Study Area.

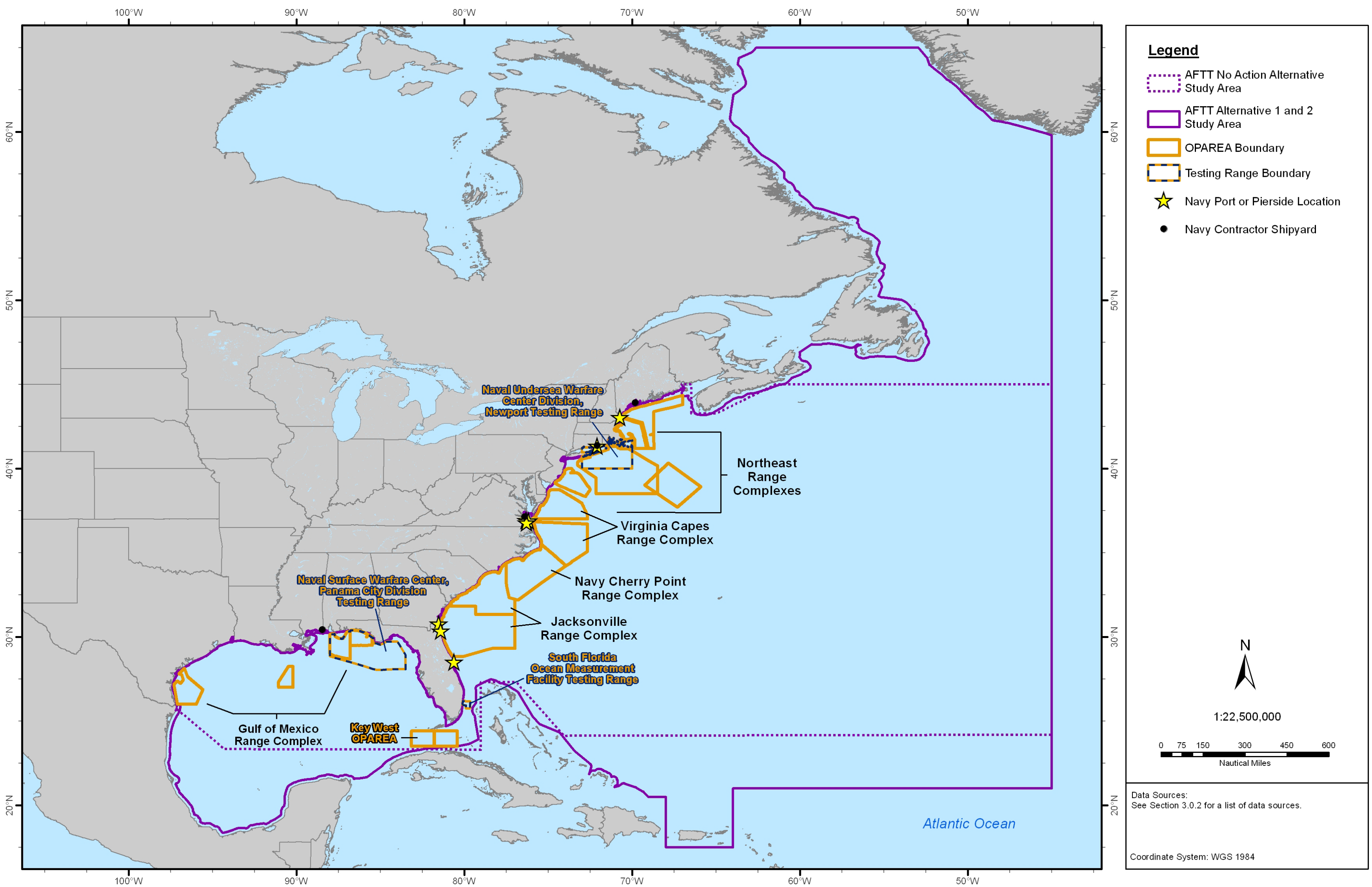

Figure ES-1: Atlantic Fleet Training and Testing Study Area

AFTT: Atlantic Fleet Training and Testing; OPAREA: operating area

ES.3 Scope and Content of the Environmental Impact Statement/Overseas Environmental Impact Statement

In this EIS/OEIS, the Navy assessed military readiness training and testing activities that could potentially impact human and natural resources, especially marine mammals, sea turtles, and other marine resources. The range of alternatives includes the No Action and other reasonable courses of action. In this EIS/OEIS, the Navy analyzed direct, indirect, cumulative, short-term, long-term, irreversible, and irretrievable impacts. The Navy is the lead agency for the Proposed Action and is responsible for the scope and content of this EIS/OEIS. The National Marine Fisheries Service (NMFS) is a cooperating agency because of its expertise and regulatory authority over marine resources. Additionally, this document will serve as NMFS' NEPA documentation for the rule-making process under the MMPA.

In accordance with the Council on Environmental Quality Regulations, 40 Code of Federal Regulations (C.F.R.) § 1505.2, the Navy will issue a Record of Decision that provides the rationale for choosing one of the alternatives. The decision will be based on factors analyzed in this EIS/OEIS, including military training and testing objectives, best available science and modeling data, potential environmental impacts, and public interest.

ES.3.1 National Environmental Policy Act

Federal agencies are required under NEPA to examine the environmental impacts of their proposed actions within the United States and its territories. An EIS is a detailed public document that provides an assessment of the potential effects that a major federal action might have on the human environment, which includes the natural environment. The Navy undertakes environmental planning for major Navy actions occurring throughout the world in accordance with applicable laws, regulations, and executive orders. Presidential Proclamation 5928, issued December 27, 1988, extended the exercise of U.S. sovereignty and jurisdiction under international law to 12 nautical miles (nm); however, the proclamation expressly provides that it does not extend or otherwise alter existing federal law or any associated jurisdiction, rights, legal interests, or obligations. Thus, as a matter of policy, the Navy analyzes environmental effects and actions within 12 nm under NEPA (an EIS).

ES.3.2 Executive Order 12114

This OEIS has been prepared in accordance with EO 12114 (44 Federal Register 1957) and Navy implementing regulations in 32 C.F.R. Part 187, *Environmental Effects Abroad of Major Federal Actions*. An OEIS is required because the proposed action and the alternatives have the potential to significantly harm the environment of the global commons. The global commons are defined as geographical areas outside the jurisdiction of any nation and include the oceans outside of the territorial limits (more than 12 nm from the coast) and Antarctica, but do not include contiguous zones and fisheries zones of foreign nations (32 C.F.R. § 187.3). This EIS and OEIS have been combined into one document, as permitted under NEPA and EO 12114, to reduce duplication.

ES.3.3 Marine Mammal Protection Act

The MMPA of 1972 (16 United States Code [U.S.C.] §§ 1361-1407) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals in the global commons (that is, the high seas) by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 U.S.C. § 1362(13)) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment: Level A (potential injury) and Level B (potential behavioral disturbance).

The MMPA directs the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if NMFS finds that the taking will have a negligible impact on the species or stock(s), and will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant). The authorization must set forth the permissible methods of taking, other means of attaining the least practicable adverse impact on the species or stock and its habitat, and requirements pertaining to the mitigation, monitoring, and reporting of such taking.

The National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of harassment and removed the "small numbers" provision as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government consistent with Section 104(c)(3) (16 U.S.C. § 1374(c)(3)). The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (Public Law 107-314). A "military readiness activity" is defined as "all training and operations of the Armed Forces that relate to combat" and "the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use." Since the Proposed Action involves conducting military readiness activities, the relevant definition of harassment is any act that

- injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment") or
- 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 ("Level B harassment") [16 U.S.C. § 1362(18)(B)(i) and (ii)].

ES.3.4 ENDANGERED SPECIES ACT

The Endangered Species Act (ESA) of 1973 (16 U.S.C. §§ 1531-1544) established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. An "endangered" species is a species in danger of extinction throughout all or a significant portion of its range. A "threatened" species is one that is likely to become endangered within the near future throughout all or in a significant portion of its range. The U.S. Fish and Wildlife Service and NMFS jointly administer the ESA and are also responsible for the listing of species (designating a species as either threatened or endangered). The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species. Section 7(a)(2) requires each federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a listed species, that agency is required to consult the Service (NMFS or U.S. Fish and Wildlife Service) which has jurisdiction over the species (50 C.F.R. § 402.14(a)). Under the terms of Section 7(b)(4) and Section 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the act provided that such taking complies with the terms and conditions of an Incidental Take Statement. The ESA applies to marine mammals, sea turtles, crocodiles, birds, marine invertebrates, fish, and plants evaluated in this EIS/OEIS.

ES.3.5 OTHER ENVIRONMENTAL REQUIREMENTS CONSIDERED

The Navy must comply with all applicable federal environmental laws, regulations, and executive orders, including, but not limited to, those listed below. Further information can be found in Chapter 3 (Affected Environment and Environmental Consequences) and Chapter 6 (Additional Regulatory Considerations).

- Abandoned Shipwreck Act
- Antiquities Act
- Clean Air Act
- Clean Water Act
- Coastal Zone Management Act
- Magnuson-Stevens Fishery Conservation and Management Act
- Migratory Bird Treaty Act
- National Historic Preservation Act
- National Marine Sanctuaries Act
- Rivers and Harbors Act
- EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*
- EO 12962, *Recreational Fisheries*
- EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*
- EO 13089, *Coral Reef Protection*
- EO 13158, *Marine Protected Areas*
- EO 13175, *Consultation and Coordination with Indian Tribal Governments*
- EO 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*

ES.4 PROPOSED ACTION AND ALTERNATIVES

The Navy's Proposed Action is to conduct training and testing activities—that may include the use of active sonar and explosives—primarily within existing range complexes and testing ranges in the western Atlantic Ocean off the east coast of the United States, in the Gulf of Mexico, and in portions of the Caribbean Sea. These activities will also occur at Navy pierside locations, Navy-contracted shipbuilder locations, port transit channels, and the lower Chesapeake Bay. Through this EIS/OEIS, the Navy will

- Reassess the environmental analysis of Navy at-sea training and testing activities contained in seven separate EISs/OEISs and various Environmental Assessments/Overseas Environmental Assessments and consolidate these analyses into a single environmental planning document. This reassessment will support reauthorization of incidental takes of marine mammals under the MMPA and incidental takes of threatened and endangered marine species through consultation under Section 7 of the ESA. The following seven EIS/OEIS documents are being consolidated:
  - Final Atlantic Fleet Active Sonar Training Environmental Impact Statement/Overseas Environmental Impact Statement (December 2008)
  - Virginia Capes Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (March 2009)
  - Navy Cherry Point Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement (April 2009)
  - Jacksonville Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (March 2009)

  - Final Environmental Impact Statement/Overseas Environmental Impact Statement, Naval Surface Warfare Center Panama City Division Mission Activities (September 2009)
  - Gulf of Mexico Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (December 2010)
  - Final Overseas Environmental Impact Statement/Environmental Impact Statement, Undersea Warfare Training Range (June 2009)

- Adjust baseline training and testing activities from current levels to the level needed to support Navy training and testing requirements beginning January 2014. As part of the adjustment, the Navy accounts for other activities and sound sources not addressed in the previous analyses.
- Analyze the potential environmental impacts of training and testing activities in additional areas (areas not covered in previous documents) where training and testing historically occurs, including Navy ports, naval shipyards, Navy-contractor shipyards, and the transit channels serving these areas.
- Update the at-sea environmental impact analyses for Navy activities in the previous documents to account for force structure changes, including those resulting from the development, testing, and use of weapons, platforms, and systems that will be operational by 2019.
- Implement enhanced range capabilities.
- Update environmental analyses with the best available science and most current acoustic analysis methods to evaluate the potential effects of training and testing activities on the marine environment.

ES.4.1 NO ACTION ALTERNATIVE

The No Action Alternative is required by regulations of the Council on Environmental Quality as a baseline against which the impacts of the Proposed Action are compared. The No Action Alternative continues baseline training and testing activities and force structure requirements as defined by existing Navy environmental planning documents.

The No Action Alternative represents the activities and events analyzed in previously completed documents. However, it would fail to meet the current purpose of and need for the Navy's Proposed Action because it would not allow the Navy to conduct the training and testing activities necessary to achieve and maintain fleet readiness. For example, the baseline activities do not account for changes in force structure requirements, the introduction of new weapons and platforms, and the training and testing required for proficiency with these systems.

ES.4.2 ALTERNATIVE 1

This alternative consists of the No Action Alternative plus the expansion of Study Area boundaries and adjustments to the locations and tempos of training and testing activities.

- **Adjustment of the Study Area:** This EIS/OEIS analyzes areas where Navy training and testing would continue as in the past, but which were not considered in previous environmental analyses. This alternative would not expand the area where the Navy trains and tests but would simply expand the area that is to be analyzed.
- **Adjustments to Locations and Tempo of Training and Testing Activities**: This alternative also includes changes to training and testing requirements necessary to accommodate (a) the relocation of ships, aircraft, and personnel, (b) planned aircraft, vessels, and weapons systems, and (c) ongoing activities not addressed in previous documentation.

- **Force Structure Changes:** Force structure changes involve the relocation of ships, aircraft, and personnel. As forces are moved within the existing Navy structure, training needs will necessarily change as the location of forces change.
- **Planned Aircraft, Vessels, and Weapons Systems:** This EIS/OEIS examines the training and testing requirements of planned vessels, aircraft, and weapons systems that the Navy would use in the Study Area.
- **Ongoing Activities:** Current training and testing activities that were not addressed in previous documentation are analyzed in this EIS/OEIS.

Alternative 1 reflects the adjustment to the baseline necessary to support current and proposed Navy at-sea training and testing activities through 2019.

ES.4.3 ALTERNATIVE 2 (PREFERRED ALTERNATIVE)

Alternative 2 consists of Alternative 1 plus the establishment of new range capabilities and modifications of existing capabilities, adjustments to types and tempos of training and testing, and the establishment of additional locations to conduct activities within the Study Area. This alternative is contingent upon potential budget increases, strategic necessity, and future training and testing requirements.

Alternative 2 includes the following training activities:

- Conduct additional surface-to-air, surface-to-surface, and anti-submarine warfare activities during post-delivery test and trial and during training events, which will be required to support an increased or accelerated delivery of surface ships and submarines.
- Increase air combat maneuver events in the Key West Range Complex.
- Introduce surface ships outfitted with kinetic energy weapon capability, and train with this new weapon system.
- Perform additional training with unmanned vehicles in support of mine warfare and of civilian port defense missions in commercial and civilian ports. Events would occur at various east coast and Gulf of Mexico locations.

Alternative 2 includes the following testing activities:

- New ship construction to include more sea trials for aircraft carriers, Joint High Speed Vessels, and amphibious assault ships; more Littoral Combat Ship Mission Package test events; and increased post-homeporting testing.
- Life cycle activities, including more ship signature test events.
- Naval Sea Systems Command Range activities, including more test events on each of the Naval Sea Systems Command's ranges and contingency for increased mine countermeasure testing at South Florida Ocean Measurement Facility Testing Range.
- Anti-surface warfare/anti-submarine warfare, including more events conducted as well as conducting kinetic energy weapon testing on vessels at sea.
- Mine warfare testing, including more events conducted.
- Shipboard protection systems and swimmer defense testing, including more events conducted and increased flexibility in conducting all chemical simulant testing in either location identified.

- Unmanned vehicle testing, including more events conducted and increased flexibility in conducting all underwater deployed unmanned aerial vehicle testing in either location identified.
- Other testing would include the introduction of the MQ-4C Triton Unmanned Aircraft Systems and their use during maritime patrol aircraft anti-submarine warfare testing events; more events conducted overall, with a 10 percent increase in the tempo of all proposed Naval Air Systems Command testing activities; and increased flexibility in conducting all at-sea explosive testing in either location identified.

ES.5 SUMMARY OF ENVIRONMENTAL EFFECTS

Environmental effects that might result from the implementation of the Navy's Proposed Action or alternatives have been analyzed in this EIS/OEIS. Resource areas analyzed include sediments and water quality, air quality, marine habitats, marine mammals, sea turtles and other marine reptiles, birds, marine vegetation, marine invertebrates, fish, cultural resources, socioeconomic resources, and public health and safety. The effects on these resources are summarized in Table ES-1. This table compares the potential environmental impacts of the No Action Alternative, Alternative 1, and Alternative 2 (Preferred Alternative).

ES.6 CUMULATIVE IMPACTS

The analyses presented in Chapters 3 (Affected Environment and Environmental Consequences) and 4 (Cumulative Impacts), indicate that the incremental contribution of the No Action Alternative, Alternative 1, or Alternative 2 to cumulative impacts on sediments and water quality, air quality, marine habitats, birds, marine vegetation, marine invertebrates, fish, cultural resources, socioeconomic resources, and public health and safety would be negligible. The No Action Alternative, Alternative 1, or Alternative 2 would also make an incremental contribution to greenhouse gas emissions, representing approximately 0.01, 0.02, and 0.02 percent of U.S. 2009 greenhouse gas emissions, respectively.

Marine mammals and sea turtles are the primary resources of concern for cumulative impacts analysis for the following reasons:

- Past human actions impacted these resources to the extent that several marine mammal species and all sea turtles species occurring in the Study Area are ESA-listed. Several marine mammal species have stocks that are classified as strategic stocks under the MMPA.
- These resources would be impacted by multiple ongoing and future actions.
- Explosive detonations and vessel strikes under the No Action Alternative, Alternative 1, and Alternative 2 have the potential to disturb, injure, or kill marine mammals and sea turtles.

The aggregate impacts of past, present, and other reasonably foreseeable future actions are expected to result in impacts on some species of marine mammals and all sea turtle species in the Study Area. The No Action Alternative, Alternative 1, or Alternative 2 would contribute to cumulative impacts, but the relative contribution would be low compared to other actions. Compared to potential mortality or injury resulting from Navy training and testing activities, marine mammal and sea turtle mortality and injury from bycatch, commercial vessel ship strikes, entanglement, ocean pollution, and other human causes are estimated to be orders of magnitude greater (hundreds of thousands of animals versus tens of animals).

Table ES-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2

Resource Category	Summary of Impacts
Sediments and Water Quality (3.1)	**No Action Alternative:** The Navy considered all potential stressors and determined that military expended materials containing the following have the potential to impact sediments and water quality: explosives and explosion byproducts, metals, chemicals other than explosives, and other materials. Impacts from explosion byproducts could be short-term and local; impacts from unconsumed explosives and metals could be long-term and local. In both situations, chemical, physical, or biological changes to sediments or water quality would be measurable but below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses. Impacts from chemicals other than explosives and from other materials could be both short- and long-term and local. Chemical, physical, or biological changes to sediments or water quality would not be detectable and would be below or within existing conditions or designated uses. **Alternative 1:** The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase, changes to sediments and water quality under Alternative 1 would still be considered localized and either short- or long-term depending on the explosive, explosive byproduct, metal, or chemical. Impacts under Alternative 1 would be below applicable standards, regulations, and guidelines and would be within existing conditions or designated uses. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase, changes to sediments and water quality under Alternative 2 would still be considered localized and either short- or long-term depending on the explosive, explosive byproduct, metal, or chemical. Impacts under Alternative 2 would be below applicable standards, regulations, and guidelines and would be within existing conditions or designated uses.
Air Quality (3.2)	**No Action Alternative:** Stressors analyzed include criteria air pollutants and hazardous air pollutants. The Proposed Action would result in minor local emissions of criteria air pollutants and hazardous air pollutants. These emissions would result in no change to attainment status of local air basins and would not cause an impact on public health. Even though these stressors co-occur in time and space, there would be sufficient dispersion so the impacts would be short term. Because changes in criteria pollutant emissions and hazardous air pollutant emissions are not expected to be detectable, air quality is expected to fully recover before experiencing a subsequent exposure. For those areas within the Study Area where the General Conformity Rule of the Clean Air Act applies, analyses showed that the low levels of emissions of all applicable criteria pollutants were *de minimis* and therefore no Conformity Determinations were required. **Alternative 1:** The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase in criteria air pollutants, changes to air quality under Alternative 1 would still be considered minor and localized; changes to air quality from hazardous air pollutants are not expected to be detectable. For those areas within the Study Area where the General Conformity Rule of the Clean Air Act applies, analyses showed that the low levels of emissions of all applicable criteria pollutants were *de minimis* and therefore no Conformity Determinations were required. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase in criteria air pollutants, changes to air quality under Alternative 2 would still be considered minor and localized; changes to air quality from hazardous air pollutants are not expected to be detectable. For those areas within the Study Area where the General Conformity Rule of the Clean Air Act applies, analyses showed that the low levels of emissions of all applicable criteria pollutants were *de minimis* and therefore no Conformity Determinations were required.

Table ES-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (Continued)

Resource Category	Summary of Impacts
Marine Habitats (3.3)	**No Action Alternative:** The Navy considered all potential stressors and analyzed the following for potential impacts on marine habitats as a non-living substrate for sedentary biological communities (marine vegetation and invertebrates): acoustic (explosives on or near the bottom only) and physical disturbance and strikes (military expended materials and seafloor devices). The activities could impact marine habitats by localized disturbance of the seafloor, cratering of soft bottom sediments, and structural damage to hard bottom habitats. Impacts on soft bottom habitats would be short term, and impacts on hard bottom would be long term. Activities under the No Action Alternative would not impact the ability of marine substrates to serve their function as habitat. Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of explosives on or near the bottom, military expended materials, and seafloor devices during training and testing activities may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of non-living substrates that constitute Essential Fish Habitat and Habitat Areas of Particular Concern. **Alternative 1**: The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase, changes to marine substrates could include localized disturbance of the seafloor, cratering of soft bottom sediments, and structural damage to hard bottom habitats. Impacts on soft bottom habitats would be short term, and impacts on hard bottom would be long term. Activities under Alternative 1 would not impact the ability of marine substrates to serve their function as habitat. Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of explosives on or near the bottom, military expended materials, and seafloor devices under Alternative 1 may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of non-living substrates that constitute Essential Fish Habitat and Habitat Areas of Particular Concern. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase, changes to marine substrates could include localized disturbance of the seafloor, cratering of soft bottom sediments, and structural damage to hard bottom habitats. Impacts on soft bottom habitats would be short term, and impacts on hard bottom would be long term. Activities under Alternative 2 would not impact the ability of marine substrates to serve their function as habitat. Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of explosives on or near the bottom, military expended materials, and seafloor devices under Alternative 2 may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of non-living substrates that constitute Essential Fish Habitat and Habitat Areas of Particular Concern.
Marine Mammals (3.4)	**No Action Alternative**: The Navy considered all potential stressors and analyzed the following: acoustic (sonar and other active acoustic sources; explosives; pile driving; swimmer defense airguns; weapons firing, launch, and impact noise; vessel noise; aircraft noise); energy (electromagnetic devices and high energy lasers); physical disturbance and strike (vessels in-water devices, military expended materials, seafloor devices); entanglement (fiber optic cables and guidance wires; parachutes); ingestion (munitions and military expended materials other than munitions); and secondary (explosives and byproducts, metals, chemicals, and transmission of disease and parasites).

MMPA: Marine Mammal Protection Act

Table ES-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (Continued)

Resource Category	Summary of Impacts
	Acoustic: Pursuant to the MMPA, the use of sonar and other active acoustic sources may result Level A or Level B harassment of certain marine mammals; the use of explosives may result in mortality, Level A or Level B harassment of certain marine mammals; pile driving is not expected to result in mortality but may result in Level A or Level B harassment of bottlenose dolphins; the use of swimmer defense airguns, weapons firing, vessel noise, and aircraft noise are not expected to result in mortality, Level A or Level B harassment of any marine mammals. Pursuant to the ESA, sonar and other active acoustic sources and explosives may affect and are likely to adversely affect certain ESA-listed marine mammals; pile driving, swimmer defense airguns, weapons firing, vessel noise, and aircraft noise may affect but are not likely to adversely affect certain ESA-listed marine mammals; and all acoustic sources will have no effect on marine mammal critical habitats. Energy: Pursuant to the MMPA, the use of electromagnetic devices and high energy lasers is not expected to result in mortality, Level A or B harassment of any marine mammals. Pursuant to the ESA, the use of electromagnetic devices may affect but are not likely to adversely affect certain ESA-listed marine mammals and will have no effect on marine mammal critical habitats. Pursuant to the ESA, the use of high energy lasers will have no effect on any ESA-listed marine mammal and will have no effect on marine mammal critical habitats. Physical Disturbance and Strike: Pursuant to the MMPA, the use of vessels may result in mortality or Level A harassment of certain marine mammal species but is not expected to result in Level B harassment of any marine mammal. The use of in-water devices, military expended materials, and seafloor devices are not expected to result in mortality, Level A or B harassment of any marine mammal. Pursuant to the ESA, vessel use may affect and is likely to adversely affect certain ESA-listed species. The use of in-water devices and military expended materials may affect but is not likely to adversely affect certain marine mammal species. The use of seafloor devices will have no effect on any ESA-listed marine mammal. The use of vessels, in-water devices, military expended materials, and seafloor devices will have no effect on marine mammal critical habitats. Entanglement: Pursuant to the MMPA, the use of fiber optic cables, guidance wires, and parachutes is not expected to result in mortality, Level A or B harassment of any marine mammal. Pursuant to the ESA, the use of fiber optic cables, guidance wires, and parachutes may affect but is not likely to adversely affect certain ESA-listed marine mammals. Ingestion: Pursuant to the MMPA, the potential for ingestion of all military expended materials is not expected to result in mortality, Level A or B harassment of any marine mammal. Pursuant to the ESA, the potential for ingestion of all military expended materials may affect but is not likely to adversely affect certain ESA-listed species. Secondary: Pursuant to the MMPA, secondary stressors are not expected to result in mortality, Level A or B harassment of any marine mammal. Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect certain ESA-listed marine mammals and will have no effect on marine mammal critical habitats. The use of sonar and active acoustic sources are not expected to result in mortality, although the potential for beaked whale mortality coincident with use of sonar and other active acoustic sources is considered. The Navy has requested 10 beaked whale mortality takes under the MMPA as part of all training activities combined to account for any unforeseen potential impacts. **Alternative 1**: The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on marine mammals under Alternative 1 are still not expected to decrease the overall fitness of any marine mammal population. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on marine mammals under Alternative 2 are still not expected to decrease the overall fitness of any marine mammal population.

ESA: Endangered Species Act; MMPA: Marine Mammal Protection Act

Table ES-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (Continued)

Resource Category	Summary of Impacts
Sea Turtles and Other Marine Reptiles (3.5)	**No Action Alternative**: The Navy considered all potential stressors and the following have been analyzed: acoustic (sonar and other active acoustic sources, explosives, pile driving, swimmer defense airguns, weapons firing launch, and impact noise, and aircraft and vessel noise); energy (electromagnetic devices, high energy lasers); physical disturbance and strikes (vessels, in-water devices, military expended materials, seafloor devices); entanglement (fiber optic cables, guidance wires, and parachutes); and ingestion (munitions and military expended materials other than munitions); and secondary (explosives and byproducts, metals, and chemicals). All five sea turtle species in the Study Area are ESA-listed species. Acoustics: Pursuant to the ESA, the use of sonar, other active sources, and explosives may affect and is likely to adversely affect ESA-listed sea turtles; and may affect but is not likely to adversely affect the American crocodile or American alligator. Pile driving, swimmer defense airguns and weapons firing noise may affect but are not likely to adversely ESA-listed sea turtles; and will have no effect on the American crocodile or American alligator. Aircraft and vessel noise may affect but is not likely to adversely affect ESA-listed sea turtles, the American crocodile, or the American alligator. Acoustic stressors will have no effect on critical habitat for any ESA-listed marine reptiles. Energy: Pursuant to the ESA, the use of electromagnetic devices may affect but is not likely to adversely affect ESA-listed sea turtles; and will have no effect on the American crocodile or American alligator. The use of high energy lasers will have no effect on any ESA-listed sea turtle species, the American alligator, or the American crocodile. The use of electromagnetic devices and high energy lasers will have no effect on critical habitat for any ESA-listed marine reptile. Physical Disturbance and Strikes: Pursuant to the ESA, vessel use may affect and is likely to adversely affect ESA-listed sea turtles. The use of in-water devices and military expended materials may affect but is not likely to adversely affect ESA-listed sea turtles. The use of vessels, in-water devices, and military expended materials will have no effect on the American crocodile or American alligator. The use of vessels, in-water devices, and military expended materials will have no effect on critical habitat for any ESA-listed marine reptiles. Entanglement: Pursuant to the ESA, the use of fiber optic cables, guidance wires, and parachutes may affect but is not likely to adversely affect ESA-listed sea turtles; and will have no effect on the American crocodile or American alligator. Ingestion: Pursuant to the ESA, the use of munitions with the potential for ingestion may affect but is not likely to adversely affect ESA-listed green, hawksbill, Kemp's ridley, and loggerhead sea turtles; and will have no effect on the leatherback sea turtle, American crocodile, or American alligator. The potential for ingestion of military expended materials other than munitions may affect but is not likely to adversely affect ESA-listed sea turtles; and will have no effect on the American crocodile or American alligator. Secondary: Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect ESA-listed sea turtles, the American crocodile, or the American alligator and will have no effect on critical habitat for any ESA-listed marine reptile. **Alternative 1**: The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on sea turtles under Alternative 1 are still not expected to decrease the overall fitness of any sea turtle, American crocodile, or American alligator population. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on sea turtles under Alternative 2 are still not expected to decrease the overall fitness of any sea turtle, American crocodile, or American alligator population.

ESA: Endangered Species Act;

Table ES-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (Continued)

Resource Category	Summary of Impacts
Birds (3.6)	**No Action Alternative:** The Navy considered all potential stressors and analyzed the following: acoustic (sonar and other active acoustic sources; explosives and swimmer defense airguns; pile driving; weapons firing, launch, and impact noise; aircraft and vessel noise); energy (electromagnetic devices, high energy lasers); physical disturbance and strikes (aircraft and aerial targets, vessels and in-water devices, military expended materials); ingestion (military expended materials); and Secondary (general emissions). Acoustic: Pursuant to the ESA, the use of sonar and other active acoustic sources may affect but is not likely to adversely affect ESA-listed roseate terns and will have no effect on ESA-listed piping plover (and its critical habitat), ESA-candidate red knot, or ESA-listed Bermuda petrel. The use of explosives, swimmer defense airguns, aircraft, and vessels may affect but is not likely to adversely affect ESA-listed or ESA-candidate bird species, and will have no effect on piping plover critical habitat. Pile driving may affect but is not likely to adversely affect ESA-listed piping plover and roseate terns, and will have no effect on the ESA-candidate red knot, the ESA-listed Bermuda petrel, or piping plover critical habitat. Weapons firing, launch, and impact noise may affect but is not likely to adversely affect ESA-listed Bermuda petrel or roseate terns, the ESA-candidate red knot, and will have no effect on piping plover (and its critical habitat). Energy: Pursuant to the ESA, the use of electromagnetic devices during training and testing activities may affect but is not likely to adversely affect ESA-listed piping plover (and its critical habitat), Bermuda petrel, roseate tern, or ESA-candidate red knot. The use of high energy lasers during training and testing activities will have no effect on ESA-listed piping plover (and its critical habitat), Bermuda petrel, roseate tern, or ESA-candidate red knot. Physical Disturbance and Strikes: Pursuant to the ESA, the use of aircraft and aerial targets, vessels and in-water devices, and military expended materials may affect but is not likely to adversely affect ESA-listed piping plover, Bermuda petrel, roseate tern, or ESA-candidate red knot, and will have no effect on piping plover critical habitat. Ingestion: Pursuant to the ESA, the potential for ingestion of military expended materials used during training and testing activities may affect but is not likely to adversely affect ESA-listed Bermuda petrel or roseate tern and will have no effect on the ESA-listed piping plover or the ESA-candidate red knot. Secondary: Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect ESA-listed or ESA-candidate bird species and will have no effect on critical habitat. **Alternative 1**: The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on birds under Alternative 1 are still not expected to decrease the overall fitness of any bird population. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on birds under Alternative 2 are still not expected to decrease the overall fitness of any bird population.

ESA: Endangered Species Act;

Table ES-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (Continued)

Resource Category	Summary of Impacts
Marine Vegetation (3.7)	**No Action Alternative**: The Navy considered all potential stressors and analyzed the following: acoustic (explosives); physical disturbance and strike (vessels, in-water devices, military expended materials, and seafloor devices); and secondary stressors (sediment and water quality). Acoustics: Pursuant to the ESA, the use of explosives will have no effect on ESA-listed Johnson's seagrass or its critical habitat. Physical Disturbance and Strikes: Pursuant to the ESA, the use of vessels, in-water devices, military expended materials, and seafloor devices will have no effect on ESA-listed Johnson's seagrass or its critical habitat. Secondary: Pursuant to the ESA, secondary stressors will have no effect on ESA-listed Johnson's seagrass or its critical habitat. Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, electromagnetic devices and contaminant stressors associated with training and testing activities will have no adverse impact on marine vegetation that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. Explosives and other impulsive sources, vessel movement, in-water devices, military expended materials, and seafloor devices associated with training and testing activities may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of marine vegetation that constitutes Essential Fish Habitat or Habitat Areas of Particular Concern. **Alternative 1**: The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts from acoustic stressors and physical disturbance are not expected to result in detectable changes to marine vegetation growth, survival, or propagation and are not expected to result in population-level impacts. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts from acoustic stressors and physical disturbance are not expected to result in detectable changes to marine vegetation growth, survival, or propagation and are not expected to result in population-level impacts.
Marine Invertebrates (3.8)	**No Action Alternative**: The Navy considered all potential stressors and analyzed the following: acoustic (sonar and other non-impulsive acoustic sources, explosives, and other impulsive acoustic sources); energy (electromagnetic devices and high energy lasers); physical disturbance and strikes (vessels and in-water devices, military expended materials, and seafloor devices); entanglement (fiber optic cables, guidance wires, and parachutes); ingestion (military expended materials); and secondary (explosives and byproducts, metals, chemicals, and other materials). Acoustics: Pursuant to the ESA, the use of all non-impulsive and impulsive acoustic sources will have no effect on ESA-listed or proposed coral species. The use of all non-impulsive and impulsive acoustic sources will have no effect on elkhorn and staghorn critical habitat. Energy: Pursuant to the ESA, the use of electromagnetic devices and high energy lasers will have no effect on ESA-listed or proposed coral species. The use of electromagnetic devices and high energy lasers will have no effect on critical habitat.

ESA: Endangered Species Act

Table ES-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (Continued)

Resource Category	Summary of Impacts
	Physical Disturbance and Strikes: Pursuant to the ESA, the use of vessels and in-water devices will have no effect on ESA-listed or proposed coral species. The use of military expended materials and seafloor devices may affect but is not likely to adversely affect ESA-listed or proposed coral species. The use of vessels, in-water devices, and seafloor devices would have no effect on critical habitat. The use of military expended materials may affect but is not likely to adversely affect critical habitat. Entanglement: Pursuant to the ESA, the use of fiber optic cables, guidance wires, and parachutes will have no effect on ESA-listed or proposed coral species. Ingestion: Pursuant to the ESA, the potential for ingestion of military expended materials will have no effect on ESA-listed or proposed coral species. Secondary: Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect ESA-listed or proposed coral species and may affect but are not likely to adversely affect critical habitat. Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of sonar and other acoustic sources, vessel noise, swimmer defense airguns, weapons firing noise, electromagnetic sources, high energy lasers, vessel movement, in-water devices, and metal, chemical, or other material contaminants will have no adverse effect on sedentary invertebrate beds or reefs that constitute Essential Fish Habitat or Habitat Areas of Particular Concern. The use of electromagnetic sources will have minimal and temporary adverse impact to invertebrates occupying water column Essential Fish Habitat or Habitat Areas of Particular Concern. The use of explosives, pile driving, military expended materials, seafloor devices, and explosives and explosion byproduct contaminants may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of sedentary invertebrate beds or reefs that constitute Essential Fish Habitat or Habitat Areas of Particular Concern. **Alternative 1**: The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on marine invertebrates under Alternative 1 are not anticipated to result in population-level impacts. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on marine invertebrates under Alternative 2 are not anticipated to result in population-level impacts.
Fish (3.9)	**No Action Alternative:** The Navy considered all potential stressors and the following were analyzed: acoustic (sonar and other non-impulsive acoustic sources, explosives, and other impulsive acoustic sources); energy (electromagnetic devices, high energy lasers); physical disturbance and strikes (vessels and in-water devices, military expended materials, and seafloor devices); entanglement (fiber optic cables and guidance wires, parachutes); ingestion (munitions and military expended materials other than munitions); and secondary (explosives and explosion byproducts, metals, chemicals, and other materials).

ESA: Endangered Species Act

Table ES-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (Continued)

Resource Category	Summary of Impacts
	Acoustic: Pursuant to the ESA, the use of sonar and other non-impulsive acoustic sources may affect but is not likely to adversely affect ESA-listed fish species; will have no effect on Atlantic salmon or smalltooth sawfish critical habitat; and may affect but is not likely to adversely affect Gulf sturgeon critical habitat. Pursuant to the ESA, the use of explosives and other impulsive acoustic sources may affect and is likely to adversely affect ESA-listed Atlantic sturgeon, Gulf sturgeon, and smalltooth sawfish;; may affect but is not likely to adversely affect the Atlantic salmon, largetooth sawfish, and shortnose sturgeon; will have no effect on Atlantic salmon or smalltooth sawfish critical habitat; and may affect but is not likely to adversely affect Gulf sturgeon critical habitat. Energy: Pursuant to the ESA, the use of electromagnetic devices during training and testing activities may affect but is not likely to adversely affect ESA-listed largetooth sawfish, smalltooth sawfish, shortnose sturgeon, Gulf sturgeon, and Atlantic sturgeon; will have no effect on Atlantic salmon; will have no effect on Atlantic salmon or smalltooth sawfish critical habitat; and may affect but is not likely to adversely affect Gulf sturgeon critical habitat. Pursuant to the ESA, the use of high energy lasers will have no effect on ESA-listed fish species; and will have no effect on Atlantic salmon, smalltooth sawfish, or Gulf sturgeon critical habitat. Physical Disturbance and Strikes: Pursuant to the ESA, the use of vessels, in-water devices, military expended materials, and seafloor devices may affect but is not likely to adversely affect ESA-listed fish species; may affect but is not likely to adversely affect Gulf sturgeon critical habitat; and will have no effect on Atlantic salmon and smalltooth sawfish critical habitat. Entanglement: Pursuant to the ESA, the use of fiber optic cables, guidance wires, and parachutes may affect but is not likely to adversely affect ESA-listed fish species. Ingestion: Pursuant to the ESA, the potential for ingestion of military expended materials may affect but is not likely to adversely affect ESA-listed fish species. Secondary Stressors: Pursuant to the ESA, secondary stressors may affect but are not likely to adversely affect ESA-listed fish species and will have no effect on Atlantic salmon, smalltooth sawfish, and Gulf sturgeon critical habitat. Pursuant to the Essential Fish Habitat requirements, the use of sonar and other active acoustic sources (Atlantic herring only), explosives, pile driving, and electromagnetic devices may have a minimal and temporary adverse effect on the fishes that occupy water column Essential Fish Habitat. **Alternative 1**: The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on fish under Alternative 1 are not expected to decrease the overall fitness of any fish population. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase, impacts on fish under Alternative 2 are not expected to decrease the overall fitness of any fish population.

ESA: Endangered Species Act

Table ES-1: Summary of Environmental Impacts for the No Action Alternative, Alternative 1, and Alternative 2 (Continued)

Resource Category	Summary of Impacts
Cultural Resources (3.10)	**No Action Alternative:** The Navy considered all potential stressors and the following have been analyzed: acoustic (underwater explosions, sonic booms, and cratering from underwater detonations) and physical disturbance and strike (use of seafloor devices and deposition of military expended materials). Acoustic and physical disturbance and strike stressors would not affect submerged prehistoric sites and submerged historic resources in accordance with Section 106 of the National Historic Preservation Act because measures were previously implemented to protect these resources. **Alternative 1:** The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase in activities under Alternative 1, acoustic and physical disturbance and strike stressors would not affect submerged prehistoric sites and submerged historic resources in accordance with Section 106 of the National Historic Preservation Act because measures were previously implemented to protect these resources. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase in activities under Alternative 2, acoustic and physical disturbance and strike stressors would not affect submerged prehistoric sites and submerged historic resources in accordance with Section 106 of the National Historic Preservation Act because measures were previously implemented to protect these resources.
Socioeconomic Resources (3.11)	**No Action Alternative:** The Navy considered all potential stressors and the following have been analyzed: accessibility (availability of access on the ocean and in the air); airborne acoustics (weapons firing, aircraft, and vessel noise); physical disturbance and strikes (aircraft, vessels and in-water devices, military expended materials); and secondary impacts from availability of resources. Impacts would be short term and temporary. Therefore, impacts on socioeconomic resources would be negligible. **Alternative 1:** The number of individual impacts may increase under Alternative 1, but the types of impacts would be the same as the No Action Alternative. Despite the increase in activity under Alternative 1, impacts to socioeconomic resources would still be considered short term and temporary. Therefore, impacts on socioeconomic resources would be negligible. **Alternative 2 (Preferred Alternative)**: The number of individual impacts may increase under Alternative 2, but the types of impacts would be the same as the No Action Alternative. Despite the increase in activity under Alternative 2, impacts to socioeconomic resources would still be considered short term and temporary. Therefore, impacts on socioeconomic resources would be negligible.
Public Health and Safety (3.12)	**No Action Alternative**: The Navy considered all potential stressors and the following have been analyzed: underwater energy; in-air energy; physical interactions; and indirect impacts from sediment and water quality changes. Because of the Navy's standard operating procedures, impacts on public health and safety would be unlikely. **Alternative 1:** Despite the increase in activities under Alternative 1, Navy safety procedures would continue to prevent proposed activities being co-located with public activities. Because of the Navy's safety procedures, the potential for activities to impact public health and safety under Alternative 1 would be unlikely. **Alternative 2 (Preferred Alternative)**: Despite the increase in activities under Alternative 2, Navy safety procedures would continue to prevent proposed activities being co-located with public activities. Because of the Navy's safety procedures, the potential for activities to impact public health and safety under Alternative 2 would be unlikely.

ES.7 STANDARD OPERATING PROCEDURES, MITIGATION, AND MONITORING

Within the Study Area, the Navy implements standard operating procedures, mitigation, and monitoring efforts during the Proposed Action. Navy standard operating procedures have the indirect benefit of reducing potential impacts on marine resources. Mitigation measures are designed to help reduce or avoid potential impacts on marine resources. Marine species monitoring efforts are designed to track compliance with take authorizations, evaluate the effectiveness of mitigation measures, and improve understanding of the impacts of training and testing activities on marine resources.

ES.7.1 STANDARD OPERATING PROCEDURES

The Navy currently employs standard practices to provide for the safety of personnel and equipment, including vessels and aircraft, as well as the success of the training and testing activities. In many cases there are incidental environmental, socioeconomic, and cultural benefits resulting from standard operating procedures. Standard operating procedures serve the primary purpose of providing for safety and mission success, and are implemented regardless of their secondary benefits. This is what distinguishes standard operating procedures, which are a component of the Proposed Action, from mitigation measures, which are designed entirely for the purpose of reducing environmental impacts resulting from the Proposed Action. Because of their importance for maintaining safety and mission success, standard operating procedures have been considered as part of the Proposed Action under each alternative, and therefore are included in the Chapter 3 (Affected Environment and Environmental Consequences) environmental analyses for each resource.

ES.7.2 MITIGATION

The Navy recognizes that the Proposed Action has the potential to impact the environment. Unlike standard operating procedures, which are established for reasons other than environmental benefit, mitigation measures are modifications to the Proposed Action that are implemented for the sole purpose of reducing a specific potential environmental impact on a particular resource. The Navy undertook two assessment steps for each recommended mitigation measure (Step 1 is an effectiveness assessment and Step 2 is an operational assessment). Table ES-2 summarizes the Navy’s recommended mitigation measures with currently implemented mitigation measures for each activity category also summarized in the table. These measures have been coordinated with NMFS and the U.S. Fish and Wildlife Service through the consultation and permitting processes. The Record of Decision for this EIS/OEIS will address any additional mitigation measures that may result from ongoing regulatory processes.

ES.7.3 MITIGATION MEASURES CONSIDERED BUT ELIMINATED

A number of mitigation measures were suggested during the public comment periods for this EIS/OEIS or previous Navy environmental documents. As a result of the assessment process, the Navy determined that some of the suggested measures would likely be ineffective at reducing environmental impacts, have an unacceptable operational impact based on the operational assessment, or would be incompatible with Section 5.2.2, Overview of Mitigation Approach.

ES.7.4 MONITORING

The Navy is committed to demonstrating environmental stewardship while executing its National Defense Mission and complying with the suite of federal environmental laws and regulations. As a complement to the Navy’s commitment to avoiding and reducing impacts of the Proposed Action through mitigation, the Navy will undertake monitoring efforts to track compliance with take authorizations, help evaluate the effectiveness of implemented mitigation measures, and gain a better understanding of the impacts of the Proposed Action on marine resources. Taken together, mitigation and monitoring comprise the Navy's integrated approach for reducing environmental impacts from the Proposed Action. The Navy's overall monitoring approach will seek to leverage and build on existing research efforts whenever possible.

Consistent with the cooperating agency agreement with NMFS, mitigation and monitoring measures presented in this Final EIS/OEIS focus on the requirements for protection and management of marine resources. Discussions with resource agencies during the consultation and permitting processes may result in changes to the mitigation as described in this document. Such changes will be reflected in the Record of Decision and consultation documents such as the ESA Biological Opinion.

The Integrated Comprehensive Monitoring Program is intended to coordinate monitoring efforts across all regions where the Navy trains and to allocate the most appropriate level and type of effort for each range complex. The current Navy monitoring program is composed of a collection of "range-specific" monitoring plans, each of which was developed individually as part of MMPA and ESA compliance processes as environmental documentation was completed. These individual plans establish specific monitoring requirements for each range complex or testing range and are collectively intended to address the Integrated Comprehensive Monitoring Program top-level goals. A Scientific Advisory Group of leading marine mammal scientists developed recommendations that would serve as the basis for a Strategic Plan for Navy monitoring. The Strategic Plan is intended to be a primary component of the Integrated Comprehensive Monitoring Program and provide a "vision" for Navy monitoring across geographic regions—serving as guidance for determining how to most efficiently and effectively invest the marine species monitoring resources to address Integrated Comprehensive Monitoring Program top-level goals and satisfy MMPA regulatory requirements. The objective of the Strategic Plan is to continue the evolution of Navy marine species monitoring towards a single integrated program, incorporating Scientific Advisory Group recommendations, and establishing a more transparent framework for soliciting, evaluation, and implementing monitoring work across the Fleet range complexes.

Table ES-2: Summary of Recommended Mitigation Measures

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Specialized Training	Lookouts will complete the Introduction to the U.S. Navy Afloat Environmental Compliance Training Series and the U.S. Navy Marine Species Awareness Training or civilian equivalent.	The mitigation zones observed by Lookouts are specified for each Mitigation Zone Procedural Measure below.	The mitigation zones observed by Lookouts are specified for each Mitigation Zone Procedural Measure below.
Low-Frequency and Hull-Mounted Mid-Frequency Active Sonar during Anti-Submarine Warfare and Mine Warfare	2 Lookouts (general) 1 Lookout (minimally manned, moored, or anchored)	Sources that can be powered down: 1,000 yd. (914 m) and 500 yd. (457 m) power downs and 200 yd. (183 m) shutdown for marine mammals (hull-mounted mid-frequency and low-frequency) and sea turtles (low-frequency only). Sources that cannot be powered down: 200 yd. (183 m) shutdown for marine mammals and sea turtles. Both: observation for concentrations of floating vegetation (*Sargassum* or kelp paddies).	Hull-mounted mid-frequency: 1,000 yd. (914 m) and 500 yd. (457 m) power downs and 200 yd. (183 m) shutdown for marine mammals and sea turtles; avoidance of *Sargassum* rafts. Low-frequency: None
High-Frequency and Non-Hull Mounted Mid-Frequency Active Sonar	1 Lookout	200 yd. (183 m) for marine mammals (high-frequency and mid-frequency), sea turtles (bins MF8, MF9, MF10, and MF12 only), and concentrations of floating vegetation (*Sargassum* or kelp paddies).	Non-hull mounted mid-frequency: 200 yd. (183 m) for marine mammals, floating vegetation, and kelp paddies. High-frequency: None
Improved Extended Echo Ranging Sonobuoys	1 Lookout	600 yd. (549 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Passive acoustic monitoring conducted with Navy assets participating in the activity.	1,000 yd. (914 m) for marine mammals and sea turtles; 400 yd. (366 m) for floating vegetation and kelp paddies. Passive acoustic monitoring conducted with Navy assets participating in the activity.
Explosive Sonobuoys Using 0.6–2.5 Pound NEW	1 Lookout	350 yd. (320 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Passive acoustic monitoring conducted with Navy assets participating in the activity.	None
Anti-Swimmer Grenades	1 Lookout	200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies).	200 yd. (183 m) for marine mammals, sea turtles, floating vegetation, and kelp paddies.

m: meter; NEW: net explosive weight; yd.: yard

Table ES-2: Summary of Recommended Mitigation Measures (Continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Mine Countermeasure and Neutralization Activities Using Positive Control Firing Devices	General: 1 or 2 Lookouts (NEW dependent) Diver-placed: 2 Lookouts Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, artificial reefs, shipwrecks, and live hard bottom.	Both: NEW dependent for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 350 yd. (320 m) from surveyed shallow coral reefs, live hard bottom, artificial reefs, and shipwrecks. Both: 1 nm from beach in the VACAPES Range Complex and 3,000 ft. (914 m) around Fisherman Island for birds. Diver-placed: 3.2 nm from an estuarine inlet and 1.6 nm from shoreline within the Navy Cherry Point Range Complex for sea turtles.	General: NEW dependent for marine mammals and sea turtles. Diver-placed: 700 yd. (640 m) for up to 20 lb. NEW for marine mammals and turtles. Both: 1,000 ft. (305 m) from surveyed live hard bottom, artificial reefs, and shipwrecks. Both: 1 nm from beach and 3,000 ft. (914 m) around Fisherman Island in the VACAPES Range Complex for birds. Diver-placed: 3.2 nm from estuarine inlet and 1.6 nm from shoreline in VACAPES, Navy Cherry Point, and JAX Range Complexes for sea turtles.
Mine Neutralization Activities Using Diver-Placed Time-Delay Firing Devices	4 Lookouts Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, artificial reefs, shipwrecks, and live hard bottom.	Up to 10 min. time-delay using up to 20 lb. NEW: 1,000 yd. (915 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs, live hard bottom, artificial reefs, and shipwrecks. 1 nm from beach in the VACAPES Range Complex and 3,000 ft. (914 m) around Fisherman Island for birds. 3.2 nm from an estuarine inlet and 1.6 nm from shoreline within the Navy Cherry Point Range Complex for sea turtles.	10 min. time-day on 20 lb. NEW: 1,450 yd. (1.3 km) for marine mammals and sea turtles.

ft.: feet; JAX: Jacksonville; km: kilometer; lb.: pound; m: meter; min.: minute; NEW: net explosive weight; nm: nautical mile; yd.: yard; VACAPES: Virginia Capes

Table ES-2: Summary of Recommended Mitigation Measures (Continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Explosive and Non-Explosive Gunnery Exercises – Small- and Medium-Caliber Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	200 yd. (183 m) for marine mammals, sea turtles, floating vegetation, and surveyed shallow coral reefs.
Explosive and Non-Explosive Gunnery Exercises – Large-Caliber Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	Explosive: 600 yd. (549 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Non-Explosive: 200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 70 yd. (64 m) within 30 degrees on either side of the gun target line on the firing side for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 350 yd. (320 m) for surveyed shallow coral reefs.	Explosive: 600 yd. (549 m) for marine mammals, sea turtles, floating vegetation, and surveyed shallow coral reefs. Non-Explosive: 200 yd. (183 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 70 yd. (64 m) around entire ship for marine mammals and sea turtles.
Non-Explosive Missile Exercises and Explosive Missile Exercises (Including Rockets) up to 250 Pound NEW Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	900 yd. (823 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	1,800 yd. (1.6 km) for marine mammals, sea turtles, floating vegetation, and kelp paddies.
Explosive Missile Exercises Using 251–500 Pound NEW Using a Surface Target	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	2,000 yd. (1.8 km) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	None

km: kilometer; lb.: pound; m: meter; NEW: net explosive weight; yd.: yard

Table ES-2: Summary of Recommended Mitigation Measures (Continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Explosive and Non-Explosive Bombing Exercises	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	Explosive: 2,500 yd. (2.3 km) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Non-Explosive: 1,000 yd. (914 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). Both: 350 yd. (320 m) for surveyed shallow coral reefs.	Explosive: 5,100 yd. (4.7 km) for marine mammals, sea turtles, and floating vegetation. Non-Explosive: 1,000 yd. (914 m) for marine mammals, sea turtles, floating vegetation, and kelp paddies.
Torpedo (Explosive) Testing	1 Lookout	2,100 yd. (1.9 km) for marine mammals, sea turtles, concentrations of floating vegetation (*Sargassum* or kelp paddies), and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.	5,063 yd. (4.6 km) for marine mammals, sea turtles, floating vegetation, and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.
Sinking Exercises	2 Lookouts	2.5 nm for marine mammals, sea turtles, concentrations of floating vegetation (*Sargassum* or kelp paddies), and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.	4.5 nm for marine mammals and sea turtles. 2.5 nm for floating vegetation and jellyfish aggregations. Passive acoustic monitoring conducted with Navy assets participating in the activity.
At-Sea Explosive Testing	1 Lookout Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs.	1,600 yd. (1.4 km) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies). 350 yd. (320 m) for surveyed shallow coral reefs.	None
Ordnance Testing – Line Charge Testing	1 Lookout	900 yd. (823 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies).	880 yd. (805 m) for marine mammals and sea turtles. 0.5 mi. (0.8 km) for Gulf sturgeon.

km: kilometer; lb.: pound; m: meter; mi: mile; nm: nautical mile; yd.: yard

Table ES-2: Summary of Recommended Mitigation Measures (Continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Ship Shock Trials	At least 10 Lookouts or trained marine species observers (or combination)	10,000 lb. and 40,000 lb. charge: 3.5 nm for all locations for marine mammals, sea turtles, concentrations of floating vegetation (*Sargassum* or kelp paddies), jellyfish aggregations, large schools of fish, and flocks of seabirds.	10,000 lb. charge: 3 nm/3.5 nm for VACAPES / JAX for marine mammals, sea turtles, floating vegetation, jellyfish aggregations, large schools of fish, and flocks of seabirds. 40,000 lb. charge: None.
Elevated Causeway System – Pile Driving	1 Lookout	60 yd. (55 m) for marine mammals, sea turtles, and concentrations of floating vegetation (*Sargassum* or kelp paddies).	None
Vessel Movements	1 Lookout	500 yd. (457 m) for whales. 200 yd. (183 m) for all other marine mammals (except bow riding dolphins).	500 yd. (457 m) for whales. 200 yd. (183 m) for all other marine mammals (except bow riding dolphins).
Towed In-Water Device Use	1 Lookout	250 yd. (229 m) for marine mammals.	250 yd. (229 m) for marine mammals.
Precision Anchoring	No Lookouts in addition to standard personnel standing watch Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, artificial reefs, shipwrecks, and live hard bottom	Avoidance of precision anchoring within the anchor swing diameter of surveyed shallow coral reefs, live hard bottom, artificial reefs, and shipwrecks.	Avoidance of precision anchoring within the anchor watch circle diameter of surveyed shallow coral reefs, live hard bottom, artificial reefs, and shipwrecks.
North Atlantic Right Whale Calving Habitat off the Southeast United States	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Avoidance or minimization of conduct of specific activities seasonally. Use Early Warning System sightings data.	Avoidance or minimization of conduct of specific activities seasonally. Use Early Warning System sightings data.

JAX: Jacksonville; km: kilometer; lb.: pound; m: meter; nm: nautical mile; VACAPES: Virginia Capes; yd.: yard

Table ES-2: Summary of Recommended Mitigation Measures (Continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
North Atlantic Right Whale Foraging Habitat off the Northeast	3 Lookouts during torpedo (non-explosive) testing activities All other activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Avoidance or minimization of conduct of specific activities seasonally. Use Sighting Advisory System sightings data. Specific measures for torpedo (non-explosive) testing activities year-round.	Avoidance or minimization of conduct of specific activities seasonally. Use Sighting Advisory System sightings data. Conduct torpedo (non-explosive) testing activities in five designated areas seasonally. Submit written requests prior to conducting hull-mounted surface and submarine active sonar training or helicopter dipping in the mitigation area.
North Atlantic Right Whale Mid-Atlantic Migration Corridor	1 Lookout	Practice increased vigilance, exercise extreme caution, and proceed at the slowest speed that is consistent with safety, mission, and training and testing objectives.	Practice increased vigilance, exercise extreme caution, and proceed at the slowest speed that is consistent with safety, mission, and training and testing objectives.
West Indian Manatee Habitat	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Mayport, Florida: Comply with all federal, state, and local Manatee Protection Zones; sightings communication. Port Canaveral, Florida: Pierside sonar observations and sightings communication. Kings Bay, Georgia: Pierside sonar observations and sightings communication. Camp Lejeune, North Carolina: Pile driving observations and sightings log.	Mayport, Florida: Comply with all federal, state, and local Manatee Protection Zones; sightings communication. Port Canaveral, Florida: Pierside sonar observations and sightings communication. Kings Bay, Georgia: Pierside sonar observations and sightings communication. Camp Lejeune, North Carolina: None
Planning Awareness Areas	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Limit planning major active sonar exercises.	Limit planning major active sonar exercises.

Table ES-2: Summary of Recommended Mitigation Measures (Continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Shallow Coral Reefs, Hard bottom Habitat, Artificial Reefs, and Shipwrecks	No Lookouts in addition to standard personnel standing watch Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs, artificial reefs, shipwrecks, and live hard bottom	No precision anchoring within the anchor swing diameter and no explosive mine countermeasure and neutralization activities within 350 yd. (320 m) of surveyed shallow coral reefs, live hard bottom, artificial reefs, and shipwrecks. No explosive or non-explosive small-, medium-, and large-caliber gunnery exercises using a surface target; explosive or non-explosive missile exercises using a surface target; explosive or non-explosive bombing exercises; or at-sea explosive testing within 350 yd. (320 m) of surveyed shallow coral reefs.	Varying mitigation zone distances based on marine mammal ranges to effects.
Live Hard bottom and Shallow Coral Reefs within South Florida Ocean Measurement Facility	No Lookouts in addition to standard personnel standing watch Protective Measures Assessment Protocol will contain maps of surveyed shallow coral reefs and live hard bottom	Anchors and Mine-like Objects: Installation of anchors and mine-like objects are conducted using real-time GIS and GPS, along with groundtruth and verification support, which will help the Navy avoid sensitive marine species and communities during deployment, installation, and recovery. Bottom Crawling Unmanned Underwater Vehicles: If deployment occurs greater than 9.8 ft. (3 m) in depth, it will be conducted using real-time GIS and GPS, along with groundtruth and verification support, which will help the Navy avoid sensitive marine species and communities.	Anchors and Mine-like Objects: Installation of anchors and mine-like objects are conducted using real-time GIS and GPS, along with groundtruth and verification support, which will help the Navy avoid sensitive marine species and communities during deployment, installation, and recovery. Bottom Crawling Unmanned Underwater Vehicles: None

ft.: feet; GIS: Geographic Information System; GPS: Global Positioning System; m: meter; yd.: yard

Table ES-2: Summary of Recommended Mitigation Measures (Continued)

Activity Category or Mitigation Area	Recommended Lookout Procedural Measure	Recommended Mitigation Zone and Protection Focus	Current Measure and Protection Focus
Sea Turtle Nesting Habitat	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	Naval Surface Warfare Center, Panama City Division: Sea turtle nesting season is defined as from March through September; Avoidance of ordnance testing – line charge testing activities during the night during nesting season. Navy Cherry Point Range Complex: Positive control and time-delay diver-placed mine neutralization and countermeasure activities remain 3.2 nm from estuarine inlets and 1.6 nm from shoreline from March through September.	Naval Surface Warfare Center, Panama City Division: Sea turtle nesting season is defined as from May through September; Avoidance of electromagnetic mine countermeasure and neutralization activities within 32 yd. (30 m) of shore during nesting season; Avoidance of ordnance testing – line charge testing activities (day and night) during nesting season. VACAPES, Navy Cherry Point, and JAX Range Complexes: Positive control diver-placed mine neutralization and countermeasure activities remain 3.2 nm from estuarine inlets and 1.6 nm from shoreline.
Piping Plover Habitat in Virginia	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	1 nm from beach in VACAPES Range Complex and 3,000 ft. (914 m) around Fisherman Island during positive control and time-delay diver-placed mine neutralization and countermeasure activities.	1 nm from beach in VACAPES Range Complex and 3,000 ft. (914 m) around Fisherman Island during positive control diver-placed mine neutralization and countermeasure activities.
Gulf Sturgeon Habitat in the Gulf of Mexico	Activity-specific measures described in the Lookout Procedural Measures and Mitigation Zone Procedural Measures	No ordnance testing – line charge testing activities will occur within nearshore Gulf of Mexico waters in Escambia, Santa Rosa, Okaloosa, Walton, Bay, and Gulf counties in Florida from the shoreline to 1 mi. (1.6 km) offshore between October and March (except within the designated line charge testing location on Santa Rosa Island).	No ordnance testing – line charge testing activities will occur within nearshore Gulf of Mexico waters in Escambia, Santa Rosa, Okaloosa, Walton, Bay, and Gulf counties in Florida from the shoreline to 1 mi. (1.6 km) offshore between October and March.

ft.: feet; JAX: Jacksonville; km: kilometer; m: meter; mi.: mile; nm: nautical mile; VACAPES: Virginia Capes; yd.: yard

ES.7.5 Reporting

The Navy is committed to documenting and reporting relevant aspects of training and testing activities in order to document species sightings, reduce environmental impact, and improve future environmental assessments. Initiatives include exercise and monitoring reporting, stranding response plan, bird strikes, and manatee reporting.

ES.8 Other Considerations

ES.8.1 Consistency with Other Federal, State, Regional, and Local Plans, Policies, and Regulations

Based on an evaluation of consistency with statutory obligations, the Navy's proposed training and testing activities would not conflict with the objectives or requirements of federal, state, regional or local plans, policies, or legal requirements. The Navy consulted with regulatory agencies as appropriate during the NEPA process and before implementing the Proposed Action to ensure that all legal requirements are met.

In accordance with the Coastal Zone Management Act, the Navy reviewed the enforceable policies of each state and territory's federally-approved Coastal Zone Management Plan relevant to the Study Area. There are 18 states (Alabama, Connecticut, Delaware, Florida, Georgia, Louisiana, Maine, Maryland, Massachusetts, Mississippi, New Hampshire, New Jersey, New York, North Carolina, Rhode Island, South Carolina, Texas, and Virginia) and two U.S. territories (Puerto Rico and U.S. Virgin Islands) whose coastal zones could be affected by the Proposed Action. Based on an evaluation of the effects of the Proposed Action discussed in this EIS/OEIS and the enforceable policies of each state and territory's Coastal Zone Management Plan, and pursuant to 15 C.F.R. § 930.39, the Navy prepared consistency determinations for the affected states and territories.

Many areas of the marine environment have some level of federal, state, or local management or protection. Marine protected areas vary widely in purpose, managing agencies, management approaches, level of protection, and restrictions on human uses. The levels of protection provided by these marine protected areas range from fully protected reserves (i.e., no take of any species is permitted) to sites allowing multiple uses, including fishing, recreation, and industrial uses (National Marine Protected Areas Center 2008). EO 13158, *Marine Protected Areas*, requires each federal agency whose actions affect the natural or cultural resources protected by a marine protected area to identify such actions, and in taking such actions, avoid harm to those natural and cultural resources to the maximum extent practicable. All resources of the marine protected areas located within the Study Area have been incorporated into the analyses in Chapter 3 (Affected Environment and Environmental Consequences). In accordance with EO 13158, the Navy has considered the potential impacts of its proposed activities on the national system of marine protected areas that contain marine waters within the Study Area. Management policies specific to military activities have been reviewed as well as any area-specific prohibitions.

ES.8.2 Relationship Between Short-Term Use of Man's Environment and Maintenance and Enhancement of Long-Term Productivity

In accordance with NEPA, this EIS/OEIS analyzes 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. The Proposed Action could result in both short- and long-term environmental impacts. However, these are not expected to result in any impacts that would reduce environmental productivity, permanently narrow the range of beneficial uses of the environment, or pose long-term risks to health, safety, or general welfare of the public.

ES.8.3 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENT OF RESOURCES

For the Proposed Action, most resource commitments would be neither irreversible nor irretrievable. Most impacts would be short term and temporary, or long lasting but within historical or desired conditions. Because there would be no building or facility construction, the consumption of material typically associated with such construction (e.g., concrete, metal, sand, fuel) would not occur. Energy typically associated with construction activities would not be expended and irretrievably lost.

Implementation of the Proposed Action would require fuels used by aircraft and vessels. Since fixed- and rotary-wing aircraft and ship activities would increase relative to the baseline, total fuel use would increase. Therefore, total fuel consumption would increase under the Proposed Action, and this nonrenewable resource would be considered irretrievably lost.

ES.8.4 ENERGY REQUIREMENTS AND CONSERVATION POTENTIAL OF ALTERNATIVES AND MITIGATION MEASURES

Resources that will be permanently and continually consumed by project implementation include water, electricity, natural gas, and fossil fuels; however, the amount and rate of consumption of these resources would not result in significant environmental impacts or the unnecessary, inefficient, or wasteful use of resources. Prevention of the introduction of potential contaminants is an important component of mitigation of the alternatives’ adverse impacts. To the extent practicable, considerations to prevent the introduction of potential contaminants are included.

Sustainable range management practices are in place that protect and conserve natural and cultural resources and preserve access to training areas for current and future training requirements while addressing potential encroachments that threaten to impact range and training area capabilities.

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1 PURPOSE AND NEED

1.1 INTRODUCTION

Major conflicts, terrorism, lawlessness, and natural disasters all have the potential to threaten national security of the United States (U.S.). National security, prosperity, and vital interests of the United States are increasingly tied to other nations because of the close relationships between the United States and other national economies. The U.S. Department of the Navy (Navy) carries out training and testing activities to be able to protect the United States against its enemies, to protect and defend the rights of the United States and its allies to move freely on the oceans, and to provide humanitarian assistance to failed states. The Navy operates on the world's oceans, seas, and coastal areas—the international maritime domain—on which 90 percent of the world's trade and two-thirds of its oil are transported. The majority of the world's population also lives within a few hundred miles of an ocean.

The U.S. Congress, after World War II, established the National Command Authorities to identify defense needs based on the existing and emergent situations in the United States and overseas that must be dealt with now or may be dealt with in the future. The National Command Authorities, which are composed of the President and the Secretary of Defense, divide defense responsibilities among services. The heads (secretaries) of each service ensure that military personnel are trained, prepared, and equipped to meet those operational requirements.

Training and testing activities that prepare the Navy to fulfill its mission to protect and defend the United States and its allies potentially impact the environment. These activities may trigger legal requirements identified in many U.S. federal environmental laws, regulations, and executive orders.

Training. Navy personnel first undergo entry-level (or schoolhouse) training, which varies according to their assigned warfare community (aviation, surface warfare, submarine warfare, and special warfare) and the community's unique requirements. Personnel then train within their warfare community at sea in preparation for deployment; each warfare community has primary mission areas (areas of specialized expertise that involve multiple warfare communities) that overlap one another, described in detail in Chapter 2 (Description of Proposed Action and Alternatives). The Marine Corps similarly trains to support its core capabilities.

Testing. The Navy researches, develops, tests, and evaluates new platforms[1], systems, and technologies. Many tests are conducted in realistic conditions at sea and can range in scale from testing new software, to operating manned portable devices, to conducting ship shock trials. Testing activities may occur independently of or in conjunction with training activities.

The Navy prepared this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) to comply with the National Environmental Policy Act (NEPA) and Executive Order (EO) 12114. The Navy also prepared this EIS/OEIS to assess the potential environmental impacts associated with the two categories of military readiness activities mentioned above: training and testing. Collectively, the at-sea areas in this EIS/OEIS are referred to as the Atlantic Fleet Training and Testing (AFTT) Study Area (Figure 1.1-1). The land areas and land activities associated with the range complexes and operating areas (OPAREAs) within the AFTT Study Area (Study Area) were covered in previous environmental documents and are not part of the analysis in this EIS/OEIS.

[1] Throughout this EIS/OEIS, ships and aircraft may be referred to as "platforms"; weapons, combat systems, sensors, and related equipment may be referred to as "systems."

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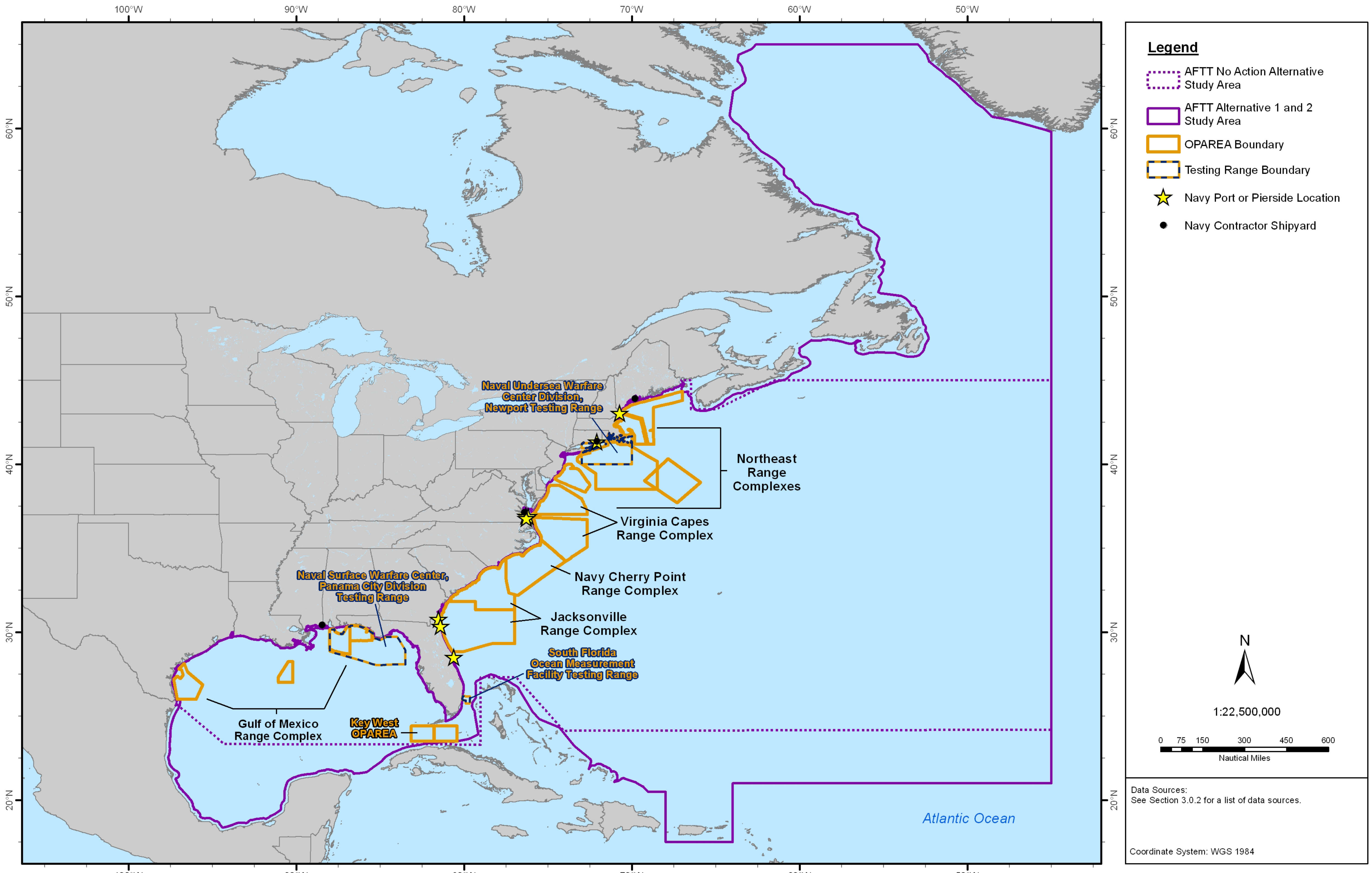

Figure 1.1-1: Atlantic Fleet Training and Testing Study Area

AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

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1.2 THE NAVY'S ENVIRONMENTAL COMPLIANCE AND AT-SEA POLICY

In 2000, the Navy completed a thorough review of its environmental compliance requirements for training at sea and instituted a policy designed to comprehensively address them. The policy, known as the At-Sea Policy, directed, in part, that the Navy develop a programmatic approach to environmental compliance for exercises and training at sea for ranges and OPAREAs within its areas of responsibility (U.S. Department of the Navy 2000). Ranges affected by the At-Sea Policy are designated water areas that are managed and used to conduct training or testing activities. OPAREAs affected by the policy are those ocean areas, defined by specific geographic coordinates, used by the Navy to undertake training and testing activities. To meet the requirements of the policy, the Navy developed an updated Concept of Operations for Phase II Environmental Planning and Compliance for Navy Military Readiness and Scientific Research Activities At Sea in September of 2010. The concept of operations laid out a plan to achieve comprehensive environmental planning and compliance for Navy training and testing activities at sea.

Phase I of the planning program. The first phase of the planning program was accomplished by preparation and completion of individual or separate environmental documents for each range complex and OPAREA. The Navy prepared NEPA/EO 12114 documents for range complexes and OPAREAs on the east coast and in the Gulf of Mexico to analyze training and testing activities. Many of these range complexes and OPAREAs predate World War II and have remained in continuous use by naval forces. The previous NEPA/EO 12114 documents cataloged training and testing activities, analyzed potential environmental impacts, and supported permits and other requirements under applicable environmental laws, regulations, and executive orders. As an example, Marine Mammal Protection Act (MMPA) incidental take authorizations (also known as Letters of Authorization), issued by the National Marine Fisheries Service (NMFS), were obtained for range complexes on the east coast and in the Gulf of Mexico and will expire in early 2014[2].

Phase II of the planning program. The second phase of the planning program will cover activities previously analyzed in Phase I NEPA/EO 12114 documents and also analyze additional geographic areas including, but not limited to, pierside locations and transit routes. This EIS/OEIS is part of the second phase of environmental planning documents needed to support the Navy's request to obtain an incidental take authorization from NMFS. The Navy reevaluated impacts from historically conducted activities and updated the training and testing activities based on changing operational requirements, including those associated with new platforms and systems. The Navy will use this new analysis to support incidental take authorizations under the MMPA.

The Study Area combines the geographic scope of the range complexes on the east coast and in the Gulf of Mexico, as well as study areas covered in NEPA documents for other OPAREAs on the east coast, and analyzes ongoing, routine at-sea activities that occur during transit between these range complexes and OPAREAs. The Navy expanded the geographic scope of this EIS/OEIS to include additional areas where training and testing activities historically occur; this EIS/OEIS also includes new platforms and weapon systems not addressed in previous NEPA/EO 12114 documents.

[2] The Navy did not reanalyze the land portions of these range complexes in this EIS/OEIS because the Incidental Take Statements and Biological Opinions of nonjeopardy for those land portions will not be altered by the Proposed Action.

1.3 PROPOSED ACTION

The Navy's Proposed Action, described in detail in Chapter 2 (Description of Proposed Action and Alternatives), is to conduct training and testing activities—which may include the use of active sound navigation and ranging (sonar) and explosives—in the western Atlantic Ocean off the east coast of the United States, in the Gulf of Mexico, and portions of the Caribbean Sea. These activities will also occur at Navy pierside locations, Navy-contracted shipbuilder locations, port transit channels, and the lower Chesapeake Bay (see Figure 1.1-1 and Section 2.1 [Description of the Atlantic Fleet Training and Testing Study Area] for more detail on the geographic areas analyzed with regard to the Proposed Action). The Proposed Action also includes activities such as sonar maintenance and gunnery exercises conducted concurrently with ship transits and which may occur outside Navy range complexes and testing ranges. The Proposed Action includes pierside sonar testing conducted as part of overhaul, modernization, maintenance, and repair activities at shipyards and Navy piers.

1.4 PURPOSE OF AND NEED FOR PROPOSED MILITARY READINESS TRAINING AND TESTING ACTIVITIES

The purpose of the Proposed Action is to conduct training and testing activities to ensure that the Navy meets its mission, which is to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is achieved in part by conducting training and testing within the Study Area.

The following sections are an overview of the need for military readiness training and testing activities.

> Title 10 Section 5062 of the U.S. Code provides: "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."

1.4.1 WHY THE NAVY TRAINS

Naval forces must be ready for a variety of military operations—from large-scale conflict to maritime security and humanitarian assistance/disaster relief—to deal with the dynamic, social, political, economic, and environmental issues that occur in today's world. The Navy supports these military operations through its continuous presence on the world's oceans: the Navy can respond to a wide range of issues because, on any given day, over one-third of its ships, submarines, and aircraft are deployed overseas. Naval forces must be prepared for a broad range of capabilities—from full-scale armed conflict in a variety of different geographic areas[3] to disaster relief efforts[4]—before deployment on the world's oceans. To learn these capabilities, personnel must train with the equipment and systems that will achieve military objectives. The training process provides personnel with an in-depth understanding of their individual limits and capabilities; the training process also helps the testing community improve new weapon systems.

Modern weapons bring both unprecedented opportunity and innumerable challenges to the Navy. For example, modern (or smart) weapons are very accurate and help the Navy accomplish its mission with

[3] Operation Iraqi Freedom in Iraq and Operation Enduring Freedom in Afghanistan; maritime security operations, including anti-piracy efforts like those in Southeast Asia and the Horn of Africa.

[4] Evacuation of noncombatants from American embassies under hostile conditions, as well as humanitarian assistance/disaster relief like the tsunami responses in 2005 and 2011 and Haiti's earthquake in 2009.

greater precision and far less collateral damage than in past conflicts; however, modern weapons are very complex to use. Military personnel must train regularly with these weapons to understand the capabilities, limitations, and operations of the platform or system. Modern military actions require teamwork among hundreds or thousands of people and the use of various equipment, vehicles, ships, and aircraft to achieve success.

Military readiness training and preparation for deployment include everything from teaching basic and specialized individual military skills to intermediate skills or small unit training. As personnel increase in skill level and complete the basic training, they advance to intermediate and larger exercise training events, which culminate in advanced, integrated training events composed of large groups of personnel and, in some instances, joint service exercises[5].

Military readiness training must be as realistic as possible to provide the experiences so important to success and survival. While simulators and synthetic training are critical elements of training—to provide early skill repetition and enhance teamwork—there is no substitute for live training in a realistic environment. The range complexes, test ranges, and OPAREAs have these realistic environments, with sufficient sea and airspace vital for safety and mission success. Just as a pilot would not be ready to fly solo after simulator training, a Navy commander cannot allow military personnel to engage in real combat activities based merely on simulator training.

1.4.2 FLEET READINESS TRAINING PLAN

The Navy developed the Fleet Response Plan to ensure the constant readiness of naval forces. This plan maintains, staffs, and trains naval forces to deploy for missions. The Fleet Response Plan increases the number of personnel and vessels that can be deployed on short notice. For example, the Navy completed an unscheduled deployment of an additional aircraft carrier to the Middle East in January 2007 because of adherence to the Fleet Response Plan. Observance of the Fleet Response Plan also allows the Navy to respond to global events more robustly while maintaining a structured process that ensures continuous availability of trained, ready Navy forces.

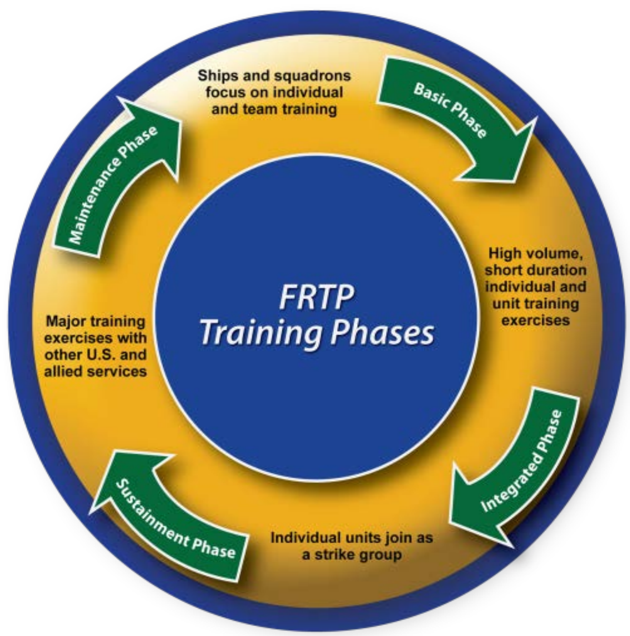

Figure 1.4-1: Fleet Readiness Training Plan

The Fleet Readiness Training Plan implements the requirements in the Fleet Response Plan. The Fleet Readiness Training Plan outlines the training activities required for military readiness that prepares Navy personnel for any conflict or operation. The Navy's building-block approach to training is cyclical and qualifies its personnel to perform their assigned missions. Training activities proceed in four phases: basic, integrated, sustainment, and maintenance, as depicted in Figure 1.4-1.

[5] Large group exercises may include carrier strike groups and expeditionary strike groups. Joint exercises may be with other U.S. services and other nations.

1.4.2.1 Basic Phase

The basic phase consists of training exercises performed by individual ships and aircraft; it is characterized mostly as unit level training. Fundamental combat skills are learned and practiced during this phase. Operating area and range support requirements for unit level training are of relatively modest size compared to large-scale, major exercises. Training exercises with two or more units (ships or aircraft, or both), known as coordinated unit level training exercises, are also included in the basic phase. These training exercises further refine the basic, fundamental skills while increasing difficulty through coordination with other units.

Access to local range complexes and OPAREAs near the locations where Sailors and Marines are stationed reduces the amount of travel time and training costs.

1.4.2.2 Integrated Phase

The integrated phase combines the units involved in the basic, coordinated unit-level training into strike groups. Strike groups are composed of multiple ships and aircraft. Strike group skills and proficiencies are developed and evaluated through major exercises. The integrated phase concludes when the strike group is certified for deployment, meaning that the strike group demonstrated the skills and proficiencies across the entire spectrum of warfare that may be needed during deployment.

Major exercises in this phase require access to large, relatively unrestricted ocean OPAREAs, multiple targets, and unique range attributes (oceanographic features, proximity to naval bases, and land-based targets).

1.4.2.3 Sustainment Phase

The strike group needs continued training activities to maintain its skills after certification for deployment in the integrated phase; these continued training activities fall within the sustainment phase. Sustainment phase activities provide strike groups additional training, as well as the ability to evaluate new and developing technologies and to evaluate and develop new tactics.

Similar to the integrated phase, sustainment exercises require access to large, relatively unrestricted ocean OPAREAs and their unique range attributes to support the scenarios.

1.4.2.4 Maintenance Phase

Naval forces enter the maintenance phase after returning from deployment. Maintenance may involve relatively minor repair or major overhaul, depending on the system and its age. The maintenance phase also includes testing a ship's systems; these tests may take place pierside or at sea. Naval forces reenter the basic phase upon completion of the maintenance phase.

1.4.3 WHY THE NAVY TESTS

The Navy's research and acquisition community conducts military readiness activities that involve testing. The Navy tests ships, aircraft, weapons, combat systems, sensors, and related equipment, and it conducts scientific research activities to achieve and maintain military readiness. The fleet identifies military readiness requirements to support its mission; the Navy's research and acquisition community, including the Navy's systems commands and associated scientific research organizations, provides Navy personnel with ships, aircraft, weapons, combat systems, sensors, and related equipment. The Navy's research and acquisition community is responsible for researching, developing, testing, evaluating, acquiring, and delivering modern platforms and systems to the fleet—and supporting the systems throughout their life. The Navy's research and acquisition community is responsible for furnishing high-quality platforms, systems, and support matched to the requirements and priorities of the fleet, while providing the necessary high return on investment to the American taxpayer.

The Navy's research and acquisition community includes the following:

- The Naval Air Systems Command, which develops, acquires, delivers, and sustains aircraft and systems with proven capability and reliability to ensure that Sailors achieve mission success.
- The Naval Sea Systems Command, which develops, acquires, delivers, and maintains surface ships, submarines, and weapon system platforms that provide the right capability to Sailors.
- The Space and Naval Warfare Systems Command, which provides Sailors with knowledge superiority by developing, delivering, and maintaining effective, capable, and integrated command, control, communications, computer, intelligence, and surveillance systems.
- The Office of Naval Research, which plans, fosters, and encourages scientific research that promotes future naval seapower and enhances national security.
- The Naval Research Laboratory, which conducts a broad program of scientific research, technology, and advanced development to meet the complex technological challenges of today's world.

The Navy's research and acquisition community, in cooperation with private companies, designs, tests and builds components, systems, and platforms to address requirements identified by the fleets. Private companies are contracted to assist the Navy in acquiring the platform, system, or upgrade. The Navy's research and acquisition community must test and evaluate the platform, system, or upgrade to validate whether it performs as expected and to determine whether it is operationally effective, suitable, survivable, and safe for its intended use by the fleet.

Testing performed by the Navy's research and acquisition community can be categorized as scientific research testing, private contractor testing, developmental testing and operational testing (including lot acceptance testing), fleet training support, follow-on test and evaluation, or maintenance and repair testing. Fleet training events often offer the most suitable environment for testing a system because such training is designed to accurately replicate operational conditions. System tests, therefore, are often embedded in training events such that it would be difficult for an observer to differentiate the two activities.

- **Scientific research testing.** Navy testing organizations conduct scientific research to evaluate emerging threats or technology enhancement before developing a new system. As an example, testing might occur on a current weapon system to determine if a newly developed technology would improve system accuracy or enhance safety to personnel.
- **Private contractor testing.** Contractors are often required to conduct performance and specification tests before delivering a system or platform to the Navy. These tests may be conducted on a Navy range, in a Navy OPAREA, or seaward of ranges and OPAREAs; these tests are sometimes done in conjunction with fleet training activities.
- **Developmental testing.** A series of tests are conducted by specialized Navy units to evaluate a platform or system's performance characteristics and to ensure that it meets all required specifications.
- **Operational testing**. Operations are conducted with the platform or system as it would be used by the fleet.

- **Fleet training support.** Systems still under development may be integrated on ships or aircraft for testing. If training has not been developed for use of a particular system, the Navy's systems commands may support the fleet by providing training on the operation, maintenance, and repair of the system during developmental testing activities.
- **Follow-on test and evaluation.** A follow-on test and evaluation phase occurs when a platform receives a new system, after a significant upgrade to an existing system, or when the system failed to meet contractual performance specifications during previous testing. Tests similar to those conducted during the developmental testing or operational testing phase are conducted again, as needed, to ensure that the modified or new system meets performance requirements and does not conflict with existing platform systems and subsystems.
- **Maintenance and repair testing.** Following periodic maintenance, overhaul, modernization, or repair of systems, testing of the systems may be required to assess performance. These testing activities may be conducted at shipyards or Navy piers.

Preparatory checks of a platform or system-to-be-tested are often made prior to actual testing to ensure the platform or system is operating properly. This preparatory check is similar to checking the wipers and brakes on a car before taking a trip. These checks are done to ensure everything is operating properly before expending the often-considerable resources involved in conducting a full-scale test. For example, the MH-60 helicopter program often conducts a functional check of its dipping sonar system in a nearshore area before conducting a more rigorous test of the sonar system farther offshore. Pierside platform and systems checks are conducted during Navy repair and construction activities and are essential to ensure safe operation of the platform or system at sea.

The Navy uses a number of different testing methods, including computer simulation and analysis, throughout the development of platforms and systems. Although simulation is a key component in the development of platforms and systems, it cannot provide information on how a platform or system will perform or whether it will be able to meet performance and other specification requirements in the environment in which it is intended to operate without comparison to actual performance data. For this reason, platforms and systems must undergo at-sea testing at some point in the development process. Thus, like the fleet, the research and acquisition community requires access to large, relatively unrestricted ocean operating areas, multiple strike targets, and unique range attributes to support its testing requirements. Navy platforms and systems must be tested and evaluated within the broadest range of operating conditions available (e.g., bathymetry, topography, geography) because Navy personnel must be capable of performing missions within the wide range of conditions that exist worldwide. Furthermore, Navy personnel must be assured that platforms and systems will meet performance specifications in the real-world environment in which they will be operated.

1.5 Overview and Strategic Importance of Existing Range Complexes and Testing Ranges

The Navy historically uses areas along the eastern coast of the United States and in the Gulf of Mexico for training and testing. These areas were designated by the Navy into geographic regions, and named "range complexes" (Figure 1.1-1). A range complex is a set of adjacent areas of sea space, undersea space, land ranges, and overlying airspace delineated for military training and testing activities. Range complexes provide controlled and safe environments where military ship, submarine, and aircraft crews can train in realistic conditions. The combination of undersea ranges and operating areas with land training ranges, safety landing fields, and nearshore amphibious landing sites is critical to realistic training, which allows electronics on the range to capture data on the effectiveness of tactics and equipment—data that provide a feedback mechanism for training evaluation.

In previous decades, the Navy developed facilities in the Study Area to provide support for at-sea testing of platforms and systems. These existing facilities support specific Navy testing requirements. Fleet assets support testing activities on test ranges, while systems commands frequently conduct tests on fleet range complexes and use fleet assets to support the testing. Range complexes must provide flexibility to meet these diverse training and testing requirements given the wide range of warfare specialties and range of skills and proficiencies the fleets must demonstrate before certification for deployment.

The range complexes and testing ranges analyzed in this EIS/OEIS have each existed for many decades, some dating back to the 1940s. Range use and infrastructure have developed over time as training and testing requirements in support of modern warfare have evolved. The Navy has not proposed and is not proposing to create new range complexes or operating areas. Further, only activities historically conducted or similar to those historically conducted within the at-sea portions of the current range complexes are proposed and therefore analyzed within this EIS/OEIS. Land-based activities were analyzed in prior EISs/OEISs and, therefore, are not re-addressed within this document. Thus, for example, activities conducted at Rodman Range in the Jacksonville Range Complex are not included in this EIS/OEIS.

Proximity of the AFTT range complexes to naval homeports is strategically important to the Navy because close access allows for efficient execution of training activities and non-training maintenance functions and access to alternate airfields when necessary. The proximity of training to homeports also ensures that Sailors and Marines do not have to routinely travel far from their families. For example, the Norfolk and Jacksonville areas are home to thousands of military families. The Navy is required to track and, where possible, limit the amount of time Sailors and Marines spend deployed from home. Less time away from home is an important factor in military readiness, morale, and retention. The proximate availability of the AFTT range complexes is critical to Navy efforts in these areas.

Northeast Range Complexes: The Northeast Range Complexes are the Boston Range Complex, Narragansett Bay Range Complex, and Atlantic City Range Complex, which consist of OPAREAs and associated special use airspace for fleet training and testing activities. The OPAREAs and special use airspace areas are the Boston OPAREA, Narragansett Bay OPAREA, and Atlantic City OPAREA. These complexes occupy waters off the coasts of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, and New Jersey.

Naval Undersea Warfare Center Division, Newport Testing Range: The Naval Undersea Warfare Center Division, Newport Testing Range consists of waters within Narragansett Bay; nearshore waters of Rhode Island Sound; Block Island Sound; and coastal waters of New York, Connecticut, and Massachusetts.

Virginia Capes Range Complex: The Virginia Capes Range Complex consists of an OPAREA and several associated special use airspaces. The Virginia Capes OPAREA extends southward from the Delaware-Maryland border along the coast of Maryland, Virginia, and North Carolina.

Navy Cherry Point Range Complex: The Navy Cherry Point Range Complex consists of an OPAREA and associated special use airspace. The Navy Cherry Point OPAREA extends southeast along the coast of North Carolina.

Jacksonville Range Complex: The Jacksonville Range Complex consists of two OPAREAs and associated special use airspace. The OPAREAs extend southward from the North Carolina-South Carolina border and along the coasts of South Carolina, Georgia, and Florida.

Naval Surface Warfare Center Carderock Division, South Florida Ocean Measurement Facility Testing Range: The South Florida Ocean Measurement Facility Testing Range is located at two sites just south of Fort Lauderdale, Florida.

Key West Range Complex: The Key West Range Complex consists of an OPAREA and associated extensive special use airspace in proximity to Key West, Florida.

Gulf of Mexico Range Complex: The Gulf of Mexico Range Complex consists of four OPAREAs and associated special use airspace in the Gulf of Mexico. These four OPAREAs are proximal to Panama City, Pensacola, New Orleans, and Corpus Christi.

Naval Surface Warfare Center, Panama City Division Testing Range: The Naval Surface Warfare Center, Panama City Division conducts testing activities in the Pensacola and Panama City OPAREAs, in St. Andrew Bay, and military warning areas W-151, W-155, and W-470.

Information on the range complexes and testing ranges included in the Study Area can be found in Section 2.1 (Description of the Atlantic Fleet Training and Testing Study Area).

1.6 The Environmental Planning Process

The National Environmental Policy Act (NEPA) of 1969 requires federal agencies to examine the environmental impacts of their proposed actions within the United States and its territories. An EIS is a detailed public document that provides an assessment of the potential effects that a major federal action might have on the human environment, which includes the natural environment. The Navy undertakes environmental planning for major Navy actions occurring throughout the world in accordance with applicable laws, regulations, and executive orders.

1.6.1 National Environmental Policy Act Requirements

The first step in the NEPA process (Figure 1.6-1) for an EIS is to prepare a Notice of Intent to develop an EIS. The Notice of Intent is published in the *Federal Register* and provides an overview of the proposed action and the scope of the EIS. The Notice of Intent is also the first step in engaging the public.

Scoping is an early and open process for developing the "scope" of issues to be addressed in an EIS and for identifying significant issues related to a proposed action. The scoping process for an EIS is initiated by publication of the Notice of Intent in the *Federal Register* and local newspapers. During scoping, the public helps define and prioritize issues through public meetings and written comments.

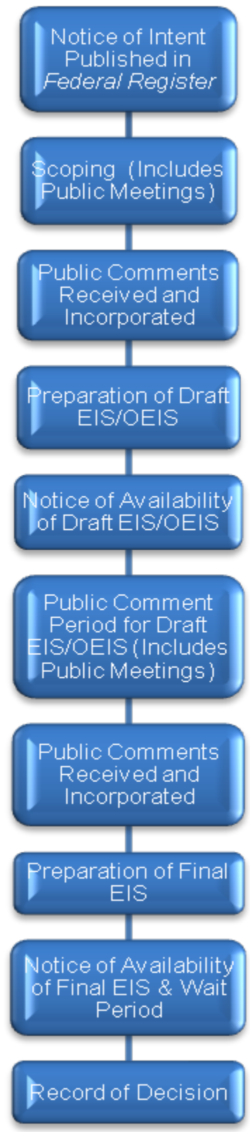

Figure 1.5-1: National Environmental Policy Act Process

Subsequent to the scoping process, a Draft EIS is prepared to assess potential impacts of the proposed action and alternatives on the environment. When completed, a Notice of Availability is published in the *Federal Register* and notices are placed in local or regional newspapers announcing the availability of the Draft EIS. The Draft EIS is circulated for review and comment; public meetings are also held.

The Final EIS addresses all public comments received on the Draft EIS. Responses to public comments may include correction of data, clarifications of and modifications to analytical approaches, and inclusion of new or additional data or analyses.

Finally, the decision maker will issue a Record of Decision no earlier than 30 days after a Final EIS is made available to the public.

1.6.2 EXECUTIVE ORDER 12114

Executive Order 12114, *Environmental Impacts Abroad of Major Federal Actions*, directs federal agencies to provide for informed environmental decision making for major federal actions outside the United States and its territories. Presidential Proclamation 5928, issued December 27, 1988, extended the exercise of U.S. sovereignty and jurisdiction under international law to 12 nautical miles (nm); however, the proclamation expressly provides that it does not extend or otherwise alter existing federal law or any associated jurisdiction, rights, legal interests, or obligations. Thus, as a matter of policy, the Navy analyzes environmental effects and actions within 12 nm under NEPA (an EIS) and those effects occurring beyond 12 nm under the provisions of EO 12114 (an OEIS).

1.6.3 OTHER ENVIRONMENTAL REQUIREMENTS CONSIDERED

The Navy must comply with all applicable federal environmental laws, regulations, and executive orders, including, but not limited to, those listed below. Further information can be found in Chapter 3 (Affected Environment and Environmental Consequences) and Chapter 6 (Additional Regulatory Considerations).

- Abandoned Shipwreck Act
- Antiquities Act
- Clean Air Act
- Clean Water Act
- Coastal Zone Management Act
- Endangered Species Act
- Magnuson-Stevens Fishery Conservation and Management Act
- Marine Mammal Protection Act
- Migratory Bird Treaty Act
- National Historic Preservation Act
- National Marine Sanctuaries Act
- Rivers and Harbors Act
- EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*
- EO 12962, *Recreational Fisheries*
- EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*
- EO 13089, *Coral Reef Protection*
- EO 13158, *Marine Protected Areas*
- EO 13175, *Consultation and Coordination with Indian Tribal Governments*
- EO 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*

1.7 SCOPE AND CONTENT

In this EIS/OEIS, the Navy assessed military readiness training and testing activities that could potentially impact human and natural resources, especially marine mammals, sea turtles, and other marine resources. The range of alternatives includes the No Action and other reasonable courses of action. In this EIS/OEIS, the Navy analyzed direct, indirect, cumulative, short-term, long-term, irreversible, and irretrievable impacts. The Navy is the lead agency for the Proposed Action and is responsible for the scope and content of this EIS/OEIS. The National Marine Fisheries Service is a cooperating agency because of its expertise and regulatory authority over marine resources. Additionally, this document will serve as NMFS' NEPA documentation for the rule-making process under the MMPA.

In accordance with the Council on Environmental Quality Regulations, 40 C.F.R. § 1505.2, the Navy will issue a Record of Decision that provides the rationale for choosing one of the alternatives. The decision will be based on factors analyzed in this EIS/OEIS, including military training and testing objectives, best available science and modeling data, potential environmental impacts, and public interest.

1.8 ORGANIZATION

To meet the need for decision making, this EIS/OEIS is organized as follows:

- Chapter 1 describes the purpose of and need for the Proposed Action.
- Chapter 2 describes the Proposed Action, alternatives considered but eliminated in the EIS/OEIS, and alternatives to be carried forward for analysis in the EIS/OEIS (including the preferred alternative).
- Chapter 3 describes the existing conditions of the affected environment and analyzes the potential impacts of the training and testing activities in each alternative.
- Chapter 4 describes the analysis of cumulative impacts, which are the impacts of the Proposed Action when added to past, present, and reasonably foreseeable future actions.
- Chapter 5 describes the measures the Navy evaluated that could mitigate impacts to the environment.
- Chapter 6 describes other considerations required by NEPA and describes how the Navy complies with other federal, state, and local plans, policies, and regulations.
- Chapter 7 includes a list of the EIS/OEIS preparers.
- Chapter 8 includes a list of agencies, government officials, tribes, groups, and individuals on the distribution lists for receipt of the Draft EIS/OEIS, Proposed Rule notification, and the Final EIS/OEIS.
- Appendices provide technical information that supports the EIS/OEIS analyses and its conclusions.

1.9 RELATED ENVIRONMENTAL DOCUMENTS

The progression of NEPA/EO 12114 documentation for Navy activities has developed from planning individual range complex exercises and testing events to theater assessment planning that spans multiple years and covers multiple range complexes. The following publicly available documents relate to Navy training and testing activities and may be referenced in this EIS/OEIS, as appropriate:

- Final Atlantic Fleet Active Sonar Training Environmental Impact Statement/Overseas Environmental Impact Statement (December 2008)
- Virginia Capes Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (March 2009), Navy Cherry Point Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (April 2009), Jacksonville Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (March 2009), Gulf of Mexico Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement (December 2010), and Final Environmental

Assessment/Overseas Environmental Assessment on the Key West Range Complex (January 2010)

- Final Environmental Assessment for the Homebasing of the MH-60R/S on the East Coast of the United States (May 2002)
- Final EIS for Proposed Homeporting of Additional Surface Ships at Naval Station Mayport, Florida (January 2009)
- Final EIS for Introduction of the P-8A Multi-Mission Maritime Aircraft into the U.S. Navy Fleet (March 2009)
- EIS for Introduction of F/A-18E/F Super Hornets to the East Coast of the U.S. (July 2003)
- Shock Trials of the Mesa Verde (LPD-19) Final EIS/OEIS (May 2008)
- Environmental Impact Statement for the Shock Trial of the Winston S Churchill (DDG-81) (February 2001)
- Overseas Environmental Assessment for High Speed Sea Trials in the Gulf of Mexico (June 2009)
- Programmatic Overseas Environmental Assessment on Sinking Exercises (SINKEX) in the Western Atlantic Ocean (March 2006)
- Final Overseas Environmental Impact Statement/Environmental Impact Statement for Undersea Warfare Training Range (June 2009)
- Final Environmental Impact Statement/Overseas Environmental Impact Statement for Naval Surface Warfare Center, Panama City Division Mission Activities (September 2009)
- Environmental Assessment of Test Operations in Rhode Island Waters for the Naval Undersea Warfare Center Division Newport (May 2008)
- Environmental Impact Statement for Surveillance Towed Array Sensor System Low-Frequency Active (SURTASS LFA) Sonar (April 2007)
- Final Environmental Assessment for the Transition of E-2C Hawkeye to E-2D Advanced Hawkeye at Naval Station Norfolk, Virginia and Naval Base Ventura County Point Mugu, California (January 2009)
- Final Environmental Assessment for the Homeporting of Six Zumwalt Class Destroyers at East and West Coast Installations (Including Hawaii) (May 2008)

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REFERENCES

U.S. Department of the Navy, Undersecretary of the Navy. (2000). Memorandum for the Chief of Naval operations [and] Commandant of Marine Corps: Compliance with environmental requirements in the conduct of naval exercises or training at sea. Washington, DC.

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2 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

The Department of the Navy's (Navy) Proposed Action is to conduct training and testing activities— that may include the use of active sonar and explosives[1]—primarily within existing range complexes and testing ranges in the western Atlantic Ocean off the east coast of the United States, in the Gulf of Mexico, and in portions of the Caribbean Sea. These activities will also occur at Navy pierside locations, Navy-contracted shipbuilder locations, port transit channels, and the lower Chesapeake Bay (Figure 2.1-1). The Proposed Action includes activities such as sonar maintenance and gunnery exercises conducted concurrently with ship transits and that may occur outside of Navy range complexes and testing ranges. The Proposed Action also includes pierside sonar testing conducted as part of overhaul, modernization, maintenance, and repair activities at Navy piers, as well as new construction at Navy-contracted shipbuilder locations.

Through this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS), the Navy will

- Reassess the environmental analysis of Navy at-sea training and testing activities contained in seven separate EISs/OEISs and various Environmental Assessments (EAs)/Overseas Environmental Assessments (OEAs) and consolidate these analyses into a single environmental planning document. This reassessment will support reauthorization of incidental takes of marine mammals under the Marine Mammal Protection Act (MMPA) and incidental takes of threatened and endangered marine species through consultation under Section 7 of the Endangered Species Act (ESA). The following seven EIS/OEIS documents are being consolidated:
    - *Final Atlantic Fleet Active Sonar Training Environmental Impact Statement/Overseas Environmental Impact Statement* (December 2008)
    - *Virginia Capes Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement* (March 2009)
    - *Navy Cherry Point Range Complex Environmental Impact Statement/Overseas Environmental Impact Statement* (April 2009)
    - *Jacksonville Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement* (March 2009)
    - *Final Environmental Impact Statement/Overseas Environmental Impact Statement, Naval Surface Warfare Center Panama City Division Mission Activities* (September 2009)
    - *Gulf of Mexico Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement* (December 2010)
    - *Final Overseas Environmental Impact Statement/Environmental Impact Statement, Undersea Warfare Training Range* (June 2009)
- Adjust baseline training and testing activities from current levels to the level needed to support Navy training and testing requirements beginning January 2014. As part of the adjustment, the Navy accounts for other activities and sound sources not addressed in the previous analyses.
- Analyze the potential environmental impacts of training and testing activities in additional areas (areas not covered in previous documents) where training and testing historically occurs, including Navy ports, naval shipyards, and Navy-contractor shipyards, and the transit channels serving these areas.

[1] The terms 'explosive' and 'high-explosive' are used interchangeably throughout the document.

- Update the at-sea environmental impact analyses for Navy activities in the previous documents to account for force structure changes, including those resulting from the development, testing, and use of weapons, platforms, and systems that will be operational by 2019.
- Implement enhanced range capabilities.
- Update environmental analyses with the best available science and most current acoustic analysis methods to evaluate the potential effects of training and testing activities on the marine environment.

In this chapter, the Navy will build upon the purpose and need to train and test by describing the study area and identifying the primary mission areas under which these activities are conducted. Each warfare community conducts activities that uniquely contribute to the success of a primary mission area. Each primary mission area requires unique skills, sensors, weapons, and technologies to accomplish the mission. For example, in the primary mission area of anti-submarine warfare, surface, submarine, and aviation communities each utilize different skills, sensors, and weapons to locate, track, and eliminate submarine threats. The testing community contributes to the success of anti-submarine warfare by anticipating and identifying technologies and systems that respond to the needs of the warfare communities. As each warfare community develops its basic skills and integrates them into combined units and strike groups, the problems of communication, coordination and planning, movement and positioning of naval forces and targeting/delivery of weapons become increasingly complex. This complexity creates a need for coordinated training and testing between the fleets and systems commands.

To address the activities needed to accomplish this training and testing in this EIS/OEIS, the Navy has broken down each training and testing activity into basic components analyzed for their potential environmental impacts. The training and testing events are captured in tables and the discussion that follows. Additionally, Chapter 2 provides detailed discussion of how the training and testing activities occur and the platforms, weapons, and systems that are required to complete the activities.

Chapter 2 is organized into eight sections.

- Section 2.1 (Description of the Atlantic Fleet Training and Testing Study Area) outlines the area where training and testing activities would occur.
- Section 2.2 (Primary Mission Areas) outlines the primary mission areas, which are how training and testing activities are categorized.
- Section 2.3 (Description of Sonar, Ordnance/Munitions, Targets, and Other Systems Employed in the Atlantic Fleet Training and Testing Events) provides information on the sonar systems, ordnance and munitions, and targets utilized during training and testing activities.
- Section 2.4 (Proposed Activities) outlines the proposed training and testing activities.
- Section 2.5 (Alternatives Development) outlines the process to develop the alternatives for the Proposed Action.
- Section 2.6 (No Action Alternative: Current Military Readiness within the Atlantic Fleet Region) outlines the No Action Alternative proposed in this EIS/OEIS.
- Section 2.7 (Alternative 1: Expansion of Study Area Plus Adjustments to the Baseline and Additional Weapons, Platforms, and Systems) outlines Alternative 1 proposed in this EIS/OEIS.
- Section 2.8 (Alternative 2: Includes Alternative 1 Plus Increased Tempo of Training and Testing Activities) outlines Alternative 2 proposed in this EIS/OEIS.

The proposed activities are complex and therefore the Navy has prepared several appendices that provide a greater level of detail – these appendices will be referenced in the appropriate chapters.

2.1 Description of the Atlantic Fleet Training and Testing Study Area

The Atlantic Fleet Training and Testing (AFTT) EIS/OEIS Study Area (Study Area) is in the western Atlantic Ocean and encompasses the east coast of North America and the Gulf of Mexico. The Study Area starts seaward from the mean high water line east to the 45-degree west longitude line, north to the 65-degree north latitude line, and south to approximately the 20-degree north latitude line. The Study Area generally follows the Commander Task Force 80 area of operations, covering approximately 2.6 million square nautical miles (nm^2) of ocean area, and includes designated Navy operating areas (OPAREAs) and special use airspace. Navy pierside locations and port transit channels where sonar maintenance and testing occur, and bays and civilian ports where training occurs (Sections 2.1.11, Bays, Harbors, and Civilian Ports, and 2.1.12, Pierside Locations) are also included in the Study Area.

The Study Area also includes several Navy testing ranges and range complexes. A range complex is a designated set of specifically bounded geographic areas and encompasses a water component (above and below the surface), airspace, and may encompass a land component where training and testing of military platforms, tactics, munitions, explosives, and electronic warfare systems occur. Range complexes include established OPAREAs and special use airspace, which may be further divided to provide better control of the area and events being conducted for safety reasons.

- **Operating Area**. An ocean area defined by geographic coordinates with defined surface and subsurface areas and associated special use airspace. OPAREAs include the following:
  - **Danger Zones.** A danger zone is a defined water area used for gunnery, bombing, rocket firing, or other especially hazardous military activities. Danger zones are established pursuant to statutory authority of the Secretary of the Army and are administered by the United States (U.S.) Army Corps of Engineers. Danger zones may be closed to the public on a full-time or intermittent basis (33 Code of Federal Regulations [C.F.R.] Part 334).
  - **Restricted Areas.** A restricted area is a defined water area for the purpose of prohibiting or limiting public access to the area. Restricted areas generally provide security for government property and also provide protection to the public from the risks of damage or injury arising from the government's use of that area (33 C.F.R. Part 334).
- **Special Use Airspace**. Airspace of defined dimensions where activities must be confined because of their nature or where limitations may be imposed upon aircraft operations that are not part of those activities (Federal Aviation Administration Order 7400.8). Types of special use airspace most commonly found in range complexes include the following:
  - **Restricted Areas.** Airspace where aircraft are subject to restriction due to the existence of unusual, often invisible hazards (e.g., release of ordnance) to aircraft. Some areas are under strict control of the Department of Defense (DoD) and some are shared with non-military agencies.
  - **Military Operations Area.** Airspace with defined vertical and lateral limits established for the purpose of separating or segregating certain military training activities from instrument flight rules traffic and to identify for visual flight rules traffic where these activities are conducted.

- **Warning Area.** Areas of defined dimensions, extending from 3 nautical miles (nm) outward from the coast of the United States, which serve to warn non-participating aircraft of potential danger.
- **Air Traffic Control Assigned Airspace.** Airspace of defined vertical/lateral limits, assigned by Air Traffic Control, for the purpose of providing air traffic segregation between the specified activity being conducted within the assigned airspace and other instrument flight rules traffic.

The Study Area includes only the at-sea components of the range complexes and testing ranges. The Study Area also includes Narragansett Bay, lower Chesapeake Bay, St. Andrew Bay, and pierside locations. The remaining inland waters and land-based portions of the range complexes are not a part of the Study Area and will be or already have been addressed under separate National Environmental Policy Act (NEPA) documentation. Some training and testing occurs outside the OPAREAs (i.e., some activities are conducted seaward of the OPAREAs, and a limited amount of active sonar is used shoreward of the OPAREAs, pierside, and in transit to and from Navy piers). The Study Area is depicted in Figure 2.1-1. Regional maps, Figures 2.1-2, 2.1-3, and 2.1-4, are provided for additional detail of the range complexes and testing ranges. The following range complexes and components are part of the Study Area.

2.1.1 Northeast Range Complexes

The three range complexes of Boston Range Complex, Narragansett Bay Range Complex, and Atlantic City Range Complex are collectively referred to as the Northeast Range Complexes. These range complexes span 761 miles (mi.) (1,225 km) along the coast from Maine to New Jersey. The Northeast Range Complexes include special use airspace with associated warning areas and surface and subsurface sea space of the Boston OPAREA, Narragansett Bay OPAREA, and Atlantic City OPAREA. For purposes of this document the CGULL testing area is considered an OPAREA and part of the Northeast Range Complexes and includes 22,525 nm^2 of sea space (Figure 2.1-2).

2.1.1.1 Special Use Airspace

The Northeast Range Complexes include 30,930 nm^2 of special use airspace overlying the Boston OPAREA, Narragansett Bay OPAREA, and Atlantic City OPAREA. The altitude at which aircraft may fly varies from the surface to 60,000 ft., except for warning area W-107A in the Atlantic City Range Complex, which is unlimited. Warning areas within the Northeast Range Complexes include W-102, W-103, W-104, W-105, W-106, and W-107.

2.1.1.2 Sea and Undersea Space

The Northeast Range Complexes include three OPAREAs – Boston, Narragansett Bay, and Atlantic City. These OPAREAs encompass 45,619 nm^2 of sea space and undersea space. The Boston, Narragansett Bay, and Atlantic City OPAREAs are offshore of the states of Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, and New Jersey. The OPAREAs of the three complexes are outside 3 nm but within 200 nm from shore.

2.1.2 Naval Undersea Warfare Center Division, Newport Testing Range

The Naval Undersea Warfare Center Division, Newport Testing Range includes the waters of Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, and Long Island Sound (Figure 2.1-2).

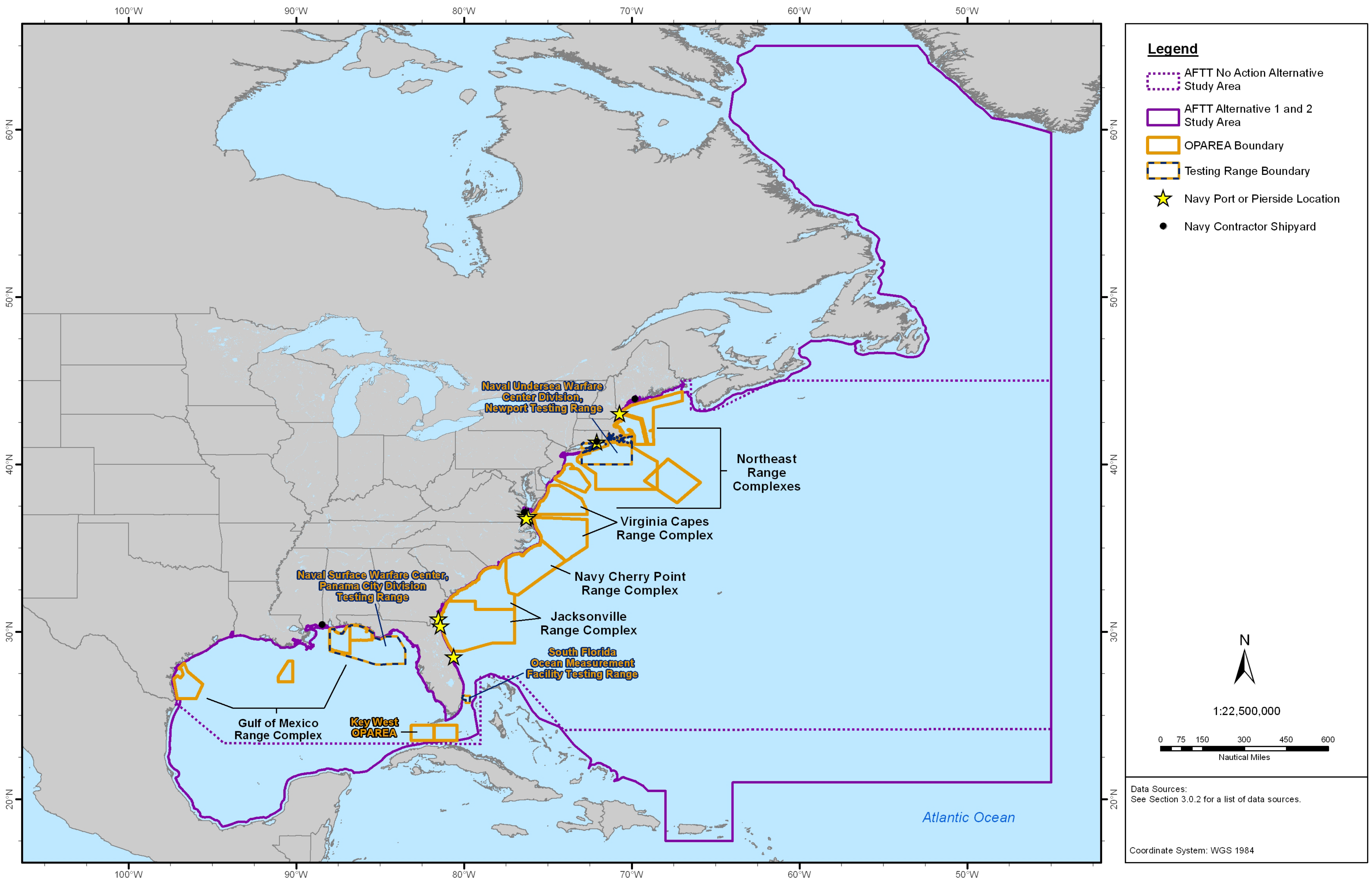

Figure 2.1-1: Atlantic Fleet Training and Testing Study Area

AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

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2.1.2.1 Special Use Airspace

A portion of Naval Undersea Warfare Center Division, Newport Testing Range is under R-4105A, known as No Man's Land Island restricted airspace. There are minimal testing requirements associated with airspace within Naval Undersea Warfare Center Division, Newport Testing Range.

2.1.2.2 Sea and Undersea Space

Three restricted areas are located within the area of the Naval Undersea Warfare Center Division, Newport Testing Range.

- Coddington Cove restricted area, adjacent to Naval Undersea Warfare Center Division, Newport,
- Narragansett Bay Restricted Area (6.1 nm^2 area surrounding Gould Island) including the Hole Test Area, and the North Test Range, and
- Rhode Island Sound Restricted Area, a rectangular box (27.2 nm^2) located in Rhode Island and Block Island Sounds.

2.1.3 Virginia Capes Range Complex

The Virginia Capes (VACAPES) Range Complex spans 270 mi. (434.5 km) along the coast from Delaware to North Carolina from the shoreline to 155 nm seaward (Figure 2.1-2). The VACAPES Range Complex includes special use airspace with associated warning and restricted areas, and surface and subsurface sea space of the VACAPES OPAREA. The VACAPES Range Complex also includes established mine warfare training areas located within the lower Chesapeake Bay and off the coast of Virginia.

2.1.3.1 Special Use Airspace

The VACAPES Range Complex includes 28,672 nm^2 of special use airspace overlying the VACAPES OPAREA. Flight altitudes range from surface to ceilings of 18,000 ft. to unlimited altitudes. Warning areas within the VACAPES Range Complex include W-50, W-386, W-387, W-72, and W-110. Restricted airspace within the VACAPES Range Complex is designated R-6606, which extends from the shoreline to approximately the 3 nm state territorial sea limit.

2.1.3.2 Sea and Undersea Space

The VACAPES Range Complex shore boundary roughly follows the shoreline from Delaware to North Carolina; the seaward boundary extends 155 nm into the Atlantic Ocean proximate to Norfolk, Virginia. The VACAPES OPAREA encompasses 27,661 nm^2 of sea space and undersea space. The VACAPES OPAREA is offshore of the states of Delaware, Maryland, Virginia, and North Carolina.

2.1.4 Navy Cherry Point Range Complex

The Navy Cherry Point Range Complex, off the coast of North Carolina, encompasses the sea space from the shoreline to 120 nm seaward. The Navy Cherry Point Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the Cherry Point OPAREA (Figure 2.1-3). The Navy Cherry Point Range Complex is adjacent to the U.S. Marine Corps Cherry Point and Camp Lejeune Range Complexes associated with Marine Corps Air Station Cherry Point and Marine Corps Base Camp Lejeune.

2.1.4.1 Special Use Airspace

The Navy Cherry Point Range Complex includes 18,966 nm^2 of special use airspace overlying the Cherry Point OPAREA. The airspace varies from the surface to unlimited altitude. Special use airspace within the Navy Cherry Point Range Complex is composed of a single warning area, W-122.

2.1.4.2 Sea and Undersea Space

The Navy Cherry Point Range Complex is roughly aligned with the shoreline and extends out 120 nm into the Atlantic Ocean. The Cherry Point OPAREA encompasses 18,617 nm^2 of sea space and undersea space. The Navy Cherry Point Range Complex is offshore of the states of North Carolina and South Carolina.

2.1.5 JACKSONVILLE RANGE COMPLEX

The Jacksonville (JAX) Range Complex spans 520 mi. along the coast from North Carolina to Florida from the shoreline to 250 nm seaward. The JAX Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the Charleston and JAX OPAREAs. The Undersea Warfare Training Range is located within the JAX Range Complex (Figure 2.1-3 and Appendix H, Impacts Due to Atlantic Fleet Training and Testing Activities at the Undersea Warfare Training Range).

2.1.5.1 Special Use Airspace

The JAX Range Complex includes approximately 50,068 nm^2 of special use airspace overlying the Charleston and JAX OPAREAs. Flight altitudes range from the surface to unlimited altitudes. Warning areas within the JAX Range Complex include: W-132, W-133, W-134, W-157, W-158, and W-159.

2.1.5.2 Sea and Undersea Space

The JAX Range Complex shore boundary roughly follows the shoreline and extends out 250 nm into the Atlantic Ocean proximate to Jacksonville, Florida. The JAX Range Complex includes two OPAREAs: Charleston and JAX. Combined, these OPAREAs encompass 50,090 nm^2 of sea space and undersea space. The Charleston and JAX OPAREAs are offshore of the states of North Carolina, South Carolina, Georgia, and Florida. The Undersea Warfare Training Range is located within the JAX Range Complex.

2.1.6 NAVAL SURFACE WARFARE CENTER CARDEROCK DIVISION, SOUTH FLORIDA OCEAN MEASUREMENT FACILITY TESTING RANGE

The Naval Surface Warfare Center Carderock Division operates the South Florida Ocean Measurement Facility Testing Range, an offshore testing area in support of various Navy and non-Navy programs. The South Florida Ocean Measurement Facility Testing Range is located adjacent to the Port Everglades entrance channel in Fort Lauderdale, Florida (Figure 2.1-3). The test area at South Florida Ocean Measurement Facility Testing Range includes an extensive cable field located within a restricted anchorage area, and two designated submarine operating areas.

2.1.6.1 Special Use Airspace

The South Florida Ocean Measurement Facility Testing Range does not include identified special use airspace. The airspace adjacent to South Florida Ocean Measurement Facility Testing Range is managed by the Fort Lauderdale International Airport. Air operations at the South Florida Ocean Measurement Facility Testing Range are coordinated with Fort Lauderdale International Airport by the air units involved in the test events.

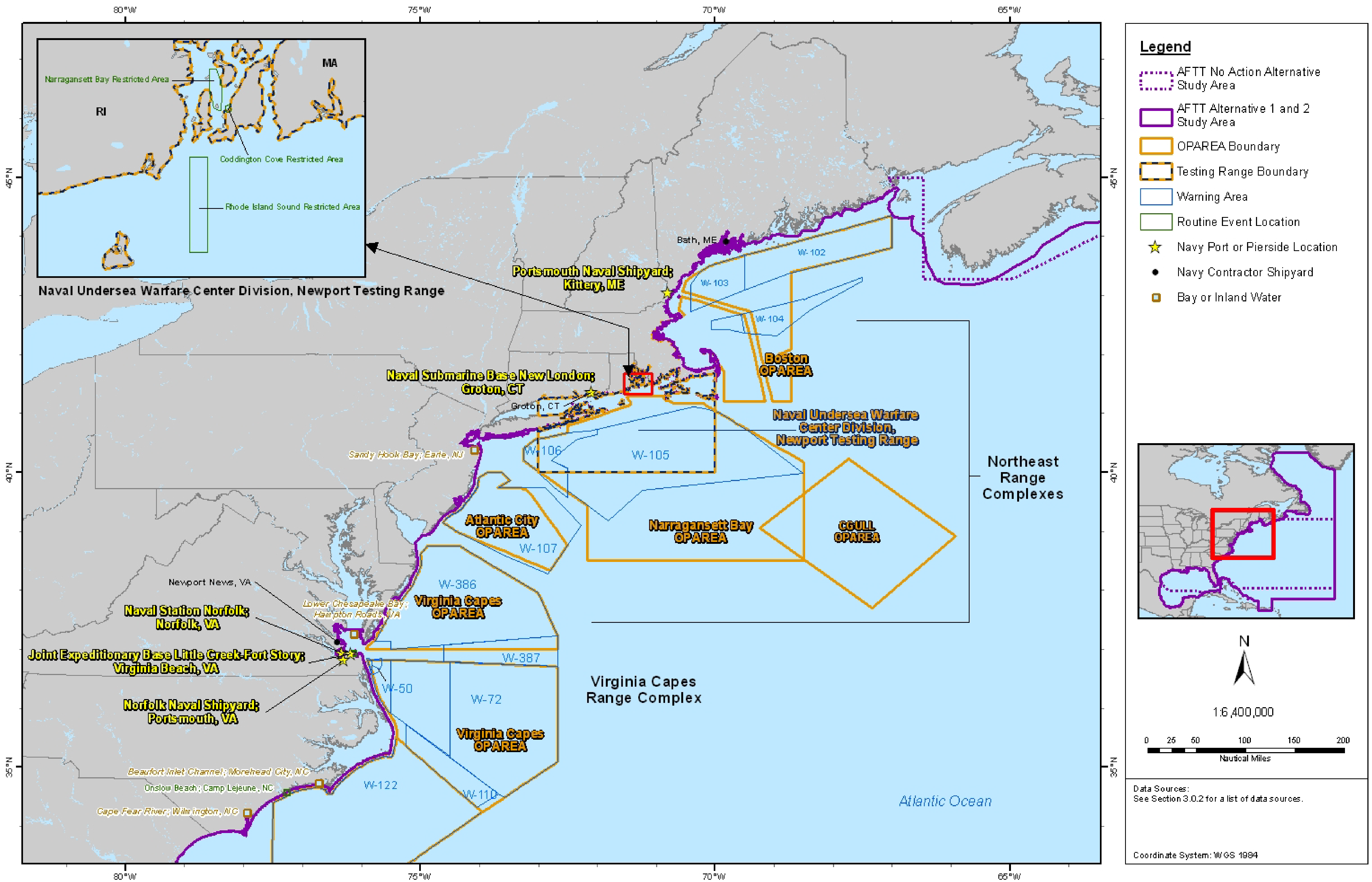

Figure 2.1-2: Study Area, Mid-Atlantic Region

AFTT: Atlantic Fleet Training and Testing; CT: Connecticut; MA: Massachusetts; ME: Maine; NC: North Carolina; NJ: New Jersey; OPAREA: Operating Area; RI: Rhode Island; VA: Virginia

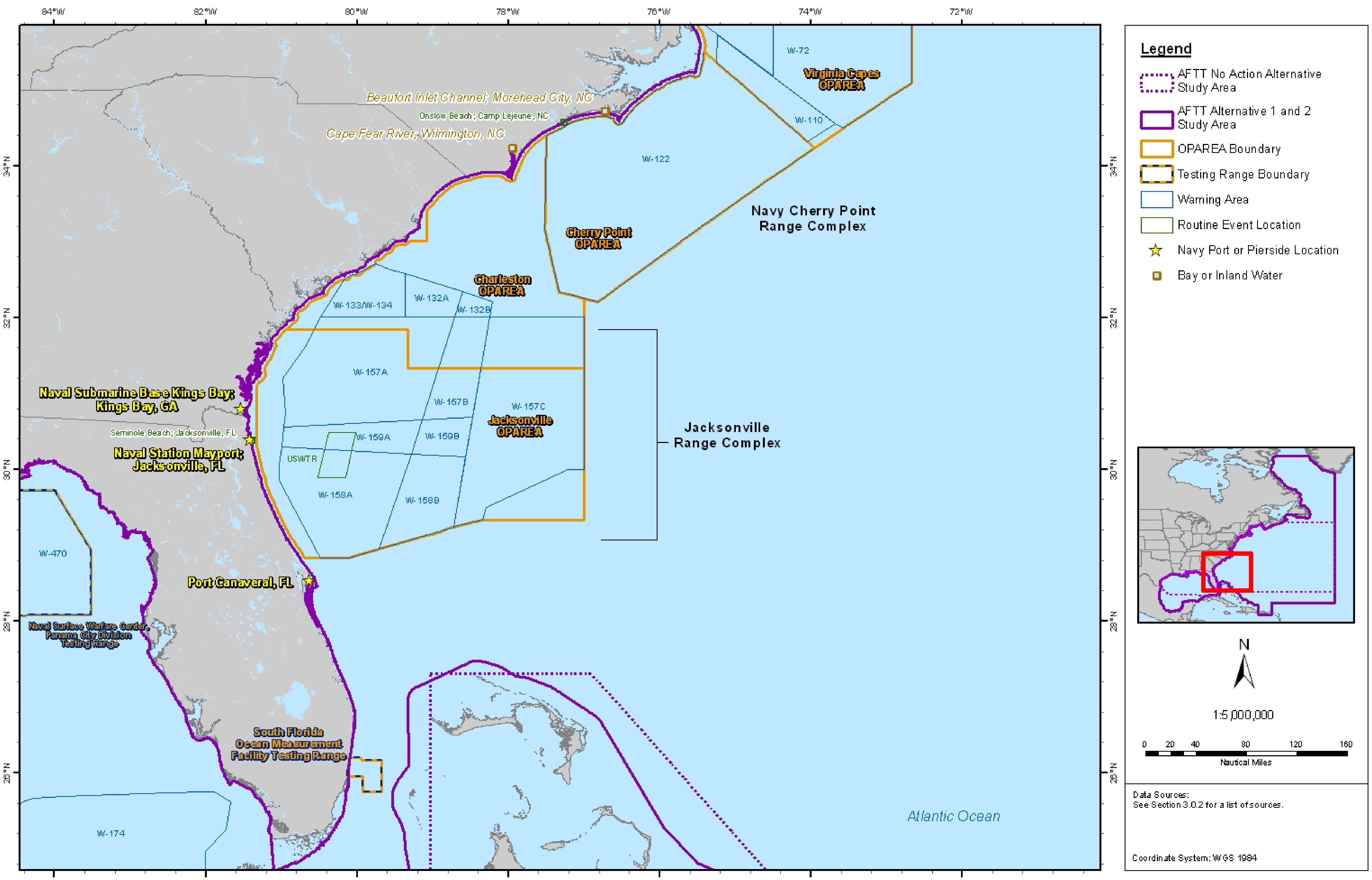

Figure 2.1-3: Study Area, Southeast Region

AFTT: Atlantic Fleet Training and Testing; FL: Florida; GA: Georgia; NC: North Carolina; OPAREA: Operating Area; USWTR: Undersea Warfare Training Area

2.1.6.2 Sea and Undersea Space

South Florida Ocean Measurement Facility Testing Range is divided into four subareas:

- The Port Everglades Shallow Submarine Operating Area is a 120-nm^2 area that encompasses nearshore waters from the shoreline to 900 ft. (274 m) deep and 8 nm offshore.
- The Notice of Intent Temporary Use Area is a 41-nm^2 area used for special purpose surface vessel[2] and submarine operations where the test vessels are restricted from maneuvering and require additional protection. This Notice of Intent Temporary Use Area encompasses waters from 60 to 600 ft. (18 to 183 m) deep and from 1 to 3 mi. (1.6 to 4.8 km) offshore.
- The Port Everglades Deep Submarine Operating Area is a 335-nm^2 area that encompasses the offshore range from 900 to 2,500 ft. (274 to 762 m) in depth and from 9 to 25 nm offshore.
- The Port Everglades Restricted Anchorage Area is an 11 nm^2 restricted anchorage area ranging in depths from 60 to 600 ft. (18 to 183 m) where the majority of the South Florida Ocean Measurement Facility Testing Range cables run from offshore sensors to the shore facility and where several permanent measurement arrays are used for vessel signature acquisition.

2.1.7 Key West Range Complex

The Key West Range Complex lies off the southwestern coast of mainland Florida and along the southern Florida Keys, extending seaward into the Gulf of Mexico 150 nm and south into the Straits of Florida 60 nm. The Key West Range Complex includes special use airspace with associated warning areas and surface and subsurface sea space of the Key West OPAREA (Figure 2.1-4).

2.1.7.1 Special Use Airspace

The Key West Range Complex includes approximately 20,647 nm^2 of special use airspace overlying and north of the Key West OPAREA. Flight altitudes range from the surface to unlimited. Warning areas within the Key West Range Complex include W-174A, W-174B, W-174C, W-174E, W-174F, W-174G, W-465A, W-465B, Bonefish Air Traffic Control Assigned Airspace, and Tortugas Military Operating Area.

2.1.7.2 Sea and Undersea Space

The Key West OPAREA is 8,288 nm^2 of sea space and undersea space south of Key West, Florida.

2.1.8 Naval Surface Warfare Center, Panama City Division Testing Range

The Naval Surface Warfare Center, Panama City Division Testing Range is located off the panhandle of Florida and Alabama, extending from the shoreline to 120 nm seaward, and includes St. Andrew Bay. Naval Surface Warfare Center, Panama City Division Testing Range also includes special use airspace and offshore surface and subsurface waters of offshore OPAREAs (Figure 2.1-4).

2.1.8.1 Special Use Airspace

Special use airspace associated with Naval Surface Warfare Center, Panama City Division Testing Range includes warning areas overlying and east of the Pensacola and Panama City OPAREAs. The warning areas include W-151, W-155, and W-470.

[2] The terms 'vessel' and 'ship' are used interchangeably throughout the document.

2.1.8.2 Sea and Undersea Space

The Naval Surface Warfare Center, Panama City Division Testing Range includes the waters of St. Andrew Bay and the sea space within the Gulf of Mexico from the mean high tide line to 120 nm offshore. The Panama City OPAREA covers 3,084 nm^2 of sea space and lies off the coast of the Florida panhandle. The Pensacola OPAREA lies off the coast of Alabama and Florida west of the Panama City OPAREA and totals 4,882 nm^2.

2.1.9 GULF OF MEXICO RANGE COMPLEX

The Gulf of Mexico (GOMEX) Range Complex contains four separate OPAREAs: Panama City, Pensacola, New Orleans, and Corpus Christi. The OPAREAs within the GOMEX Range Complex are not contiguous but are scattered throughout the Gulf of Mexico unlike the previously described range complexes. The GOMEX Range Complex includes special use airspace with associated warning areas and restricted airspace, and surface and subsurface sea space of the Panama City, Pensacola, New Orleans, and Corpus Christi OPAREAs (Figure 2.1-4).

2.1.9.1 Special Use Airspace

The GOMEX Range Complex includes approximately 23,651 nm^2 of special use airspace overlying the Panama City, Pensacola, New Orleans, and Corpus Christi OPAREAs and airspace north of the New Orleans OPAREA. Flight altitudes range from the surface to unlimited. Warning areas within the GOMEX Range Complex include W-151, W-155, W-92, W-54, W-59, and W-228. Restricted airspace associated with the Pensacola OPAREA, designated R-2908, extends from the shoreline to approximately 3 nm offshore.

2.1.9.2 Sea and Undersea Space

The GOMEX Range Complex encompasses 25,753 nm^2 of sea and undersea space, and includes 285 nm of coastline. The OPAREAs span from the eastern shores of Texas to the western panhandle of Florida. They are described as follows:

- Panama City OPAREA lies off the coast of the Florida panhandle and totals 3,084 nm^2.
- Pensacola OPAREA lies off the coast of Florida west of the Panama City OPAREA and totals 4,882 nm^2.
- New Orleans OPAREA lies off the coast of Louisiana and totals 2,607 nm^2.
- Corpus Christi OPAREA lies off the coast of Texas and totals 6,867 nm^2.

2.1.10 ATLANTIC FLEET ACTIVE SONAR TRAINING ENVIRONMENTAL IMPACT STATEMENT / OVERSEAS ENVIRONMENTAL IMPACT STATEMENT

The Atlantic Fleet Active Sonar Training EIS/OEIS analyzed active sonar training activities located along the east coast and within the Gulf of Mexico. The study area boundaries included the sea space and airspace shoreward to the mean high water line and seaward to 45-degree west longitude, north to 45-degree north latitude, and south to approximately 22-degree north latitude.

2.1.11 BAYS, HARBORS, AND CIVILIAN PORTS

The Study Area includes Narragansett Bay, the lower Chesapeake Bay, and St. Andrew Bay for training and testing activities. Ports included for civilian port defense training events include Earle, New Jersey; Groton, Connecticut; Norfolk, Virginia; Morehead City, North Carolina; Wilmington, North Carolina; Kings Bay, Georgia; Mayport, Florida; Beaumont, Texas; and Corpus Christi, Texas.

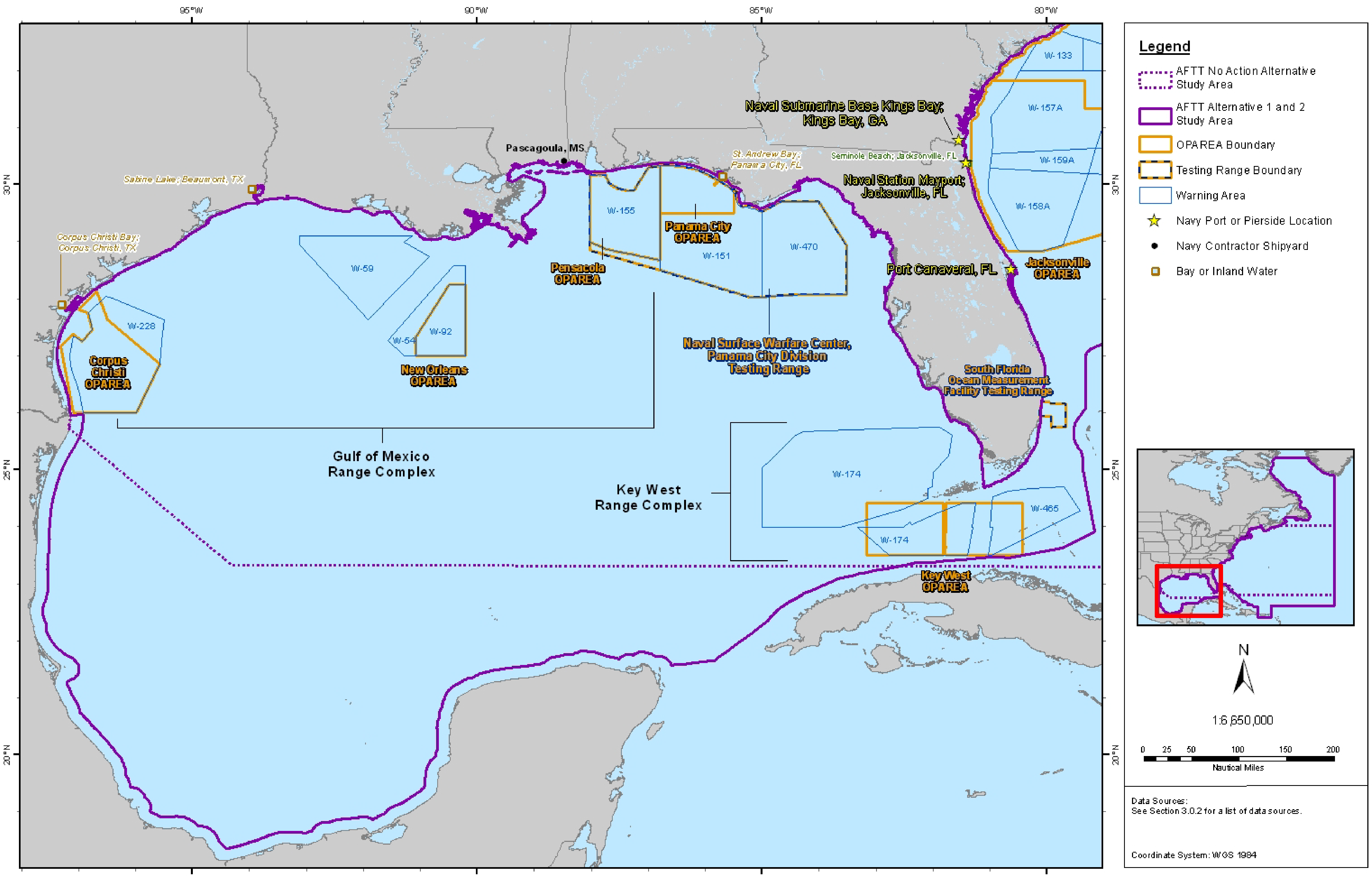

Figure 2.1-4: Study Area, Gulf of Mexico Region

AFTT: Atlantic Fleet Training and Testing; FL: Florida; GA: Georgia; MS: Mississippi; OPAREA: Operating Area; TX: Texas

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2.1.12 Pierside Locations

The Study Area includes pierside locations where Navy surface ship and submarine sonar maintenance and testing occur. For purposes of this EIS/OEIS, pierside locations include channels and transit routes in ports and facilities associated with ports and shipyards. These locations in the Study Area are located at the following Navy ports and naval shipyards:

- Portsmouth Naval Shipyard, Kittery, Maine;
- Naval Submarine Base New London, Groton, Connecticut;
- Naval Station Norfolk, Norfolk, Virginia;
- Joint Expeditionary Base Little Creek – Fort Story, Virginia Beach, Virginia;
- Norfolk Naval Shipyard, Portsmouth, Virginia;
- Naval Submarine Base Kings Bay, Kings Bay, Georgia;
- Naval Station Mayport, Jacksonville, Florida; and
- Port Canaveral, Cape Canaveral, Florida.

Navy-contractor shipyards in the following cities are also in the Study Area:

- Bath, Maine;
- Groton, Connecticut;
- Newport News, Virginia; and
- Pascagoula, Mississippi.

2.2 Primary Mission Areas

The Navy categorizes training activities into functional warfare areas called primary mission areas. Training activities fall into the following eight primary mission areas:

- Anti-air warfare
- Strike warfare
- Anti-submarine warfare
- Mine warfare
- Amphibious warfare
- Anti-surface warfare
- Electronic warfare
- Naval special warfare

Most training activities addressed in this EIS/OEIS are categorized under one of these warfare areas; those activities that do not fall within one of these areas are in a separate category. Each warfare community (surface, subsurface, aviation, and special warfare) may train in some or all of these primary mission areas. A large number of testing activities can also be categorized under these primary mission areas and are often integrated with fleet actions and assets. The sonars, ordnance, munitions, and targets used in the training and testing activities are described in Section 2.3 (Description of Sonar, Ordnance/Munitions, Targets, and Other Systems Employed in Atlantic Fleet Training and Testing Events). Short descriptions of individual training and testing events are provided in Tables 2.4-1, 2.4-2, and 2.4-3 (Section 2.4, Proposed Activities). More detailed descriptions of the training and testing activities can be found in Appendix A (Navy Activities Descriptions).

2.2.1 Anti-Air Warfare

The mission of anti-air warfare is to destroy or reduce enemy air and missile threats (including unmanned airborne threats) and serves two purposes: to protect U.S. forces from attacks from the air and to gain air superiority. Anti-air warfare also includes providing U.S. forces with adequate attack warnings, while denying hostile forces the ability to gather intelligence about U.S. forces.

Aircraft conduct anti-air warfare through radar search, detection, identification, and engagement of airborne threats—generally by firing anti-air missiles or cannon fire. Surface ships conduct anti-air warfare through an array of modern anti-aircraft weapon systems such as aircraft detecting radar, naval guns linked to radar-directed fire-control systems, surface-to-air missile systems, and radar-controlled cannons for close-in point defense.

Testing of anti-air warfare systems is required to ensure the equipment is fully functional under the conditions for which it will be used. Tests may be conducted on radar and other early warning detection and tracking systems, new guns or gun rounds, and missiles. Testing of these systems may be conducted on new ships and aircraft, and on existing ships and aircraft following maintenance, repair, or modification. For some systems, tests are conducted periodically to assess operability. Additionally, tests may be conducted in support of scientific research to assess new and emerging technologies.

2.2.2 AMPHIBIOUS WARFARE

The mission of amphibious warfare is to project military power from the sea to the shore through the use of naval firepower and Marine Corps landing forces. It is used to attack a threat located on land by a military force embarked on ships. Amphibious warfare operations include small unit reconnaissance or raid missions to large-scale amphibious operations involving multiple ships and aircraft combined into a strike group.

Amphibious warfare training ranges from individual, crew, and small unit events to large task force exercises. Individual and crew training include amphibious vehicles and naval gunfire support training. Small-unit training operations include shore assaults, boat raids, airfield or port seizures, and reconnaissance. Large-scale amphibious exercises involve ship-to-shore maneuver, naval fire support, such as shore bombardment, and air strike and close air support training.

Testing of guns, munitions, aircraft, ships, and amphibious vessels and vehicles used in amphibious warfare are often integrated into training activities and in most cases, the systems are used in the same manner in which they are used for fleet training activities. These tests, as well as full operational evaluations on existing amphibious vessels and vehicles following maintenance, repair, or modernization, may be conducted independently or in conjunction with other amphibious ship and aircraft activities. Testing is performed to ensure effective ship-to-shore coordination and transport of personnel, equipment, and supplies. Tests may also be conducted periodically on other systems, vessels, and aircraft intended for amphibious operations to assess operability and to investigate efficacy of new technologies.

2.2.3 STRIKE WARFARE

The mission of strike warfare is to conduct offensive attacks on land-based targets, such as refineries, power plants, bridges, major roadways, and ground forces to reduce the enemy’s ability to wage war. Strike warfare employs weapons by manned and unmanned air, surface, submarine, and naval special warfare assets in support of extending dominance over enemy territory (power projection).

Strike warfare includes training of fixed-wing attack aircraft pilots and aircrews in the delivery of precision-guided munitions, non-guided munitions, rockets, and other ordnance, including the high-speed anti-radiation missile, against land-based targets in all conditions. Not all strike mission training events involve dropping ordnance and instead the event is simulated with video footage obtained by onboard sensors.

Testing of weapons used in strike warfare is conducted to develop new types of weapons that provide better capabilities and to ensure currently developed weapons perform as designed and deployed. Tests may also be conducted periodically on other systems, vessels, or aircraft intended for strike warfare operations to assess operability and to investigate efficacy of new technologies.

2.2.4 ANTI-SURFACE WARFARE

The mission of anti-surface warfare is to defend against enemy ships or boats. In the conduct of anti-surface warfare, aircraft use cannons, air-launched cruise missiles or other precision guided munitions; ships employ torpedoes, naval guns, and surface-to-surface missiles; and submarines attack surface ships using torpedoes or submarine-launched, anti-ship cruise missiles.

Anti-surface warfare training includes surface-to-surface gunnery and missile exercises, air-to-surface gunnery and missile exercises, and submarine missile or torpedo launch events.

Testing of weapons used in anti-surface warfare is conducted to develop new technologies and to assess weapon performance and operability with new systems and platforms, such as unmanned systems. Tests include various air-to-surface guns and missiles, surface-to-surface guns and missiles, and bombing tests. Testing events may be integrated into training activities to test aircraft or aircraft systems in the delivery of ordnance on a surface target. In most cases the tested systems are used in the same manner in which they are used for fleet training activities.

2.2.5 ANTI-SUBMARINE WARFARE

The mission of anti-submarine warfare is to locate, neutralize, and defeat hostile submarine threats to surface forces (see Appendix H, Impacts Due to Atlantic Fleet Training and Testing Activities at the Undersea Warfare Training Range). Anti-submarine warfare is based on the principle of a layered defense of surveillance and attack aircraft, ships, and submarines all searching for hostile submarines. These forces operate together or independently to gain early warning and detection, and to localize, track, target, and attack hostile submarine threats.

Anti-submarine warfare training addresses basic skills such as detection and classification of submarines, and distinguishing between sounds made by enemy submarines and those of friendly submarines, ships, and marine life. More advanced, integrated anti-submarine warfare training exercises are conducted in coordinated, at-sea training events involving submarines, ships, fixed-wing aircraft, and helicopters. This training integrates the full spectrum of anti-submarine warfare from detecting and tracking a submarine to attacking a target using either exercise torpedoes or simulated weapons.

Testing of anti-submarine warfare systems is conducted to develop new technologies and assess weapon performance and operability with new systems and platforms, such as unmanned systems. Testing uses ships, submarines, and aircraft to demonstrate capabilities of torpedoes, missiles, countermeasure systems, and underwater surveillance and communications systems. Torpedo development, testing, and refinement are critical to successful anti-submarine warfare. At-sea sonar testing ensures systems are fully functional in an open-ocean environment prior to delivery to the fleet for operational use. Anti-submarine warfare systems on fixed-wing aircraft and helicopters (including dipping sonar) are tested to evaluate the ability to search and track a submarine or similar target. Sonobuoys deployed from surface vessels and aircraft are tested to verify the integrity and performance of a group, or lot, of sonobuoys in advance of delivery to the fleet for operational use. The sensors and systems onboard helicopters and maritime patrol aircraft are tested to ensure that tracking systems perform to specifications and meet operational requirements. Tests may be conducted as part of a large-scale fleet training event involving submarines, ships, fixed-wing aircraft, and helicopters. These integrated training events offer opportunities to conduct research and acquisition activities and to train aircrew in the use of new or newly enhanced systems during a large-scale, complex exercise.

2.2.6 Electronic Warfare

The mission of electronic warfare is to degrade the enemy's ability to use their electronic systems, such as communication systems and radar, in order to confuse or deny them the ability to defend their forces and assets. Electronic warfare is also used to recognize an emerging threat and counter an enemy's attempt to degrade the electronic capabilities of the Navy.

Typical electronic warfare activities include threat avoidance training, signals analysis for intelligence purposes, and use of airborne and surface electronic jamming devices to defeat tracking and communications systems.

Testing of electronic warfare systems is conducted to improve the capabilities of systems and ensure compatibility with new systems. Testing involves the use of aircraft, surface ships, and submarine crews to evaluate the effectiveness of electronic systems. Typical electronic warfare testing activities include the use of airborne and surface electronic jamming devices and chaff and flares to defeat tracking and communications systems. Chaff tests evaluate newly developed or enhanced chaff, chaff dispensing equipment, or modified aircraft avoidance systems' use against chaff deployment. Flare tests evaluate deployment performance and crew competency with newly developed or enhanced flares, flare dispensing equipment, or modified aircraft avoidance systems' use against flare deployment.

2.2.7 Mine Warfare

The mission of mine warfare is to detect, and avoid or neutralize mines to protect Navy ships and submarines and to maintain free access to ports and shipping lanes. Mine warfare also includes offensive mine laying to gain control of, or deny the enemy access to sea space. Naval mines can be laid by ships (including purpose-built minelayers), submarines, or aircraft.

Mine warfare neutralization (destruction) training includes exercises in which ships, aircraft, submarines, or underwater vehicles search for mines. Personnel train to destroy or disable mines by attaching and detonating underwater explosives to the mine. Other neutralization techniques involve impacting the mine with a bullet-like projectile or intentionally triggering the mine to detonate.

Testing and development of mine warfare systems is conducted to improve sonar, laser, and magnetic detectors intended to hunt, locate, and record the positions of mines for avoidance or subsequent neutralization. Mine warfare testing and development falls into two primary categories: mine detection and classification and mine countermeasure and neutralization. Mine detection and classification testing involves the use of air, surface, and subsurface vessels and uses sonar, including towed and side-scan sonar, mine countermeasure systems, and unmanned vehicles to support mine detection and classification testing. These mine detection systems are generally helicopter based and are sometimes used in conjunction with a mine neutralization system. Mine countermeasure and neutralization testing includes the use of air, surface, and subsurface units and uses tracking devices, countermeasure and neutralization systems, and general purpose bombs to evaluate the effectiveness of neutralizing mine threats. Most neutralization tests use mine shapes, or non-explosive practice mines, to evaluate a new or enhanced capability. During an airborne neutralization test, a previously located mine is destroyed or rendered nonfunctional using a helicopter based system that may involve the firing of a projectile or the deployment of a towed neutralization system. A small percentage of mine warfare tests require the use of high-explosive mines to evaluate and confirm the ability of the system to neutralize a high-explosive mine under operational conditions. The majority of mine warfare systems are currently deployed by ships and helicopters; however, future mine warfare missions will increasingly rely on unmanned vehicles. Tests may also be conducted in support of scientific research to support these new technologies.

2.2.8 Naval Special Warfare

The mission of naval special warfare is to conduct unconventional warfare, direct action, combat terrorism, special reconnaissance, security assistance, counter-drug operations, and recovery of personnel from hostile situations. Naval special warfare operations are highly specialized and require continual and intense training.

Naval special warfare units utilize a combination of specialized training, equipment, and tactics, including insertion and extraction operations using parachutes, submerged vehicles, rubber boats, and helicopters; boat-to-shore and boat-to-boat gunnery; underwater demolition training; reconnaissance; and small arms training.

Testing is conducted on both conventional and unconventional weapons used by naval special warfare units, including testing of submersible vehicles capable of inserting and extracting personnel or payloads into denied areas from strategic distances, active acoustic devices, underwater communications systems, and underwater demolition technologies. Doppler sonar and side scan sonar are tested for their ability to be used during extraction and insertion missions.

2.3 Description of Sonar, Ordnance/Munitions, Targets, and Other Systems Employed in Atlantic Fleet Training and Testing Events

The Navy uses a variety of sensors, platforms, weapons, and other devices, including ones used to ensure the safety of Sailors and Marines, to meet its mission. Training and testing with these systems may have the potential to introduce acoustic (sound) energy and expended materials into the environment. The environmental impact of these activities will be analyzed in Chapter 3 (Affected Environment and Environmental Consequences) of this EIS/OEIS. This section presents and organizes sonar systems, ordnance, munitions, targets, and other systems in a manner intended to facilitate understanding of both the activities that use them and the environmental effects analysis from them, later described in Chapter 3 (Affected Environment and Environmental Consequences) of this EIS/OEIS.

2.3.1 Sonar Systems and Other Acoustic Sensors

2.3.1.1 What is Sonar?

Sonar, originally an acronym for “SOund Navigation And Ranging,” is a technique that uses underwater sound to navigate, communicate, or detect underwater objects (the term sonar is also used for the equipment used to generate and receive sound). There are two basic types of sonar: active and passive.

Active sonar emits sound waves that travel through the water, reflect off objects, and return to the receiver. Sonar is used to determine the distance to an underwater object by calculating the speed of sound in water and the time for the sound wave to travel to the object and back. For example, active sonar systems are used to track targets or to aid in navigation of the vessel by identifying known ocean floor features. Some whales, dolphins, and bats use echolocation, a similar technique, to identify their surroundings and to locate prey.

Passive sonar uses listening equipment, such as underwater microphones (hydrophones) and receiving sensors on ships, submarines, aircraft, and autonomous vehicles, to pick up underwater sounds. The advantage of passive sonar is that it places no sound in the water, and thus does not reveal the location of the listening vessel. Passive sonar can indicate the presence, character, and direction of ships and submarines; however, passive sonar is increasingly ineffective as modern submarines become quieter. Passive sonar has no potential acoustic impact on the environment, and therefore, is not discussed further or analyzed within this EIS/OEIS.

All sounds, including sonar, are categorized by frequency. For this EIS/OEIS, active sonar is categorized into four frequency ranges: low-frequency[3], mid-frequency, high-frequency, and very high-frequency.

- Low-frequency active sonar emits sounds at frequencies less than 1 kilohertz (kHz). Low-frequency active sonar is useful for detecting objects at great distances because low-frequency sounds do not dissipate as rapidly as higher frequency sounds.
- Mid-frequency active sonar emits sounds at frequencies from 1 to 10 kHz. Mid-frequency active sonar is the Navy's primary tool for detecting and identifying submarines. Active sonar in this frequency range provides a valuable combination of range and target accuracy.
- High-frequency active sonar emits sounds at frequencies greater than 10 kHz, up to 100 kHz. High-frequency sounds dissipate rapidly and have a small effective range; however, high-frequency sounds provide higher resolution of objects and are useful at detecting and identifying smaller objects such as sea mines.
- Very high-frequency sources are those that operate above 100 kHz but below 200 kHz.

Modern sonar technology includes a variety of sonar sensor and processing systems. In concept, the simplest active sonar emits sound waves, or "pings," sent out in multiple directions and the sound waves then reflect off of the target object in multiple directions (Figure 2.3-1). The sonar source calculates the time it takes for the reflected sound waves to return; this calculation determines the distance to the target object. More sophisticated active sonars emit a ping and then rapidly scan or listen to the sound waves in a specific area. This provides both distance to the target and directional information. Even more advanced sonars use multiple receivers to listen to echoes from several directions simultaneously and provide efficient detection of both direction and distance. It should be noted that active sonar is rarely used continuously throughout the listed activities. In addition, when sonar is in use, the sonar "pings" occur at intervals, referred to as a duty cycle, and the signals themselves are very short in duration. For example, a sonar that emits a 1-second ping every 10 seconds has a 10 percent duty cycle.

The Navy utilizes sonar systems and other acoustic sensors in support of a variety of mission requirements. Primary uses include detection of and defense against submarines (anti-submarine warfare) and mines (mine warfare); safe navigation and effective communications; and oceanographic surveys. Specific examples of how sonar systems are used for Navy activities are discussed in the following sections.

[3] Surveillance Towed Array Sensor System (SURTASS) Low-Frequency Active sonar, which may be used in the Study Area, is not among the sources analyzed in this document. The potential environmental impacts from use of SURTASS Low-Frequency Active sonar are analyzed in separate analyses under the National Environmental Policy Act.

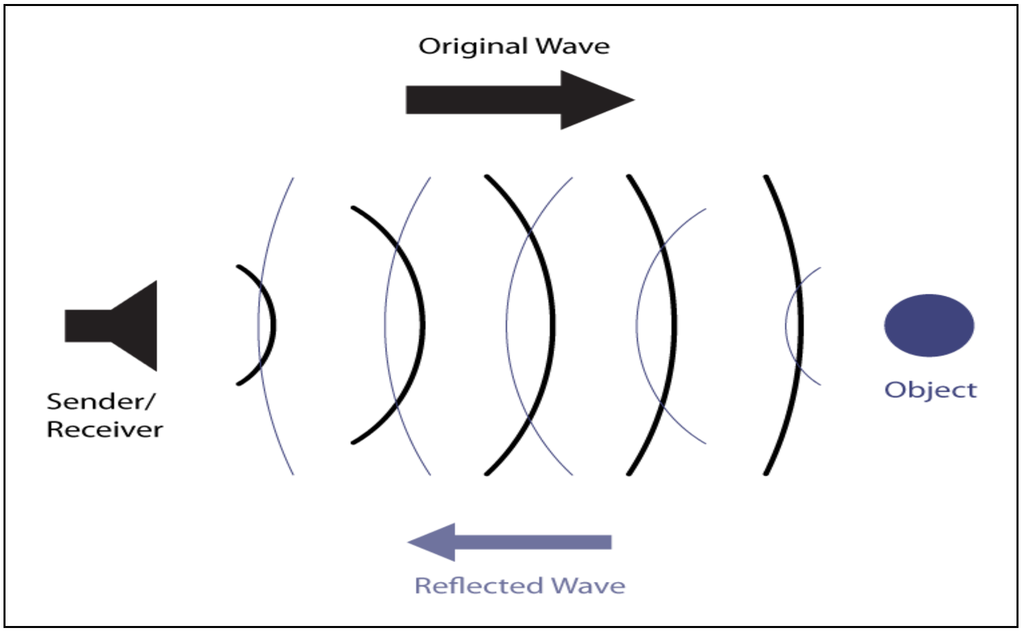

Figure 2.3-1: Principle of an Active Sonar

Anti-Submarine Warfare. Systems used in anti-submarine warfare include sonars, torpedoes, and acoustic countermeasure devices. These systems are employed from a variety of platforms (surface ships, submarines, helicopters, and fixed-wing aircraft). Surface ships conducting anti-submarine warfare are typically equipped with hull-mounted sonar (passive and active) for the detection of submarines. Helicopters use dipping sonar or sonobuoys (passive and active) to locate submarines (or submarine targets during training and testing exercises). Fixed-wing aircraft deploy both active and passive expendable sonobuoys to assist in detecting and tracking submarines. Submarines are equipped with hull-mounted sonars to detect, localize, and track other submarines and surface ships. Submarines primarily use passive sonar; active sonar is used mostly for navigation. There are also unmanned vehicles currently being developed to deploy anti-submarine warfare systems.

Anti-submarine warfare activities often use mid-frequency (i.e., 1 to 10 kHz) active sonar, though low-frequency and high-frequency active sonar systems are also used for specialized purposes. The Navy is currently developing and testing sonar systems that may utilize lower frequencies and longer duty cycles—albeit at lower source levels—than current systems. However, these new systems would only be operational if they significantly increase the Navy’s ability to detect and identify quiet submarine threats.

The types of sonar systems and acoustic sensors used during anti-submarine warfare sonar training and testing exercises include the following:

- **Surface Ship Sonar Systems:** A variety of surface ships operate hull-mounted mid-frequency active sonar during training exercises and testing activities (Figure 2.3-2). Typically, only cruisers, destroyers, and frigates have surface ship sonar systems.

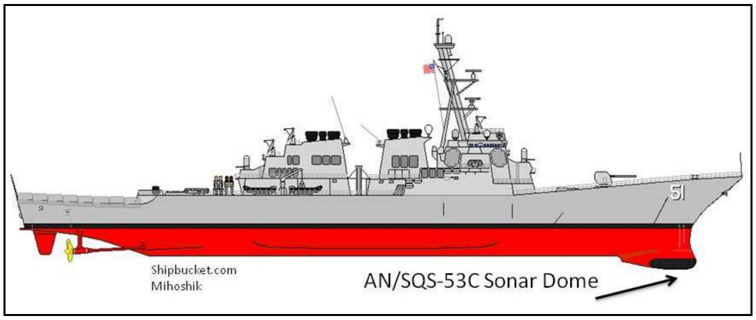

Figure 2.3-2: Guided Missile Destroyer with an AN/SQS-53 Sonar

- **Submarine Sonar Systems:** Submarines are equipped with hull-mounted mid-frequency and high-frequency active sonar used to detect and target enemy submarines and surface ships (Figure 2.3-3). A submarine's mission relies on its stealth; therefore, a submarine uses its active sonar sparingly because each sound emission gives away the submarine's location.

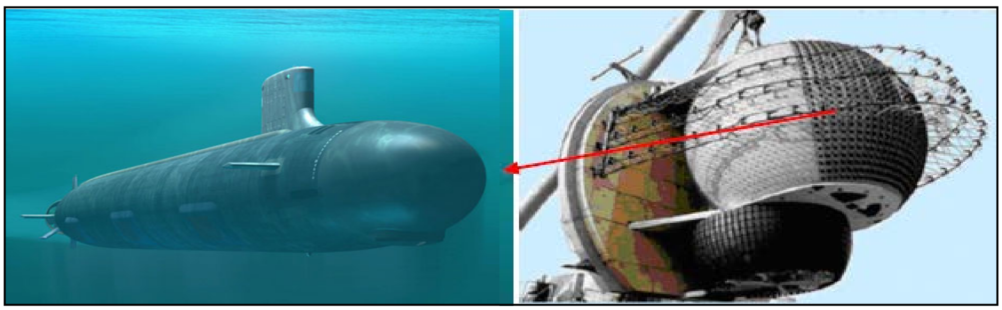

Figure 2.3-3: Submarine AN/BQQ-10 Active Sonar Array

- **Aircraft Sonar Systems:** Aircraft sonar systems include sonobuoys and dipping sonars.
    - **Sonobuoys:** Sonobuoys are expendable devices that contain a transmitter and a hydrophone. The sounds collected by the sonobuoy are transmitted back to the aircraft for analysis. Sonobuoys are either active or passive and allow for short and long-range detection of surface ships and submarines. These systems are deployed by both helicopter and fixed-wing patrol aircraft (Figure 2.3-4).

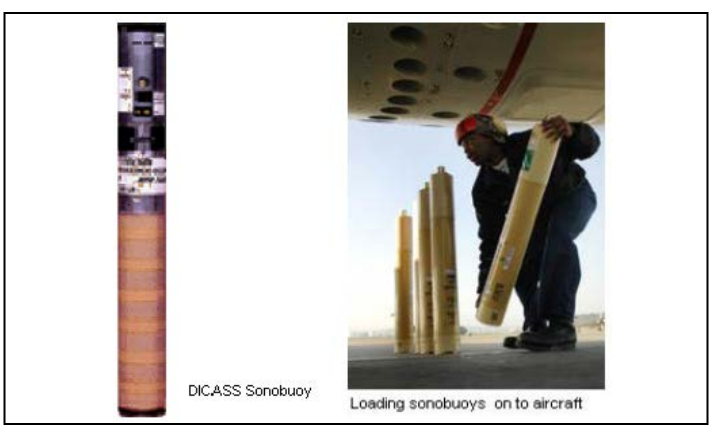

Figure 2.3-4: Sonobuoy (e.g., AN/SSQ-62)

- **Dipping Sonars:** Dipping sonars are recoverable devices lowered into the water via cable from manned and unmanned helicopters (Figure 2.3-5). The sonar detects underwater targets and determines the distance and movement of the target relative to the position of the helicopter.

Figure 2.3-5: Helicopter Deploys Dipping Sonar

- **Exercise Torpedoes:** Surface ships, aircraft, and submarines primarily use torpedoes in anti-submarine warfare (Figure 2.3-6). Recoverable, non-explosive torpedoes, categorized as either lightweight or heavyweight, are used during training and testing. Heavyweight torpedoes use a guidance system to operate the torpedo autonomously or remotely through an attached wire (guidance wire). The autonomous guidance systems operate either passively (listening for sounds generated by the target) or actively (pinging to search for the target). Torpedo training in the Study Area is mostly simulated—solid masses that approximate the weight and shape of a torpedo are fired, rather than fully functional torpedoes. Testing in the Study Area mostly uses fully functional exercise torpedoes.

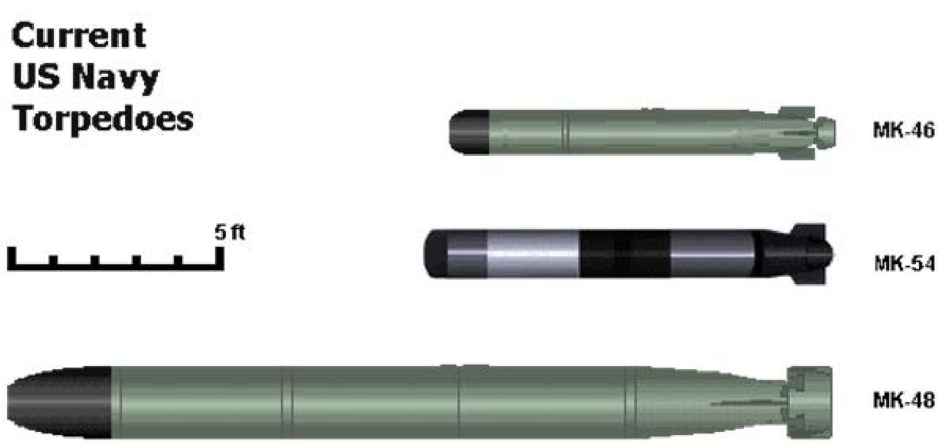

Figure 2.3-6: Current United States Navy Torpedoes

- **Acoustic Countermeasures:** Countermeasure devices are towed or free-floating noisemakers that alter the acoustic signature of a Navy ship or submarine (Figure 2.3-7) to avoid detection. In addition, countermeasures act as an alternative target for an incoming threat, such as a torpedo. Countermeasures are either expendable or recoverable.

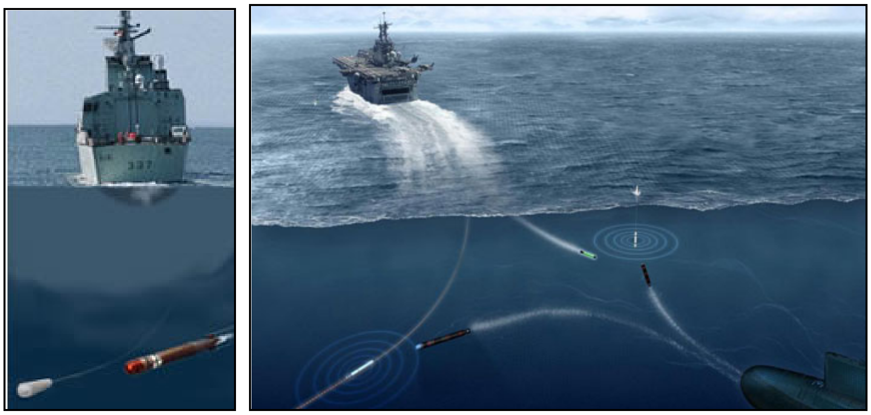

Figure 2.3-7: Acoustic Countermeasures

- **Anti-Submarine Warfare Training Targets:** Anti-submarine warfare training targets are autonomous undersea vehicles used to simulate target submarines (Figure 2.3-8). The training targets are equipped with one or more of the following devices: (1) acoustic projectors emitting sounds to simulate submarine acoustic signatures, (2) echo repeaters to simulate the characteristics of the echo of a sonar signal reflected from a submarine, and (3) magnetic sources that mimic those of a submarine.

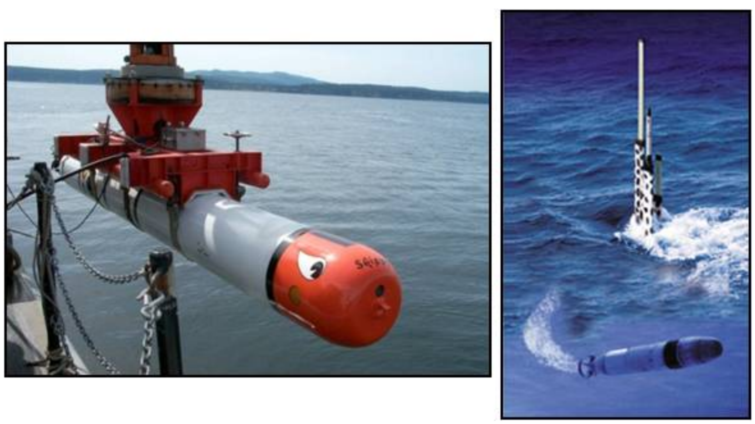

Figure 2.3-8: Anti-Submarine Warfare Training Targets
(Source: Graphic on right side from Lockheed Martin)

Mine Warfare. Mine warfare training and testing activities use a variety of different sonar systems that are typically high frequency (greater than 10 kHz) and very high-frequency (greater than 180 kHz). These sonar systems are used to detect, locate, and characterize moored and bottom mines (Figure 2.3-9). The majority of mine warfare sonar sensors can be deployed by more than one platform (i.e., helicopter, unmanned underwater vehicle, or surface ship) and may be interchangeable among platforms. Surface ships and submarines use sonar to detect mines and objects and minesweeping ships use a specialized variable-depth mine detection and classification high-frequency active sonar system to detect mines.

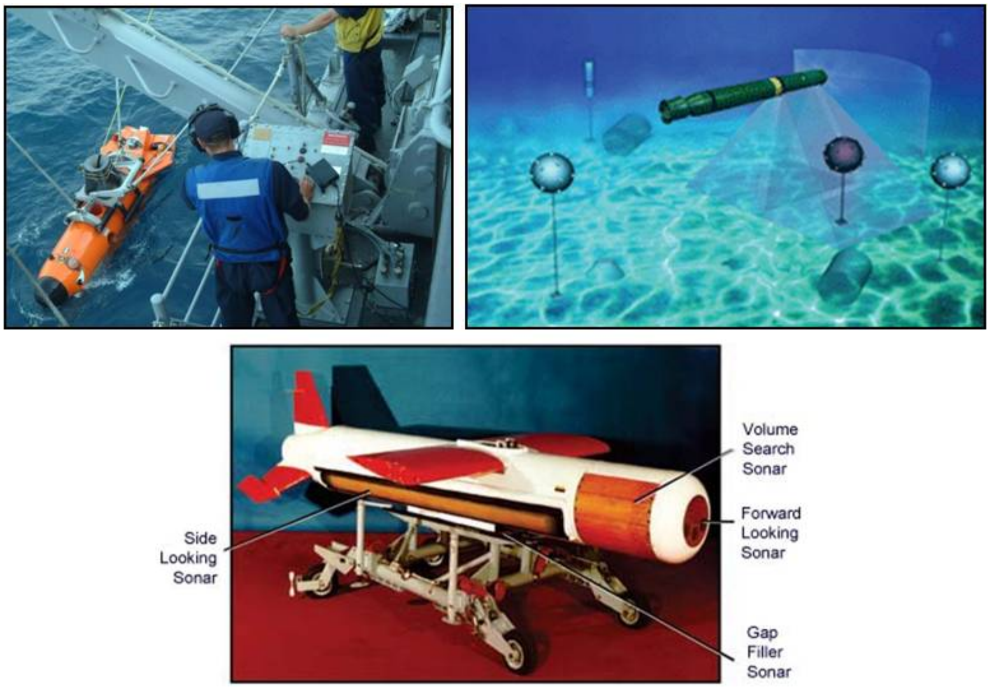

Figure 2.3-9: Mine Warfare Systems

Safety, Navigation, Communications, and Oceanographic Systems. Naval ships, submarines, and unmanned surface and subsurface vehicles rely on equipment and instrumentation that use active sonar during both routine operations and training and testing events. Sonar systems are used to gauge water depth, detect and map objects, navigational hazards, and the ocean floor, and transmit communication signals.

Other Acoustic Sensors. The Navy uses a variety of other acoustic sensors to protect ships anchored or at the pier, as well as shore facilities. These systems, both active and passive, detect potentially hostile swimmers, broadcast warnings to alert Navy divers of potential hazards, and gather information regarding ocean characteristics (ocean currents and wave measurements). They are generally stationary systems in Navy harbors and piers. Navy marine mammals (Atlantic bottlenose dolphins [*Tursiops truncatus*] and California sea lions [*Zalophus californianus*]) are also used to detect hostile swimmers around Navy facilities. A trained animal is deployed under behavioral control of a handler to find an intruding swimmer. Upon finding the “target” of the search, the animal returns to the boat and alerts the animal handlers, and the animals are given a localization marker or leg cuff that they attach to the intruder. Swimmers that have been marked with a leg cuff are reeled in by security support boat personnel via a line attached to the cuff. In addition, the Navy’s research and acquisition community uses various sensors for tracking during testing activities and to collect data for test analysis.

2.3.2 ORDNANCE/MUNITIONS

Most ordnance and munitions used during training and testing events fall into three basic categories: projectiles, missiles, and bombs. Ordnance can be further defined by their net explosive weight, which is the actual weight in pounds of the explosive substance without the packaging, casings, bullets, etc. Net explosive weight is also the trinitrotoluene (TNT) equivalent of energetic material, which is the standard measure of strength of bombs and other explosives. For example, a 2,000-pound (lb.) (907 kg) bomb may have anywhere from 600 to 1,000 lb. (272 to 454 kg) of net explosive weight.

Projectiles. Projectiles are fired during gunnery exercises from a variety of weapons, including pistols and rifles to large-caliber, turret-mounted guns on the decks of Navy ships. Projectiles can be either high-explosive munitions (e.g., certain cannon shells), or non-explosive practice munitions (e.g., rifle/pistol bullets). Explosive rounds can be fused to either explode on impact or in the air (i.e., just prior to impact). Projectiles are broken down into three basic categories in this EIS/OEIS:

- **Small-Caliber Projectiles:** These projectiles are up to and including .50 caliber (approximately 1/2 inch [in.] diameter). Small-caliber projectiles (e.g., bullets), are primarily fired from pistols, rifles, and machine guns (i.e., small arms) and mostly during training events for an individual Sailor to become and remain proficient (Figure 2.3-10).

Figure 2.3-10: Shipboard Small Arms Training

- **Medium-Caliber Projectiles:** These projectiles are larger than .50 caliber, but smaller than 57 millimeter (mm) (approximately 2-1/4 in. diameter). The most common size medium- caliber projectiles are 20 mm, 25 mm, and 40 mm. Medium-caliber projectiles are fired from machine guns operated by one to two crewman and mounted on the deck of a ship, wing-mounted guns on aircraft, and fully automated guns mounted on ships for defense against missile attack (Figure 2.3-11). Medium-caliber projectiles also include 40 mm grenades, which can be fired from hand-held grenade launchers or crew-served deck-mounted guns. Medium-caliber projectiles can be non-explosive practice munitions or high-explosive projectiles. High-explosive projectiles are usually fused to detonate on impact; however, advanced high-explosive projectiles can detonate based on time, distance, or proximity to a target.

Figure 2.3-11: Shipboard Medium-Caliber Guns

- **Large-Caliber Projectiles:** These includes projectiles 57 mm and larger. The largest projectile currently in service has a 5 in. (12.7 centimeter [cm]) diameter, but larger weapons are under development. The most widely used large-caliber projectiles are 57 mm, 76 mm, and 5 in. (12.7 cm) (Figure 2.3-12). The most common 5-in. (12.7-cm) projectile is approximately 26 in. (66 cm) long and weighs 70 lb. (31.8 kg). Large-caliber projectiles are fired exclusively from turret-mounted guns located on ship decks and can be used to fire on surface ships and boats, in defense against missiles and aircraft, and against land-based targets. Large-caliber projectiles can be non-explosive practice munitions or high-explosive munitions. High-explosive projectiles can detonate on impact or in the air.

Figure 2.3-12: Shipboard Large-Caliber Gun and Projectiles

Missiles. Missiles are rocket or jet-propelled munitions used to attack ships, aircraft, and land-based targets, as well as defend ships against other missiles. Guidance systems and advanced fusing technology ensure that missiles reliably impact on or detonate near their intended target. Missiles are categorized according to their intended target, as described below, and can be further classified according to net explosive weight. Rockets are included within the category of missiles.

- **Anti-Air Missiles:** Anti-air missiles are fired from ships and aircraft against enemy aircraft and incoming missiles (Figure 2.3-13). Anti-air missiles are configured to explode near, or on impact with their intended target. Missiles are the primary ship-based defense against incoming missiles.

Figure 2.3-13: Rolling Airframe Missile and Air-to-Air Missile

- **Anti-Surface Missiles:** Anti-surface missiles are fired from aircraft, ships, and submarines against surface ships (Figure 2.3-14). Anti-surface missiles are typically configured to detonate on impact or just above the intended target.

Figure 2.3-14: Anti-Surface Missile Fired from MH-60 Helicopter

- **Strike Missiles:** Strike missiles are fired from aircraft, ships, and submarines against land-based targets. Strike missiles are typically configured to detonate on impact or near their intended target. The AGM-88 High-speed Anti-Radiation Missile, used to destroy enemy radar sites, is an example of a strike missile used during at-sea training, and is fired at a floating sea-borne target that replicates a land-based radar site.

Bombs. Bombs are unpowered munitions dropped from aircraft on land and water targets. The majority of bombs used during training and testing in the Study Area are non-explosive. However, explosive munitions are occasionally used for proficiency inspections and testing requirements. Bombs are in two categories: general-purpose bombs and subscale practice bombs. Similar to missiles, bombs are further classified according to the net explosive weight of the bomb.

- **General-Purpose Bombs:** General-purpose bombs consist of precision-guided and unguided full-scale bombs, ranging in size from 250 to 2,000 lb. (Figure 2.3-15). Common bomb nomenclature used includes: MK 80 series, which is the Navy's standard model; Guided Bomb Units and Joint Direct Attack Munitions, which are precision guided (including laser guided) bombs; and the Joint Standoff weapon, which is a long-range "glider" precision weapon. General-purpose bombs can be either non-explosive practice munitions or high-explosive.

Figure 2.3-15: F/A-18 Bomb Release and Loading General Purpose Bombs

- **Subscale Bombs:** Subscale bombs (Figure 2.3-16) are non-explosive practice munitions containing a spotting (smoke) charge to aid in scoring the accuracy of hitting the target during training and testing activities. Common subscale bombs are 25 lb. (11.3 kg) and less and are steel-constructed. Laser guided training rounds are another variation of a subscale practice bomb. They weigh approximately 100 lb. and are cost-effective non-explosive weapons used in training aircrew in laser-guided weapons employment.

Figure 2.3-16: Subscale Bombs for Training

Other Munitions. There are other munitions and ordnance used in naval at-sea training and testing events that do not fit into one of the above categories, and are discussed below:

- **Ship Shock Charges:** Ship shock trials use various sizes of underwater explosives to send a shock wave through a ship's hull to simulate near misses during combat. Four size classes of charges (ranging from 1,000 to 58,000 lb. net explosive weight) can be used in any combination during the execution of a shock trial.
- **Demolition Charges:** Divers place explosive charges in the marine environment during some training and testing activities. These activities may include the use of timed charges, in which the charge is placed, a timer is started, and the charge detonates at the set time. Munitions of up to 60-lb. blocks of composition 4 (C-4) plastic explosive, with the necessary detonators and cords, are used to support mine neutralization, demolition, and other warfare activities. All demolition charges are further classified according to the net explosive weight of the charge.
- **Anti-Swimmer Grenades:** Maritime security forces use hand grenades to defend against enemy scuba divers.
- **Torpedoes:** Explosive torpedoes are required in some training and testing events. Torpedoes are described as either lightweight or heavyweight and are further categorized according to the net explosive weight.
- **Extended Echo Ranging Sonobuoys:** Extended Echo Ranging sonobuoys include Improved Extended Echo Ranging sonobuoys and mini sound-source seeker sonobuoys that use explosive charges as the active sound source instead of electrically produced sounds.

2.3.3 TARGETS

Training and testing require an assortment of realistic and challenging targets. Targets vary from items as simple and ordinary as an empty steel drum used for small-caliber weapons training from the deck of a ship, to sophisticated, unmanned aerial drones used in air defense training. For this EIS/OEIS, targets are organized by warfare area.

- **Anti-Air Warfare Targets:** Anti-air warfare targets, tow target systems, and aerial targets, are used in training and testing events that involve detection, tracking, defending against, and attacking enemy missiles and aircraft. Aerial tow target systems include textile (nylon banner) and rigid (fiberglass shapes) towed targets used for gunnery events. Aerial targets include expendable rocket powered missiles and recoverable radio-controlled drones used for gunnery and missile exercises (Figure 2.3-17). Parachute flares are used as air-to-air missile targets. Manned high-performance aircraft may be used as targets—to test ship and aircraft defensive systems and procedures—without the actual firing of munitions.

Figure 2.3-17: Deployment and Recovery of Anti-Air Warfare Targets

- **Anti-Surface Warfare Targets:** Stationary and towed targets are used as anti-surface warfare targets during gunnery events. Targets include floating steel drums, inflatable shapes or target balloons (e.g., Killer Tomato™) (Figure 2.3-18), and towed sleds. Remote-controlled, high-speed targets, such as jet skis and motorboats, are also used (Figure 2.3-19).

Figure 2.3-18: Deploying a "Killer Tomato™" Floating Target

Figure 2.3-19: Ship Deployable Surface Target and High-Speed Maneuverable Seaborne Target

- **Anti-Submarine Warfare Targets:** Anti-submarine warfare uses multiple types of targets, including the following:
  - **Submarines:** Submarines may act as tracking and detection targets during training and testing events.
  - **Motorized Autonomous Targets:** Motorized autonomous targets simulate the acoustic and magnetic characteristics of a submarine, providing realism for exercises when a submarine is not available. These mobile targets resemble torpedoes, with some models designed for recovery and reuse, while other models are expendable.
  - **Stationary Artificial Targets:** Stationary targets either resemble submarine hulls or are simulated systems with acoustic properties of enemy submarines. These targets either rest on the sea floor or are suspended at varying depths in the water column.

2.3.4 Defensive Countermeasures

Naval forces depend on effective defensive countermeasures to protect against missile and torpedo attack. Defensive countermeasures are devices designed to confuse, distract, and confound precision-guided munitions. Defensive countermeasures are in three basic categories:

- **Chaff:** Chaff consists of reflective, aluminum-coated glass fibers used to obscure ships and aircraft from radar-guided systems. Chaff, which is stored in canisters, is either dispensed from aircraft or fired into the air from the decks of surface ships when an attack is imminent. The glass fibers create a radar cloud that masks the position of the ship or aircraft.
- **Flares:** 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 and fired from ships.
- **Acoustic Countermeasures:** Acoustic countermeasures are used by surface ships and submarines to defend against torpedo attack. Acoustic countermeasures are either released from ships and submarines or towed at a distance behind the ship.

2.3.5 MINE WARFARE SYSTEMS

Mine warfare systems are in two broad categories: mine detection and mine neutralization.

Mine Detection Systems. Mine detection systems are used to locate, classify, and map suspected mines. Once located, the mines can either be neutralized or avoided. These systems are specialized to either locate mines on the surface, in the water column, or on the sea floor.

- **Towed or Hull-Mounted Mine Detection Systems:** These detection systems use acoustic and laser or video sensors to locate and classify suspect mines. Helicopters, ships, and unmanned vehicles are used for towed systems, which can rapidly assess large areas (Figure 2.3-20).

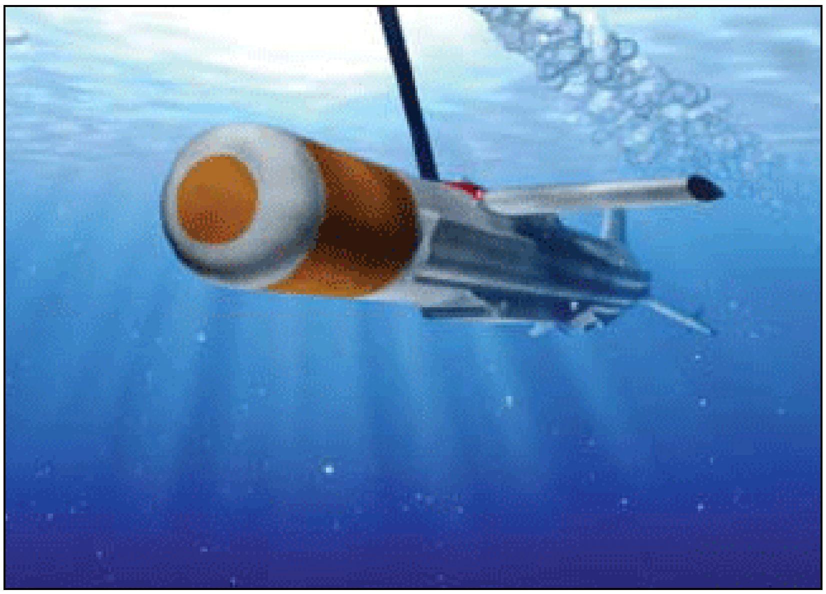

Figure 2.3-20: Towed Mine Detection System

- **Airborne Laser Mine Detection Systems:** Airborne laser detection systems work in concert with neutralization systems. The detection system initially locates mines and a neutralization system is then used to relocate and neutralize the mine (Figure 2.3-21).

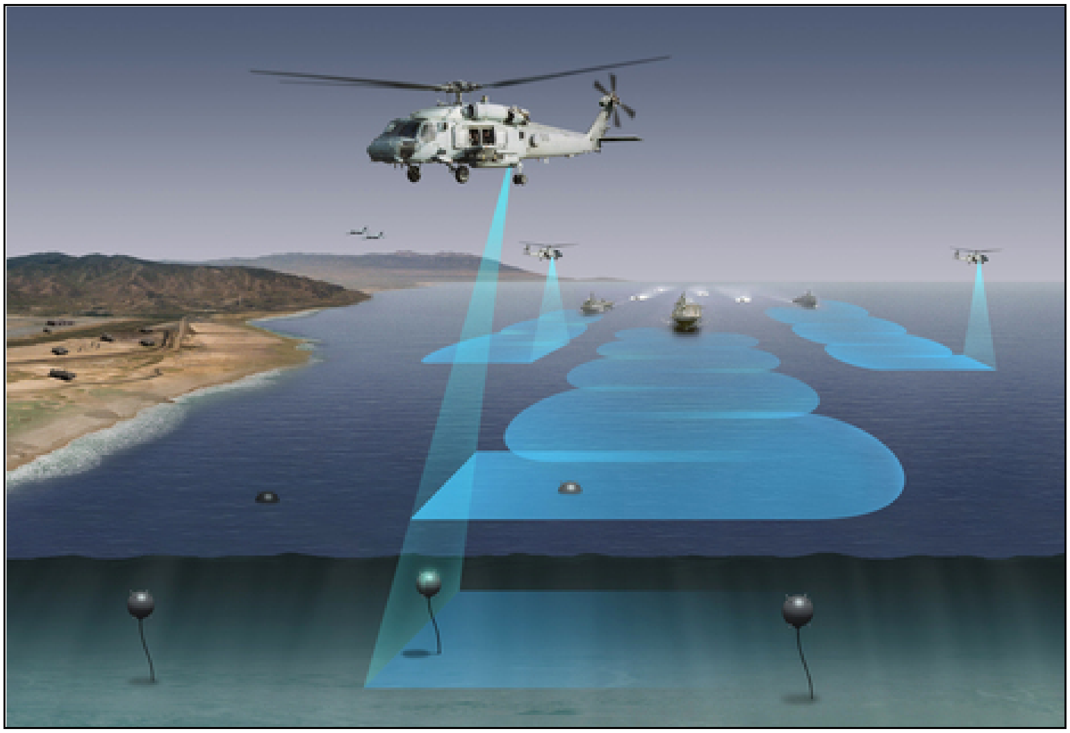

Figure 2.3-21: AN/AES-1 Airborne Laser Mine Detection System

- **Unmanned/Remotely Operated Vehicles:** These vehicles use acoustic and video or lasers to locate and classify mines. Unmanned/remotely operated vehicles provide unique mine warfare capabilities in nearshore littoral areas, surf zones, ports, and channels.
- **Marine Mammal System:** Navy personnel and Navy marine mammals work together to detect specified underwater objects. The Navy deploys trained bottlenose dolphins and California sea lions as part of the marine mammal minehunting and object recovery system.

Mine Neutralization Systems. These systems disrupt, disable, or detonate mines to clear ports and shipping lanes, as well as littoral, surf, and beach areas in support of naval amphibious operations. Mine neutralization systems can clear individual mines or a large number of mines quickly.

- **Towed Influence Mine Sweep Systems:** These systems use towed equipment that mimic a particular ship's magnetic and acoustic signature triggering the mine and causing it to explode (Figure 2.3-22).

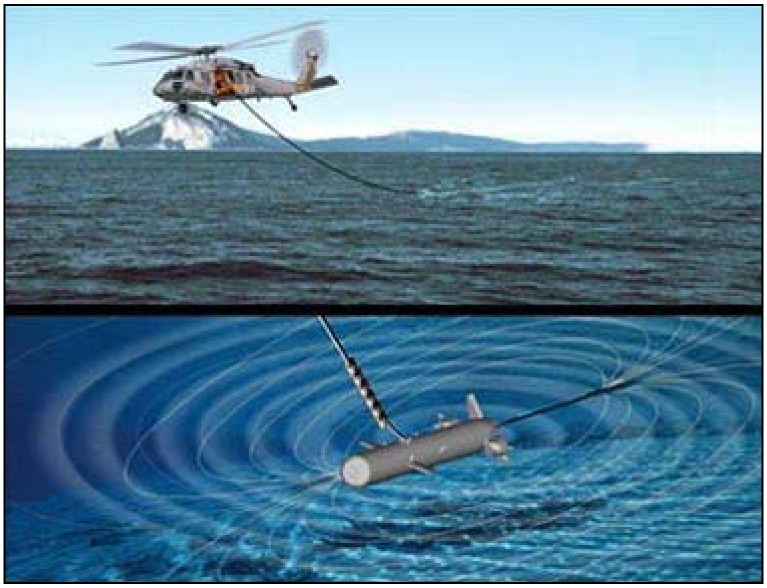

Figure 2.3-22: Organic and Surface Influence Sweep

- **Towed Mechanical Mine Sweeping Systems:** These systems tow a sweep wire to snag the line that attaches a moored mine to its anchor and then uses a series of cables and cutters to sever those lines. Once these lines are cut, the mines float to the surface where explosive ordnance personnel can neutralize the mines.
- **Unmanned/Remotely Operated Mine Neutralization Systems:** Surface ship and helicopters operate these systems, which place explosive charges near or directly against mines to destroy the mine (Figure 2.3-23).

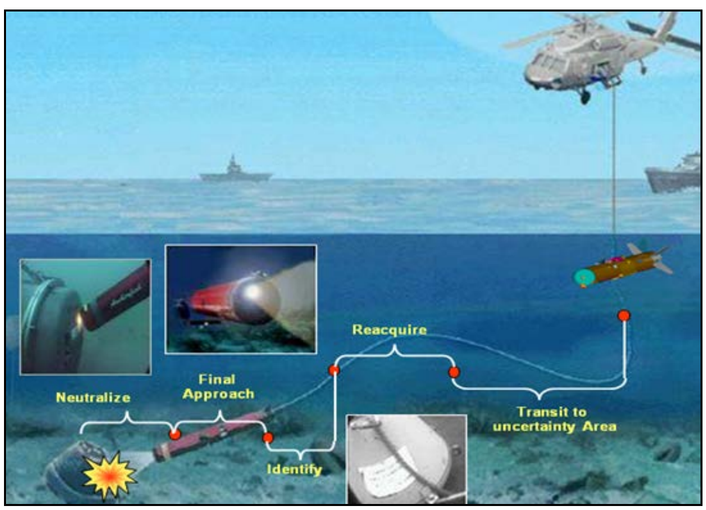

Figure 2.3-23: Airborne Mine Neutralization System

- **Projectiles:** Small- and medium-caliber projectiles fired from surface ships or hovering helicopters are used to neutralize floating and near-surface mines.
- **Diver Emplaced Explosive Charges:** Operating from small craft, divers place explosive charges, which may utilize time delay fusing, near or on mines to destroy the mine or disrupt its ability to function.

2.3.6 MILITARY EXPENDED MATERIALS

Navy training and testing events may introduce or expend various items, such as non-explosive munitions and targets, into the marine environment as a direct result of using these items for their intended purpose. In addition to the items described below, some accessory materials—related to the carriage or release of these items—may be released. These materials, referred to as military expended materials, are not recovered, and potentially result in environmental impacts. These impacts are analyzed in detail in Chapter 3 (Affected Environment and Environmental Consequences) of this EIS/OEIS. This section includes descriptions of a representative sample of military expended materials. A more comprehensive discussion can be found in Chapter 3 (Affected Environment and Environmental Consequences).

Military expended materials analyzed in this document include the following:

- **Sonobuoys:** Sonobuoys consist of parachutes and the sonobuoys themselves.
- **Torpedo Launch Accessories:** Torpedoes are usually recovered; however, materials such as parachutes used with air-dropped torpedoes, guidance wire used with submarine-launched torpedoes, and ballast weights are expended. Explosive filled torpedoes expend torpedo fragments.
- **Projectiles and Bombs:** Non-explosive projectiles, non-explosive bombs, or fragments from explosive projectiles and bombs are expended during training and testing exercises. These items are primarily constructed of lead (most small-caliber projectiles) or steel (medium- and large-caliber projectiles and all bombs).
- **Missiles and Rockets:** Non-explosive missiles and missile fragments from explosive missiles are expended during training and testing events. Propellant, and any explosive material involved, is consumed during firing/detonation. Some missiles include a wire, which is also expended. Rockets are similar to missiles and both non-explosive and fragments may be expended.
- **Countermeasures:** Countermeasures (acoustic, chaff, flares) are expended as a result of training exercises, with the exception of towed acoustic countermeasures. Chaff activities also include an expended canister, end caps, and pistons. Flares expend only end caps and pistons.
- **Targets:** Some targets are designed to be expended; other targets, such as aerial drones and remote-controlled boats, are recovered for re-use. Targets struck with ordnance will result in target fragments.

2.3.7 CLASSIFICATION OF ACOUSTIC AND EXPLOSIVE SOURCES

In order to better organize and facilitate the analysis of approximately 300 individual sources of underwater acoustic sound or explosive energy, a series of source classifications, or source bins, were developed. The use of source classification bins provides the following benefits:

- provides the ability for new sensors or munitions to be covered under existing authorizations, as long as those sources fall within the parameters of a "bin;"
- simplifies the source utilization data collection and reporting requirements anticipated under the MMPA authorizations;
- ensures a conservative approach to all impact estimates, as all sources within a given class are modeled as the loudest source (lowest frequency, highest source level, longest duty cycle, or largest net explosive weight) within that bin;
- allows analysis to be conducted in a more efficient manner, without any compromise of analytical results; and

- provides a framework to support the reallocation of source usage (hours/explosives) between different source bins, as long as the total numbers of takes remain within the overall analyzed and authorized limits. This flexibility is required to support evolving Navy training and testing requirements, which are linked to real world events.

There are two primary types of source classes: impulsive and non-impulsive acoustic. A description of each source classification is provided in Tables 2.3-1 and 2.3-2. Impulsive bins are based on the net explosive weight of the munitions or explosive devices or the source level for air and water guns. Non-impulsive acoustic sources are grouped into bins based on the frequency[4], source level[5], and when warranted, the application in which the source would be used. The following factors further describe the considerations associated with the development of active acoustic source classifications:

- Frequency of the non-impulsive acoustic source.
  - Low-frequency sources operate below 1 kHz
  - Mid-frequency sources operate at and above 1 kHz, up to and including 10 kHz
  - High-frequency sources operate above 10 kHz, up to and including 100 kHz
  - Very high-frequency sources operate above 100 kHz but below 200 kHz
- Decibel (dB) level of the non-impulsive acoustic source.
  - Greater than 160 dB, but less than 180 dB
  - Equal to 180 dB and up to 200 dB
  - Greater than 200 dB
- Application in which the source would be used.
  - How a sensor is employed supports how the sensor's acoustic emissions are analyzed.
  - Factors considered include pulse length (time source is "on"); beam pattern (whether sound is emitted as a narrow, focused beam, or, as with most explosives, in all directions); and duty cycle (how often or how many times a transmission occurs in a given period during an event).

[4] Bins are based on the typical center frequency of the source. Although harmonics may be present, those harmonics would be several dB lower than the primary frequency.
[5] Source decibel levels are expressed in terms of sound pressure level and are values given in decibels (dB) referenced to one microPascal (µPa) at one meter. Information regarding acoustic sources is provided in more detail in Section 3.0.5.3.1 (Acoustic Stressors).

Table 2.3-1: Training and Testing Non-Impulsive Acoustic Sources Used in the Atlantic Fleet Training and Testing Study Area

Source Class Category	Source Class	Description
Low-Frequency (LF): Sources that produce low-frequency (less than 1 kHz) signals.	LF3	Low-frequency sources greater than 200 dB
	LF4	Low-frequency sources equal to 180 dB and up to 200 dB
	LF5	Low-frequency sources greater than 160 dB, but less than 180 dB
Mid-Frequency (MF): Tactical and non-tactical sources that produce mid-frequency (1 to 10 kHz) signals.	MF1	Hull-mounted surface ship sonars (e.g., AN/SQS-53C and AN/SQS-60)
	MF1K	Kingfisher mode associated with MF1 sonars
	MF2	Hull-mounted surface ship sonars (e.g., AN/SQS-56)
	MF2K	Kingfisher mode associated with MF2 sonars
	MF3	Hull-mounted submarine sonars (e.g., AN/BQQ-10)
	MF4	Helicopter-deployed dipping sonars (e.g., AN/AQS-22 and AN/AQS-13)
	MF5	Active acoustic sonobuoys (e.g., DICASS)
	MF6	Active underwater sound signal devices (e.g., MK 84)
	MF8	Active sources (greater than 200 dB) not otherwise binned
	MF9	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned
	MF10	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned
	MF11	Hull-mounted surface ship sonars with an active duty cycle greater than 80%
	MF12	Towed array surface ship sonars with an active duty cycle greater than 80%
High-Frequency (HF): Tactical and non-tactical sources that produce high-frequency (greater than 10 kHz but less than 200 kHz) signals.	HF1	Hull-mounted submarine sonars (e.g., AN/BQQ-10)
	HF2	High-Frequency Marine Mammal Monitoring System
	HF3	Other hull-mounted submarine sonars (classified)
	HF4	Mine detection and classification sonar (e.g., AN/AQS-20)
	HF5	Active sources (greater than 200 dB) not otherwise binned
	HF6	Active sources (equal to 180 dB and up to 200 dB) not otherwise binned
	HF7	Active sources (greater than 160 dB, but less than 180 dB) not otherwise binned
	HF8	Hull-mounted surface ship sonars (e.g., AN/SQS-61)
Anti-Submarine Warfare (ASW): Tactical sources such as active sonobuoys and acoustic countermeasures systems used during the conduct of anti-submarine warfare training and testing activities.	ASW1	Mid-Frequency Deep Water Active Distributed System (DWADS)
	ASW2	Mid-Frequency Multistatic Active Coherent sonobuoy (e.g., AN/SSQ-125)
	ASW3	Mid-frequency towed active acoustic countermeasure systems (e.g., AN/SLQ-25)
	ASW4	Mid-frequency expendable active acoustic device countermeasures (e.g., MK 3)

Table 2.3-1: Training and Testing Non-Impulsive Acoustic Sources Used in the Atlantic Fleet Training and Testing Study Area (Continued)

Source Class Category	Source Class	Description
Torpedoes (TORP): Source classes associated with the active acoustic signals produced by torpedoes.	TORP1	Lightweight torpedo (e.g., MK 46, MK 54, or Anti-Torpedo Torpedo)
	TORP2	Heavyweight torpedo (e.g., MK 48)
Doppler Sonars (DS): Sonars that use the Doppler effect to aid in navigation or collect oceanographic information.	DS1	Low-frequency Doppler sonar (e.g., Webb Tomography Source)
Forward Looking Sonar (FLS): Forward or upward looking object avoidance sonars.	FLS2 – FLS3	High-frequency sources with short pulse lengths, narrow beam widths, and focused beam patterns used for navigation and safety of ships
Acoustic Modems (M): Systems used to transmit data acoustically through the water.	M3	Mid-frequency acoustic modems (greater than 190 dB)
Swimmer Detection Sonars (SD): Systems used to detect divers and submerged swimmers.	SD1 – SD2	High-frequency sources with short pulse lengths, used for detection of swimmers and other objects for the purpose of port security
Airguns (AG): Underwater airguns used during swimmer defense and diver deterrent training and testing activities.	AG	Up to 60 cubic inch airguns (e.g., Sercel Mini-G)
Synthetic Aperture Sonars (SAS): Sonars in which active acoustic signals are post-processed to form high-resolution images of the seafloor.	SAS1	MF SAS systems
	SAS2	HF SAS systems
	SAS3	VHF SAS systems

Table 2.3-2: Training and Testing Explosive Sources Used in the Study Area

Source Class	Representative Munitions	Net Explosive Weight[1] (lb.)
E1	Medium-caliber projectiles	0.1-0.25
E2	Medium-caliber projectiles	0.26-0.5
E3	Large-caliber projectiles	0.6-2.5
E4	Improved Extended Echo Ranging sonobuoy	2.6-5
E5	5-in. projectiles	6-10
E6	15-lb. shaped charge	11-20
E7	40-demo block/shaped charge	21-60
E8	250-lb. bomb	61-100
E9	500-lb. bomb	101-250
E10	1,000-lb. bomb	251-500
E11	650-lb. mine	501-650
E12	2,000-lb. bomb	651-1,000
E13	1,200-lb. HBX[2] charge	1,001-1,740
E14	2,500-lb. HBX charge	1,741-3,625
E15	5,000-lb. HBX charge	3,626-7,250
E16	10,000-lb. HBX charge	7,251-14,500
E17	40,000-lb. HBX charge	14,501-58,000

[1] Net Explosive Weight refers to the amount of explosives; the actual weight of a munition may be larger due to other components
[2] HBX: High Blast Explosive family of binary explosives composed of Royal Demolition Explosive (RDX) (explosive nitroamine), TNT, powdered aluminum, and D-2 wax with calcium chloride

2.3.7.1 Sources Qualitatively Analyzed

There are in-water active 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, which are not anticipated to result in takes of protected species and, therefore, are not required to be quantitatively analyzed. These sources will be categorized as *de minimis* sources and will be qualitatively analyzed to determine the appropriate determinations under NEPA, the MMPA, and the ESA. When used during routine training and testing activities, and in a typical environment, *de minimis* sources generally meet one or more of the following criteria:

- Acoustic source classes listed in Table 2.3-3 (actual source parameters listed in the classified bin list)
- Acoustic sources that transmit primarily above 200 kilohertz (kHz)
- Sources operated with source levels of 160 decibels (dB ref 1µPa) or less

The types of sources with source levels less than 160 dB are typically hand-held sonars, range pingers, transponders, and acoustic communication devices. Assuming spherical spreading for a 160 dB source, the sound will attenuate to less than 140 dB within 10 meters (m), and less than 120 dB within 100 m of the source. Using the behavioral risk function equation:

$$R = \frac{1 - \left(\frac{L - B}{K}\right)^{-A}}{1 - \left(\frac{L - B}{K}\right)^{-2A}}$$

where,

R = risk (0-1.0)
L = received level (RL) in dB (140 dB)
B = basement RL in dB (120 dB)
K = RL increment above basement with 50 percent risk (45 dB)
A = risk transition sharpness

For odontocetes, pinnipeds, manatees, sea otters, and polar bears, A = 10, therefore, R = 0.0003, or 0.03 percent risk. For mysticetes, A = 8, therefore, R = 0.0015, or 0.15 percent risk.

Therefore:

- For all marine mammals subject to a behavioral risk function, these sources will not significantly increase the number of potential exposures as determined by the effects criteria.
- For beaked whales, the range to 140 dB behavioral threshold from a 160 dB source is 10 meters. The likelihood of any potential behavioral effect is low because of the small affected area and the relative low density of beaked whales.
- For harbor porpoises, there will be a 100 m zone from the source to 120 dB behavioral threshold. Based on the above discussion and the extremely short propagation ranges to 120 dB, the potential for exposures that would result in changes to behavioral patterns to an extent where those patterns are abandoned or significantly altered is unlikely.
- For sea turtles, the behavioral threshold of 175 dB is above the 160 dB source level, and therefore no behavioral effect would be expected.
- Additionally, for all of the above calculations, absorption of sound in water is not a consideration but would increase the actual transmission losses and further reduce the low potential for exposures.

2.3.7.2 Source Classes Qualitatively Analyzed

An entire source bin, or some sources from a bin, may be excluded from quantitative analysis (Table 2.3-3) within the scope of this EIS/OEIS if one or more of the following criteria are met:

- The source is expected to result in responses that are short term and inconsequential based on system acoustic characteristics (e.g., short pulse length, narrow beamwidth, downward-directed beam) and manner of system operation.
- The sources are determined to meet the criteria specified in Section 2.3.7.1 (Sources Qualitatively Analyzed) or Table 2.3-3.
- Bins contain sources needed for safe operation and navigation.

Sources that meet these criteria are qualitatively analyzed in Table 2.3-3 to determine the appropriate determinations under NEPA, MMPA, and ESA (Table 2.3-3).

Table 2.3-3: Training and Testing Source Classes Excluded from Quantitative Analysis

Source Class Category	Source Class	Description
Fathometers High-frequency sources used to determine water depth	FA1 – FA4	Marine mammals are expected to exhibit no more than short-term and inconsequential responses to the sonar, profiler, or pinger given their characteristics (e.g., narrow downward-directed beam). Such reactions are not considered to constitute "taking" and, therefore, no additional quantitative modeling is required for marine species that might encounter these sound sources. Fathometers use a downward-directed, narrowly focused beam directly below the vessel (typically much less than 30 degrees), using a short pulse length (less than 10 milliseconds). Use of fathometers is required for safe operation of Navy vessels.
Hand-Held Sonar High-frequency sonar devices used by Navy divers for object location	HHS1	Hand-held sonars generate very high frequency sound at low power levels, short pulse lengths, and narrow beam widths. Because output from these sound sources would attenuate to below any current threshold for marine species at a very short range, and they are under positive control of the diver on which direction the sonar is pointed, marine species reactions are not likely. No additional quantitative modeling is required for marine species that might encounter these sound sources.
Doppler Sonar/Speed Logs Navigation equipment, downward focused, narrow beam width, high-frequency/very high-frequency spectrum utilizing very short pulse lengths	DS2, DS3, DS4	Marine species are expected to exhibit no more than short-term and inconsequential responses to the sonar, profiler, or pinger given their characteristics (e.g., narrow, downward-directed beam), which is focused directly beneath the platform. Such reactions are not considered to constitute "taking" and, therefore, no additional quantitative modeling is required for marine species that might encounter these sound sources.
Imaging Sonar (IMS) High-frequency or very high-frequency, very short pulse lengths, narrow bandwidths. IMS1 is a side-scan sonar (high-frequency/very high-frequency, narrow beams, downward directed). IMS2 is a downward looking source, narrow beam, and operates above 180 kHz (basically a fathometer)	IMS1, IMS2	These side scan sonars operate in a very high-frequency range (over 120 kHz) relative to marine mammal hearing (Richardson et al. 1995[1]; Southall et al. 2007[2]). The frequency range from these side scan sonars is beyond the hearing range of mysticetes (baleen whales) pinnipeds, manatees, and sea turtles and, therefore, not expected to affect these species in the Study Area. The frequency range from these side scan sonars falls within the upper end of the odontocete (toothed whale) hearing spectrum (Richardson et al. 1995[1]), which means they are not perceived as loud acoustic signals with frequencies below 120 kHz by these animals. Therefore, marine species may be less likely to react to these types of systems in a biologically significant way. Further, in addition to spreading loss for acoustic propagation in the water column, high-frequency acoustic energies are more quickly absorbed through the water column than sounds with lower frequencies (Urick 1983[3]). Additionally, these systems are generally operated in the vicinity of the sea floor, thus reducing the sound potential of exposure even more. Marine species are expected to exhibit no more than short-term and inconsequential responses to the imaging sonar given their characteristics (e.g., narrow, downward-directed beam and short pulse length [generally 20 milliseconds]). Such reactions are not considered to constitute "taking" and, therefore, no additional quantitative modeling is required for marine species that might encounter these sound sources.

Table 2.3-3: Training and Testing Source Classes Excluded from Quantitative Analysis (Continued)

Source Class Category	Source Class	Description
High-Frequency Acoustic Modems (M) and Tracking Pingers (P)	M2, P1, P2, P3, P4	Acoustic modems and tracking pingers operate at frequencies between 2 and 170 kHz, have low duty cycles (single pings in some cases), short pulse lengths (typically 20 milliseconds), and relatively low source levels. Marine species are expected to exhibit no more than short-term and inconsequential responses to these systems given the characteristics described above. Such reactions are not considered to constitute "taking" and, therefore, no additional quantitative modeling is required for animals that might encounter these sound sources
Acoustic Releases (R) Systems that transmit active acoustic signals to release a bottom-mounted object from its housing in order to retrieve the device at the surface	R1, R2, R3	Acoustic releases operate at mid and high frequencies. Because these types of devices are only used to retrieve bottom-mounted devices, they typically transmit only a single ping. Marine species are expected to exhibit no more than short-term and inconsequential responses to these sound sources given that any sound emitted is extremely short in duration. Such reactions are not considered to constitute "taking" and, therefore, no additional quantitative modeling is required for marine species that might encounter these sound sources.
Side-Scan Sonars (SSS) Sonars that use active acoustic signals to produce high-resolution images of the seafloor	SSS1, SSS2, SSS3	Marine species are expected to exhibit no more than short-term and inconsequential responses to these systems given the system characteristics such as a downward-directed beam and use of short pulse lengths (less than 20 milliseconds). Such reactions are not considered to constitute "taking" and, therefore, no additional quantitative modeling is required for marine species that might encounter these sound sources.
Small Impulsive Sources	Sources with explosive weights less than 0.1 lb. net explosive weight (less than bin E1)	Quantitative modeling in multiple locations has validated that these low-level impulsive sources are expected to cause no more than short-term and inconsequential responses in marine species due to the low explosive weight and corresponding very small zone of influence associated with these types of sources.

2.4 PROPOSED ACTIVITIES

The Navy has conducted military readiness activities throughout the northwest Atlantic Ocean and Gulf of Mexico for decades. The tempo and types of training and testing activities have fluctuated because of the introduction of new technologies, the evolving nature of international events, advances in warfighting doctrine and procedures, and force structure (organization of ships, weapons and personnel) changes. Such developments influenced the frequency, duration, intensity, and location of required training and testing activities. As discussed in Chapter 1 (Purpose and Need), training and testing activities were analyzed in the Tactical Theater Training Assessment Program Phase I documents. The proposed activities in this EIS/OEIS (Phase II) account for those factors that cause training and testing fluctuations in two ways. First, training and testing activities have evolved to meet changes to military readiness requirements. Second, this EIS/OEIS includes additional geographic areas where training and testing activities historically occur.

2.4.1 PROPOSED TRAINING ACTIVITIES

The training activities proposed by the Navy are described in Table 2.4-1. The table is organized according to primary mission areas and includes the activity name and a short description. Appendix A (Navy Activities Descriptions) has more detailed descriptions of the activities.

Table 2.4-1: Typical Training Activities in the Study Area

Activity Name	Activity Description
Anti-Air Warfare (AAW)	
Air Combat Maneuver (ACM)	Aircrews engage in flight maneuvers designed to gain a tactical advantage during combat.
Air Defense Exercises (ADEX)	Aircrew and ship crews conduct defensive measures against threat aircraft or missiles.
Gunnery Exercise (Air-to-Air) (GUNEX [A-A])	Aircrews defend against threat aircraft with cannons (machine gun).
Missile Exercise (Air-to-Air) (MISSILEX [A-A])	Aircrews defend against threat aircraft with missiles.
Gunnery Exercise (Surface-to-Air) (GUNEX [S-A])	Surface ship crews defend against threat missiles and aircraft with guns.
Missile Exercise (Surface-to-Air) (MISSILEX [S-A])	Surface ship crews defend against threat missiles and aircraft with missiles.
Amphibious Warfare (AMW)	
Naval Surface Fire Support Exercise – Land-based target (FIREX [Land])	Surface ship crews use large-caliber guns to fire on land-based targets in support of forces ashore.
Naval Surface Fire Support Exercise – At Sea (FIREX [At Sea])	Surface ship crews use large-caliber guns to support forces ashore; however, the land target is simulated at sea. Rounds impact the water and are scored by passive acoustic hydrophones located at or near the target area.
Marine Expeditionary Unit (MEU) Certification Exercise (CERTEX)	Amphibious Ready Group exercise conducted to validate the Marine expeditionary unit's readiness for deployment and includes small boat raids; visit, board, search, and seizure training; helicopter and mechanized amphibious raids; and a non-combatant evacuation operations.
Amphibious Assault	Forces move ashore from ships at sea for the immediate execution of inland objectives.
Amphibious Raid/Humanitarian Assistance Operations	Small unit forces move ashore swiftly from ships at sea for a specific short-term mission. These are quick operations with as few personnel as possible.

Table 2.4-1: Typical Training Activities in the Study Area (Continued)

Activity Name	Activity Description
Strike Warfare (STW)	
High-Speed Anti-Radiation Missile Exercise (Air- to- Surface) (HARMEX [A-S])	Aircrews launch a High-Speed Anti-Radiation Missile (HARM) against threat radar sites.
Anti-Surface Warfare (ASUW)	
Maritime Security Operations (MSO)	Helicopter and surface ship crews conduct a suite of maritime security operations (e.g., visit, board, search, and seizure; maritime interdiction operations; force protection; and anti-piracy operation).
Gunnery Exercise (Surface-to-Surface) (Ship) (GUNEX [S-S] – Ship)	Ship crews engage surface targets with ship's small-, medium-, and large-caliber guns.
Gunnery Exercise (Surface-to-Surface) (Boat) (GUNEX [S-S] – Boat)	Small boat crews engage surface targets with small- and medium-caliber guns.
Missile Exercise (Surface-to-Surface) (MISSILEX [S-S])	Surface ship crews defend against threat missiles and other surface ships with missiles.
Gunnery Exercise (Air-to-Surface) (GUNEX [A-S])	Fixed-wing and helicopter aircrews, including embarked personnel, use small- and medium-caliber guns to engage surface targets.
Missile Exercise (Air-to-Surface) (MISSILEX [A-S])	Fixed-wing and helicopter aircrews fire both precision-guided missiles and unguided rockets against surface targets.
Bombing Exercise (Air-to-Surface) (BOMBEX [A-S])	Fixed-wing aircrews deliver bombs against surface targets.
Laser Targeting	Fixed-winged, helicopter, and ship crews use single or multi-beam lasers to illuminate enemy targets or to defend against approaching hostile forces.
Sinking Exercise (SINKEX)	Aircraft, ship, and submarine crews deliver ordnance on a seaborne target, usually a deactivated ship, which is deliberately sunk using multiple weapon systems.
Anti-Submarine Warfare (ASW)	
Tracking Exercise/ Torpedo Exercise – Submarine (TRACKEX/TORPEX – Sub)	Submarine crews search, track, and detect submarines. Exercise torpedoes may be used during this event.
Tracking Exercise/ Torpedo Exercise – Surface (TRACKEX/TORPEX – Surface)	Surface ship crews search, track and detect submarines. Exercise torpedoes may be used during this event.
Tracking Exercise/ Torpedo Exercise – Helicopter (TRACKEX/TORPEX – Helo)	Helicopter crews search, detect and track submarines. Recoverable air launched torpedoes may be employed against submarine targets.
Tracking Exercise/ Torpedo Exercise – Maritime Patrol Aircraft (TRACKEX/TORPEX – MPA)	Maritime patrol aircraft crews search, detect, and track submarines. Recoverable air launched torpedoes may be employed against submarine targets.

Table 2.4-1: Typical Training Activities in the Study Area (Continued)

Activity Name	Activity Description
Tracking Exercise – Maritime Patrol Aircraft Extended Echo Ranging Sonobuoy (TRACKEX – MPA sonobuoy)	Maritime patrol aircraft crews search, detect, and track submarines with extended echo ranging sonobuoys. Recoverable air launched torpedoes may be employed against submarine targets.
Anti-Submarine Warfare Tactical Development Exercise	Multiple ships, aircraft and submarines coordinate their efforts to search, detect and track submarines with the use of all sensors. Anti-submarine warfare tactical development exercise is a dedicated anti-submarine warfare event.
Integrated Anti-Submarine Warfare Course (IAC)	Multiple ships, aircraft, and submarines coordinate the use of their sensors, including sonobuoys, to search, detect and track threat submarines. Integrated Anti-Submarine Warfare Course is an intermediate level training event and can occur in conjunction with other major exercises.
Group Sail	Multiple ships and helicopters integrate the use of sensors, including sonobuoys, to search, detect and track a threat submarine. Group sails are not dedicated anti-submarine warfare events and involve multiple warfare areas.
Anti-Submarine Warfare for Composite Training Unit Exercise (COMPTUEX)	Anti-submarine warfare activities conducted during a composite training unit exercise.
Anti-Submarine Warfare for Joint Task Force Exercise (JTFEX)/Sustainment Exercise (SUSTAINEX)	Anti-submarine warfare activities conducted during a joint task force exercise / sustainment exercise.
Electronic Warfare (EW)	
Electronic Warfare Operations (EW OPS)	Aircraft, surface ship and submarine crews attempt to control portions of the electromagnetic spectrum used by enemy systems to degrade or deny the enemy's ability to take defensive actions.
Counter Targeting – Flare Exercise (FLAREX)	Fixed-winged aircraft and helicopters crews defend against an attack by deploying flares to disrupt threat infrared missile guidance systems.
Counter Targeting – Chaff Exercise (CHAFFEX)	Surface ships, fixed-winged aircraft and helicopter crews defend against an attack by deploying chaff, a radar reflective material, which disrupt threat targeting and missile guidance radars.
Mine Warfare (MIW)	
Mine Countermeasures Exercise (MCM) – Ship Sonar	Littoral combat ship crews detect and avoid mines while navigating restricted areas or channels using active sonar.
Explosive Ordnance Disposal (EOD)/Mine Neutralization	Personnel disable threat mines. Explosive charges may be used.
Underwater Mine Countermeasures (UMCM) Raise, Tow, Beach and Exploitation Operations	Personnel recover moored mines, transfer the mines to shore, and disassemble them.
Mine Countermeasures -Towed Mine Neutralization	Ship crews and helicopter aircrews tow systems (e.g., Organic and Surface Influence Sweep, MK 104/105) through the water designed to disable and/or trigger mines.
Mine Countermeasures – Mine Detection	Ship crews and helicopter aircrews detect mines using towed and laser mine detection systems (e.g., AN/AQS-20, Airborne Laser Mine Detection System).

Table 2.4-1: Typical Training Activities in the Study Area (Continued)

Activity Name	Activity Description
Mine Countermeasures – Mine Neutralization	Ship crews and helicopter aircrews disable mines by firing small- and medium-caliber projectiles.
Mine Countermeasures – Mine Neutralization – Remotely Operated Vehicles	Ship crews and helicopter aircrews disable mines using remotely operated underwater vehicles.
Mine Laying	Fixed-winged aircraft and submarine crews drop/launch non-explosive mine shapes.
Coordinated Unit Level Helicopter Airborne Mine Countermeasure Exercises	Helicopters aircrew members train as a squadron in the use of airborne mine countermeasures, such as towed mine detection and neutralization systems.
Civilian Port Defense	Maritime security operations for military and civilian ports and harbors. Only the sonar portion of this activity is analyzed in this document. Marine mammal systems may be used during the exercise.
Major Exercises	
Composite Training Unit Exercise (COMPTUEX)	Intermediate level exercise designed to create a cohesive Strike Group prior to deployment or joint task force exercise. Typically seven surface ships, helicopters, maritime patrol aircraft, two submarines, and various unmanned vehicles. Marine mammal systems may be used during the exercise.
Joint Task Force Exercise (JTFEX)/ Sustainment Exercise (SUSTAINEX)	Final fleet exercise prior to deployment of the Strike Group. Serves as a ready-to-deploy certification for all units involved. Typically nine surface ships, helicopters, maritime patrol aircraft, two submarines, and various unmanned vehicles. Marine mammal systems may be used during the exercise.
Other Training Activities	
Search and Rescue (SAR)	Helicopter crews rescue military personnel at-sea.
Precision Anchoring	Ship crews train in releasing of anchors in designated locations.
Elevated Causeway System (ELCAS)	A temporary pier is constructed off the beach. Supporting pilings are driven into the sand and then later removed. The elevated causeway system is a portion of a larger activity, Joint Logistics Over the Shore (JLOTS) which is covered under separate documentation.
Submarine Navigation (SUB NAV)	Submarine crews locate underwater objects and ships while transiting in and out of port.
Submarine Navigation under Ice Certification	Submarine crews train to operate under ice. During training and certification other submarines and ships simulate ice.
Surface Ship Object Detection	Surface ship crews locate underwater objects that may impede transit in and out of port.
Surface Ship Sonar Maintenance	Pierside and at-sea maintenance of sonar systems.
Submarine Sonar Maintenance	Pierside and at-sea maintenance of sonar systems.

2.4.2 PROPOSED TESTING ACTIVITIES

The Navy's research and acquisition community engages in a broad spectrum of testing activities in support of the fleet. These activities include, but are not limited to, basic and applied scientific research and technology development; testing, evaluation, and maintenance of systems (missiles, radar, and sonar), and platforms (surface ships, submarines, and aircraft); and acquisition of systems and platforms to support Navy missions and give a technological edge over adversaries.

The individual commands within the research and acquisition community included in this EIS/OEIS are Naval Air Systems Command, Naval Sea Systems Command, and the Office of Naval Research and Naval Research Laboratory.

The Navy operates in an ever-changing strategic, tactical, and funding and time-constrained environment. Testing activities occur in response to emerging science or fleet operational needs. For example, future Navy experiments to develop a better understanding of ocean currents may be designed based on advancements made by non-government researchers not yet published in the scientific literature. Similarly, future but yet unknown Navy operations within a specific geographic area may require development of modified Navy assets to address local conditions. Such modifications must be tested in the field to ensure they meet fleet needs and requirements. Accordingly, generic descriptions of some of these activities are the best that can be articulated in a long-term, comprehensive document, like this EIS/OEIS.

Some testing activities are similar to training activities conducted by the fleet. For example, both the fleet and the research and acquisition community fire torpedoes. While the firing of a torpedo might look identical to an observer, the difference is in the purpose of the firing. The fleet might fire the torpedo to practice the procedures for such a firing, whereas the research and acquisition community might be assessing a new torpedo guidance technology or to ensure the torpedo meets performance specifications and operational requirements. These differences may result in different analysis and potential mitigations for the activity.

2.4.2.1 Naval Air Systems Command Testing Activities

Naval Air Systems Command testing activities generally fall in the primary mission areas used by the fleets. Naval Air Systems Command activities include, but are not limited to, the testing of new aircraft platforms, weapons, and systems before those platforms, weapons, and systems are integrated into the fleet. In addition to the testing of new platforms, weapons, and systems, Naval Air Systems Command also conducts lot acceptance testing of weapons and systems, such as sonobuoys.

The majority of testing and development activities conducted by Naval Air Systems Command are similar to fleet training events, and many platforms (e.g., the MH-60 helicopter) and systems (e.g., Airborne Towed Minehunting System [AN/AQS-20A]) currently being tested are already being used by the fleet or will ultimately be integrated into fleet training activities. However, some testing and development may be conducted in different locations and in a different manner than the fleet and, therefore, though the potential environmental effects may be the same, the analysis for those events may differ. Training with systems and platforms delivered to the fleet within the timeframe of this document are analyzed in the training sections of this EIS/OEIS. This section only addresses Naval Air Systems Command's testing activities, which are described in Table 2.4-2.

Table 2.4-2: Typical Naval Air Systems Command Testing Activities in the Study Area

Activity Name	Activity Description
Anti-Air Warfare (AAW)	
Air Combat Maneuver (ACM) Test	This event is identical to the air combat maneuver training event. Test events involve two or more aircraft, each engaged in continuous proactive and reactive changes in aircraft attitude, altitude, and airspeed. No weapons are fired during air combat maneuver test activities.
Air Platform/Vehicle Test	Testing performed to quantify the flying qualities, handling, airworthiness, stability, controllability, and integrity of an air platform or vehicle. No weapons are released during an air platform/vehicle test. In-flight refueling capabilities are tested.
Air Platform Weapons Integration Test	Testing performed to quantify the compatibility of weapons with the aircraft from which they would be launched or released. Mostly non-explosive weapons or shapes are used, but some tests may require the use of high-explosive weapons.
Air-to-Air (A-A) Weapons System Test	Test to evaluate the effectiveness of air-launched weapons against designated airborne targets. Fixed-wing or rotary-wing aircraft may be used. No testing of high-explosive weapons is planned.
Air-to-Air Missile Test	This event is similar to the training event missile exercise (air-to-air). Tests are a type of air-to-air weapon system test in which non-explosive practice air-to-air missiles are fired from fixed-wing aircraft against unmanned aerial drones such as BQM-34 and BQM-74.
Air-to-Air Gunnery Test	This event is similar to the training event gunnery exercise air-to-air. An air-to-air gunnery test involves the firing of guns from both fixed-wing and rotary-wing aircraft against a towed aerial banner which serves as the target. Typically non-explosive practice rounds are fired and the targets fired upon are unmanned aerial drones.
Intelligence, Surveillance, and Reconnaissance Test	Test to evaluate communications capabilities of fixed-wing and rotary-wing aircraft, including unmanned systems that can carry cameras, sensors, communications equipment, or other payloads. New systems are tested at sea to ensure proper communications between aircraft and ships.
Anti-Surface Warfare (ASUW)	
Air-to-Surface Missile Test	This event is similar to the training event missile exercise (air-to-surface). Test may involve both fixed-wing and rotary-wing aircraft launching missiles at surface maritime targets to evaluate the weapon system or as part of another systems integration test.
Air-to-Surface Gunnery Test	This event is similar to the training event gunnery exercise (air-to-surface). Strike fighter and helicopter aircrews evaluate new or enhanced aircraft guns against surface maritime targets to test that the gun, gun ammunition, or associated systems meet required specifications or to train aircrew in the operation of a new or enhanced weapon system.
Rocket Test	Rocket testing evaluates the integration, accuracy, performance, and safe separation of laser-guided and unguided 2.75-in. rockets fired from a hovering or forward flying helicopter or from a fixed-wing strike aircraft.
Air-to-Surface Bombing Test	This event is similar to the training event bombing exercise (air-to-surface). Strike fighter and maritime patrol aircraft test the delivery of non-explosive practice bombs against surface maritime targets with the goal of evaluating the bomb, the bomb carry and delivery system, and any associated systems that may have been newly developed or enhanced.
Laser Targeting Test	Aircrew use laser targeting devices integrated into aircraft or weapon systems to evaluate targeting accuracy and precision and to train aircrew in the use of newly developed or enhanced laser targeting devices. Lasers are designed to illuminate designated targets for engagement with laser-guided weapons.

Table 2.4-2: Typical Naval Air Systems Command Testing Activities in the Study Area (Continued)

Activity Name	Activity Description
High Energy Laser Weapons Test	High energy laser weapons tests evaluate the specifications, integration, and performance of an aircraft mounted, approximately 25 kW high energy laser. The laser is intended to be used as a weapon to disable small surface vessels.
Electronic Warfare (EW)	
Electronic Systems Evaluation	Test that evaluates the effectiveness of electronic systems to control, deny, or monitor critical portions of the electromagnetic spectrum. In general, electronic warfare testing will assess the performance of three types of electronic warfare systems: electronic attack, electronic protect, and electronic support.
Chaff Test	Similar to the training event counter targeting – chaff exercise, chaff tests evaluate newly developed or enhanced chaff, chaff dispensing equipment, or modified aircraft systems against chaff deployment. Tests may also train pilots and aircrew in the use of new chaff dispensing equipment. Chaff tests are often conducted with flare tests and air combat maneuver events, as well as other test events, and are not typically conducted as standalone tests.
Flare Test	Similar to the training event counter targeting – flare exercise, flare tests evaluate newly developed or enhanced flares, flare dispensing equipment, or modified aircraft systems against flare deployment. Tests may also train pilots and aircrew in the use of newly developed or modified flare deployment systems. Flare tests are often conducted with chaff tests and air combat maneuver events, as well as other test events, and are not typically conducted as standalone tests.
Anti-Submarine Warfare (ASW)	
Anti-Submarine Warfare Torpedo Test	This event is similar to the training event torpedo exercise. The test evaluates anti-submarine warfare systems onboard rotary-wing and fixed-wing aircraft and the ability to search for, detect, classify, localize, and track a submarine or similar target.
Kilo Dip	A kilo dip is the operational term used to describe a functional check of a helicopter deployed dipping sonar system. The sonar system is briefly activated to ensure all systems are functional. A kilo dip is simply a precursor to more comprehensive testing.
Sonobuoy Lot Acceptance Test	Sonobuoys are deployed from surface vessels and aircraft to verify the integrity and performance of a lot, or group, of sonobuoys in advance of delivery to the fleet for operational use.
Anti-Submarine Warfare Tracking Test—Helicopter	This event is similar to the training event anti-submarine warfare tracking exercise/torpedo exercise – helicopter. The test evaluates the sensors and systems used to detect and track submarines and to ensure that helicopter systems used to deploy the tracking systems perform to specifications.
Anti-Submarine Warfare Tracking Test—Maritime Patrol Aircraft	This event is similar to the training event anti-submarine warfare tracking exercise/torpedo exercise – maritime patrol aircraft extended echo ranging sonobuoy. The test evaluates the sensors and systems used by maritime patrol aircraft to detect and track submarines and to ensure that aircraft systems used to deploy the tracking systems perform to specifications and meet operational requirements.
Mine Warfare (MIW)	
Airborne Mine Neutralization System Test (AMNS)	Airborne mine neutralization tests of the Airborne Mine Neutralization System evaluate the system's ability to detect and destroy mines. The Airborne Mine Neutralization System uses up to four unmanned underwater vehicles equipped with high-frequency sonar, video cameras, and explosive neutralizers.
Airborne Projectile-Based Mine Clearance System Test	An MH-60 helicopter uses a laser-based detection system to search for mines and to fix mine locations for neutralization with an airborne projectile-based mine clearance system. The system neutralizes mines by firing a small- or medium-caliber inert, supercavitating projectile from a hovering helicopter.

Table 2.4-2: Typical Naval Air Systems Command Testing Activities in the Study Area (Continued)

Activity Name	Activity Description
Airborne Towed Minesweeping Test – AN/ALQ-220 (OASIS)	Tests of the Organic Airborne and Surface Influence Sweep (OASIS) would be conducted by a helicopter to evaluate the functionality of Organic Airborne and Surface Influence Sweep at sea. The Organic Airborne and Surface Influence Sweep is towed from a forward flying helicopter and works by emitting an electromagnetic field and mechanically generated underwater sound to simulate the presence of a ship. The sound and electromagnetic signature cause nearby mines to explode.
Airborne Towed Minehunting Sonar Test – AN/AQS-20A	Tests of the AN/AQS-20A to evaluate the search capabilities of this towed, mine hunting, detection, and classification system. The sonar on the AN/AQS-20A identifies mine-like objects in the deeper parts of the water column.
Airborne Laser-Based Mine Detection System Test (ALMDS)	An airborne mine hunting test of the AN/AES-1 Airborne Laser Mine Detection System, or "ALMDS" evaluates the system's ability to detect, classify, and fix the location of floating and near-surface, moored mines. The system uses a laser to locate mines and may operate in conjunction with an airborne projectile-based mine detection system to neutralize mines.
Mine Laying Test	Fixed-wing aircraft evaluate the performance of mine laying equipment and software systems to lay mines. A mine test may also train aircrew in laying mines using a new or enhanced mine deployment system.
Other Testing Activities	
Test and Evaluation Catapult Launch	Tests evaluate the function of aircraft carrier catapults at sea following enhancements, modifications, or repairs to catapult launch systems. This includes aircraft catapult launch tests. No weapons or other expendable materials would be released.
Air Platform Shipboard Integration Test	Tests evaluate the compatibility of aircraft and aircraft systems with ships and shipboard systems. Tests involve physical operations and verify and evaluate communications and tactical data links. This test function also includes an assessment of carrier-shipboard suitability and hazards of electromagnetic radiation to personnel, ordnance, and fuels.
Shipboard Electronic Systems Evaluation	Tests measure ship antenna radiation patterns and test communication systems with a variety of aircraft.
Maritime Security	Maritime patrol aircraft and helicopters participate in maritime security activities and fleet training events. Aircraft and surface ships identify, track, intercept, board, and inspect foreign merchant vessels suspected of not complying with United Nations/allied sanctions or conflict rules of engagement.

2.4.2.2 Naval Sea Systems Command Testing Activities

Naval Sea Systems Command testing activities (Table 2.4-3) are aligned with its mission of new ship construction, life cycle support, and weapon systems development. Each major category of Naval Sea Systems Command activities is described below.

2.4.2.2.1 New Ship Construction Activities

Ship construction activities include pierside testing of ship systems, tests to determine how the ship performs at sea (sea trials), and developmental and operational test and evaluation programs for new technologies and systems. Pierside and at-sea testing of systems aboard a ship may include sonar, acoustic countermeasures, radars, and radio equipment. In this EIS/OEIS, pierside testing at Navy contractor shipyards consists only of sonar systems. During sea trials, each new ship propulsion engine is operated at full power and subjected to high-speed runs and steering tests. At-sea test firing of shipboard weapon systems, including guns, torpedoes, and missiles, are also conducted.

2.4.2.2.2 Shock Trials

One ship of each new class (or major upgrade) of combat surface ships constructed for the Navy typically undergoes an at-sea shock trial. A shock trial is a series of underwater detonations that send a shock wave through the ship's hull to simulate near misses during combat. A shock trial allows the Navy to validate the shock hardness of the ship and assess the survivability of the hull and ship's systems in a combat environment as well as the capability of the ship to protect the crew.

2.4.2.2.3 Life Cycle Activities

Testing activities are conducted throughout the life cycle of a Navy ship to verify performance and mission capabilities. Sonar system testing occurs pierside during maintenance, repair, and overhaul availabilities, and at sea immediately following most major overhaul periods. A Combat System Ship Qualification Trial is conducted for new ships and for ships that have undergone modification or overhaul of their combat systems.

Radar cross signature testing of surface ships is conducted on new vessels and periodically throughout a ship’s life cycle to measure how detectable the ship is to radar. Additionally, electromagnetic measurements of off-board electromagnetic signatures are conducted for submarines, ships, and surface craft periodically.

2.4.2.2.4 Range Activities

Naval Sea Systems Command’s testing ranges are used to conduct principal testing, analysis, and assessment activities for ship and submarine platforms, including ordnance, mines, and machinery technology for surface combat systems. Naval Surface Warfare Center, Panama City Division Testing Range focuses on surface warfare tests that often involve mine countermeasures such as sonar operations, electromagnetic operations, laser operations, and ordnance/projectile operations. Naval Undersea Warfare Center Division, Newport Testing Range focuses on the undersea aspects of warfare and is, therefore, structured to test systems such as torpedoes and unmanned underwater vehicles. The South Florida Ocean Measurement Facility Testing Range retains a unique capability that focuses on signature analysis operations and mine warfare testing events.

2.4.2.2.5 Additional Activities Outside Naval Sea Systems Command Ranges

Numerous test activities and technical evaluations in support of Naval Sea Systems Command’s systems development mission occur outside the predefined boundaries of the Naval Sea Systems Command’s testing ranges and often in conjunction with fleet activities within the Study Area. Tests within this category include, but are not limited to, anti-surface warfare, anti-submarine warfare, and mine warfare tests using torpedoes, sonobuoys, and mine detection and neutralization systems.

Unique Naval Sea Systems Command planned testing includes a kinetic energy weapon, which uses electromagnetic energy to propel a round at a target, and alternative electromagnetic or directed energy devices. In addition, areas of potential increased future equipment and systems testing are swimmer detection systems, lasers, new radars, unmanned vehicles, and chemical-biological detectors.

Table 2.4-3: Typical Naval Sea Systems Command Testing Activities in the Study Area

Activity Name		Activity Description
Ship Construction and Maintenance		
New Ship Construction		
Surface Combatant Sea Trials	Pierside Sonar Testing	Ship's sonar systems are tested pierside to ensure proper operation.
	Propulsion Testing	Ship is run at high speeds in various formations (e.g., straight-line and reciprocal paths).
	Gun Testing	Gun systems are tested using non-explosive practice munitions.
	Missile Testing	Launching systems are tested using missiles fired at target drones.
	Decoy Testing	Includes testing of the MK 36 Decoy Launching system.
	Surface Warfare Testing – Large-Caliber	Ships defend against surface targets with large-caliber guns.
	Anti-Submarine Warfare Testing	Ships demonstrate capability of countermeasure systems and underwater surveillance and communications systems.
Aircraft Carrier Sea Trials	Propulsion Testing	Ship is run at high speeds in various formations (e.g., straight-line and reciprocal paths).
	Gun Testing – Small-Caliber	Small-caliber gun systems are tested using non-explosive rounds.
	Gun Testing – Medium-Caliber	Medium-caliber gun systems are tested using non-explosive and explosive rounds.
	Missile Testing	Missile systems are tested using explosive rounds.
	Bomb Testing	Non-explosive bombs are tested.
Submarine Sea Trials	Pierside Sonar Testing	Submarine's sonar systems are tested pierside to ensure proper operation.
	Propulsion Testing	Submarine is run at high speeds in various formations and at various depths.
	Weapons System Testing	Submarine weapons systems are tested by cycling water through them in lieu of actual weapons firing.
	Anti-Submarine Warfare Testing	Submarines demonstrate capability of underwater surveillance and communications systems.
Other Ship Class Sea Trials	Propulsion Testing	Ship is run at high speeds in various formations (e.g., straight-line and reciprocal paths).
	Gun Testing – Small-Caliber	Small-caliber gun systems are tested using non-explosive rounds.
Anti-Submarine Warfare Mission Package Testing		Ships and their supporting platforms (e.g., helicopters, unmanned aerial systems) detect, localize, and prosecute submarines.
Surface Warfare Mission Package Testing		Ships defend against surface targets with small-, medium-, and large-caliber guns and medium range missiles.
Mine Countermeasure Mission Package Testing		Ships conduct mine countermeasure operations.

Table 2.4-3: Typical Naval Sea Systems Command Testing Activities in the Study Area (Continued)

Event Name	Event Description
Post-Homeporting Testing (all classes)	Electronic, navigation, and refueling capabilities are tested.
Ship Shock Trials	Explosives are detonated underwater against surface ships.
Life Cycle Activities	
Ship Signature Testing	Ship and submarine radars and electromagnetic signatures are tested.
Surface Ship Sonar Testing/ Maintenance	Pierside and at-sea testing of ship systems occurs periodically following major maintenance periods and for routine maintenance.
Submarine Sonar Testing/ Maintenance	Pierside and at-sea testing of submarine systems occurs periodically following major maintenance periods and for routine maintenance.
Combat System Ship Qualification Trial (CSSQT) – In-Port Maintenance Period	All combat systems are tested to ensure they are functioning in a technically acceptable manner and are operationally ready to support at-sea CSSQT events.
Combat System Ship Qualification Trial (CSSQT) – Air Defense (AD)	Ship's capability to detect, identify, track, and successfully defend against live and simulated targets is tested.
Combat System Ship Qualification Trial (CSSQT) – Surface Warfare (SUW)	Capabilities of shipboard sensors to detect and track surface targets, relay the data to the gun weapon system, and defend against targets are tested.
Combat System Ship Qualification Trial (CSSQT) – Undersea Warfare (USW)	Ship's ability to track and defend against undersea targets is tested.
Naval Sea Systems Command Range Activities	
Naval Surface Warfare Center, Panama City Division Testing Range	
Air Operations	Various aircraft operations are conducted in support of other test activities.
Surface Operations	Surface vessel operations for deployment and recovery of mine warfare systems and testing of communication and propulsion systems are conducted.
Subsurface Operations	Subsurface operations include testing of underwater vehicles, items placed on the ocean floor, and diving activities.
Sonar Operations	Testing of sonar systems determines their capability to detect, locate, and characterize mine-like objects.
Electromagnetic Operations	Electromagnetic operations test an array of magnetic sensors used in mine countermeasure operations.
Laser Operations	Laser systems are tested to determine effectiveness as a tool to identify mine-like objects.
Ordnance Operations	Airborne, surface, organic (readily available units in place), and shallow water mine countermeasure systems are tested using explosive ordnance.
Projectile Firing	Airborne and surface crews defend against surface targets with small-, medium-, and large-caliber guns.
Unmanned Underwater Vehicles Demonstration	The performance of multiple unmanned underwater vehicles and associated acoustic, optical, and magnetic systems are tested and demonstrated.
Mine Detection and Classification Testing	Air, surface, and subsurface vessels detect and classify mines and mine-like objects.
Mine Countermeasure / Neutralization Testing	Air, surface, and subsurface vessels neutralize threat mines and mine-like objects.
Stationary Source Testing	Stationary equipment (including swimmer defense systems) is deployed to determine functionality.

Table 2.4-3: Typical Naval Sea Systems Command Testing Activities in the Study Area (Continued)

Event Name	Event Description
Special Warfare Testing	Submersibles capable of inserting and extracting personnel or payloads into denied areas from strategic distances are tested.
Unmanned Underwater Vehicle Testing	Unmanned underwater vehicles are deployed to evaluate hydrodynamic parameters, to full mission, multiple vehicle functionality assessments.
Ordnance Testing	Airborne and surface crews defend against surface targets with small-, medium-, and large-caliber guns, as well as line charge testing.
Naval Undersea Warfare Center Division, Newport Testing Range	
Launcher Testing	Launcher systems are tested to evaluate performance.
Torpedo Testing	Non-explosive practice torpedoes are launched to record operational data.
Towed Equipment Testing	Surface vessel or unmanned underwater vehicle deploys equipment to determine functionality of towed systems.
Unmanned Underwater Vehicle Testing	Unmanned underwater vehicles are deployed to evaluate hydrodynamic parameters, to full mission, multiple vehicle functionality assessments.
Unmanned Surface Vehicle Testing	Unmanned surface vehicles are deployed to verify the functionality of basic capabilities and complex tests that involve multiple participants and missions.
Unmanned Aerial System Testing	Unmanned aerial systems are launched to test the capability to perform intelligence, surveillance, and reconnaissance, and extend the communications range of unmanned underwater vehicles, unmanned surface vehicles, and submarines.
Semi-Stationary Equipment Testing	Semi-stationary equipment (e.g., a hydrophone) is deployed to determine functionality.
Unmanned Underwater Vehicle Demonstrations	The performance of multiple unmanned underwater vehicles and associated acoustic, optical, and magnetic systems is tested and demonstrated.
Pierside Integrated Swimmer Defense Testing	Swimmer defense testing ensures that systems can effectively detect, characterize, verify, and defend against swimmer/diver threats in harbor environments.
South Florida Ocean Measurement Facility Testing Range	
Signature Analysis Operations	Electromagnetic, acoustic, optical, and radar signature measurements of surface ships and submarines are tested.
Mine Testing Activities	Air, surface, and sub-surface systems detect, counter, and neutralize ocean-deployed mine-like objects.
Surface Testing Activities	Various surface vessels, moored equipment, and materials are tested to evaluate performance in the marine environment.
Subsurface Testing Activities	Various underwater, bottom crawling, robotic vehicles utilized in underwater search, recovery, installation, and scanning activities are tested.
Unmanned Underwater Vehicle Demonstrations	The performance of multiple unmanned underwater vehicles and associated acoustic, optical, and magnetic systems are tested and demonstrated.
Additional Activities at Locations Outside of Naval Sea Systems Command Ranges	
Anti-Surface Warfare (ASUW) / Anti-Submarine Warfare (ASW) Testing	
Missile Testing	Missile testing includes various missiles fired from submarines and surface combatants.
Kinetic Energy Weapon Testing	A kinetic energy weapon uses stored energy released in a burst to accelerate a non-explosive projectile.
Electronic Warfare Testing	Testing will include radiation of military and commercial radar and communication systems (or simulators).

Table 2.4-3: Typical Naval Sea Systems Command Testing Activities in the Study Area (Continued)

Event Name	Event Description
Torpedo (Non-Explosive) Testing	Air, surface, or submarine crews employ non-explosive torpedoes against submarines or surface vessels.
Torpedo (Explosive) Testing	Air, surface, or submarine crews employ explosive torpedoes against artificial targets or deactivated ships.
Countermeasure Testing	Towed sonar arrays and surface ship torpedo defense systems are employed to detect and neutralize incoming weapons.
Pierside Sonar Testing	Pierside testing to ensure systems are fully functional in a controlled pierside environment prior to at-sea test activities.
At-Sea Sonar Testing	Sonar systems are tested at sea to ensure they are fully functional in an open ocean environment.
Mine Warfare (MIW) Testing	
Mine Detection and Classification Testing	Air, surface, and subsurface vessels detect and classify mines and mine-like objects.
Mine Countermeasure / Neutralization Testing	Air, surface, and subsurface vessels neutralize threat mines that would otherwise restrict passage through an area.
Shipboard Protection Systems and Swimmer Defense Testing	
Pierside Integrated Swimmer Defense Testing	Swimmer defense testing ensures that systems can effectively detect, characterize, verify, and defend against swimmer/diver threats in harbor environments.
Shipboard Protection Systems Testing	Loudhailers and small-caliber munitions are used to protect a ship against small boat threats.
Chemical/Biological Simulant Testing	Chemical/biological agent simulants are deployed against surface ships.
Unmanned Vehicle Testing	
Underwater Deployed Unmanned Aerial System Testing	Unmanned aerial systems are launched by submarines and special operations forces while submerged.
Unmanned Vehicle Development and Payload Testing	Vehicle development involves the production and upgrade of new unmanned platforms on which to attach various payloads used for different purposes.
Other Testing Activities	
Special Warfare Testing	Special warfare includes testing of submersibles capable of inserting and extracting personnel or payloads into denied areas from strategic distances.
Radio-Frequency Communications Testing	Radio-frequency communications for towed or floating buoys are tested.
Hydrodynamic Testing	Submarines maneuver in the submerged operating environment.
At-Sea Explosives Testing	Explosives are detonated at sea.

2.4.2.3 Office of Naval Research and Naval Research Laboratory Testing Activities

As the Department of the Navy's Science and Technology provider, Office of Naval Research and Naval Research Laboratory provide technology solutions for Navy and Marine Corps needs. The Office of Naval Research's mission, defined by law, is to plan, foster, and encourage scientific research in recognition of its paramount importance as related to the maintenance of future naval power, and the preservation of national security. Further, Office of Naval Research manages the Navy's basic, applied, and advanced research to foster transition from science and technology to higher levels of research, development, test, and evaluation. The Ocean Battlespace Sensing Department explores science and technology in the areas of oceanographic and meteorological observations, modeling, and prediction in the battlespace environment; submarine detection and classification (anti-submarine warfare); and mine warfare applications for detecting and neutralizing mines in both the ocean and littoral environment. The Office of Naval Research events include research, development, test, and evaluation activities; surface processes acoustic communications experiments; shallow water acoustic communications experiments; sediment acoustics experiments; shallow water acoustic propagation experiments; and long-range acoustic propagation experiments. Typical Office of Naval Research testing activities are shown in Table 2.4-4; however, because of the unpredictable nature of scientific discoveries, these descriptions are provided as examples only. The Office of Naval Research will strive to predict acoustic activity and account for that activity within the classifications described in Section 2.3.1 (Sonar Systems and Other Acoustic Sensors).

Table 2.4-4: Typical Office of Naval Research Activities in the Study Area

Acoustics Experiments	Description
Martha's Vineyard Coastal Observatory Acoustic Communications Experiment (Coastal)	The Martha's Vineyard Coastal Observatory Acoustic Communications Experiment is designed to investigate ocean surface processes and their role in the generation and evolution of surface bubbles, roughness, and internal turbulence; to investigate the impact of these processes on the propagation of acoustic signals in the ocean; and to test and evaluate different techniques for underwater acoustic communications. Acoustic (active) sources used during the experiments are deployed on bottom-mounted tripods. Passive acoustic receiving arrays (hydrophones) are also deployed on bottom-mounted tripods located at varying distances from the sources. The experiment also involves the use of small scientific acoustic sources that record and measure bubble formation. The data collected will enable scientists to understand more about the effects of bubbles on the propagation of high-frequency sound in shallow water environments. Event duration is one to two weeks.
Sediment Acoustics Experiment (Coastal)	The Sediment Acoustics Experiment is designed to investigate the seasonal variability in seafloor and shallow sub-bottom acoustic properties in shallow water Gulf of Mexico marine environments. The objective is to increase understanding of the variability of seafloor and shallow sub-surface acoustic properties that affect the ability to identify anthropogenic objects in the nearshore environment. The results will enhance understanding of surface and subsurface seafloor geological characteristics, including geoacoustical and geotechnical properties. Event duration is one to two weeks.
Northwestlant Tomography Experiment (Deep Water)	The primary purpose of Northwestlant Tomography Experiment is to gain an understanding of the behavior of low-frequency sound transmissions in the deep ocean over long distances in areas of naval interest. The experiments combine measurements of acoustic propagation and ambient noise on a vertical line array with the use of an ocean acoustic tomography array to help characterize a complex and highly dynamic region of the ocean. Deep water and long range experiments are designed to collect baseline acoustic and oceanographic data in the Study Area. The experimental active acoustic sources used include phase-coded m-sequence sources at center frequencies of 85 Hz, 230 Hz, and 270 Hz, and a source which will transmit pre-programmed sequences at frequencies in the 10–1,000 Hz band. Event duration is 52 weeks.

Table 2.4-4: Typical Office of Naval Research Activities in the Study Area (Continued)

Acoustics Experiments	Description
East Coast Shallow Water Experiment (Continental Shelf)	The goals of this experiment are to determine the dominant physical processes that affect the acoustic field and to develop decision making tools for use in shallow water environments. This includes knowing how to choose the relevant environmental parameters to measure, how often to measure them, and how to best select acoustic applications frequencies. Shallow water acoustic experiments aid in meeting the Navy's mission of fully defining the coastal underwater environment and the variables that determine shallow underwater sound transmission. This understanding is important because all users of the ocean environment must rely on acoustic signals to sense their undersea surroundings and to perform the many tasks underwater for which light and other electromagnetic radiation are used in the atmosphere. Underwater sound is used for such basic tasks as measuring ocean depth, locating underwater objects, navigation, and communication. Event duration is one to two weeks.

2.5 Alternatives Development

The identification, consideration, and analysis of alternatives are important aspects of the NEPA process and contribute to the goal of objective decision making. The Council on Environmental Quality provides guidance on the development of alternatives. The regulations require the decision maker to consider the environmental effects of the Proposed Action and a range of alternatives (including the No Action Alternative) to the Proposed Action (40 C.F.R. § 1502.14). The range of alternatives include reasonable alternatives, which must be rigorously and objectively explored, as well as other alternatives that were considered but eliminated from detailed study. To be reasonable, an alternative must meet the stated purpose of and need for the Proposed Action. Mitigation measures are discussed throughout this EIS/OEIS in connection with affected resources, and are also addressed separately in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring).

The purpose of including a No Action Alternative in environmental impact analyses is to ensure that agencies compare the potential impacts of the Proposed Action to the potential impacts of maintaining the status quo.

The Navy developed the alternatives considered in this EIS/OEIS after careful assessment by subject matter experts, including military units and commands that utilize the ranges, military range management professionals, and Navy environmental managers and scientists.

2.5.1 Alternatives Eliminated from Further Consideration

Alternatives eliminated from further consideration are described in Sections 2.5.1.1 (Alternative Training and Testing Locations) through 2.5.1.3 (Simulated Training and Testing). The Navy determined that these alternatives did not meet the purpose of and need for the Proposed Action after thorough consideration of each.

2.5.1.1 Alternative Training and Testing Locations

The Navy's use of training and testing ranges evolved over the decades because these geographic areas allow for the entire spectrum of training and testing to occur. While some unit-level training and some testing activities may require only one training element (sea surface space, undersea space, or airspace), more advanced training and testing events may require a combination of air, surface, and undersea space as well as access to land ranges. The ability to utilize the diverse and multi-dimensional capabilities of each range complex results in the Navy's ability to develop and maintain high levels of readiness. No other locations match the unique attributes found in the Study Area, which are as follows:

- Proximity of range complexes and testing ranges off the east coast of the United States and within the Gulf of Mexico to each other.
- Proximity to the homeport regions of Norfolk, Virginia; Jacksonville, Florida; and Camp Lejeune, Jacksonville, North Carolina; as well as the Navy command headquarters, training schools, ships, submarines, aircraft squadrons, and Marine Corps forces located in each of those locations.
- Proximity to shore-based facilities and infrastructure and the logistical support provided for testing activities.
- Proximity to military families, in light of the readiness benefits derived from minimizing the length of time Sailors and Marines spend deployed away from home.
- Presence of unique training and testing ranges, which include the established mine warfare capabilities in the VACAPES Range Complex, the instrumented water ranges located at the South Florida Ocean Measurement Facility Testing Range, and naval training beaches located at Camp Lejeune capable of supporting large-scale amphibious training events.
- Environmental conditions (bathymetry, topography, and weather) that maximize the training realism and testing effectiveness.

The uniquely interrelated nature of the component parts to the range complexes and testing ranges located within the Study Area provides the training and testing support needed for complex military activities. There is no other series of integrated ranges in the Atlantic Ocean that affords this level of operational support and comprehensive integration for range activities. There are no other potential locations where land ranges, OPAREAs, undersea terrain and ranges, testing ranges, and military airspace combine to provide the venues necessary for the training and testing realism and effectiveness required to train and certify naval forces ready for combat operations.

2.5.1.2 Mitigations Including Temporal or Geographic Constraints within the Study Area

Alternatives considered under the NEPA process may include mitigation measures. This assumes, however, that appropriate mitigation can be developed before a detailed analysis of the impacts from the alternatives and compliance with other federal laws occurs. Analysis of military training and testing activities involves compliance with several federal laws, including the MMPA and the ESA. These laws require the Navy to complete complex and lengthy permitting processes, which include applying the best available science to develop mitigations. The best available science is reviewed and identified during the course of the permitting and NEPA/Executive Order (EO) 12114 processes. Consequently, to allow for potential mitigation measures to be more fully developed as part of the detailed NEPA/EO 12114 analysis and further refined and informed by applicable permitting processes, the Navy did not identify and carry forward for analysis any separate alternatives with pre-determined geographic or temporal restrictions. Rather, Chapter 5 of this EIS/OEIS (Standard Operating Procedures, Mitigation, and Monitoring) contains a detailed discussion of mitigation measures that were evaluated. Based on the analysis in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring), MMPA and ESA permitting processes, and other required regulatory consultations, practical science-based mitigation measures, including temporal or geographic constraints within the Study Area, may be implemented under either action alternative.

2.5.1.3 Simulated Training and Testing

The Navy currently uses computer simulation for training and testing whenever possible (e.g., command and control exercises are conducted without operational forces); however, there are significant limitations and its use cannot completely substitute live training or testing. Therefore, simulation as an alternative that replaces training and testing in the field does not meet the purpose of and need for the Proposed Action and has been eliminated from detailed study.

2.5.1.3.1 Simulated Training

The Navy continues to research new ways to provide realistic training through simulation, but there are limits to the realism that technology can presently provide. Unlike live training, computer-based training does not provide the requisite level of realism necessary to attain combat readiness. Simulation cannot replicate the inherent high-stress environment and complexity of the coordination needed to combine multiple military assets and personnel into a single fighting unit. Most notably, simulation cannot accurately model the behavior of sound in complex training media such as the marine environment.

Today's simulation technology does not permit anti-submarine warfare training with the degree of fidelity required to maintain proficiency. While simulators are used for the basic training of sonar technicians, they are of limited utility beyond basic training. A simulator cannot match the dynamic nature of the environment, such as bathymetry and sound propagation properties, or the training activities involving several units with multiple crews interacting in a variety of acoustic environments. Moreover, it is imperative that crews achieve competence and gain confidence in their ability to use their equipment.

Sonar operators must train regularly and frequently to develop and maintain the skills necessary to master the process of identifying underwater threats in the complex subsurface environment. Sole reliance on simulation would deny service members the ability to develop battle-ready proficiency in the employment of active sonar in the following specific areas:

- Bottom bounce and other environmental conditions. Sound hitting the ocean floor (bottom bounce) reacts differently depending on the bottom type and depth. Likewise, sound passing through changing currents, eddies, or across changes in ocean temperature, pressure, or salinity is also affected. Both of these are extremely complex to simulate, and both are common in actual sonar operations.
- Mutual sonar interference. When multiple sonar sources are operating in the vicinity of each other, interference due to similarities in frequency can occur. Again, this is a complex variable that must be recognized by sonar operators, but is difficult to simulate with any degree of fidelity.
- Interplay between ship and submarine target. Ship crews, from the sonar operator to the ship's Captain, must react to the changing tactical situation with a real, thinking adversary (a Navy submarine for training purposes). Training in actual conditions with actual submarine targets provides a challenge that cannot be duplicated through simulation.
- Interplay between anti-submarine warfare teams in the strike group. Similar to the interplay between ships and submarine targets, a ship's crew must react to all changes in the tactical situation, including changes from cooperating ships, submarines, and aircraft.

Computer simulation can provide familiarity and complement live training; however, it cannot provide the fidelity and level of training necessary to prepare naval forces for deployment. Therefore, the alternative of substituting simulation for live training fails to meet the purpose of and need for the Proposed Action and was eliminated from detailed study.

2.5.1.3.2 Simulated Testing

As described in Section 1.4.3 (Why the Navy Tests), the Navy conducts testing activities to collect scientific data; investigate, develop, and evaluate new technologies; and to support the acquisition and life cycle management of platforms and systems used by the warfighters. Throughout the life cycle of platforms and systems, from performing basic research to procurement of the platform or system, the Navy uses a number of different testing methods, including computer simulation, when appropriate. The Navy cannot use or rely exclusively on simulation when performing a number of specific testing activities, including collection of scientific data; verifying contractual requirements; and assessing performance criteria, specifications, and operational capabilities.

The Navy collects scientific data that can only be obtained from direct measurements of the marine environment to support scientific research associated with development of new platforms and systems. A full understanding of how waves in the ocean move, for example, can only be fully understood by collecting information on waves. This type of direct scientific observation and measurement of the environment is vital to developing simulation capabilities by faithfully replicating environmental conditions.

As the acquisition authority for the Navy, the various Systems Commands are responsible for administering large contracts for the Navy's procurement of platforms and systems. These contracts include performance criteria and specifications that must be verified to assure that the Navy accepts platforms and systems that support the warfighter's needs. Although simulation is a key component in platform and systems development, it does not adequately provide information on how a system will perform or whether or not it will be able to meet performance and other specification requirements because of the complexity of the technologies in development and the marine environments in which they will operate. For this reason, at some point in the development process, platforms and systems must undergo at-sea or in-flight testing. For example, a new jet airplane design can be tested in a wind tunnel that simulates flight to assess elements like maneuverability, but eventually a prototype must be constructed and flown to confirm the wind tunnel data.

Furthermore, the Navy is required by law to operationally test major platforms, systems, and components of these platforms and systems in realistic combat conditions before full-scale production can occur. Under Title 10 of the U.S. Code, this operational testing cannot be based exclusively on computer modeling or simulation. At-sea testing provides the critical information on operability and supportability needed by the Navy to make decisions on the procurement of platforms and systems, ensuring that what is purchased performs as expected, and that tax dollars are not wasted. This testing requirement is also critical to protecting the warfighters who depend on these technologies to execute their mission with minimal risk to themselves.

This alternative—substitution of simulation for live testing—fails to meet the purpose of and need for the Proposed Action and was, therefore, eliminated from detailed study.

2.5.1.4 Reduced Training and Testing

Title 10 Section 5062 of the U.S. Code provides: "The Navy shall be organized, trained, and equipped primarily for prompt and sustained combat incident to operations at sea." Reduction or cessation of training and testing would prevent the Navy from meeting its Title 10 requirements and adequately preparing naval forces for operations at sea ranging from disaster relief to armed conflict.

2.5.2 Alternatives Carried Forward

Three alternatives are analyzed in this EIS/OEIS:

- **The No Action Alternative**—Baseline training and testing activities, as defined by existing Navy environmental planning documents, including Atlantic Fleet Active Sonar Training EIS/OEIS, VACAPES Range Complex EIS/OEIS, Navy Cherry Point Range Complex EIS/OEIS, JAX Range Complex EIS/OEIS, Naval Surface Warfare Center Panama City Division EIS/OEIS, GOMEX Range Complex EIS/OEIS, Key West Range Complex EA/OEA, and the EA of Test Operations in Rhode Island Waters for the Naval Undersea Warfare Center Division, Newport. The baseline testing activities also include those testing events that historically occur in the Study Area and have been subject to previous analysis pursuant to NEPA/EO 12114.
- **Alternative 1**—Overall expansion of the Study Area plus adjustments to types and levels of activities, from the baseline, as necessary to support current and planned Navy training and testing requirements. This alternative considers:
  - activities occurring on the range complexes and the testing ranges, as well as activities occurring within the Study Area outside of the range complexes and testing ranges; and
  - mission requirements associated with force structure changes, including those resulting from the development, testing, and ultimate introduction of new platforms (ships and aircraft) and weapon systems into the fleet.
- **Alternative 2 (Preferred Alternative)**—Consists of Alternative 1 plus the establishment of new range capabilities, as well as modifications of existing capabilities, and adjustments to type and levels of training and testing.

The alternatives are discussed in further detail in Sections 2.6 (No Action Alternative: Current Military Readiness within the Atlantic Fleet Region) through 2.8 (Alternative 2: Includes Alternative 1 Plus Increased Tempo of Training and Testing Activities).

2.6 No Action Alternative: Current Military Readiness within the Atlantic Fleet Region

The Council on Environmental Quality regulations require that a range of alternatives to the proposed action, including a No Action Alternative, be developed for analysis. The No Action Alternative serves as a baseline description from which to compare the potential impacts of the Proposed Action. The Council on Environmental Quality provides two interpretations of the No Action Alternative, depending on the Proposed Action. One interpretation would mean the proposed activity would not take place, and the resulting environmental effects from taking no action would be compared with the effects of taking the Proposed Action. For example, this interpretation would be used if the Proposed Action was the construction of a facility. The second interpretation, which applies to this EIS/OEIS, allows the No Action Alternative to be thought of in terms of continuing with the present course of action until that action is changed. The No Action Alternative for this EIS/OEIS would continue training and testing activities currently conducted (baseline activities) and force structure (personnel, weapons, and assets) requirements as defined by existing Navy environmental planning documents described in Section 2.5.2 (Alternatives Carried Forward). The No Action Alternative activities occur within the area depicted in Figure 2.6-1. Figures 2.6-2 through 2.6-4 illustrate specific locations where explosive use occurs under the No Action Alternative. The No Action Alternative represents those training and testing activities and events as set forth in previously completed Navy environmental planning documents. However, the No Action Alternative would fail to meet the purpose of and need for the Proposed Action because it would not allow the Navy to meet current and future training and testing requirements necessary to achieve and maintain fleet readiness. For example, the baseline activities do not account for changes in force structure requirements, the introduction of new or upgraded weapons and platforms, or the training and testing required for proficiency with these systems.

Tables 2.8-1, 2.8-2, and 2.8-3 summarize the baseline training and testing activities that would occur under the No Action Alternative.

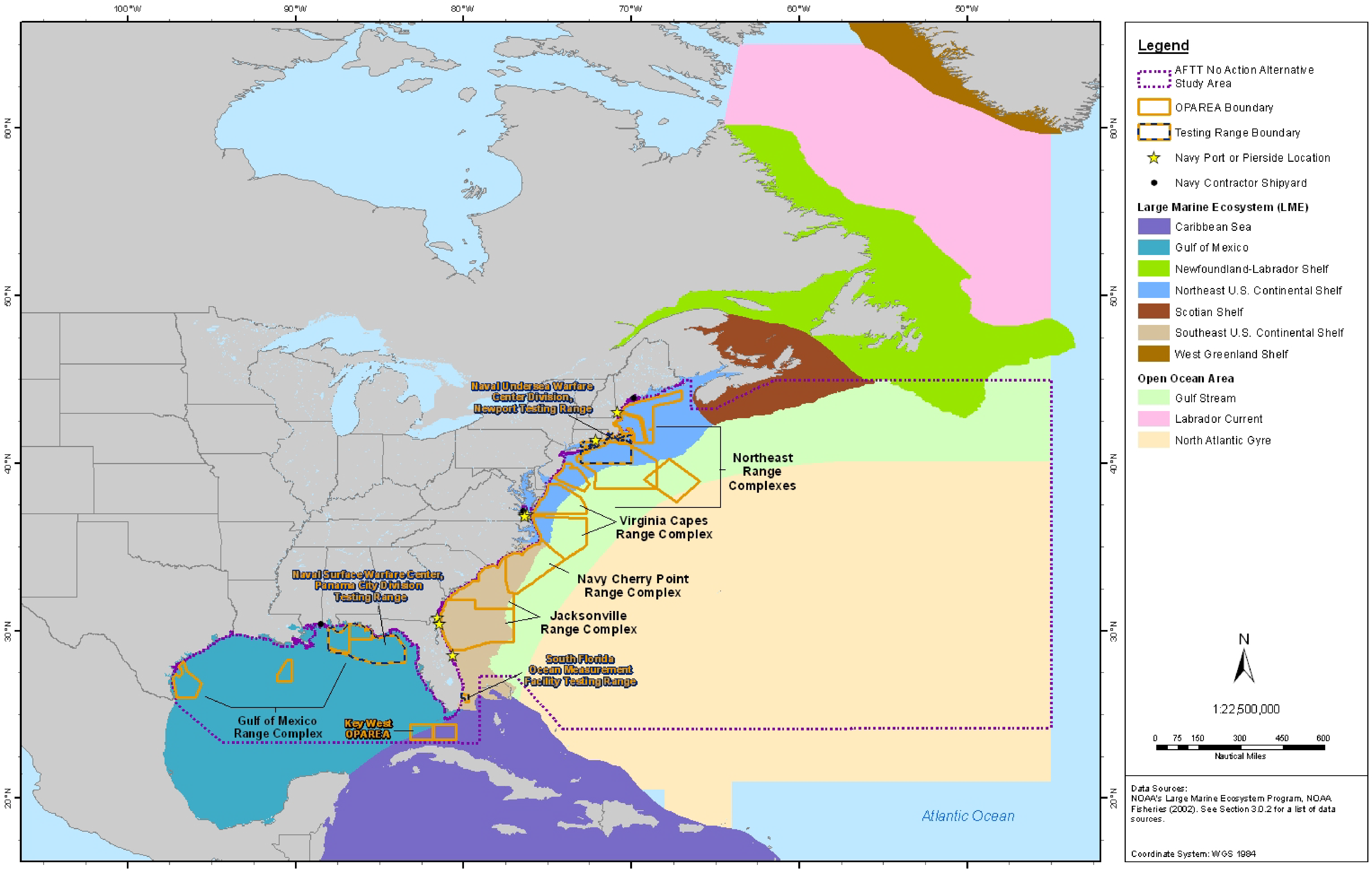

Figure 2.6-1: No Action Alternative Study Area Boundary

AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area; NOAA: National Oceanic and Atmospheric Administration

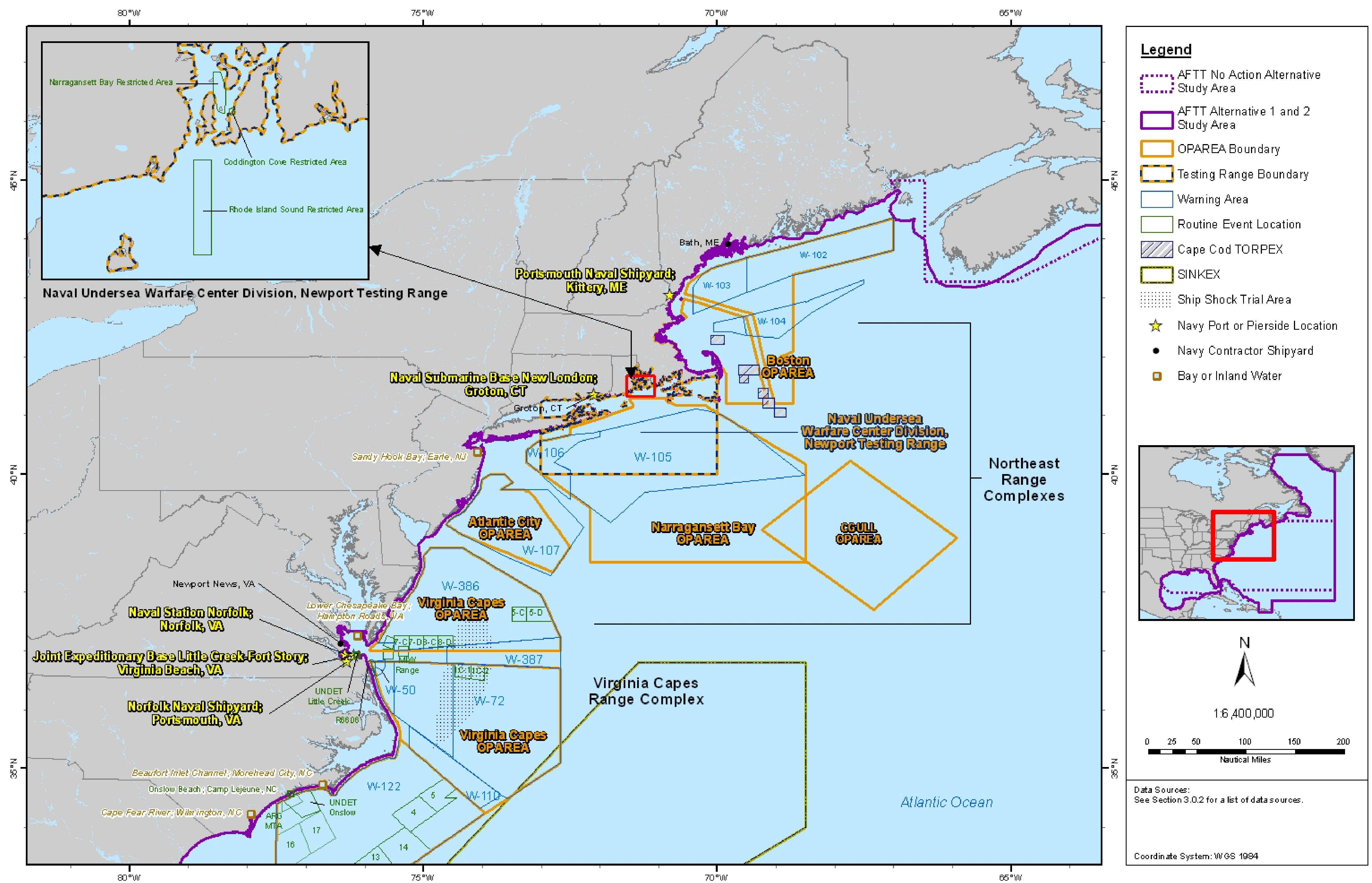

Figure 2.6-2: Mid-Atlantic Region Areas for Training and Testing

AFTT: Atlantic Fleet Training and Testing; ARG MTA: Amphibious Readiness Group Mine Training Area; CSG MTA: Carrier Strike Group Mine Training Area; CT: Connecticut; NC: North Carolina; NJ: New Jersey; ME: Maine; OPAREA: Operating Area; SINKEX: Sinking Exercise; TORPEX: Torpedo Exercise; UNDET: Underwater Detonation; VA: Virginia

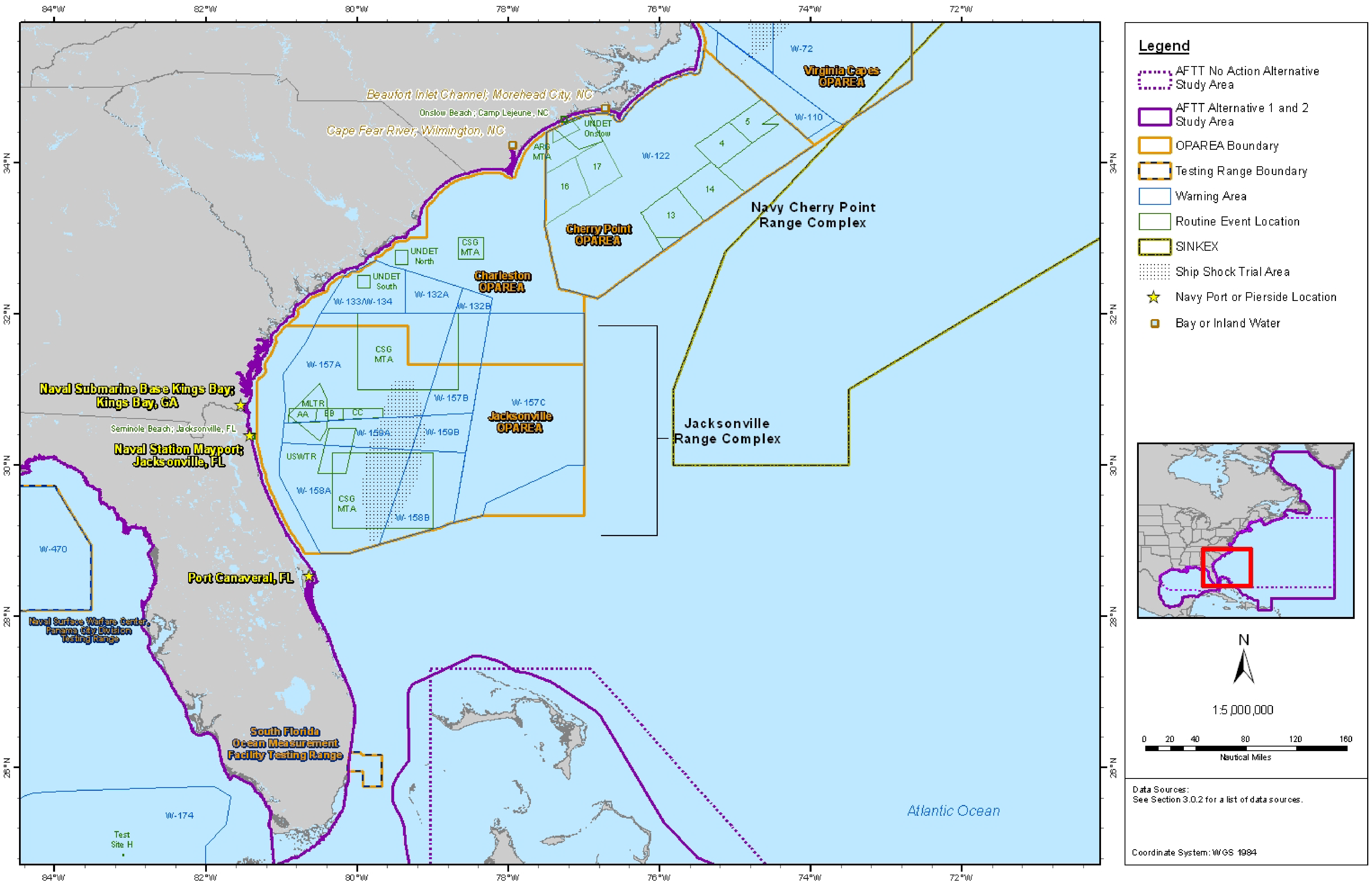

Figure 2.6-3: Southeast Atlantic Region Areas for Training and Testing

AFTT: Atlantic Fleet Training and Testing; ARG MTA: Amphibious Readiness Group Mine Training Area; CSG MTA: Carrier Strike Group Mine Training Area; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; NC: North Carolina; OPAREA: Operating Area; SINKEX: Sinking Exercise; UNDET: Underwater Detonation; USWTR: Undersea Warfare Training Range

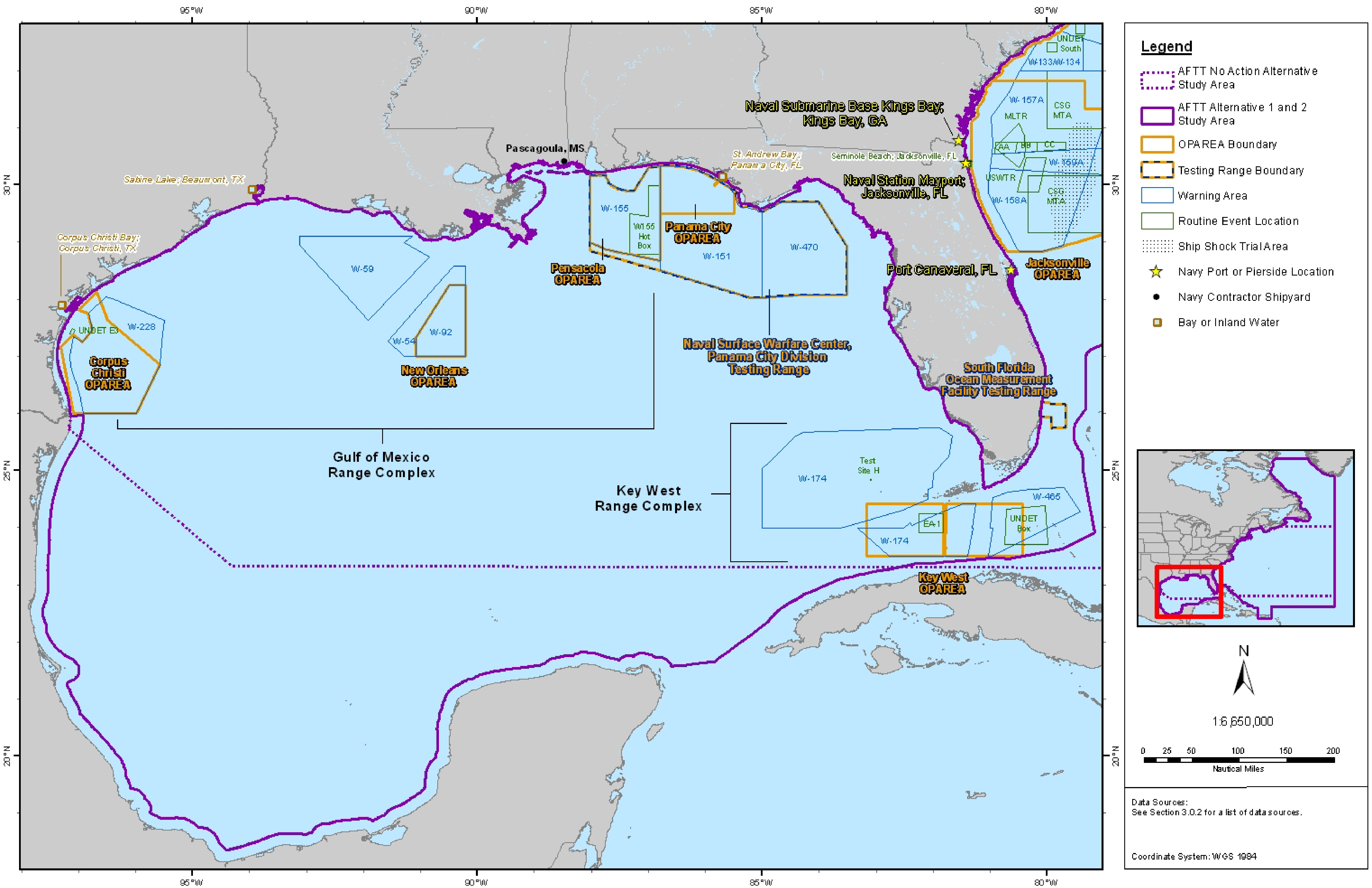

Figure 2.6-4: Gulf of Mexico Region Areas for Training and Testing

AFTT: Atlantic Fleet Training and Testing; CSG MTA: Carrier Strike Group Mine Training Area; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; MS: Mississippi; OPAREA: Operating Area; TX: Texas; UNDET: Underwater Detonation; USWTR: Undersea Warfare Training Range

2.7 ALTERNATIVE 1: EXPANSION OF THE STUDY AREA PLUS ADJUSTMENTS TO THE BASELINE AND ADDITIONAL WEAPONS, PLATFORMS, AND SYSTEMS

Alternative 1 would consist of the No Action Alternative plus the expansion of the Study Area, as well as adjustments to locations and tempo of training and testing activities, including the addition of platforms and systems.

- **Expansion of the overall study area.** The overall Study Area boundaries for Alternative 1 would be the area depicted in Figure 2.1-1 and described in Section 2.1 (Description of the Atlantic Fleet Training and Testing Study Area). This EIS/OEIS contains analyses of areas where Navy training and testing would continue as in the past, but were not considered in previous environmental analyses. This adjustment is not an expansion of where the Navy trains and tests, but is simply an expansion of the area to be analyzed. Previous EIS/OEISs were developed for a single range complex, testing range, or type of activity. This EIS/OEIS is combining all the ranges and activities into one document, which allows for additional areas to be analyzed, including:
  - Expanding north to the 65 degree north latitude line
  - Expanding south to the 20 degree north latitude line
  - Navy piers, Navy shipyards, and Navy-contractor shipyards
- **Adjustments to locations and tempo of training and testing activities.** This alternative includes changes to training and testing requirements necessary to accommodate the following:
  - Force structure changes, which include the relocation of ships, aircraft, and personnel to meet Navy needs. Training and testing requirements must adapt to meet these new forces.
  - Development and introduction of ships, aircraft, and weapon systems.
  - Current training and testing requirements not addressed in previous environmental documents.

Alternative 1 reflects adjustments to baseline activities necessary to support all current and proposed Navy at-sea training and testing activities. Locations identified within Tables 2.8-1 through 2.8-3 represent the areas where events are typically scheduled to be conducted. Generally, the range complex or testing range is identified, but for some activities, smaller areas within the range are identified. Events could occur outside of the specifically identified areas if environmental conditions are not favorable on a range, the range is unavailable due to other units training or testing, it poses a risk to civilian or commercial users, or to meet fleet readiness requirements.

2.7.1 PROPOSED ADJUSTMENTS TO BASELINE TRAINING ACTIVITIES

The proposed adjustments to baseline levels and types of training categorized by primary mission areas are as follows:

Anti-Air Warfare

- Expand areas within the VACAPES, Navy Cherry Point, JAX, and Key West Range Complexes where anti-air warfare events, such as air combat maneuvers and gunnery and missile exercises, would be conducted in order to allow for greater operational flexibility.
- Increase air combat maneuver events in the VACAPES Range Complex to allow use of improved range instrumentation.

- Reallocate the number of air-to-air missile events between the range complexes, and increase the number in VACAPES.
- Utilize new and different targets such as LUU-2 illumination flares and the BQM-34 Firebee in missile exercises.
- Utilize new and upgraded weapons such as the 57 mm (large-caliber) gun system and rolling airframe missile system.

Amphibious Warfare

- Support firing exercise (at sea) requirements by increasing the number of events and amount of high-explosive rounds used.
- Increase the flexibility to conduct firing exercises (at sea) outside of the established gunnery boxes located in the JAX OPAREA.
- Provide capability to conduct amphibious humanitarian aid/disaster relief events in the JAX Range Complex.

Strike Warfare

- Provide ability to conduct High Speed Anti-Radiation Missile exercise (HARMEX) in all warning areas in the VACAPES and Navy Cherry Point Range Complexes.

Anti-Surface Warfare

- Increase maritime security operations training in response to evolving requirements (e.g., anti-piracy training and increased force protection training at pier, in transit to and from port, and in nearshore waters).
- Increase gunnery, bombing, and missile events and the amount of high-explosive rounds used. Increased use of high-explosive munitions is needed for specific certification requirements and when non-explosive practice munitions are not available.
- Expand areas within the established JAX Range Complex where gunnery exercises may be conducted in order to allow for greater operational flexibility.
- Account for the entire suite of air-to-surface missiles (e.g., add analysis of the Harpoon missile).
- Utilize new weapons, such as the 57 mm turret-mounted gun on the Littoral Combat Ship, the upgraded 20 mm close-in weapon system that allows for its use in defending against surface craft, the 30 mm gun, and new precision guided missiles/rockets currently under development.

Anti-Submarine Warfare

- Increase number of events conducted and the amount of acoustic sensors used during those events.
- Account for the introduction of new anti-submarine warfare sensors into the fleet.
- Analyze anti-submarine warfare activities conducted on the Undersea Warfare Training Range.

Electronic Warfare

There are no substantive adjustments to electronic warfare training events that would require additional analysis.

Mine Warfare

- Conduct mine warfare training, which includes placement of temporary training mines, in additional areas to allow for deep water mine-hunting.
- Conduct additional coordinated unit level training events.

- Increase number of events conducted and the amount of time acoustic sensors are used during those events.
- Account for the introduction and use of new mine warfare sensors, neutralizers, and platforms, especially unmanned and remotely operated vehicles.
- Increase the number of high-explosive mine neutralization events to align with new mission training requirements.
- Expand areas in the VACAPES Range Complex, to include waters adjacent to W-50, for mine warfare events.

Naval Special Warfare

There are no substantive adjustments to naval special warfare training events that would require additional analysis.

Other Training

- Conduct civilian port defense training events in various ports and harbors.

2.7.2 Proposed Adjustments to Baseline Testing Activities

New Ship Construction

- Conduct sea trials on new ship classes: DDG 1000, amphibious assault ships, and T-AGOs.
- Increase sea trials on existing platforms: VIRGINIA Class submarines, Littoral Combat Ship, aircraft carriers, Joint High Speed Vessels, and Landing Platform Dock.
- Conduct testing on new Littoral Combat Ship mission packages: anti-submarine warfare, surface warfare, and mine countermeasures. See Section 2.7.3.2 (Ships) discussion of the Littoral Combat Ship for more information.

Shock Trials

- Conduct shock trials on three platforms: DDG 1000, Littoral Combat Ship, and aircraft carrier.

Life Cycle Activities

- Increase the number of and locations for Combat System Ship Qualification Trials.
- Increase surface ship submarine sonar testing and maintenance.

Naval Sea Systems Command Range Activities

- Conduct additional stationary sonar source testing at Naval Surface Warfare Center, Panama City Division Testing Range.
- Increase the number of existing events conducted at Naval Undersea Warfare Center Division, Newport Testing Range and expand areas where testing occurs.
- Conduct additional unmanned aerial system testing at Naval Undersea Warfare Center Division, Newport Testing Range.
- Conduct testing activities at the South Florida Ocean Measurement Facility Testing Range.

Anti-Air Warfare

- Increase air platform weapons integration testing using only non-explosive practice munitions in the VACAPES Range Complex.

Anti-Surface Warfare

- Increase number of events conducted.

- Increase flexibility of locations used during testing.
- Develop and test new and existing anti-surface warfare systems.
- Increase air-to-surface missile tests occurring in the VACAPES and GOMEX Range Complexes.
- Decrease air-to-surface missile tests occurring in the JAX Range Complex.
- Increase air-to-surface gunnery tests occurring in the VACAPES and JAX Range Complexes and the addition of high-explosive rounds.
- Increase 2.75 in. (7 cm) rocket tests in the VACAPES and JAX Range Complexes and the addition of high-explosive rockets.
- Increase laser targeting tests occurring in the JAX Range Complex.
- Addition of high energy laser weapons tests in the VACAPES Range Complex.

Anti-Submarine Warfare

- Increase in anti-submarine warfare torpedo tests occurring in the VACAPES and JAX Range Complexes.
- Increase in functional checks of the AN/AQS-22 dipping sonar system (i.e., kilo dips) occurring in the Narragansett Bay and the VACAPES and JAX Range Complexes.
- Decrease in functional checks of the AN/AQS-22 dipping sonar system (i.e., kilo dips) occurring in the Navy Cherry Point Range Complex.
- Increase in anti-submarine warfare tracking test—helicopter events occurring in the Northeast, VACAPES, JAX, and GOMEX Range Complexes as well as other areas of the AFTT Study Area.
- Decrease in anti-submarine warfare tracking test—helicopter events occurring in the Navy Cherry Point Range Complex.
- Develop and test anti-submarine warfare sensors.

Electronic Warfare

- Increase in electronic system evaluation tests occurring in the VACAPES Range Complex and the addition of electronic system evaluation tests in the GOMEX Range Complex.
- Increase in chaff and flare tests occurring in the VACAPES and GOMEX Range Complexes.
- Decrease in chaff and flare tests occurring in the Navy Cherry Point and JAX Range Complexes.

Mine Warfare Testing

- Increase in airborne mine neutralization system tests of the AN/ASQ-235 in the Naval Surface Warfare Center, Panama City Division Testing Range.
- Decrease in airborne projectile-based mine clearance system tests in the VACAPES Range Complex and the addition of high-explosive mines.
- Increase in airborne projectile-based mine clearance system tests in the Naval Surface Warfare Center, Panama City Division Testing Range and the addition of high-explosive mines.
- Increase in airborne mine neutralization tests of the AN/ALQ-220 (OASIS) in the Naval Surface Warfare Center, Panama City Division Testing Range.
- Increase in airborne mine hunting tests of the AN/AQS-20A in the Naval Surface Warfare Center, Panama City Division Testing Range.
- Increase in airborne mine hunting tests of the AN/AES-1 (ALMDS) in the Naval Surface Warfare Center, Panama City Division Testing Range.
- Increase in mine laying test events occurring in the VACAPES and JAX Range Complexes.

Shipboard Protection Systems and Swimmer Defense Testing

- Increase number of events conducted.

Unmanned Vehicle Testing

- Increase number of events conducted.

Other Testing

- Addition of at-sea explosive testing.
- Addition of air platform shipboard integration tests in the Navy Cherry Point and JAX Range Complexes.

2.7.3 Proposed Additional Platforms and Systems

The following is a representative list of additional platforms, weapons, and systems analyzed. The ships and aircraft will not be an addition to the fleet but, rather, would replace older ships and aircraft that are decommissioned and removed from the inventory. Information regarding Navy platforms and systems can be found on the Navy Fact File website: http://www.navy.mil/navydata/fact.asp.

2.7.3.1 Aircraft

F-35 Joint Strike Fighter

The F-35 Joint Strike Fighter Lightning II aircraft will complement the Navy's F/A-18E/F. The F-35 is projected to make up about one-third of the Navy's strike fighter inventory by 2020. The Marine Corps will have a variant of the F-35 with a short takeoff, vertical landing capability, which will replace the AV-8B. The Navy variant for aircraft carrier use is scheduled for delivery in 2015; the Marine Corps variant is scheduled for initial operating capability in 2012. The F-35 will operate similarly to the aircraft it replaces or complements. It will operate in the same areas and will be used in the same training exercises such as air-to-surface and air-to-air missile exercises, bombing exercises, and any other exercises where fixed-wing aircraft are used in training. No new activities will result from the introduction of the F-35.

EA-18G Airborne Electronic Attack Aircraft

The EA-18G will serve as the Navy's replacement for the aging fleet of EA-6Bs providing a capability to detect, identify, locate, and suppress hostile emitters. It will operate similarly to the EA-6B, and in the same training areas, but will provide greater speed and altitude capabilities. No new activities will result from the introduction of the EA-18G.

E-2D Airborne Early Warning

The E-2D Advanced Hawkeye is the carrier-based airborne early warning aircraft follow on variant of the E-2C Hawkeye. The E-2D will operate similarly to the E-2C, in the same training areas, with an increased on-station time as the new aircraft will include an in-flight refueling capability. Fleet integration is expected in 2015.

2.7.3.2 Ships

Aircraft Carrier (Gerald R. Ford Class)

The CVN 21 program is designing the replacement for the Nimitz class carriers. The new aircraft carriers' capabilities will be similar to those of the carriers they will replace, and they will train in the same operating areas as the predecessor aircraft carriers. The first aircraft carrier (CVN 78) is expected to be delivered in 2015. No new activities will result from the introduction of the CVN 21 class of aircraft carriers.

DDG 1000 Multi-Mission Destroyer (Zumwalt Class)

Developed under the DD(X) destroyer program, Zumwalt (DDG 1000) is the lead ship of a class of next-generation multi-mission destroyers tailored for land attack and littoral dominance. The DDG 1000 will operate similarly to the existing Arleigh Burke class of destroyers; however, it will provide greater capability in the nearshore sea space and will train more in that environment. Its onboard weapons and systems will include a 155-mm advanced gun system to replace the 5-in. gun system on current destroyers. This gun system will fire a new projectile (see Section 2.7.3.6, Munitions, for a description of the Long Range Land Attack Projectile) at greater distances.

The DDG 1000 will also be equipped with two new sonar systems; the AN/SQS-60 hull-mounted mid-frequency sonar, and the AN/SQS-61 hull-mounted high-frequency sonar.

The first ship of this class is expected to be delivered in 2016. This class will join the fleets and conduct training alongside existing DDG classes of ships. The introduction of DDG 1000 class would require an increase to training allowances in exercises currently being conducted by existing DDG class ships.

Littoral Combat Ship

The Littoral Combat Ship is a fast, agile, mission-focused platform designed for operation in nearshore environments yet capable of open-ocean operation. These ships are capable of speeds in excess of 40 knots. As a focused-mission ship, the Littoral Combat Ship is equipped to perform one primary mission at any given time; however, the mission orientation can be changed by changing out its mission packages. Mission packages are supported by special detachments that will deploy manned and unmanned vehicles and sensors in support of mine, undersea, and surface warfare missions. The first Littoral Combat Ships were delivered to the fleet in 2008 and 2010. These ships will train primarily in the Navy's existing nearshore operating areas.

Joint High Speed Vessel

The Joint High Speed Vessel will be capable of transporting personnel, equipment, and supplies 1,200 nm at an average speed of 35 knots. It will be able to transport company-sized units with their vehicles, or reconfigure to become a troop transport for an infantry battalion. The Joint High Speed Vessel, while performing a variety of lift and support missions, will be a non-combatant vessel that operates in permissive environments or in higher threat environments under the protection of combatant vessels and other joint forces.

Amphibious Combat Vehicle

The Marine Corps is developing a vehicle to replace the Amphibious Assault Vehicle. The Amphibious Combat Vehicle will be the expected replacement, which the Marine Corps hopes to have introduced to the Fleet Marine Force by 2020. The Amphibious Combat Vehicle will have the capability of transporting Marines from naval ships located beyond the horizon to shore and further inland.

2.7.3.3 Unmanned Vehicles and Systems

Unmanned Underwater Vehicle Systems

Unmanned underwater vehicles will support several high-priority missions including: (1) intelligence, surveillance, and reconnaissance; (2) mine countermeasures; (3) anti-submarine warfare; (4) oceanography; (5) communication/navigation network nodes; (6) payload delivery; (7) information operations; and (8) time-critical strike.

Sea Maverick Unmanned Underwater Vehicle

Sea Maverick is a fully autonomous underwater vehicle specifically designed to minimize impacts on the environment. It uses no active sonar, and has an advanced propeller system encased to prevent damage to sea beds and other marine life.

Unmanned Surface Vehicles

Unmanned surface vehicles are primarily autonomous systems designed to augment current and future platforms to help deter maritime threats. They will employ a variety of sensors designed to extend the reach of manned ships.

Spartan Unmanned Surface Vehicle

The Spartan is an unmanned surface vehicle with a dipping sonar system that will be supported by the Littoral Combat Ship. It will train in areas where current sonar training is conducted on Navy ranges.

Sea Horse Unmanned Surface Vehicle

The Sea Horse is an unmanned surface vehicle designed to provide force protection capabilities in harbors and bays.

Unmanned Aerial Systems

Unmanned aerial systems operate as intelligence, search, and reconnaissance sensors or as armed combat air systems.

MQ-8B Fire Scout

The Fire Scout vertical take-off and landing tactical aerial vehicle system is designed to operate from air-capable ships with initial deployment on a guided missile frigate, followed by final integration and test onboard the Littoral Combat Ship. This unmanned aerial system is capable of providing radio voice communications relay and has a baseline payload that includes electro-optical/infrared sensors and a laser designator that enables the system to find tactical targets, track and designate targets, accurately provide targeting data to strike platforms, and perform battle damage assessment. There is current testing to place a weapon system on the Fire Scout.

MQ-4C Triton Unmanned Aircraft System

The MQ-4C Triton Unmanned Aircraft System is a complimentary system to the P-8 aircraft, providing maritime reconnaissance support to the Navy. It will be equipped with electro-optical/infrared sensors, can remain on station for 30 hours, and fly at approximately 60,000 ft. (18.3 km).

2.7.3.4 Missiles/Rockets/Bombs

AGM-154 Joint Standoff Weapon

The Joint Standoff Weapon is a missile able to be launched at increased standoff distances, using global positioning system and inertial navigation for guidance. All Joint Standoff Weapon variants share a common body but can be configured for use against area targets or bunker penetration. This weapon would be integrated into strike warfare exercises as well as exercises where the use of this type of missile is required.

MK 54 Vertical Launch Anti-Submarine Rocket Missile

The Navy has designated the MK 54 torpedo to replace the MK 46 torpedo for rapid employment by surface ships. The missile is a rocket-propelled, three-stage weapon deployed on ships equipped with the MK 41 Vertical Launching System. Once entering the water, the MK 54 torpedo will operate similarly to the MK 46 it replaces.

MK 54 Torpedo, High Altitude Anti-Submarine Warfare Capability

The high altitude anti-submarine warfare capability is a low-cost, self-contained air launch accessory kit that enables the MK 54 torpedo to be launched at high altitude. The torpedo then glides to its normal launch altitude close to the surface, and jettisons the air launch accessory kit prior to water entry at a pre-determined location. Once in the water, the MK 54 torpedo will operate similarly to the MK 46 that it replaces.

Guided Rocket Systems

Guided rocket systems include the low-cost guided imaging rocket (a guided infrared 2.75-in. [7-cm] rocket system) and the advanced precision kill weapon system (a laser-guided 2.75-in. [7-cm] rocket). The MH-60 helicopter is one platform expected to be equipped with these rockets.

Joint Air-to-Ground Missile

The Joint Air-to-Ground Missile is a proposed replacement and upgrade to existing Navy air-to-surface missiles currently in use. In addition to having a longer operating range than existing weapons, the Joint Air-to-Ground Missile could include a multi-mode seeker with a combination of a semi-active laser, passive infrared detection capabilities, and radar. The MH-60 helicopter and F/A-18 jet are Navy aircraft platforms from which this new missile would be fired.

2.7.3.5 Guns

Kinetic Energy Weapon

The electromagnetic kinetic energy weapon uses electrical energy to accelerate projectiles to supersonic velocities. The kinetic energy weapon will be operated from ships, firing projectiles toward land targets. Kinetic energy weapons do not require powders or explosives to fire the round and could have ranges as great as 300 mi. (483 km). At-sea demonstration is planned for 2016.

2.7.3.6 Munitions

Long Range Land Attack Projectile

The Long Range Land Attack Projectile is part of a family of 155-mm projectiles designed to be fired from the Advanced Gun System for the Navy's next-generation DDG 1000 destroyer. The Long Range Land Attack Projectile allows the DDG 1000 class to provide precision fire support to U.S. Marine Corps and U.S. Army forces from a safe distance offshore. This capability would be integrated into amphibious and strike warfare exercises.

2.7.3.7 Other Systems

High-Altitude Anti-Submarine Warfare

High-altitude anti-submarine warfare integrates new and modifies existing sensors to enhance the sonobuoy capability to conduct anti-submarine warfare at high altitude. Sonobuoy modifications include integrating global positioning system for precise sonobuoy positional information and a digital uplink/downlink for radio frequency interference management. New sensors include a meteorological sensing device (dropsonde) for sensing atmospheric conditions from the aircraft altitude to the surface.

Littoral Combat Ship Anti-Submarine Warfare Module

The anti-submarine warfare module provides a littoral anti-submarine warfare capability that includes active sonar. An increase to unit level and joint surface ship anti-submarine warfare exercises is to be expected upon introduction to the fleets, and training would continue on existing Navy ranges.

Littoral Combat Ship Mine Countermeasure Module

The mine countermeasure module brings together several systems to support bottom mapping, mine detection, mine neutralization, and mine clearance. An increase to surface ship mine warfare training is expected upon introduction to the fleets. This module would include mine detecting sonar and lasers, and neutralization techniques that involve underwater detonations.

Littoral Combat Ship Surface Warfare Module

The surface warfare module is designed to enable the Littoral Combat Ship to combat small, fast boat threats to the fleet. This module would include guns and missiles. An increase to anti-surface warfare training is expected upon introduction to the fleets.

High-Duty Cycle Sonar

High-duty cycle sonar technology provides improved detection performance and improved detection and classification decision time. This technology will be implemented as an alteration to the existing AN/SQQ-89A(V)15 surface ship combat system.

Littoral Combat Ship Variable Depth Sonar

The variable depth sonar system is a mid-frequency sonar system that will be towed by the Littoral Combat Ship and integrated into the Littoral Combat Ship anti-submarine warfare mission package.

SQS-60 and SQS-61 Sonar

The AN/SQS-60 and 61 are integrated hull-mounted sonar components of the DDG-1000 Zumwalt class destroyer. The SQS-60 is a mid-frequency active sonar and the SQS-61 is a high-frequency active sonar.

Submarine Communications at Speed and Depth

Using expendable buoys, the communications at speed and depth system allows acoustic two-way networked communications with submarines. Initial operating capability is planned for 2012.

High Energy Laser

The High Energy Laser System is being developed by the Navy as a new air-to-surface weapon to be operated from aircraft, such as the MH-60 helicopter. It will operate with at minimum of 25 kilowatts and would be intended to be used as a weapon to disable small surface vessels.

2.7.4 PROPOSED NEW ACTIVITIES

Alternative 1 includes some activities that were not analyzed in previous documents. Representative new activities considered within this analysis are as follows:

- The use of new and existing unmanned vehicles and their acoustic sensors, in support of homeland security and anti-terrorism/force protection. This type of training is critical in protecting our nation’s military and civilian harbors, ports, and shipping lanes.
- Surface-to-surface missile exercises. These events, previously analyzed as part of sinking exercises, will now also be analyzed as stand-alone events.

- Requirement to conduct at-sea mine laying. These events were previously conducted at the now-closed Small Point Mining Range off the coast of Maine.
- Navy divers conducting mine-neutralization, without the use of explosives.
- Coordinated, unit level training with airborne mine countermeasures with multiple aircraft crews training as a team.
- Testing of the new high energy laser weapon.

2.8 ALTERNATIVE 2: INCLUDES ALTERNATIVE 1 PLUS INCREASED TEMPO OF TRAINING AND TESTING ACTIVITIES

Alternative 2 consists of all activities that would occur under Alternative 1 plus the establishment of new range capabilities, as well as modifications of existing capabilities; adjustments to type and tempo of training and testing; and establishment of additional locations to conduct activities within the Study Area. This alternative allows for potential range enhancements and infrastructure requirements (which may require separate NEPA documentation) by analyzing increased training and testing that could occur due to new range capabilities. This alternative allows for potential budget increases, strategic necessity, and future training and testing requirements. Tables 2.8-1, 2.8-2, and 2.8-3 provide a summary of the training and testing activities to be analyzed under Alternative 2. Alternative 2 is the Preferred Alternative.

2.8.1 PROPOSED ADJUSTMENTS TO ALTERNATIVE 1 TRAINING ACTIVITIES

The proposed adjustments to Alternative 1 levels and types of training are as follows:

Anti-Air Warfare

There are no substantive adjustments to anti-air warfare training events that would require additional analysis.

Amphibious Warfare

- Additional amphibious raid/humanitarian assistance operations at Naval Station Mayport in JAX OPAREA.

Strike Warfare

There are no substantive adjustments to strike warfare training events that would require additional analysis.

Anti-Surface Warfare

- Additional ship large-caliber gunnery exercises.

Anti-Submarine Warfare

There are no substantive adjustments to anti-submarine warfare training events that would require additional analysis.

Electronic Warfare

There are no substantive adjustments to electronic warfare training events that would require additional analysis.

Mine Warfare

There are no substantive adjustments to mine warfare training events that would require additional analysis.

Naval Special Warfare

There are no substantive adjustments to other training events that would require additional analysis.

Other Training

There are no substantive adjustments to naval special warfare training events that would require additional analysis.

2.8.2 PROPOSED ADJUSTMENTS TO ALTERNATIVE 1 TESTING ACTIVITIES

The proposed adjustments to Alternative 1 levels and types of testing are as follows:

New Ship Construction

- Increase number of sea trials for aircraft carriers, Joint High Speed Vessel, amphibious assault ships.
- Increase number of mission package test events.
- Increase post-homeporting testing based on additional ships constructed.

Shock Trials

There are no substantive adjustments to ship shock trials that would require additional analysis.

Life Cycle Activities

- Increase number of ship signature test events.

Naval Sea Systems Command Range Activities

- Increase number of testing events on each of the Naval Sea Systems Command's ranges.
- Contingency for increased mine countermeasure testing at South Florida Ocean Measurement Facility Testing Range.

Anti-Surface Warfare/Anti-Submarine Warfare

- Increase number of events conducted.
- Conduct kinetic energy weapon testing on vessels at-sea (e.g., on DDG 1000 vessels).

Mine Warfare Testing

- Increase number of events conducted.

Shipboard Protection Systems and Swimmer Defense Testing

- Increase number of events conducted.
- Increase flexibility in conducting all chemical/biological simulant testing in locations identified.

Unmanned Vehicle Testing

- Increase number of events conducted.
- Increase flexibility in conducting all underwater deployed unmanned aerial system testing in either location identified.

Other Testing

- Introduce MQ-4C Triton Unmanned Aircraft Systems and their use during maritime patrol aircraft anti-submarine warfare testing events.
- Increase number of events conducted overall, with a 10 percent increase in the tempo of all proposed Naval Air Systems Command testing activities.
- Increase flexibility in conducting all at-sea explosive testing in either location identified.

Table 2.8-1: Baseline and Proposed Training Activities

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Anti-Air Warfare (AAW)									
Air Combat Maneuver (ACM)	2,320	None*	VACAPES: W-72 (Air 2A/B, 3A/B)	3,200	None	VACAPES	3,200	None	VACAPES
	385	None*	Cherry Point: W-122 (Areas 1, 8, 15, 16)	1,155	None	Cherry Point	1,155	None	Cherry Point
	498	None*	JAX: W-157A (Area 3X, 4X)	1,270	None	JAX	1,270	None	JAX
	5,700	None	Key West: W-174A/B/C/E/F/G, W-465A/B, Bonefish ATCAA	5,700	None	Key West	5,700	None	Key West
Air Defense Exercise (ADEX)	595	None	VACAPES: W-386, W-72	595	None	VACAPES	595	None	VACAPES
	21	None	Cherry Point: W-122	5,166	None	Cherry Point	5,166	None	Cherry Point
	117	None	JAX: W-132, W-133, W-134, W-157, W-158	5,157	None	JAX	5,157	None	JAX
	80	None	GOMEX: W-151, W-155	85	None	GOMEX	85	None	GOMEX
Gunnery Exercise (Air-to-Air) – Medium-Caliber (GUNEX [A-A]) – Medium-Caliber	30	15,000 rounds	VACAPES: W-72A	120	96,000 rounds	VACAPES	120	96,000 rounds	VACAPES
	10	4,800 rounds	Cherry Point: W-122 (Areas 9, 10, 11, 12)	40	20,800 rounds	Cherry Point	40	20,800 rounds	Cherry Point
	23	8,250 rounds	JAX: W-157A, W-133 (Area 2X)	75	62,400 rounds	JAX	75	62,400 rounds	JAX
	36	36,000 rounds	Key West: W-174A	70	56,000 rounds	Key West	70	56,000 rounds	Key West
Missile Exercise (Air-to-Air) (MISSILEX [A-A])	160	160 missiles (48 HE)[1]	VACAPES: W-72A	40	40 HE missiles	VACAPES	40	40 HE missiles	VACAPES
	20	20 missiles (12 HE)	Cherry Point: W-122	43	43 HE missiles	Cherry Point	43	43 HE missiles	Cherry Point
	22	22 missiles (7 HE)	JAX: W-132, W-133, W-134, W-157, W-158	37	37 HE missiles	JAX	37	37 HE missiles	JAX
	N/A[2]	N/A	Key West	8	8 HE missiles	Key West	8	8 HE missiles	Key West
Gunnery Exercise (Surface-to-Air) – Large-Caliber (GUNEX [S-A]) – Large-Caliber	18	362 rounds	VACAPES: W-386, W-72	136	1,760 HE rounds	VACAPES	136	1,760 HE rounds	VACAPES
	13	292 rounds	JAX: Surface Gunnery Areas AA, BB, CC	84	1,100 HE rounds	JAX	84	1,100 HE rounds	JAX

A-A: Air-to-Air; AAW: Anti-Air Warfare; ACM: Air Combat Maneuver; ADEX: Air Defense Exercise; Cherry Point: Navy Cherry Point Range Complex; GOMEX: Gulf of Mexico Range Complex; GUNEX: Gunnery Exercise; HE: High-Explosive; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; MISSILEX: Missile Exercise; N/A: Not Analyzed; S-A: Surface-to-Air; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Anti-Air Warfare (AAW) (Continued)									
Gunnery Exercise (Surface-to-Air) – Medium-Caliber (GUNEX [S-A]) – Medium-Caliber	30	64,000 rounds	VACAPES: W-386, W-72	180	409,200 rounds	VACAPES	180	409,200 rounds	VACAPES
	N/A[2]	N/A	Cherry Point	5	11,000 rounds	Cherry Point	5	11,000 rounds	Cherry Point
	11	20,800 rounds	JAX: Surface Gunnery Areas AA, BB, CC	84	165,000 rounds	JAX	84	165,000 rounds	JAX
	N/A	N/A	Other AFTT Areas[3]	14	30,000 rounds	Other AFTT Areas	14	30,000 rounds	Other AFTT Areas
Missile Exercise (Surface-to-Air) (MISSILEX [S-A])	N/A	N/A	Northeast	4	4 HE missiles	Northeast	4	4 HE missiles	Northeast
	24	24 HE missiles[1]	VACAPES: W-386 (Air D, G, H, K)	32	32 HE missiles	VACAPES	32	32 HE missiles	VACAPES
	8	8 HE missiles	Cherry Point: W-122	8	8 HE missiles	Cherry Point	8	8 HE missiles	Cherry Point
	8	8 HE missiles	JAX: W-132, W-133, W-134, W-157, W-158, W-159	15	15 HE missiles	JAX	15	15 HE missiles	JAX
	N/A	N/A	GOMEX	8	8 HE missiles	GOMEX	8	8 HE missiles	GOMEX
Amphibious Warfare (AMW)									
Naval Surface Fire Support Exercise – Land-Based Target (FIREX [Land])[4]	30	3,000 rounds	Firing Point: Cherry Point Impact Area: Camp Lejeune Range G-10	30	2,030 rounds	Firing Point: Cherry Point Impact Area: Camp Lejeune Range G-10	30	2,030 rounds	Firing Point: Cherry Point Impact Area: Camp Lejeune Range G-10
Naval Surface Fire Support Exercise – At Sea (FIREX [At Sea])	22	1,540 rounds (858 HE)	VACAPES: 5C/D, 7C/D, 8C/D, 1C1/2	32	2,328 rounds (2,240 HE)	VACAPES	32	2,328 rounds (2,240 HE)	VACAPES
	2	140 rounds (78 HE)	Cherry Point: Area 4/5, 13/14	4	320 rounds (280 HE)	Cherry Point	4	320 rounds (280 HE)	Cherry Point
	10	700 rounds (390 HE)	JAX: Surface Gunnery Areas BB & CC	12	960 rounds (840 HE)	JAX	12	960 rounds (840 HE)	JAX
	8	800 rounds	GOMEX: Panama City OPAREA W-151 A/B, Pensacola OPAREA W-155A	2	160 rounds (140 HE)	GOMEX	2	160 rounds (140 HE)	GOMEX
Marine Expeditionary Unit (MEU) Certification Exercise (CERTEX)	N/A	N/A	Cherry Point	2	None*	Cherry Point	2	None*	Cherry Point
Amphibious Assault	10	None	Cherry Point: Onslow Bay	10	None	Cherry Point: Onslow Bay	10	None	Cherry Point: Onslow Bay
Amphibious Raid/ Humanitarian Assistance Operations	24	None	Cherry Point: Onslow Bay	36	None	Cherry Point: Onslow Bay	36	None	Cherry Point: Onslow Bay
	N/A	N/A	JAX	2	None	JAX	6	None	JAX: Mayport

AAW: Anti-Air Warfare; AMW: Amphibious Warfare; CERTEX: Certification Exercise; Cherry Point: Navy Cherry Point Range Complex; FIREX: Fire Support Exercise; GOMEX: Gulf of Mexico Range Complex; GUNEX: Gunnery Exercise; HE: High-Explosive; JAX: Jacksonville Range Complex; MEU: Marine Expeditionary Unit; MISSILEX: Missile Exercise; S-A: Surface-to-Air; N/A: Not Analyzed; Northeast: Northeast Range Complexes; OPAREA: Operating Area; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[3] Other AFTT Areas include areas outside of range complexes and testing ranges but still within the AFTT Study Area. Other AFTT Area events typically refer to those events that occur while vessels are in transit.

[4] FIREX-Land impacts of ordnance on land-based targets are not being analyzed in this document (U.S. Marine Corps 2009). High-explosives are used without effect on the marine environment.

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Strike Warfare (STW)									
High-Speed Anti-Radiation Missile Exercise (Air-to-Surface) (HARMEX [A-S])	26	26 HE missiles	VACAPES: W-386 (Air E, F, I, J)	12	12 HE missiles	VACAPES	12	12 HE missiles	VACAPES
	8	8 HE missiles[1]	Cherry Point: W-122 (Areas 18, 19, 20, 21)	8	8 HE missiles	Cherry Point	8	8 HE missiles	Cherry Point
Anti-Surface Warfare (ASUW)									
Maritime Security Operations (MSO)	N/A[2]	N/A	Northeast	2	None	Northeast	2	None	Northeast
	136	None	VACAPES	602	None	VACAPES	602	None	VACAPES
	68	None	Cherry Point	70	None	Cherry Point	70	None	Cherry Point
	150	None	JAX	152	None	JAX	152	None	JAX
	54	None	GOMEX: Pensacola, Panama City OPAREAs	54	None	GOMEX	54	None	GOMEX
Maritime Security Operations (MSO) – Anti-Swimmer Grenades	N/A	N/A	Northeast	2	52 HE grenades	Northeast	2	52 HE grenades	Northeast
	36	N/A	VACAPES:	4	74 HE grenades	VACAPES	4	74 HE grenades	VACAPES
	N/A	N/A	Cherry Point:	2	28 HE grenades	Cherry Point	2	28 HE grenades	Cherry Point
	96	80 HE grenades	JAX: Charleston OPAREA UNDET Boxes North and South	2	24 HE grenades	JAX	2	24 HE grenades	JAX
	8	20 HE grenades	GOMEX: Panama City OPAREA Corpus Christi UNDET Box E3	2	28 HE grenades	GOMEX	2	28 HE grenades	GOMEX
Gunnery Exercise (Surface-to-Surface) – Ship Small-Caliber (GUNEX [S-S] – Ship) Small-Caliber	120	261,600 rounds	VACAPES: W-386, W-72	1,224	2,750,000 rounds	VACAPES	1,224	2,750,000 rounds	VACAPES
	82	67,240 rounds	Cherry Point	150	212,240 rounds	Cherry Point	150	212,240 rounds	Cherry Point
	44	105,000 rounds	JAX: Surface Gunnery Areas AA, BB, CC	80	1,100,000 rounds	JAX	80	1,100,000 rounds	JAX
	8	2,400 rounds	GOMEX: Panama City, Pensacola OPAREAs	16	36,000 rounds	GOMEX	16	36,000 rounds	GOMEX
	N/A	N/A	Other AFTT Areas[3]	70	201,000 rounds	Other AFTT Areas	70	201,000 rounds	Other AFTT Areas
Gunnery Exercise (Surface-to-Surface) – Ship Medium-Caliber	120	137,400 rounds	VACAPES: W-386, W-72	500	46,260 rounds (5,000 HE)	VACAPES	500	46,260 rounds (5,000 HE)	VACAPES

ASUW: Anti-Surface Warfare; Cherry Point: Navy Cherry Point Range Complex; GOMEX: Gulf of Mexico Range Complex; GUNEX: Gunnery Exercise; HARMEX: High-Speed Anti-Radiation Missile Exercise; HE: High-Explosive (indicated by shaded cells); JAX: Jacksonville Range Complex; MSO: Maritime Security Operations; N/A: Not Analyzed; Northeast: Northeast Range Complexes; OPAREA: Operating Area; S-S: Surface-to-Surface; STW: Strike Warfare; UNDET: Underwater Detonation; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[3] Other AFTT Areas include areas outside of range complexes and testing ranges but still within the AFTT Study Area. Other AFTT Area events typically refer to those events that occur while vessels are in transit.

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Anti-Surface Warfare (ASUW) (Continued)									
(GUNEX [S-S] – Ship) – Medium-Caliber	18	28,800 rounds	Cherry Point	63	35,100 rounds (600 HE)[1]	Cherry Point	63	35,100 rounds (600 HE)	Cherry Point
	44	26,400 rounds	JAX: Surface Gunnery Areas AA, BB, CC	200	21,240 rounds (2,000 HE)	JAX	200	21,240 rounds (2,000 HE)	JAX
	16	8,000 rounds	GOMEX: Panama City, Pensacola OPAREAs	32	3,840 rounds (320 HE)	GOMEX	32	3,840 rounds (320 HE)	GOMEX
	N/A[2]	N/A	Other AFTT Areas[3]	32	3,840 rounds (320 HE)	Other AFTT Areas	32	3,840 rounds (320 HE)	Other AFTT Areas
Gunnery Exercise (Surface-to-Surface) – Ship Large-Caliber (GUNEX [S-S] – Ship) – Large-Caliber	137	2,800 rounds	VACAPES: W-386, W-72	116	4,200 rounds (2,644 HE)	VACAPES	120	4,360 rounds (2,644 HE)	VACAPES
	34	1,330 rounds	Cherry Point OPAREA	24	1,400 rounds (586 HE)	Cherry Point	26	1,480 rounds (586 HE)	Cherry Point
	99	1,770 rounds	JAX: Surface Gunnery Areas AA, BB & CC	102	4,060 rounds (2,508 HE)	JAX	106	4,220 rounds (2,508 HE)	JAX
	16	440 rounds	GOMEX: Panama City, Pensacola OPAREAs	24	1,400 rounds (144 HE)	GOMEX	24	1,400 rounds (144 HE)	GOMEX
	N/A	N/A	Other AFTT Areas	16	553 rounds (96 HE)	Other AFTT Areas	18	633 rounds (96 HE)	Other AFTT Areas
Gunnery Exercise (Surface-to-Surface) – Boat Small-Caliber (GUNEX [S-S] – Boat) – Small-Caliber	N/A	N/A	Northeast	10	27,500 rounds	Northeast	10	27,500 rounds	Northeast
	36	220,000 rounds	VACAPES: W-50C, R-6606	202	286,600 rounds	VACAPES	202	286,600 rounds	VACAPES
	N/A	N/A	Cherry Point	32	135,500 rounds	Cherry Point	32	135,500 rounds	Cherry Point
	192	93,300 rounds	JAX: Charleston OPAREA UNDET Boxes North and South	200	123,800 rounds	JAX	200	123,800 rounds	JAX
	10	37,200 rounds	GOMEX: Panama City OPAREA Corpus Christi UNDET Box E3	10	37,200 rounds	GOMEX	10	37,200 rounds	GOMEX
	N/A	N/A	Other AFTT Areas[1]	18	26,500 rounds	Other AFTT Areas	18	26,500 rounds	Other AFTT Areas
Gunnery Exercise (Surface-to-Surface) – Boat Medium-Caliber	N/A	N/A	Northeast	2	700 rounds	Northeast	2	700 rounds	Northeast
	36	600 rounds	VACAPES: W-50C, R-6606	204	127,536 rounds (936 HE)	VACAPES	204	127,536 rounds (936 HE)	VACAPES

ASUW: Anti-Surface Warfare; Cherry Point: Navy Cherry Point Range Complex; GOMEX: Gulf of Mexico Range Complex; GUNEX: Gunnery Exercise; HE: High-Explosive (indicated by shaded cells); JAX: Jacksonville Range Complex; N/A:Not Analyzed; Northeast: Northeast Range Complexes; OPAREA: Operating Area; S-S: Surface-to-Surface; UNDET: Underwater Detonation; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[3] Other AFTT Areas include areas outside of range complexes and testing ranges but still within the AFTT Study Area. Other AFTT Area events typically refer to those events that occur while vessels are in transit.

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Anti-Surface Warfare (ASUW) (Continued)									
(GUNEX [S-S] – Boat) – Medium-Caliber	N/A[2]	N/A	Cherry Point: W-122	26	64,000 rounds (626 HE)[1]	Cherry Point	26	64,000 rounds (626 HE)	Cherry Point
	96	12,700 rounds	JAX: Charleston OPAREA UNDET Boxes North and South	194	13,480 rounds (120 HE)	JAX	194	13,480 rounds (120 HE)	JAX
	4	2,880	GOMEX: Panama City OPAREA Corpus Christi UNDET Box E3	8	2,900 rounds (32 HE)	GOMEX	8	2,900 rounds (32 HE)	GOMEX
Missile Exercise (Surface-to-Surface) (MISSILEX [S-S])	N/A	N/A	VACAPES	10	10 (8 HE)	VACAPES	10	10 (8 HE)	VACAPES
	N/A	N/A	JAX	10	10 (8 HE)	JAX	10	10 (8 HE)	JAX
Gunnery Exercise (Air-to-Surface) – Small-Caliber (GUNEX [A-S]) – Small-Caliber	522	818,000 rounds	VACAPES: W-72A, W-50C, W-386 (Air K)	619	821,000 rounds	VACAPES	619	821,000 rounds	VACAPES
	120	132,000 rounds	Cherry Point: W-122 (Areas 1, 2, 3, 8, 9, 10, 15, 16, 17)	130	196,000 rounds	Cherry Point	130	196,000 rounds	Cherry Point
	168	304,140 rounds	JAX: W-132, W-133, W-134, W-157, W-158	262	310,700 rounds	JAX	262	310,700 rounds	JAX
Gunnery Exercise [Air-to-Surface] – Medium-Caliber (GUNEX [A-S]) – Medium-Caliber	11	7,000 rounds	VACAPES: W-386 (Air K)	220	176,000 rounds (44,000 HE)	VACAPES	220	176,000 rounds (44,000 HE)	VACAPES
	20	4,800 rounds	Cherry Point: W-122	210	104,800 rounds (20,000 HE)	Cherry Point	210	104,800 rounds (20,000 HE)	Cherry Point
	N/A	N/A	JAX	245	198,400 rounds (44,000 HE)	JAX	245	198,400 rounds (44,000 HE)	JAX
	40	24,000 rounds	GOMEX: Pensacola OPAREA W-155 Hotbox	40	24,000 rounds (6,000 HE)	GOMEX	40	24,000 rounds (6,000 HE)	GOMEX
Missile Exercise (Air-to-Surface) – Rocket (MISSILEX [A-S]) – Rocket	97	3,700 rockets	VACAPES: W-386 (Air-K), W-72A	100	3,800 HE rockets	VACAPES	100	3,800 HE rockets	VACAPES
	N/A	N/A	JAX OPAREA	100	3,800 HE rockets	JAX	100	3,800 HE rockets	JAX
	N/A	N/A	GOMEX	10	380 HE rockets	GOMEX	10	380 HE rockets	GOMEX
Missile Exercise (Air-to-Surface) (MISSILEX [A-S])	80	80 HE missiles	VACAPES: W-386 (Air-K), W-72A	98	98 HE missiles	VACAPES	98	98 HE missiles	VACAPES
	16	16 missiles (14 HE)	Cherry Point: W-122 (16,17)	32	32 HE missiles	Cherry Point	32	32 HE missiles	Cherry Point
	73	73 HE missiles	JAX: W-157A, W-159A (Missile Laser Training Area)	118	118 HE missiles	JAX	118	118 HE missiles	JAX

A-S: Air-to-Surface; ASUW: Anti-Surface Warfare; Cherry Point: Navy Cherry Point Range Complex; GOMEX: Gulf of Mexico Range Complex; GUNEX: Gunnery Exercise; HE: High-Explosive (indicated by shaded cells); JAX: Jacksonville Range Complex; MISSILEX: Missile Exercise; N/A: Not Analyzed; OPAREA: Operating Area; S-S: Surface-to-Surface; UNDET: Underwater Detonation; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Anti-Surface Warfare (ASUW) (Continued)									
Bombing Exercise (Air-to-Surface) (BOMBEX [A-S])	266	575 bombs (20 HE)[1]	VACAPES: W-386 (Air-K, 7D & part of 8C), W-72A/B	359	674 bombs (64 HE)	VACAPES	359	674 bombs (64 HE)	VACAPES
	88	811 bombs	Cherry Point: W-122	88	1,195 bombs (32 HE)	Cherry Point	88	1,195 bombs (32 HE)	Cherry Point
	155	696 bombs	JAX: W-157A/B, W-158A/B	417	1,293 bombs (32 HE)	JAX	417	1,293 bombs (32 HE)	JAX
	49	296 bombs (4 HE)	GOMEX: Pensacola OPAREA, W-151 A/C, W-155B	66	339 bombs (4 HE)	GOMEX	66	339 bombs (4 HE)	GOMEX
Laser Targeting	272	None	VACAPES: W-386 (Air-K), W-72A	272	None	VACAPES	272	None	VACAPES
	303	None	JAX: W-132 W-133, W-134, W-157, W-158	315	None	JAX	315	None	JAX
Sinking Exercise (SINKEX)	6	< 50,000 lb. NEW	Other AFTT Areas[3]: SINKEX box	1	1 HE bomb; 11 HE missiles; 700 HE rounds; 1 HE torpedo (representative scenario)	Other AFTT Areas: SINKEX box	1	1 HE bomb; 11 HE missiles; 700 HE rounds; 1 HE torpedo (representative scenario)	Other AFTT Areas: SINKEX box
Anti-Submarine Warfare (ASW)									
Tracking Exercise/ Torpedo Exercise – Submarine (TRACKEX/ TORPEX – Sub)	30		Northeast	24		Northeast	24		Northeast
	10		VACAPES	8		VACAPES	8		VACAPES
	14		Cherry Point	1		Cherry Point	1		Cherry Point
	45		JAX[7]	25		JAX[7]	25		JAX[7]
	1		Gulf of Mexico	0		Gulf of Mexico	0		Gulf of Mexico
	0		Other AFTT Areas[3]	44		Other AFTT Areas	44		Other AFTT Areas
	100	72 torpedoes[5]	TOTAL	102	80 torpedoes[5]	TOTAL	102	80 torpedoes[5]	TOTAL
Tracking Exercise/ Torpedo Exercise – Surface (TRACKEX/ TORPEX – Surface)	0		Northeast	3		Northeast	3		Northeast
	69		VACAPES	201		VACAPES	201		VACAPES
	91		Cherry Point	47		Cherry Point	47		Cherry Point
	292		JAX[7]	412		JAX[7]	412		JAX[7]
	5		Gulf of Mexico	3		Gulf of Mexico	3		Gulf of Mexico
	0		Other AFTT Areas	98		Other AFTT Areas	98		Other AFTT Areas
	457	18 torpedoes[5]	TOTAL	764	18 torpedoes[5]	TOTAL	764	18 torpedoes[5]	TOTAL

A-S: Air-to-Surface; ASW: Anti-Submarine Warfare; ASUW: Anti-Surface Warfare; BOMBEX: Bombing Exercise; Cherry Point: Navy Cherry Point Range Complex; GOMEX: Gulf of Mexico Range Complex; HE: High-Explosive; JAX: Jacksonville Range Complex; Northeast: Northeast Range Complexes; SINKEX: Sinking Exercise; TORPEX: Torpedo Exercise; TRACKEX: Tracking Exercise; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[3] Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Other AFTT Area events typically refer to those events that occur while vessels are in transit.

[5] Number of torpedoes represents total for entire AFTT Study Area for each activity.

[7.] Training activities occurring on Undersea Warfare Training Range can be found in Appendix A at A.1.9.9 and Appendix H

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Anti-Submarine Warfare (ASW) (Continued)									
Tracking Exercise/ Torpedo Exercise – Helicopter (TRACKEX/ TORPEX – Helo)	25		VACAPES	12		VACAPES	12		VACAPES
	25		Cherry Point	12		Cherry Point	12		Cherry Point
	115		JAX[7]	384		JAX[7]	384		JAX[7]
	0		Other AFTT Areas[3]	24		Other AFTT Areas	24		Other AFTT Areas
	165	18 torpedoes[5]	TOTAL	432	18 torpedoes[5]	TOTAL	432	18 torpedoes[5]	TOTAL
Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft (TRACKEX/TORPEX – MPA)	238		Northeast	79		Northeast	79		Northeast
	79		VACAPES	158		VACAPES	158		VACAPES
	111		Cherry Point	40		Cherry Point	40		Cherry Point
	356		JAX[7]	475		JAX[7]	475		JAX[7]
	7		Gulf of Mexico	0		Gulf of Mexico	0		Gulf of Mexico
	791	18 torpedoes[5]	TOTAL	752	18 torpedoes[5]	TOTAL	752	18 torpedoes[5]	TOTAL
Tracking Exercise – Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys (TRACKEX–MPA Sonobuoy)	34	340 HE sonobuoys[1]	Northeast	34	170 HE sonobuoys	Northeast	34	170 HE sonobuoys	Northeast
	34	340 HE sonobuoys	VACAPES	68	340 HE sonobuoys	VACAPES	68	340 HE sonobuoys	VACAPES
	34	340 HE sonobuoys	Cherry Point	16	80 HE sonobuoys	Cherry Point	16	80 HE sonobuoys	Cherry Point
	34	340 HE sonobuoys	JAX[7]	202	1,010 HE sonobuoys	JAX[7]	202	1,010 HE sonobuoys	JAX[7]
	34	340 HE sonobuoys	Gulf of Mexico	0	None	Gulf of Mexico	0	None	Gulf of Mexico
	170		TOTAL	320		TOTAL	320		TOTAL
Anti-Submarine Warfare Tactical Development Exercise	4	None*	JAX	4	None*	JAX	4	None*	JAX
Integrated Anti-Submarine Warfare Course	0.2	None*	VACAPES	0	None*	VACAPES	0	None*	VACAPES
	1.4	None*	Cherry Point	2	None*	Cherry Point	2	None*	Cherry Point
	2.4	None*	JAX	2	None*	JAX	2	None*	JAX
	1	None*	Gulf of Mexico	1	None*	Gulf of Mexico	1	None*	Gulf of Mexico
Group Sail	3	None	VACAPES	5	35 HE sonobuoys	VACAPES	5	35 HE sonobuoys	VACAPES
	4	None	Cherry Point	5	35 HE sonobuoys	Cherry Point	5	35 HE sonobuoys	Cherry Point
	13	None	JAX	10	70 HE sonobuoys	JAX	10	70 HE sonobuoys	JAX
Submarine Command Course (SCC) Operations	0.4	None	Northeast	For Alternatives 1 and 2 this event is included in TRACKEX/TORPEX – SUB training event.					
	1.6	None	JAX						
ASW For Composite Training Unit Exercise (COMPTUEX)	4	44 HE sonobuoys	VACAPES/ Cherry Point/ JAX	4	280 HE sonobuoys	VACAPES/ Cherry Point/ JAX	4	280 HE sonobuoys	VACAPES/ Cherry Point/ JAX
	1	11 HE sonobuoys	Gulf of Mexico	1	70 HE sonobuoys	Gulf of Mexico	1	70 HE sonobuoys	Gulf of Mexico
ASW For Joint Task Force Exercise (JTFEX)/ Sustainment Exercise (SUSTAINEX)	2	15 HE sonobuoys	VACAPES/ Cherry Point/ JAX	4	28 HE sonobuoys	VACAPES/ Cherry Point/ JAX	4	28 HE sonobuoys	VACAPES/ Cherry Point/ JAX

ASW: Anti-Submarine Warfare; Cherry Point: Navy Cherry Point Range Complex; COMPTUEX: Composite Training Unit Exercise; HE: High-Explosive (indicated by shaded cells); JAX: Jacksonville Range Complex; JTFEX: Joint Task Force Exercise; MPA: maritime patrol aircraft; Northeast: Northeast Range Complexes; SCC: Submarine Command Course; SUSTAINEX: Sustainment Exercise; TORPEX: Torpedo Exercise; TRACKEX: Tracking Exercise; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[3] Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Other AFTT Area events typically refer to those events that occur while vessels are in transit.

[5] Number of torpedoes represents total for entire AFTT Study Area for each activity.

[7.] Training activities occurring on Undersea Warfare Training Range can be found in Appendix A at A.1.9.9

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Electronic Warfare (EW)									
Electronic Warfare Operations (EW Ops)	302	None	VACAPES: W-386 (Air-K), W-72	302	None	VACAPES	302	None	VACAPES
	2,620	None	Cherry Point: W-122	2,620	None	Cherry Point	2,620	None	Cherry Point
	181	None	JAX: W-132, W-133, W-134, W-157, W-158	181	None	JAX	181	None	JAX
Counter Targeting Flare Exercise (FLAREX)	80	None	VACAPES: W-386, W-72	104	None	VACAPES	104	None	VACAPES
	107	None	Cherry Point: W-122 (Areas 1, 8, 15, 16)	377	None	Cherry Point	377	None	Cherry Point
	94	None	JAX: W-157A (Areas 3X, 4X)	318	None	JAX	318	None	JAX
	368	None	GOMEX: Panama City OPAREA, W-151 A/B	368	None	GOMEX	368	None	GOMEX
	900	None	Key West: W-174 A/B/C/E/F/G, W-465A/B, Bonefish ATCAA	900	None	Key West	900	None	Key West
Counter Targeting Chaff Exercise (CHAFFEX) – Ship	28	None	VACAPES: W-386, W-72	37	None	VACAPES	37	None	VACAPES
	74	None	Cherry Point: W-122 (1, 8, 15, 16)	74	None	Cherry Point	74	None	Cherry Point
	74	None	JAX: W-157A (Areas 3X, 4X)	78	None	JAX	78	None	JAX
	14	None	GOMEX: W-151 A/B, W-155 A/B	18	None	GOMEX	18	None	GOMEX
Counter Targeting Chaff Exercise (CHAFFEX) – Aircraft	1,981	None	VACAPES: W-386, W-72	157	None	VACAPES	157	None	VACAPES
	572	None	Cherry Point: W-122 (Areas 1, 8, 15, 16)	686	None	Cherry Point	686	None	Cherry Point
	424	None	JAX: W-157A (Areas 3X, 4X)	532	None	JAX	532	None	JAX
	368	None	GOMEX: W-151 A/B, W-155 A/B	62	None	GOMEX	62	None	GOMEX
	3,000	None	Key West: W-174A/B/C/E/F/G, W-465A/B	3,000	None	Key West	3,000	None	Key West

Bonefish ATCAA: Bonefish Air Traffic Control Assigned Airspace; CHAFFEX: Counter Targeting Chaff Exercise; Cherry Point: Navy Cherry Point Range Complex; EW Ops: Electronic Warfare Operations; FLAREX: Flare Exercise; GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Mine Warfare (MIW)									
Mine Countermeasures Exercise (MCM) – Ship Sonar	0	None	VACAPES: W-50, Lower Chesapeake Bay	48	None	VACAPES	48	None	VACAPES
	0	None	JAX: CSG Mine Training Area	48	None	JAX	48	None	JAX
	0	N/A	GOMEX	20	None	GOMEX	20	None	GOMEX
Mine Neutralization – Explosive Ordnance Disposal (EOD)	24	24 HE charges[1]	VACAPES: W-50	524	524 HE charges	VACAPES	524	524 HE charges	VACAPES
	N/A	N/A	VACAPES: Little Creek	30	1,518 HE charges of varying sizes	VACAPES: Little Creek	30	1,518 HE charges are of varying sizes	VACAPES: Little Creek
	20	20 HE charges	Cherry Point: Onslow Bay UNDET Area	16	16 HE charges	Cherry Point	16	16 HE charges	Cherry Point
	12	12 HE charges	JAX: Charleston OPAREA UNDET Areas	20	20 HE charges	JAX	20	20 HE charges	JAX
	0	None	GOMEX	16	16 HE charges	GOMEX	16	16 HE charges	GOMEX
	N/A[2]	N/A	Key West	12	12 HE charges	Key West	12	12 HE charges	Key West
Underwater Mine Countermeasure (UMCM) Raise, Tow, Beach, and Exploitation Operations	N/A	N/A	VACAPES	290	None	VACAPES	290	None	VACAPES
	N/A	N/A	Cherry Point	24	None	Cherry Point	24	None	Cherry Point
	N/A	N/A	JAX	56	None	JAX	56	None	JAX
	N/A	N/A	GOMEX	56	None	GOMEX	56	None	GOMEX
Airborne Mine Countermeasure (AMCM) – Towed Mine Neutralization	980	None	VACAPES: W-50, Lower Chesapeake Bay	880	None	VACAPES	880	None	VACAPES
	183	None	Cherry Point: ARG Mine Training Area	183	None	Cherry Point	183	None	Cherry Point
	134	None	JAX: CSG Mine Training Areas	155	None	JAX	155	None	JAX
	N/A	N/A	GOMEX	94	None	GOMEX	94	None	GOMEX
Airborne Mine Countermeasure (AMCM) – Mine Detection	1,232	None	VACAPES: MIW Sonar Training Areas	1,540	None	VACAPES	1,540	None	VACAPES
	393	None	Cherry Point: ARG Mine Training Area	371	None	Cherry Point	371	None	Cherry Point
	322	None	JAX: CSG Mine Training Area	317	None	JAX	317	None	JAX
	N/A	N/A	GOMEX	310	None	GOMEX	310	None	GOMEX

AMCM: Airborne Mine Countermeasures; ARG: Amphibious Ready Group; Cherry Point: Navy Cherry Point Range Complex; CSG: Carrier Strike Group; EOD: Explosive Ordnance Disposal; GOMEX: Gulf of Mexico Range Complex; HE: High-Explosive; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; MCM: Mine Countermeasure Exercise; MIW: Mine Warfare; N/A: Not Analyzed; OPAREA: Operating Area; UMCM – Underwater Mine Countermeasures; UNDET: Underwater Detonation; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Mine Countermeasure (MCM) – Mine Neutralization Small- and Medium-Caliber	110	2,750 rounds	VACAPES: W-50	110	2,750 rounds	VACAPES	110	2,750 rounds	VACAPES
	27	675 rounds	Cherry Point: Onslow Bay UNDET Area	27	675 rounds	Cherry Point	27	675 rounds	Cherry Point
	27	675 rounds	JAX: Charleston OPAREA UNDET Areas	27	675 rounds	JAX	27	675 rounds	JAX
Mine Countermeasure (MCM) – Mine Neutralization – Remotely Operated Vehicle	210	210 neutralizers (30 HE)[1]	VACAPES: W-50	630	630 neutralizers (60 HE)	VACAPES	630	630 neutralizers (60 HE)	VACAPES
	27	27 neutralizers	Cherry Point: Onslow Bay UNDET Area	71	71 neutralizers	Cherry Point	71	71 neutralizers	Cherry Point
	27	27 neutralizers	JAX: Charleston OPAREA UNDET Areas	71	71 neutralizers	JAX	71	71 neutralizers	JAX
	N/A[2]	N/A	GOMEX	132	132 neutralizers (20 HE)	GOMEX	132	132 neutralizers (20 HE)	GOMEX
Mine Laying	N/A	N/A	VACAPES	4	48 mine shapes	VACAPES	4	48 mine shapes	VACAPES
	N/A	N/A	Cherry Point	2	24 mine shapes	Cherry Point	2	24 mine shapes	Cherry Point
	N/A	N/A	JAX	1	12 mine shapes	JAX	1	12 mine shapes	JAX
Coordinated Unit Level Helicopter Airborne Mine Countermeasure Exercises	N/A	N/A	VACAPES	2	None	VACAPES	2	None	VACAPES
	N/A	N/A	Cherry Point	2	None	Cherry Point	2	None	Cherry Point
	N/A	N/A	JAX	2	None	JAX	2	None	JAX
	N/A	N/A	GOMEX	2	None	GOMEX	2	None	GOMEX
Civilian Port Defense	N/A	N/A	N/A	1 event every other year (3 total)	4 HE charges	Occurs in a different area each year in waters around Earle, NJ; Groton, CT; Hampton Roads, VA; Morehead City, NC; Wilmington, NC; Kings Bay, GA; Mayport, FL; Beaumont, TX; Corpus Christi, TX	1 event every other year (3 total)	4 HE charges	Occurs in a different area each year in waters around Earle, NJ; Groton, CT; Hampton Roads, VA; Morehead City, NC; Wilmington, NC; Kings Bay, GA; Mayport, FL; Beaumont, TX; Corpus Christi, TX
Major Exercises									
Composite Training Unit Exercise (COMPTUEX)[6]	5		VACAPES/ Cherry Point/ JAX/ GOMEX	5		VACAPES/ Cherry Point/ JAX/ GOMEX	5		VACAPES/ Cherry Point/ JAX/ GOMEX
Joint Task Force Exercise (JTFX)/ Sustainment Exercise (SUSTAINEX)[6]	2		VACAPES/ Cherry Point/ JAX	4		VACAPES/ Cherry Point/ JAX	4		VACAPES/ Cherry Point/ JAX

Cherry Point: Navy Cherry Point Range Complex; COMPTUEX: Composite Training Unit Exercise; GOMEX: Gulf of Mexico Range Complex; HE: High-Explosive (indicated by shaded cells); JAX: Jacksonville Range Complex; JTFX: Joint Task Force Exercise; MCM: Mine Countermeasure Exercise; N/A: Not Analyzed; OPAREA: Operating Area; SUSTAINEX: Sustainment Exercise; UNDET: Underwater Detonation; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[6] Numbers for ordnance included in unit level training and composite training activities for each alternative.

Table 2.8-1: Baseline and Proposed Training Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location	No. of events (per year)	Ordnance* (Number per year)	Location
Other Training Activities									
Search and Rescue (SAR)	42	None	JAX: Seminole Beach	42	None	JAX	42	None	JAX
Precision Anchoring	N/A[2]	N/A	VACAPES	640	None	VACAPES	640	None	VACAPES
	168	None	JAX	210	None	JAX	210	None	JAX
	N/A	N/A	GOMEX	8	None	GOMEX	8	None	GOMEX
Elevated Causeway System (ELCAS)	N/A	N/A	N/A	1	None	VACAPES: Joint Expeditionary Base, Little Creek and Fort Story Cherry Point: Camp Lejeune (either location)	1	None	VACAPES: Joint Expeditionary Base, Little Creek and Fort Story Cherry Point: Camp Lejeune (either location)
Submarine Navigational (SUB NAV)	165	None	Northeast	169	None	Northeast	169	None	Northeast
	78	None	VACAPES	84	None	VACAPES	84	None	VACAPES
	57	None	JAX	29	None	JAX	29	None	JAX
Submarine Under Ice Certification	N/A	N/A	Northeast	9	None	Northeast	9	None	Northeast
	N/A	N/A	VACAPES	9	None	VACAPES	9	None	VACAPES
	N/A	N/A	Cherry Point	3	None	Cherry Point	3	None	Cherry Point
	N/A	N/A	JAX	3	None	JAX	3	None	JAX
Surface Ship Object Detection	68	None	VACAPES	80	None	VACAPES	80	None	VACAPES
	40	None	JAX	64	None	JAX	64	None	JAX
Surface Ship Sonar Maintenance (in OPAREAs and Ports)	61	None	VACAPES	358	None	VACAPES	358	None	VACAPES
	82	None	Cherry Point	110	None	Cherry Point	110	None	Cherry Point
	263	None	JAX	324	None	JAX	324	None	JAX
	4	None	GOMEX	0	None	GOMEX	0	None	GOMEX
	N/A	N/A	Other AFTT Areas[3]	32	None	Other AFTT Areas	32	None	Other AFTT Areas
Submarine Sonar Maintenance (in OPAREAs and Ports)	66	None	Northeast	132	None	Northeast	132	None	Northeast
	34	None	VACAPES	68	None	VACAPES	68	None	VACAPES
	0	None	Cherry Point	0	None	Cherry Point	0	None	Cherry Point
	0	None	JAX	8	None	JAX	8	None	JAX
	N/A	N/A	Other AFTT Areas	12	None	Other AFTT Areas	12	None	Other AFTT Areas

Cherry Point: Navy Cherry Point Range Complex; ELCAS: Elevated Causeway System; GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; N/A: Not Analyzed; Northeast: Northeast Range Complexes; OPAREA: Operating Area; SAR: Search and Rescue; SUB NAV: Submarine Navigation; VACAPES: Virginia Capes Range Complex

* All major exercise munitions are distributed among the individual unit events.

[2] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[3] Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Other AFTT Area events typically refer to those events that occur while vessels are in transit.

Table 2.8-2: Baseline and Proposed Naval Air Systems Command Testing Activities

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location
Anti-Air Warfare (AAW)									
Air Combat Maneuver (ACM)	500	None	VACAPES, JAX, Cherry Point, GOMEX	500	None	AFTT Study Area	550	None	AFTT Study Area
Air Platform/ Vehicle Test	1,460	None	VACAPES (W-386, W-387A, W-72A, W-72B, but could include other Warning/Restricted Areas	1,460	None	VACAPES	1,477	None	VACAPES
	172	None	JAX	172	None	JAX	189	None	JAX
	10	None	Key West	10	None	Key West	12	None	Key West
	25	None	GOMEX	25	None	GOMEX	28	None	GOMEX
	425	None	AFTT Study Area	425	None	AFTT Study Area	468	None	AFTT Study Area
Air Platform Weapons Integration Test	150	42 missiles, 130 rockets, 12,000 medium-caliber projectiles, 300 bombs	VACAPES: W-386, W-72A, R-6604	650	240 missiles, 1,000 rockets, 40,000 medium-caliber projectiles, 400 bombs	VACAPES	715	264 missiles, 1,100 rockets, 44,000 medium-caliber projectiles, 440 bombs	VACAPES
Air to Air Weapons System Test	60	2 missiles, 9,000 medium-caliber projectiles	VACAPES: W-386 (85%), W-72 (10%), R-6604 (5%)	60	40 missiles, 9,000 medium-caliber projectiles	VACAPES	66	55 missiles, 10,000 medium-caliber projectiles	VACAPES
Air to Air Missile Test	50	50 missiles	VACAPES: W-386 (85%), W-72 (10%), R-6604 (5%)	75	75 missiles	VACAPES	83	83 missiles	VACAPES
Air to Air Gunnery Test Medium-Caliber	50	8,970 rounds	VACAPES: W-386 (85%), W-72 (10%), R-6604 (5%)	50	8,970 rounds	VACAPES	55	9,870 rounds	VACAPES
Intelligence, Surveillance, and Reconnaissance Test	35	None	VACAPES, Cherry Point, JAX	35	None	AFTT Study Area	39	None	AFTT Study Area
Anti-Surface Warfare (ASUW)									
Air-to-Surface Missile Test	39	39 missiles (5 HE)[1]	VACAPES: W-386 (85%), W-72 (10%), R-6604 (5%)	168	201 missiles (28 HE)	VACAPES	185	223 missiles (31 HE)	VACAPES
	10	10 missiles (5 HE)	JAX	41	58 missiles (16 HE)	JAX	44	65 missiles (18 HE)	JAX
	None	None	GOMEX	8	8 missiles	GOMEX	10	10 missiles	GOMEX
Air-to-Surface Gunnery Test	30	12,000 rounds	VACAPES: W-386 (85%), W-72 (10%), R-6604 (5%)	100	40,000 rounds (10,000 HE)	VACAPES	110	44,000 rounds (11,000 HE)	VACAPES
	20	16,000 rounds	JAX	50	40,000 rounds (10,000 HE)	JAX	55	44,000 rounds (11,000 HE)	JAX
Rocket Test	30	134 rockets	VACAPES: W-386 (Air G & H)	242	1,081 rockets (184 HE)	VACAPES	266	1,189 rockets (202 HE)	VACAPES
	10	113 rockets	JAX	60	680 (184 HE)	JAX	66	748 rockets (202 HE)	JAX
Air-to-Surface Bombing Test	150	355 bombs	VACAPES: W-386 (85%) W-72 (15%)	150	423 bombs	VACAPES	165	465 bombs	VACAPES
Laser Targeting Test	10	None	VACAPES	250	None	VACAPES	275	None	VACAPES
	2	None	JAX	55	None	JAX	61	None	JAX
High Energy Laser Weapons Test	None	None	None	98	None	VACAPES	108	None	VACAPES

AAW: Anti-Air Warfare; ACM: Air Combat Maneuver; ASUW: Anti-Surface Warfare; Cherry Point: Navy Cherry Point Range Complex; GOMEX: Gulf of Mexico Range Complex; HE: High-Explosive; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; VACAPES: Virginia Capes Range Complex

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] None indicates that these activities have not previously occurred.

Table 2.8-2: Baseline and Proposed Naval Air Systems Command Testing Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location
Electronic Warfare (EW)									
Electronic System Evaluation	151	None	VACAPES: W-386 (85%), W-72 (15%)	610	None	VACAPES	671	None	VACAPES
	None[2]	None	GOMEX	19	None	GOMEX	21	None	GOMEX
Chaff Test	150	None	VACAPES: W-386 (85%), W-72 (15%)	600	None	VACAPES	670	None	VACAPES
	10	None	Cherry Point	600	None	Cherry Point	670	None	Cherry Point
	10	None	JAX	600	None	JAX	670	None	JAX
	10	None	GOMEX	185	None	GOMEX	204	None	GOMEX
Flare Test	150	None	VACAPES: W-386 (85%), W-72 (15%)	600	None	VACAPES	670	None	VACAPES
	10	None	Cherry Point	600	None	Cherry Point	670	None	Cherry Point
	10	None	JAX	600	None	JAX	670	None	JAX
	10	None	GOMEX	45	None	GOMEX	50	None	GOMEX
Anti-Submarine Warfare (ASW)									
ASW Torpedo Test	13	13 torpedoes	VACAPES	184	184 torpedoes	VACAPES	202	202 torpedoes	VACAPES
	8	10 torpedoes	JAX	36	40 torpedoes	JAX	40	45 torpedoes	JAX
Kilo Dip	1	None	Narragansett Bay	2	None	Northeast	3	None	Northeast
	20	None	VACAPES, W-386 & W-72	32	None	VACAPES	35	None	VACAPES
	1	None	Cherry Point	0	None	Cherry Point	0	None	Cherry Point
	2	None	JAX: W-157, W-158, W-159	4	None	JAX	5	None	JAX
Sonobuoy Lot Acceptance Test	None	None	Key West	33	1,312 HE sonobuoys[1]	Key West	39	1,512 HE sonobuoys	Key West
ASW Tracking Test – Helicopter	2	None	Northeast	86	96 HE sonobuoys	Northeast	95	106 HE sonobuoys	Northeast
	50	None	VACAPES, W-386 & W-72	204	624 HE sonobuoys	VACAPES	224	686 HE sonobuoys	VACAPES
	2	None	Cherry Point	0	None	Cherry Point	0	None	Cherry Point
	10	None	JAX: W-157, W-158, W-159	75	None	JAX	83	None	JAX
	None	None	GOMEX	24	None	GOMEX	26	None	GOMEX
ASW Tracking Test – Maritime Patrol Aircraft	10	224 HE sonobuoys	Northeast	10	224 HE sonobuoys	Northeast	18	408 HE sonobuoys	Northeast
	8	172 HE sonobuoys	VACAPES	8	172 HE sonobuoys	VACAPES	12	264 HE sonobuoys	VACAPES
	7	152 HE sonobuoys	JAX	7	152 HE sonobuoys	JAX	11	244 HE sonobuoys	JAX
	5	112 HE sonobuoys	GOMEX	5	112 HE sonobuoys	GOMEX	9	204 HE sonobuoys	GOMEX
	5	112 HE sonobuoys	Cherry Point	5	112 HE sonobuoys	Cherry Point	9	204 HE sonobuoys	Cherry Point
	5	184 HE sonobuoys	Other AFTT Areas[3]	8	184 HE sonobuoys	Other AFTT Areas	16	368 HE sonobuoys	Other AFTT Areas

ASW: Anti-Submarine Warfare; Cherry Point: Navy Cherry Point Range Complex; EW: Electronic Warfare; GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; VACAPES: Virginia Capes Range Complex

[1] Shaded cells indicate “High-Explosive” (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] None indicates that these activities have not previously occurred.

[3] Other AFTT Areas are areas outside of named operating areas but still within the AFTT Study Area. Other AFTT Area events typically refer to those events that occur while vessels are in transit.

Table 2.8-2: Baseline and Proposed Naval Air Systems Command Testing Activities (Continued)

Range Activity	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location
Mine Warfare (MIW)									
Airborne Mine Neutralization Systems (AMNS) Test	30	120 neutralizers (90 HE)[1]	VACAPES; (W-50, W-72)	30	120 neutralizers (90 HE)	VACAPES	33	144 neutralizers (99 HE)	VACAPES
	5	None	SFOMF	0	None	SFOMF	0	None	SFOMF
	50	8 HE mines, 120 neutralizers (40 HE)	NSWC PCD[4]	120	8 HE mines, 264 neutralizers (144 HE)	NSWC PCD	132	8 HE mines, 290 neutralizers (150 HE)	NSWC PCD
Airborne Projectile-Based Mine Clearance System	12	240 rounds	VACAPES: W-50	5	100 rounds 5 HE mines	VACAPES	6	120 rounds 6 HE mines	VACAPES
	12	700 rounds	NSWC PCD	210	12,380 rounds 20 mines (4 HE)	NSWC PCD	231	13,618 rounds 20 mines (4 HE)	NSWC PCD
Airborne Towed Minesweeping Test	30	None	VACAPES; W-50 & W-72	30	None	VACAPES	33	No HE mines	VACAPES
	50	8 mines (4 HE)	NSWC PCD	65	8 mines (4 HE)	NSWC PCD	72	8 mines (4 HE)	NSWC PCD
Airborne Towed Minehunting Sonar Test	50	None	VACAPES; W-50 & W-72	50	None	VACAPES	55	None	VACAPES
	25	None	NSWC PCD	90	None	NSWC PCD	100	None	NSWC PCD
	30	None	SFOMF	0	None	SFOMF	0	None	SFOMF
Airborne Laser-Based Mine Detection System Test	30	None	VACAPES, W-50 or W-72	30	None	VACAPES	33	None	VACAPES
	50	None	NSWC PCD	110	None	NSWC PCD	121	None	NSWC PCD
Mine Laying Test	None[2]	None	VACAPES	5	50 mine shapes	VACAPES	6	60 mine shapes	VACAPES
	5	50 mine shapes	JAX	5	50 mine shapes	JAX	6	60 mine shapes	JAX
Other Testing Activities									
Test and Evaluation (T&E) Catapult Launch	8,700	None	VACAPES, Cherry Point, JAX	8,700	None	AFTT Study Area	9,570	None	AFTT Study Area
Air Platform Shipboard Integrate Test	63	None	VACAPES: W-386, W-72	63	None	VACAPES	69	None	VACAPES
	30	None	Cherry Point	30	None	Cherry Point	33	None	Cherry Point
	30	None	JAX	30	None	JAX	33	None	JAX
Shipboard Electronic Systems Evaluation	10	None	VACAPES: W-386, W-72	20	None	VACAPES	22	None	VACAPES
	2	None	Cherry Point	2	None	Cherry Point	3	None	Cherry Point
	2	None	JAX	2	None	JAX	3	None	JAX
Maritime Security	10	None	VACAPES: W-386, W-72	10	None	VACAPES	11	None	VACAPES
	10	None	Cherry Point	10	None	Cherry Point	11	None	Cherry Point
	10	None	JAX	10	None	JAX	11	None	JAX

AMNS: Airborne Mine Neutralization System; Cherry Point: Navy Cherry Point Range Complex; HE: High-Explosive; JAX: Jacksonville Range Complex; MIW: Mine Warfare; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; T&E: Test and Evaluation; VACAPES: Virginia Capes Range Complex

[1] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[2] None indicates that these activities have not previously occurred.

[4] The No Action Alternative events for this activity occurring at Naval Surface Warfare Center, Panama City Division Testing Range are included within the Naval Sea Systems Command Table 2.8-3 under the NSWC PCD No Action Alternative activities.

Table 2.8-3: Baseline and Proposed Naval Sea Systems Command Testing Activities

Event Name		No Action Alternative			Alternative 1			Alternative 2		
		No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location
Ship Construction and Maintenance										
New Ship Construction										
Surface Combatant Sea Trials	Pierside Sonar Testing	N/A[1]	N/A	N/A	5	None	Pierside: Bath, ME	5	None	Pierside: Bath, ME
					3	None	Pierside: Pascagoula, MS	3	None	Pierside: Pascagoula, MS
					2	None	Pierside: Norfolk, VA	2	None	Pierside: Norfolk, VA
					2	None	Pierside: Mayport, FL	2	None	Pierside: Mayport, FL
	Propulsion Testing	2	None	Boston Area Complex	5	None	Northeast	5	None	Northeast
		2	None	GOMEX W-155B	2	None	Gulf of Mexico	2	None	Gulf of Mexico
		N/A	N/A	VACAPES	2	None	VACAPES	2	None	VACAPES
		N/A	N/A	JAX	2	None	JAX	2	None	JAX
	Gun Testing	2	52 large-caliber rounds	Northeast: CGULL OPAREA	4	104 large-caliber rounds; 2,800 medium-caliber rounds	Northeast	4	104 large-caliber rounds; 2,800 medium-caliber rounds	Northeast
		2	52 large-caliber rounds	GOMEX W-151C	2	52 large-caliber rounds; 1,400 medium-caliber rounds	Gulf of Mexico	2	52 large-caliber rounds; 1,400 medium-caliber rounds	Gulf of Mexico
		N/A	N/A	VACAPES	2	52 large-caliber rounds; 1,400 medium-caliber rounds	VACAPES	2	52 large-caliber rounds; 1,400 medium-caliber rounds	VACAPES
		N/A	N/A	JAX	2	52 large-caliber rounds; 1,400 medium-caliber rounds	JAX	2	52 large-caliber rounds; 1,400 medium-caliber rounds	JAX
	Missile Testing	2	4 missiles	Northeast: CGULL OPAREA	4	8 HE missiles[2]	Northeast	4	8 HE missiles	Northeast
		2	4 missiles	GOMEX W-151C	2	4 HE missiles	Gulf of Mexico	2	4 HE missiles	Gulf of Mexico
		N/A	N/A	VACAPES	2	4 HE missiles	VACAPES	2	4 HE missiles	VACAPES
		N/A	N/A	JAX	2	4 HE missiles	JAX	2	4 HE missiles	JAX
	Decoy Testing	2	None	Northeast: CGULL OPAREA	4	None	Northeast	4	None	Northeast
		2	None	GOMEX W-151C	2	None	Gulf of Mexico	2	None	Gulf of Mexico
		N/A	N/A	VACAPES	2	None	VACAPES	2	None	VACAPES
		N/A	N/A	JAX	2	None	JAX	2	None	JAX
	Surface Warfare Testing – Large-Caliber	2	96 rounds	Northeast: CGULL OPAREA	4	192 rounds	Northeast	4	192 rounds	Northeast
		2	96 rounds	GOMEX W-151C	2	96 rounds	Gulf of Mexico	2	96 rounds	Gulf of Mexico
		N/A	N/A	VACAPES	2	96 rounds	VACAPES	2	96 rounds	VACAPES
		N/A	N/A	JAX	2	96 rounds	JAX	2	96 rounds	JAX
	Anti-Submarine Warfare Testing	2	None	Northeast: CGULL OPAREA	4	None	Northeast	4	None	Northeast
		2	None	GOMEX W-151C	2	None	Gulf of Mexico	2	None	Gulf of Mexico
		N/A	N/A	VACAPES	2	None	VACAPES	2	None	VACAPES
		N/A	N/A	JAX	2	None	JAX	2	None	JAX

FL: Florida; GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; ME: Maine; MS: Mississippi; N/A: Not Analyzed; Northeast: Northeast Range Complexes; OPAREA: Operating Area; VA: Virginia; VACAPES: Virginia Capes Range Complex

[1] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[2] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

Table 2.8-3: Baseline and Proposed Naval Sea Systems Command Testing Activities (Continued)

Event Name		No Action Alternative: No. of events (per year)	No Action Alternative: Ordnance (Number per year)	No Action Alternative: Location	Alternative 1: No. of events (per year)	Alternative 1: Ordnance (Number per year)	Alternative 1: Location	Alternative 2: No. of events (per year)	Alternative 2: Ordnance (Number per year)	Alternative 2: Location
New Ship Construction (Continued)										
Aircraft Carrier Sea Trials	Propulsion Testing	N/A[1]	N/A	N/A	4 events total	None	VACAPES	4 events total	None	VACAPES
	Gun Testing – Small-Caliber	N/A	N/A	N/A	100 events total	10,000 rounds total	VACAPES	100 events total	10,000 rounds total	VACAPES
							Cherry Point			Cherry Point
							JAX			JAX
	Gun Testing – Medium-Caliber	N/A	N/A	N/A	410 events total	67,200 rounds (600 HE)[2] total	VACAPES	410 events total	67,200 rounds (600 HE) total	VACAPES
							Cherry Point			Cherry Point
							JAX			JAX
	Missile Testing	N/A	N/A	N/A	17 events total	17 HE missiles total	VACAPES	17 events total	17 HE missiles total	VACAPES
	Bomb Testing	N/A	N/A	N/A	120 events total	240 bombs total	JAX	120 events total	240 bombs total	JAX
Submarine Sea Trials	Pierside Sonar Testing	N/A	N/A	N/A	3	None	Pierside: Groton, CT	3	None	Pierside: Groton, CT
					3	None	Pierside: Newport News, VA	3	None	Pierside: Newport News, VA
	Propulsion Testing	N/A	N/A	N/A	4	None	Northeast	4	None	Northeast
					4	None	VACAPES	4	None	VACAPES
					4	None	JAX	4	None	JAX
	Weapons System Testing	N/A	N/A	N/A	4	None	Northeast	4	None	Northeast
					4	None	VACAPES	4	None	VACAPES
					4	None	JAX	4	None	JAX
	Anti-Submarine Warfare Testing	N/A	N/A	N/A	4	None	Northeast	4	None	Northeast
					4	None	VACAPES	4	None	VACAPES
					4	None	JAX	4	None	JAX
Other Class Ship Sea Trials	Propulsion Testing	N/A	N/A	N/A	14	None	AFTT Study Area	14	None	AFTT Study Area
		1	None	VACAPES	2	None	VACAPES	3	None	VACAPES
		3	None	GOMEX	27	None	Gulf of Mexico	30	None	Gulf of Mexico
	Gun Testing – Small-Caliber	N/A	N/A	N/A	2	2,000 rounds	VACAPES	3	3,000 rounds	VACAPES
		2	2,000 rounds	GOMEX	24	24,000 rounds	Gulf of Mexico	28	28,000 rounds	Gulf of Mexico
ASW Mission Package Testing	Shipboard	None[3]	None	None	16	16 torpedoes	JAX	16	16 torpedoes	JAX
	Airborne	None	None	None	8	8 torpedoes	VACAPES	8	8 torpedoes	VACAPES
SUW Mission Package Testing	Gun Testing – Small-Caliber	None	None	None	4	2,000 rounds	AFTT Study Area	5	2,500 rounds	AFTT Study Area
	Gun Testing – Medium-Caliber				4	5,600 rounds (2,800 HE)	AFTT Study Area	5	7,000 rounds (3,500 HE)	AFTT Study Area
	Gun Testing – Large-Caliber				4	5,600 rounds (3,920 HE)	AFTT Study Area	5	7,000 rounds (4,900 HE)	AFTT Study Area
	Missile/Rocket Testing				13 (either location)	26 missiles/rockets (13 HE)	VACAPES	15 (either location)	30 missiles/rockets (15 HE)	VACAPES
							JAX			JAX
MCM Mission Package Testing		None	None	None	6 (either location)	96 neutralizers (48 HE)	JAX	8 (either location)	128 neutralizers (64 HE)	JAX
							VACAPES			VACAPES

ASW: Anti-submarine Warfare; Cherry Point: Navy Cherry Point Range Complex; CT: Connecticut; GOMEX: Gulf of Mexico Range Complex; HE: High-Explosive; JAX: Jacksonville Range Complex; MCM: Mine Countermeasures; N/A: Not Analyzed; SUW: Surface Warfare; VA: Virginia; VACAPES: Virginia Capes Range Complex

[1] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[2] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[3] None indicates that an event has not previously occurred.

Table 2.8-3: Baseline and Proposed Naval Sea Systems Command Testing Activities (Continued)

Event Name	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location
New Ship Construction (Continued)									
Post-Homeporting Testing (all classes)	None[3]	None	None	4	None	Northeast	4	None	Northeast
				20	None	VACAPES	22	None	VACAPES
				20	None	JAX	22	None	JAX
Shock Trials									
Aircraft Carrier Full Ship Shock Trial	N/A[1]	N/A	N/A	1 event total[4]	4 charges total[2]	VACAPES (ship shock box) JAX (ship shock box) (either location)	1 event total	4 charges total	VACAPES (ship shock box) JAX (ship shock box) (either location)
DDG 1000 Zumwalt Class Destroyer Full Ship Shock Trial	N/A	N/A	N/A	1 event total	4 charges total	VACAPES (ship shock box) JAX (ship shock box) (either location)	1 event total	4 charges total	VACAPES (ship shock box) JAX (ship shock box) (either location)
Littoral Combat Ship Full Ship Shock Trial	N/A	N/A	N/A	2 events total	4 charges/ event	VACAPES (ship shock box) JAX (ship shock box) (either location)	2 events total	4 charges/ event	VACAPES (ship shock box) JAX (ship shock box) (either location)
Life Cycle Activities									
Ship Signature Testing	N/A	N/A	N/A	1	None	VACAPES	2	None	VACAPES
				4	None	Pierside: Little Creek, VA	5	None	Pierside: Little Creek, VA
				1	None	Gulf of Mexico	2	None	Gulf of Mexico
Surface Ship Sonar Testing/Maintenance (in OPAREAs and Ports)	N/A	N/A	N/A	10	None	VACAPES	10	None	VACAPES
				6	None	JAX	6	None	JAX
Submarine Sonar Testing/Maintenance (in OPAREAs and Ports)	N/A	N/A	N/A	10	None	Northeast	12	None	Northeast
				14	None	VACAPES	16	None	VACAPES
Combat System Ship Qualification Trial (CSSQT) – In-Port Maintenance Period	N/A	N/A	N/A	6	None	Pierside: Norfolk, VA	6	None	Pierside: Norfolk, VA
				6	None	Pierside: Mayport, FL	6	None	Pierside: Mayport, FL
Combat System Ship Qualification Trial (CSSQT) – Air Defense (AD)	N/A	N/A	N/A	12	24,000 medium-caliber rounds, 240 large-caliber rounds (60 HE), 74 missiles (38 HE)	VACAPES	12	24,000 medium-caliber rounds, 240 large-caliber rounds (60 HE), 74 missiles (38 HE)	VACAPES
				3	6,000 medium-caliber rounds, 60 large-caliber rounds, 18 missiles (9 HE)	JAX	3	6,000 medium-caliber rounds, 60 large-caliber rounds, 18 missiles (9 HE)	JAX

AD: Air Defense; CSSQT: Combat System Ship Qualification Trial; DDG: Guided Missile Destroyer; FL: Florida; HE: High-Explosive; JAX: Jacksonville Range Complex; N/A: Not Analyzed; Northeast: Northeast Range Complexes; OPAREA: Operating Area; VA: Virginia; VACAPES: Virginia Capes Range Complex

[1] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline. However, shock trials have been conducted, with associated Executive Order 12114 documentation, for previous classes of ships.

[2] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[3] None indicates that an event has not previously occurred.

[4] One aircraft carrier ship shock trial will occur during the five year period.

Table 2.8-3: Baseline and Proposed Naval Sea Systems Command Testing Activities (Continued)

Event Name	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location
Life Cycle Activities (Continued)									
Combat System Ship Qualification Trial (CSSQT) – Surface Warfare (SUW)	N/A[1]	N/A	N/A	15	4,020 large-caliber rounds (1,737 HE)[2], 18,000 medium-caliber rounds, 9 missiles	VACAPES	15	4,020 large-caliber rounds (1,737 HE), 18,000 medium-caliber rounds, 9 missiles	VACAPES
				3	900 large-caliber rounds (339 HE), 6,000 medium-caliber rounds, 3 missiles	JAX	3	900 large-caliber rounds (339 HE), 6,000 medium-caliber rounds, 3 missiles	JAX
				3	900 large-caliber rounds (339 HE), 6,000 medium-caliber rounds, 3 missiles	Key West	3	900 large-caliber rounds (339 HE), 6,000 medium-caliber rounds, 3 missiles	Key West
Combat System Ship Qualification Trial (CSSQT) – Undersea Warfare (USW)	N/A	N/A	N/A	3	24 torpedoes	VACAPES	3	24 torpedoes	VACAPES
	N/A	N/A	N/A	6	48 torpedoes	JAX	6	48 torpedoes	JAX
Naval Sea Systems Command Range Activities									
Naval Surface Warfare Center, Panama City Division Testing Range (NSWC PCD)									
Air Operations	1,116 hours/year	None	NSWC PCD	NSWC PCD Range activities re-categorized as events/year rather than hours/year. See new events below for Alternative 1 and Alternative 2.					
Surface Operations	7,443 hours/year	None	NSWC PCD						
Subsurface Operations	966 items/ 1,620 hours/year	N/A	NSWC PCD						
Sonar Operations	1,080 hours/year	None	NSWC PCD						
Electromagnetic Operations	735 hours/year	None	NSWC PCD						
Laser Operations	1,053 hours/year	None	NSWC PCD						
Ordnance Operations	73 items/year	51 detonations of 1-10 lb. 3 detonations of 11-75 lb. 16 detonations of 76-600 lb. 3 line charges	NSWC PCD						
Projectile Firing	10,872 items/year	6,000 small-caliber, 4,572 medium-caliber, and 300 large-caliber rounds	NSWC PCD						
Unmanned Underwater Vehicle Demonstrations	1 event total	None	NSWC PCD	1 event total	None	NSWC PCD	1 event total	None	NSWC PCD
Mine Detection and Classification Testing	NSWC PCD Range No Action Alternative activities categorized above as hours/year or items/year rather than events/year.			71[5]	None	NSWC PCD	81[5]	None	NSWC PCD
Mine Countermeasure / Neutralization Testing				13[5]	17 HE charges	NSWC PCD	15[5]	21 HE charges	NSWC PCD
Stationary Source Testing				10	None	NSWC PCD	11	None	NSWC PCD

CSSQT: Combat System Ship Qualification Trial; HE: High-Explosive (indicated by shaded cells); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; N/A: Not Analyzed; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; SUW: Surface Warfare; USW: Undersea Warfare; VA: Virginia; VACAPES: Virginia Capes Range Complex

[1] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[2] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[5] Naval Air Systems Command activities conducted at Naval Surface Warfare Center, Panama City Division Testing Range under Alternative 1 and Alternative 2 are included in the Naval Air Systems Command Activity Table 2.8-2.

Table 2.8-3: Baseline and Proposed Naval Sea Systems Command Testing Activities (Continued)

Event Name		No Action Alternative			Alternative 1			Alternative 2		
		No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location
Naval Surface Warfare Center, Panama City Division Testing Range (NSWC PCD) (Continued)										
Special Warfare Testing		NSWC PCD Range No Action Alternative activities categorized above as hours/year or items/year rather than events/year.			100	None	NSWC PCD	110	None	NSWC PCD
Unmanned Underwater Vehicle Testing					70	None	NSWC PCD	88	None	NSWC PCD
Ordnance Testing	Line Charge Testing				3	3 HE charges[3]	NSWC PCD	4	4 HE charges	NSWC PCD
	Gun Testing – Small-Caliber				6	6,000 rounds	NSWC PCD	7	7,000 rounds	NSWC PCD
	Gun Testing – Medium-Caliber				93	4,650 rounds	NSWC PCD	102	5,100 rounds	NSWC PCD
	Gun Testing – Large-Caliber				30	300 rounds (40 HE)	NSWC PCD	33	330 rounds (50 HE)	NSWC PCD
Naval Undersea Warfare Center Division, Newport Testing Range (NUWCDIVNPT)										
Launcher Testing		30	None	Narragansett Bay and surrounding waters	35	None	NUWCDIVNPT	39	None	NUWCDIVNPT
Torpedo Testing		18	18 torpedoes	Narragansett Bay and surrounding waters	24	24 torpedoes	Narragansett Bay and Rhode Island Sound Restricted Areas	30	30 torpedoes	Narragansett Bay and Rhode Island Sound Restricted Areas
Towed Equipment Testing		25	None	Narragansett Bay and surrounding waters	30	None	NUWCDIVNPT	33	None	NUWCDIVNPT
Unmanned Underwater Vehicle Testing		47	None	Narragansett Bay and surrounding waters	111	None	NUWCDIVNPT	123	None	NUWCDIVNPT
Unmanned Surface Vehicle Testing		80	None	Narragansett Bay and surrounding waters	120	None	NUWCDIVNPT	132	None	NUWCDIVNPT
Unmanned Aerial System Testing		None	None	NUWCDIVNPT	15	None	NUWCDIVNPT	17	None	NUWCDIVNPT
Semi-Stationary Equipment Testing		103	None	Narragansett Bay and surrounding waters	140	None	NUWCDIVNPT	154	None	NUWCDIVNPT
Unmanned Underwater Vehicle Demonstrations		1 event total	None	Narragansett Bay	1 event total	None	NUWCDIVNPT	1 event total	None	NUWCDIVNPT
Pierside Integrated Swimmer Defense		5	None	NUWCDIVNPT	5	None	Pierside: Newport, RI	6	None	Pierside: Newport, RI
South Florida Ocean Measurement Facility Testing Range (SFOMF)										
Signature Analysis Activities		N/A[1]	N/A	N/A	16	None	SFOMF	18	None	SFOMF
Mine Testing Activities		N/A	N/A	N/A	21	None	SFOMF	33	None	SFOMF
Surface Testing Activities		N/A	N/A	N/A	30	None	SFOMF	33	None	SFOMF
Subsurface Testing Activities		N/A	N/A	N/A	30	None	SFOMF	33	None	SFOMF
Unmanned Underwater Vehicle Demonstrations		N/A	N/A	N/A	1 event total	None	SFOMF	1 event total	None	SFOMF

HE: High-Explosive (indicated by shaded cells); N/A: Not Analyzed; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; RDT&E: Research, Development, Test, and Evaluation; RI: Rhode Island; SFOMF: South Florida Ocean Measurement Facility Testing Range

[1] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[2] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[3] None indicates that an event has not previously occurred.

Table 2.8-3: Baseline and Proposed Naval Sea Systems Command Testing Activities (Continued)

Event Name	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location
Additional Activities at Locations Outside of Naval Sea System Command Ranges									
Anti-Surface Warfare (ASUW) / Anti-Submarine Warfare (ASW) Testing									
Missile Testing	N/A[1]	N/A	N/A	11	11 missiles	VACAPES	12	12 missiles	VACAPES
				1	1 missile	AFTT Study Area	1	1 missile	AFTT Study Area
Kinetic Energy Weapon Testing	None[3]	None	None	50	2,000 projectiles	VACAPES	55	2,200 projectiles	VACAPES
	None	None	None	1 event total	5,000 projectiles	AFTT Study Area	1 event total	5,000 projectiles	AFTT Study Area
Electronic Warfare Testing	N/A	N/A	N/A	96	None	Pierside: Norfolk, VA	106	None	Pierside: Norfolk, VA
				96	None	Pierside: Groton, CT	106	None	Pierside: Groton, CT
				65	None	Northeast	71	None	Northeast
Torpedo (Non-Explosive) Testing	1	8 torpedoes	Northeast	4	60 torpedoes	Northeast	4	60 torpedoes	Northeast
	2	32 torpedoes	JAX	11	284 torpedoes	JAX	13	347 torpedoes	JAX
	1	35 torpedoes	Boston Area Complex: Cape Cod TORPEX boxes[6]	3	96 torpedoes	Boston Area Complex: Cape Cod TORPEX boxes[6]	3	96 torpedoes	Boston Area Complex: Cape Cod TORPEX boxes[6]
	N/A	N/A	Gulf of Mexico	2	56 torpedoes	Gulf of Mexico	2	56 torpedoes	Gulf of Mexico
	N/A	N/A	VACAPES	3	52 torpedoes	VACAPES	4	69 torpedoes	VACAPES
Torpedo (Explosive) Testing	2	20 torpedoes (8 HE torpedoes)[2]	Other AFTT Areas: SINKEX box	2	28 torpedoes (8 HE torpedoes)	AFTT Study Area	2	28 torpedoes (8 HE torpedoes)	AFTT Study Area
Countermeasure Testing	N/A	N/A	N/A	1	None	AFTT Study Area	1	None	AFTT Study Area
	N/A	N/A	N/A	2	93 torpedoes	Boston Area Complex: Cape Cod TORPEX boxes/VACAPES/ GOMEX (any location)	2	93 torpedoes	Boston Area Complex: Cape Cod TORPEX boxes/VACAPES/GOM EX (any location)
Pierside Sonar Testing	4 (either location)	None	Pierside: Kings Bay, GA	1	None	Pierside: Portsmouth, NH	2	None	Pierside: Portsmouth, NH
				3	None	Pierside: Groton, CT	4	None	Pierside: Groton, CT
				6	None	Pierside: Norfolk, VA	8	None	Pierside: Norfolk, VA
			Pierside: Port Canaveral, FL	2	None	Pierside: Kings Bay, GA	3	None	Pierside: Kings Bay, GA
				3	None	Pierside: Mayport, FL	4	None	Pierside: Mayport, FL
				1	None	Pierside: Port Canaveral, FL	2	None	Pierside: Port Canaveral, FL
At-Sea Sonar Testing	N/A	N/A	N/A	4	None	AFTT Study Area	5	None	AFTT Study Area
	6 (either location)	None	VACAPES	2	None	VACAPES	3	None	VACAPES
			Northeast	1	None	Northeast	2	None	Northeast
				3	None	JAX	5	None	JAX

ASW: Anti-Submarine Warfare; ASUW: Anti-Surface Warfare; Cherry Point: Navy Cherry Point Range Complex; CT: Connecticut; FL: Florida; GA: Georgia; HE: High-Explosive; JAX: Jacksonville Range Complex; N/A: Not Analyzed; Northeast: Northeast Range Complexes; NH: New Hampshire; SINKEX: Sinking Exercise; TORPEX: Torpedo Exercise; VA: Virginia; VACAPES: Virginia Capes Range Complex

[1] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[2] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[3] None indicates that an event has not previously occurred.

[6] Torpedo testing in the Cape Cod torpedo exercise boxes is specific to this area.

Table 2.8-3: Baseline and Proposed Naval Sea Systems Command Testing Activities (Continued)

Event Name	No Action Alternative			Alternative 1			Alternative 2		
	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location	No. of events (per year)	Ordnance (Number per year)	Location
Mine Warfare (MIW) Testing									
Mine Detection and Classification Testing	N/A[1]	N/A	N/A	7	None	VACAPES	8	None	VACAPES
	N/A	N/A	N/A	58	None	JAX	58	None	JAX
Mine Countermeasure/Neutralization Testing	N/A	N/A	N/A	6	12 HE charges[2]	VACAPES	7	14 HE charges	VACAPES
				6	12 HE charges, 6 HE mines	Gulf of Mexico	7	14 HE charges, 7 HE mines	Gulf of Mexico
Shipboard Protection Systems and Swimmer Defense Testing									
Pierside Integrated Swimmer Defense	5	None	Pierside: Little Creek, VA	2	None	Pierside: Little Creek, VA	3	None	Pierside: Little Creek, VA
Shipboard Protection Systems Testing	1	800 small-caliber rounds	VACAPES	3	None	Pierside: Norfolk, VA	4	None	Pierside: Norfolk, VA
				3	1,000 small-caliber rounds	VACAPES	4	1,300 small-caliber rounds	VACAPES
Chemical/Biological Simulant Testing	220	None	VACAPES	220	None	VACAPES	968 (any location)	None	VACAPES
				220	None	Northeast		None	Northeast
				220	None	Cherry Point		None	Cherry Point
				220	None	JAX		None	JAX
Unmanned Vehicle Testing									
Underwater Deployed Unmanned Aerial System Testing	N/A	N/A	N/A	13	None	VACAPES	30 (either location)	None	VACAPES
	N/A	N/A	N/A	13	None	Northeast			Northeast
Unmanned Vehicle Development and Payload Testing	N/A	N/A	N/A	20	None	Northeast	22	None	Northeast
				20	None	VACAPES	22	None	VACAPES
				20	None	Cherry Point	22	None	Cherry Point
				20	None	JAX	22	None	JAX
				21	None	Gulf of Mexico	23	None	Gulf of Mexico
Other Testing									
Special Warfare	2	None	Key West	3	None	Key West	4	None	Key West
Radio-Frequency Communications Testing	N/A	N/A	N/A	12	None	Northeast	13	None	Northeast
Hydrodynamic Testing	None[3]	None	None	1	None	AFTT Study Area	2	None	AFTT Study Area
At-Sea Explosives Testing	None	None	None	2	20 HE charges	Gulf of Mexico	4 (either location)	40 HE charges at either location	Gulf of Mexico
			None	2	20 HE charges	JAX			JAX

Cherry Point: Navy Cherry Point Range Complex; CT: Connecticut; FL: Florida; GA: Georgia; HE: High-Explosive; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; MIW: Mine Warfare; N/A: Not Analyzed; Northeast: Northeast Range Complexes; VA: Virginia; VACAPES: Virginia Capes Range Complex

[1] N/A stands for Not Analyzed. This event was not analyzed as part of the baseline.

[2] Shaded cells indicate "High-Explosive" (HE) ordnance is expended during event. If only a portion of the ordnance expended is HE, the total number of HE is listed in parentheses.

[3] None indicates that an event has not previously occurred.

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3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

3.0 INTRODUCTION

This chapter describes existing environmental conditions in the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area) as well as the analysis of resources potentially impacted by the Proposed Action described in Chapter 2 (Description of Proposed Action and Alternatives). The Study Area is described in Section 2.1 (Description of the Atlantic Fleet Training and Testing Study Area). Depending on the frame of reference, the term “Study Area” is used to describe both the “No Action Alternative Study Area” and the “Alternatives 1 and 2 Study Area” depicted in Figure 2.1-1. Because of the immense Study Area and the broad range of Navy training and testing activities in the Proposed Action (Tables 2.8-1 through 2.8-3), this chapter is very lengthy. Therefore, Section 3.0 addresses issues that apply to many or all of the resources. The resource sections refer back to subsections in Section 3.0 for the general information contained here.

Section 3.0.1 (Regulatory Framework) presents the regulatory framework for the analyses of the resources in Chapter 3. It briefly describes each law, executive order, and directive used to develop the analyses. Other laws and regulations are listed in Chapter 6 (Additional Regulatory Considerations). Section 3.0.2 (Data Sources and Best Available Data) lists the sources of data used in the analysis.

The Study Area covers a broad range of ecosystems where Navy training and testing is proposed, so Section 3.0.3 (Ecological Characterization of the Study Area) describes areas known as large marine ecosystems and open ocean areas. The Study Area contains large portions of seven large marine ecosystems (West Greenland Shelf, Newfoundland-Labrador Shelf, Scotia Shelf, Northeast United States (U.S.) Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea) and three open ocean areas (North Atlantic Gyre, Labrador Current, and Gulf Stream). Figure 3.0-1 is an overview map of the entire Study Area overlain with the Navy’s range complexes and test ranges. Figures 3.0-2, 3.0-3, and 3.0-4 contain more details of the range complexes and testing ranges and some of the Navy’s activity areas. In addition to these descriptions, Section 3.0.3 (Ecological Characterization of the Study Area) presents information on ocean bathymetry, currents, and fronts. These topics have general applicability to the resources analyzed.

One of the major issues addressed in this Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) is the effect of sound in the water on biological resources. Section 3.0.4 (Acoustic and Explosives Primer) presents a primer on sound in water and in air. The primer explains how sound propagates through air and water; defines terms used in the analysis; and describes the physical properties of sound, metrics used to characterize sound exposure, and frequencies produced during Navy training and testing activities.

Section 3.0.5 (Overall Approach to Analysis) describes a general approach to the analysis. It identifies the resources considered for the analysis, as well as those resources eliminated from further consideration. Each Navy training and testing activity was examined to determine which environmental stressors could adversely impact a resource; these stressors were grouped into categories for ease of presentation (Table 3.0-7). Table 3.0-8 associates the stressor categories with training and testing activities.
A detailed description of each stressor category is contained in Section 3.0.5.3 (Identification of Stressors for Analysis). Descriptions of stressors that only apply to one resource are found in the associated resource section. Lastly, the general approach section contains the methods used in the biological resource sections. These methods are also organized by stressor categories.

The sections following 3.0 analyze each resource. The physical resources (sediments and water quality and air quality) are presented first (Sections 3.1 and 3.2, respectively). Any potential impacts on these resources were considered as potential secondary stressors on the remaining resources to be described: marine habitats, marine mammals, sea turtles and other marine reptiles, birds, marine vegetation, marine invertebrates, and fish (Sections 3.3 through 3.9). Following the biological resource sections are human resource sections: cultural, socioeconomics, and public health and safety (Sections 3.10, 3.11, and 3.12).

The Navy has made changes to this Final EIS/OEIS based on comments received during the public comment period. Changes include factual corrections, additions to existing information, and improvements or modifications to the analyses presented in the Draft EIS/OEIS. A summary of public comments received and the Navy's response to these comments is provided in Appendix E (Public Comments and Responses). While these comments provided valuable guidance and additional information, none of the changes between the Draft and Final EIS/OEIS resulted in substantive changes to the Proposed Action, alternatives, or the conclusions of the environmental consequences of the Proposed Action.

3.0.1 REGULATORY FRAMEWORK

In accordance with the Council on Environmental Quality regulations for implementing the requirements of the National Environmental Policy Act (NEPA), other planning and environmental review procedures are integrated to the fullest extent possible. This section provides a brief overview of the primary federal statutes (3.0.1.1), executive orders (3.0.1.2), and guidance (3.0.1.3) that form the regulatory framework for the evaluation of resources in Chapter 3 (Affected Environment and Environmental Consequences). This section also describes how each applies to the analysis of environmental consequences. Chapter 6 (Additional Regulatory Considerations) provides a summary listing and status of compliance with the applicable environmental laws, regulations, and executive orders that were considered in preparing this EIS/OEIS. More detailed information on the regulatory framework, including other statutes not listed here, may be presented as necessary in each resource section. Although all the environmental laws, regulations, and executive orders provided in Chapter 6 were evaluated in this EIS/OEIS, some were included in regulatory determinations for resources during the analysis of impacts. More detailed discussions of selected regulations are included below to provide insight into the criteria used in the analyses.

3.0.1.1 Federal Statutes

Abandoned Shipwreck Act

The 1987 Abandoned Shipwreck Act (43 United States Code [U.S.C.] §§ 2101–2106) asserts the federal government's title to any abandoned shipwreck that meets criteria for inclusion in the National Register of Historic Places. Abandoned shipwreck means any shipwreck to which title has voluntarily been given up by the owner with the intent of never claiming a right or interest in the vessel in the future and without vesting ownership in any other person. Such shipwrecks ordinarily are treated as being abandoned after the expiration of 30 days from the sinking. States have the responsibility to manage the wrecks and to allow access to the sites by the general public while preserving the historical and environmental integrity of the site for scientific investigation.

Clean Air Act

The purpose of the Clean Air Act (42 U.S.C. §§ 7401-7671q) is to protect and enhance the quality of the nation's air resources to promote the public health and welfare and the productive capacity of its population. To fulfill the act's purpose, federal agencies classify air basins according to their attainment status under the National Ambient Air Quality Standards (40 Code of Federal Regulations [C.F.R.] Part 50) and regulate emissions of criteria pollutants and air toxins to protect the public health and welfare. Noncriteria air pollutants that can affect human health are categorized as hazardous air pollutants under Section 112 of the Clean Air Act. The U.S. Environmental Protection Agency (USEPA) identified 188 hazardous air pollutants such as benzene, perchloroethylene, and methylene chloride. Section 176 (c) (1) of the Clean Air Act, commonly known as the General Conformity Rule, requires federal agencies to ensure that their actions conform to applicable implementation plans for achieving and maintaining the National Ambient Air Quality Standards for criteria pollutants.

Clean Water Act

The Clean Water Act (33 U.S.C. §§ 1251-1376) regulates discharges of pollutants in surface waters of the United States. Section 403 of the Clean Water Act provides for the protection of ocean waters (waters of the territorial seas, the contiguous zone, and the high seas beyond the contiguous zone) from point-source discharges. Under Section 403(a), USEPA or an authorized state agency may issue a permit for an ocean discharge only if the discharge complies with Clean Water Act guidelines for protection of marine waters. For the AFTT EIS/OEIS, the Proposed Action does not include the analysis of discharges incidental to the normal operation of Navy ships.

Endangered Species Act

The Endangered Species Act (ESA) of 1973 (16 U.S.C. §§ 1531-1544) established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. An "endangered" species is a species in danger of extinction throughout all or a significant portion of its range. A "threatened" species is one that is likely to become endangered within the near future throughout all or in a significant portion of its range. The U.S. Fish and Wildlife Service and National Marine Fisheries Service (NMFS) jointly administer the ESA and are also responsible for the listing of species (designating a species as either threatened or endangered). The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species. Section 7(a)(2) requires each federal agency to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action "may affect" a listed species, that agency is required to consult with the Service (NMFS or U.S. Fish and Wildlife Service) which has jurisdiction over the species (50 C.F.R. § 402.14(a)).

Magnuson-Stevens Fishery Conservation and Management Act and Sustainable Fisheries Act

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. § 1801-1882), enacted in 1976 and amended by the Sustainable Fisheries Act in 1996, mandates identification and conservation of essential fish habitat. Essential fish habitat is defined as those waters and substrates necessary (required to support a sustainable fishery and the federally managed species) to fish for spawning, breeding, feeding, or growth to maturity (i.e., full life cycle). These waters include aquatic areas and their associated physical, chemical, and biological properties used by fish, and may include areas historically used by fish. Substrate types include sediment, hard bottom, structures underlying the waters, and associated biological communities. Federal agencies are required to consult with NMFS and to prepare an essential fish habitat assessment if potential adverse effects on essential fish habitat are anticipated from their activities. Any federal agency action that is authorized, funded, or undertaken or proposed to be undertaken that may affect fisheries is subject to the Magnuson-Stevens Fishery Conservation and Management Act. In addition, federal agencies shall consult with the Secretary of

Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any essential fish habitat identified under this act.

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 U.S.C. §§ 1361-1407) established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The act further regulates "takes" of marine mammals in the global commons (that is, the high seas) by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 U.S.C. § 1362 (13)) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of harassment: Level A (potential injury) and Level B (potential behavioral disturbance).

The Marine Mammal Protection Act directs the Secretary of Commerce (Secretary) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if NMFS finds that the taking will have a negligible impact on the species or stock(s), and will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant). The authorization must set forth the permissible methods of taking; other means of effecting the least practicable adverse impact on the species or stock and its habitat; and requirements pertaining to the mitigation, monitoring, and reporting of such taking.

The National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of harassment, removed the "specified geographic area" requirement, and removed the small numbers provision as applied to military readiness activities or scientific research activities conducted by or on behalf of the federal government consistent with Section 104(c)(3) (16 U.S.C. § 1374(c)(3)). The Fiscal Year 2004 National Defense Authorization Act adopted the definition of "military readiness activity" as set forth in the Fiscal Year 2003 National Defense Authorization Act (Public Law 107-314). A "military readiness activity" is defined as "all training and operations of the Armed Forces that relate to combat" and "the adequate and realistic testing of military equipment, vehicles, weapons, and sensors for proper operation and suitability for combat use." For military readiness activities, the relevant definition of harassment is any act that

- injures or has the significant potential to injure a marine mammal or marine mammal stock in the wild ("Level A harassment") or
- 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 ("Level B harassment") [16 U.S.C. §§ 1362 (18)(B)(i) and (ii)].

Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (16 U.S.C. §§ 703-712) and the Migratory Bird Conservation Act (16 U.S.C. §§ 715–715d, 715e, 715f–715r) of 18 February 1929, are the primary laws in the United States established to conserve migratory birds. The Migratory Bird Treaty Act prohibits the taking, killing, or possessing of migratory birds or the parts, nests, or eggs of such birds, unless permitted by regulation.

The 2003 National Defense Authorization Act provides that the Armed Forces may take migratory birds incidental to military readiness activities provided that, for those ongoing or proposed activities that the Armed Forces determine may result in a significant adverse effect on a population of a migratory bird species, the Armed Forces must confer and cooperate with the U.S. Fish and Wildlife Service to develop and implement appropriate conservation measures to minimize or mitigate such significant adverse effects.

National Environmental Policy Act

The Navy prepared this EIS/OEIS in accordance with the President's Council on Environmental Quality regulations implementing NEPA (40 C.F.R. Parts 1500–1508). NEPA (42 U.S.C. §§ 4321–4347) requires federal agencies to prepare an EIS for a proposed action with the potential to significantly affect the quality of the human environment, disclose significant environmental impacts, and inform decision makers and the public of the reasonable alternatives to the proposed action. Based on Presidential Proclamation 5928, issued 27 December 1988, impacts on ocean areas that lie within 12 nautical miles (nm) of land (U.S. territory) are subject to analysis under NEPA.

Rivers and Harbors Act

The Rivers and Harbors Acts of 1890 and 1899 (33 U.S.C. §§ 401-467) are the legislative origin of the U.S. Army Corps of Engineers regulatory program. Section 10 of the Rivers and Harbors Act (33 U.S.C. § 403) prohibits the unauthorized obstruction or alteration of any navigable water of the United States. This section provides that construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters is unlawful unless the work has been recommended by the Chief of Engineers and authorized by the Secretary of the Army. Activities requiring Section 10 permits include structures (e.g., piers, wharfs, breakwaters, bulkheads, jetties, weirs, and transmission lines) and work such as dredging or disposal of dredged material, or excavation, filling, or other modifications to the navigable waters of the United States. The geographic jurisdiction of the Rivers and Harbors Act includes all navigable waters of the United States, which are defined as waters subject to the ebb and flow of the tide shoreward to the mean high water mark that may be used to transport interstate or foreign commerce (33 C.F.R. Part 329). This jurisdiction extends seaward to include all ocean waters within 3 nm from the coastline. Department of the Army permits are required to authorize certain structures or work in, or affecting, navigable waters of the United States pursuant to Section 10 of the Rivers and Harbors Act. Certain activities may fall under an authorized nationwide general permit or a regional general permit. If this is not the case, an individual Section 10 permit is required.

3.0.1.2 Executive Orders

Executive Order 12114, *Environmental Effects Abroad of Major Federal Actions*

This OEIS has been prepared in accordance with Executive Order (EO) 12114 (44 Federal Register [FR] 1957) and Navy implementing regulations in 32 C.F.R. Part 187. An OEIS is required because the Proposed Action and the alternatives have the potential to significantly harm the environment of the global commons. The global commons are defined as geographical areas outside the jurisdiction of any nation and include the oceans outside of the territorial limits (more than 12 nm from the coast) and Antarctica but do not include contiguous zones and fisheries zones of foreign nations (32 C.F.R. § 187.3). The EIS and OEIS have been combined into one document, as permitted under NEPA and EO 12114, to reduce duplication.

Executive Order 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*

EO 13514 (74 FR 52117) was signed in October 2009 to establish an integrated strategy toward sustainability in the federal government and to make reduction of greenhouse gas emissions a priority for federal agencies. The Department of Defense (DoD) developed a Strategic Sustainability Performance Plan that identifies performance-based goals and subgoals, provides a method to meet the goals (including investment strategies), and outlines a plan for reporting on performance. The Strategic Sustainability Performance Plan is included in the analyses in this EIS/OEIS.

Executive Order 13158, *Marine Protected Areas*

EO 13158 (65 FR 34909) was authorized in May 2000 to protect special natural and cultural resources by strengthening and expanding the nation's system of marine protected areas. The purpose of the order is to (1) strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded marine protected areas; (2) develop a scientifically based, comprehensive national system of marine protected areas representing diverse U.S. marine ecosystems, and the nation's natural and cultural resources; and (3) avoid causing harm to marine protected areas through federally conducted, approved, or funded activities.

Executive Order 13547, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*

EO 13547 (75 FR 43023) was issued in 2010. It is a comprehensive national policy for the stewardship of the ocean, our coasts, and the Great Lakes. This order adopts the recommendations of the Interagency Ocean Policy Task Force and directs executive agencies to implement the recommendations under the guidance of a National Ocean Council. The National Ocean Policy better coordinates and aligns coastal and ocean-related actions of federal agencies to bolster the ocean economy, improve ocean health, support local economies, and strengthen security. It also emphasizes providing better science to improve decision-making to ensure ocean resources are being sustainably used to the benefit of all Americans. The National Ocean Policy is not regulatory, nor does it direct any particular outcome on specific activities. This order establishes a national policy to

- ensure the protection, maintenance, and restoration of the health of ocean, coastal, and Great Lakes ecosystems and resources,
- enhance the sustainability of ocean and coastal economies, preserve our maritime heritage,
- support sustainable uses and access,
- provide for adaptive management to enhance our understanding of and capacity to respond to climate change and ocean acidification, and
- coordinate with our national security and foreign policy interests.

3.0.1.3 Guidance

Department of Defense and Navy Directives and Instructions

Several military communications are included in this EIS/OEIS that establish policy or a plan to govern an action, conduct, or procedure. For example, DoD Directive 4540.1, *Use of Airspace by U.S. Military Aircraft and Firings over the High Seas*, and Chief of Naval Operations Instruction 3770.4A, *Use of Airspace by U.S. Military Aircraft and Firing over the High Seas*, specify procedures for conducting aircraft maneuvers and for firing missiles and projectiles. Other directives and instructions referred to in the EIS/OEIS are specific for a range complex or test range such as the Fleet Area Control and Surveillance Facility Virginia Capes Instruction 3120.1L, which is the manual for the *Utilization of Fleet Area Control and Surveillance Facility, Virginia Capes Operating Areas*. Each range complex and test range has its own manual; however, many of the components are similar.

3.0.2 DATA SOURCES AND BEST AVAILABLE DATA

The Navy used the best available data and information to compile the environmental baseline and environmental consequences included in Chapter 3 (Affected Environment and Environmental Consequences). In accordance with NEPA, the Administrative Procedure Act (5 U.S.C. §§ 551-59, 701-06, 1305, 3105, 3344, 4301, 5362, 7521), and EO 12114, best available data accepted by the appropriate regulatory and scientific communities were used in the analyses of resources.

Literature searches of journals, books, periodicals, bulletins, and other technical reports were conducted in preparation of this EIS/OEIS. Searches included general queries in the resource areas evaluated to document the environmental baseline and specific queries for analysis of environmental consequences. A wide range of primary literature was used in preparing this EIS/OEIS from federal agencies such as the U.S. Environmental Protection Act, international organizations, state and federal agencies, and nonprofit and nongovernment organizations. Internet searches were conducted, and websites were evaluated for credibility of the source, quality of the information, and relevance of the content to ensure use of the best available information in this document.

3.0.2.1 Geographical Information Systems Data

Table 3.0-1 is a list of sources of non-Navy Geographical Information System data used in Chapter 3 figures.

Table 3.0-1: Sources of Non-Navy Geographic Information System Data Used to Generate Figures in Chapter 3

Feature/Layer	Applicable Figures	Data Source References
Large Marine Ecosystems	All Chapter 3 Figures	National Oceanic and Atmospheric Administration 2002a
Bathymetry and Ocean Basemap	3.0-6, 3.0-7, 3.0-8, 3.0-9	General Bathymetric Chart of the Oceans 2010; Intergovernmental Oceanographic Commission 2009
Sea Surface Temperature	3.0-11	University of Miami Rosenstiel School of Marine and Atmospheric Science and National Oceanographic and Atmospheric Administration 2007
Critical Habitat	All Critical Habitat Figures	National Oceanic and Atmospheric Administration 2009; U.S. Department of the Navy 2008b, 2011; U.S. Fish and Wildlife Service 2005, 2008, 2010
Florida Seagrass, Invertebrate Habitat Areas of Particular Concern	3.7-2, 3.8-2, 3.8-3	Florida Fish and Wildlife Conservation Commission 2005, 2011
PM2.5, 8-hour Ozone	3.2-1	U.S. Environmental Protection Agency 2009
NRHP Eligible or Listed Resources/Sovereign Immunity, Shipwrecks	3.10-4, 3.10-5, 3.10-6	Google Inc. 2010; National Oceanic and Atmospheric Administration 2002b
Oil-Gas Structures	3.11-1	Minerals Management Service 2006b
Active and Proposed Oil and Gas Pipelines	3.11-2	Minerals Management Service 2006a
State Seaward Extent, 12 nm Territorial Limit	3.11-1, 3.11-2	National Oceanic and Atmospheric Administration 2011
Commercially Used Waterways	3.11-3	Vanderbilt Engineering Center for Transportation Operations and Research 2004
Danger Zones and Restricted Areas	3.11-4, 3.11-5, 3.11-6, 3.11-7	33 C.F.R. Part 334

3.0.2.2 Navy Integrated Comprehensive Monitoring Program

Navy and non-Navy marine mammal scientists and research institutions have, since 2006, conducted scientific monitoring and research in and around ocean areas in the Atlantic and Pacific where the Navy has been training and testing and proposes to continue these activities. Data collected from Navy monitoring, scientific research findings, and annual reports provided to NMFS may inform the analysis of impacts on marine mammals for a variety of reasons, including species distribution, habitat use, and evaluation of potential responses to Navy activities. Monitoring is performed using various methods, including visual surveys from surface vessels and aircraft and passive acoustics. Navy monitoring can generally be divided into two types of efforts: (1) collecting long-term data on distribution, abundance, and habitat use patterns within Navy activity areas, and (2) collecting data during individual training or testing activities. Monitoring efforts during anti-submarine warfare and explosive events focus on observing individual animals in the vicinity of the event and documenting behavior and any observable responses. Although these monitoring events are very localized and short-term, over time they will provide valuable information to support the impact analysis.

Most of the training and testing activities the Navy is proposing for the next five years are similar if not identical to activities that have been occurring in the same locations for decades. For example, the mid-frequency anti-submarine warfare sonar system on the cruisers, destroyers, and frigates has the same sonar system components in the water as those first deployed in the 1970s. While the signal analysis and computing processes onboard these ships have been upgraded with modern technology, the power and output of the sonar transducer, which puts signals into the water, have not changed. Therefore, the history of past marine mammal observations, research, and monitoring reports remain applicable to the analysis of effects from the proposed future training and testing activities.

3.0.2.2.1 Distribution, Abundance, and Habitat Use

The Navy initiated a protected marine species monitoring project in June 2007 in Onslow Bay (Navy Cherry Point Range Complex) to support the planned Undersea Warfare Training Range and later expanded to a parallel monitoring site off the coast of Jacksonville, Florida (JAX Range Complex) in 2009. Beginning in 2011, the Onslow Bay project began to expand north toward Cape Hatteras (VACAPES Range Complex) and will continue to collect survey data in this region. Although the initial intent of the Onslow Bay and Jacksonville monitoring projects was to support development of the Undersea Warfare Training Range, the program has evolved to allow the gathering of robust baseline data within locations where Navy anti-submarine warfare activities regularly occur. Although these locations include regular Navy activity, the baseline data are collected during periods when training and testing is not occurring. Visual surveys have been conducted year-round (weather permitting) since the inception of the project.

From June 2007 through December 2012, as part of this baseline monitoring offshore Cape Hatteras, Onslow Bay, and Jacksonville, the Navy covered over 120,000 km of aerial visual survey and over 10,000 km of vessel visual survey. This monitoring resulted in over 28,000 individual marine mammals and over 4,500 sea turtles being sighted. In addition to visual surveys, passive acoustic monitoring has been ongoing at these sites through use of High-Frequency Acoustic Recording Packages. Tremendous amounts of acoustic data are continuously being generated and analyzed providing information of marine mammal species occurrence and complimenting the visual surveys. Although these sites are small in comparison to the overall Study Area, they represent important areas for Navy training and testing and provide a robust baseline of species occurrence and in some cases have helped to expand the overall scientific knowledge for some species.

3.0.2.2.2 Monitoring During Training and Testing Events

Monitoring during activities involving the use of sonar and other active acoustic sources and explosives is regularly conducted with a combination of visual and passive acoustic methods. These monitoring events are focused on observing individual animals in the vicinity of the event and documenting behavior and any observable responses. Although these monitoring events are very localized and short-term, over time they will provide valuable information to support the impact analysis.

3.0.2.2.2.1 Observations in Association with Activities Involving the Use of Active Acoustic Sources

Training

Monitoring efforts were conducted during training events as part of the Atlantic Fleet Active Sonar Training Letter of Authorization. From January 2009 through December 2012, nine anti-submarine warfare events (two in VACAPES and seven in JAX) were monitored before, during, or after with aerial, vessel, or passive acoustic surveys conducted by third-party or Navy-trained marine mammal observers. A total of 41.4 hours of aerial, 266.5 hours of vessel, and 26.5 hours of towed-hydrophone-array passive acoustic effort were spent collecting data before, during, or after the exercises. Over 1,200 marine mammals and over 100 sea turtles were observed during these events, and no observable behavioral disturbance, injury, or mortality was noted.

In addition, the Navy has recorded approximately 19,500 hours of passive acoustic monitoring data during anti-submarine training events. These data were collected during one event in Onslow Bay, North Carolina, and three events in the proposed JAX Undersea Warfare Training Range location using an array of Cornell's Marine Acoustic Recording Units and JASCO's Autonomous Multi-Channel Acoustic Recorders. The goal of these recordings was to test the feasibility of using passive acoustic monitoring during Navy training and testing events to assess any behavioral acoustic response to the activities. The data are currently being analyzed for the occurrence of marine mammal vocalizations during sonar activity.

Testing

Monitoring efforts were conducted during anti-submarine warfare testing events from March 2009 to May 2013 within the AFTT Study Area. Fifteen events were monitored with aerial, vessel, and passive acoustic surveys by trained marine mammal observers. A total of 255 hours of aerial and 621 hours of vessel effort were spent collecting data before, during, and after the exercises. Dolphins, large whales, manatees, and sea turtles were observed. Due to different reporting requirements, the total numbers of animals observed is unavailable. For example, the number of individual dolphins within a pod is not recorded; the after action reports only identify a single dolphin pod. Where numbers of animals were recorded, a range of 155 to 214 marine mammals (based on minimum and maximum group size) were observed during these events, and no observable behavioral disturbance, injury, or mortality was noted.

Sightings data within Narragansett Bay at the Naval Undersea Warfare Center Division, Newport Testing Range have been recorded between April 2009 and July 2012. These sightings, however, are not recorded in response to specific testing activities; all sightings data are recorded regardless of whether a test event is being conducted. A total of 45–66 dolphins or porpoises and 66–71 seals have been observed (based on minimum and maximum group size estimates).

Between June 2011 and June 2012, four mine warfare events involving sonar were monitored with vessel surveys by trained marine mammal observers off Riviera Beach, Florida. A total of 232.3 hours of vessel effort was spent collecting data before, during, and after the exercises. Seventy-three marine mammals and sea turtles were observed during these events, and no observable behavioral disturbance, injury, or mortality was noted.

Monitoring efforts were conducted during testing events as part of the Naval Surface Warfare Center, Panama City Division Letter of Authorization. From January 2010 through December 2012, four sonar test events were monitored before, during, or after with aerial surveys conducted by third-party trained marine mammal observers. A total of 43.1 hours of aerial survey effort was conducted. As a result, 454 marine mammals and 312 sea turtles were observed during these events, and no observable behavioral disturbance, injury, or mortality was noted.

From January 2010 through December 2012, sonar test events were monitored by Navy trained marine mammal observers on vessels in the Naval Surface Warfare Center, Panama City Division Testing Range. A total of 52 days of vessel effort was spent collecting data during the events. Approximately 182 marine mammals and 11 sea turtles were observed during these events, and no observable behavioral disturbance, injury, or mortality was noted.

3.0.2.2.2.2 Observations in Association with Activities Involving the Use of Explosives

Training

Monitoring efforts were conducted during training events from June 2009 to June 2012, as part of the East Coast Range Complexes Letters of Authorization. Twelve events involving the use of explosives were monitored with aerial, vessel, and passive acoustic surveys. A total of 39 hours of third-party aerial, 34.5 hours of vessel, and 53.8 hours of passive-acoustic-recording effort was spent collecting data before, during, and after the exercises. In addition, trained marine mammal observers conducted 14 hours of survey effort from the firing Navy vessel during a firing exercise event. A total of 304 marine mammals and 161 sea turtles were observed before, during, or after these events, and no observable behavioral disturbance, injury, or mortality was noted. The passive acoustic data are currently being analyzed for the occurrence of marine mammal vocalizations during the explosive events.

Testing

Monitoring efforts were conducted during testing events as part of the Naval Surface Warfare Center, Panama City Division Letter of Authorization. From January 2010 through December 2012, two detonation test events were monitored before, during, or after with aerial, vessel, or passive acoustic surveys conducted by third-party or Navy trained marine mammal observers. A total of 41.3 hours of aerial, 25.8 hours of vessel, and 29.5 hours of towed-hydrophone-array passive acoustic effort was spent collecting data before, during, or after the events. A total of 275 marine mammals, 54 sea turtles, and three acoustic detections of dolphins were observed before, during or after these events, and no observable behavioral disturbance, injury, or mortality was noted.

From January 2010 through December 2012, four detonation testing events were monitored by Navy trained marine mammal observers on vessels in the Naval Surface Warfare Center, Panama City Division Testing Range. A total of 4 days of vessel effort was spent collecting data during the events. A total of 10 marine mammals and 6 sea turtles were observed during these events, and no observable behavioral disturbance, injury, or mortality was noted.

Monitoring of the shock trials of the USS *Winston S. Churchill* (DDG 81) and USS *Mesa Verde* (LPD 19) involved pre- and post-detonation surveys by shipboard and aerial observers (U.S. Department of the Navy 2001, 2008a). Post-detonation monitoring commenced immediately after each detonation and occurred for at least two hours, with additional surveys conducted on the following two days after each of the first two detonations, and for at least five days following the third detonation. Ninety-two marine mammal and sea turtle sightings were recorded during post-detonation monitoring of the USS *Winston S. Churchill* (DDG 81) ship shock trial, and 64 marine mammals and sea turtles were observed during post-detonation monitoring of the USS *Mesa Verde* (LPD 19) ship shock trial. No observable behavioral disturbance, injury, or mortality was noted.

3.0.2.2.2.3 Relevant Data From the Hawaii-Southern California Training and Testing Study Area

In the Hawaii Range Complex portion of the Hawaii-Southern California Training and Testing (HSTT) Study Area between 2006 and 2012, 21 scientific marine mammal surveys were conducted before, during, or after major exercises. In the Southern California and Hawaii Range Complex portions of HSTT from 2009 to 2012, Navy-funded marine mammal monitoring research completed over 5,000 hours of visual survey effort covering more than 65,000 nautical miles, sighted more than 256,000 individual marine mammals, took more than 45,600 digital photos and 36 hours of digital video, attached 70 satellite tracking tags to individual marine mammals, and collected more than 40,000 hours of passive acoustic recordings. The Navy also cofunded additional visual surveys conducted by the NMFS Pacific Island Fisheries Science Center and Southwest Fisheries Science Center. Finally, an additional 1,532 sightings of an estimated 16,224 marine mammals were made and reported by Navy Lookouts aboard Navy ships within the HSTT Study Area from 2009 to 2012. No observable behavioral disturbance, injury, or mortality was noted during the surveys.

3.0.3 Ecological Characterization of the Study Area

For the purposes of this document, the Study Area includes the intertidal and subtidal marine waters within the boundaries shown in Figure 2.1-1 but does not extend above the mean high tide line. Navy activities in the marine environment predominately occur within established operating areas (OPAREAs), range complexes, test ranges, ports, and pierside locations, although some occur outside these designated areas. These locations were defined by training and testing requirements and regulated maritime and airspace boundaries. However, the Navy-defined boundaries are not consistent with ecological boundaries that may be more appropriate when assessing potential impacts on marine resources. Therefore, for the purposes of this document, the Navy analyzed the marine resources in an ecological context to more comprehensively assess the potential impacts. The Navy used biogeographic classification systems to frame this ecological context.

Biogeographic classifications organize and describe the patterns and distributions of organisms and the biological and physical processes that influence this distribution. These biogeographic classification systems and areas are described in Section 3.0.3.1 (Biogeographic Classifications). Additional ecosystem-related concepts, as well as a discussion of how Navy activities and potential stressors of the Proposed Action fit into the ecosystem, are presented in a separate detailed report titled the *Ecosystem Technical Report for the Atlantic Fleet Training and Testing (AFTT) Draft Environmental Impact Statement* (U.S. Department of the Navy 2012).

3.0.3.1 Biogeographic Classifications

For the purposes of this document, the Navy organized and described the resources in coastal waters by large marine ecosystems, where primary productivity is higher than open ocean areas; the Navy organized and described the resources in open ocean areas by main oceanographic features (currents, gyres). Primary productivity is the rate of the formation of organic material from inorganic carbon via photosynthesis (e.g., by marine vegetation) or chemical reactions.

The development of the large marine ecosystem classification system began in the mid-1980s as a spatial planning tool to address transboundary management issues such as fisheries and pollution (Duda and Sherman 2002). Large marine ecosystems are "relatively large regions on the order of 58,310 nm^2 (200,000 km^2) or greater, characterized by distinct water depths and bottom features; water features such as tides, currents, and waves; nutrient and food availability; and levels that different organisms occupy in the food chain" (National Oceanic and Atmospheric Administration 2010). The large marine ecosystem concept for ecosystem-based management includes a five-module approach: (1) productivity, (2) fish and fisheries, (3) pollution and ecosystem health, (4) socioeconomics, and (5) governance. This approach is being applied to 16 international projects in Africa, Asia, Latin America, and Eastern Europe (Duda and Sherman 2002).

The large marine ecosystem classification system was advocated by the Council on Environmental Quality's Interagency Ocean Policy Task Force (The White House Council on Environmental Quality 2010) as a marine spatial framework for regional coordination and planning in the United States. However, this task force did not endorse any particular classification system for open ocean areas. Therefore, for this EIS/OEIS, three main oceanographic features are used: the Labrador Current, the Gulf Stream, and the North Atlantic Gyre. The Study Area contains seven coastal water large marine ecosystems: the West Greenland Shelf, Newfoundland-Labrador Shelf, Scotian Shelf, Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, and Caribbean Sea. The seven large marine ecosystems and three open ocean areas are shown in Figures 3.0-1 through 3.0-4 and outlined in Sections 3.0.3.1.1 (West Greenland Shelf Large Marine Ecosystem) through 3.0.3.1.10 (North Atlantic Gyre Open Ocean Area). Designated training and testing areas in relation to each of the large marine ecosystems and open ocean areas are presented in Table 3.0-2.

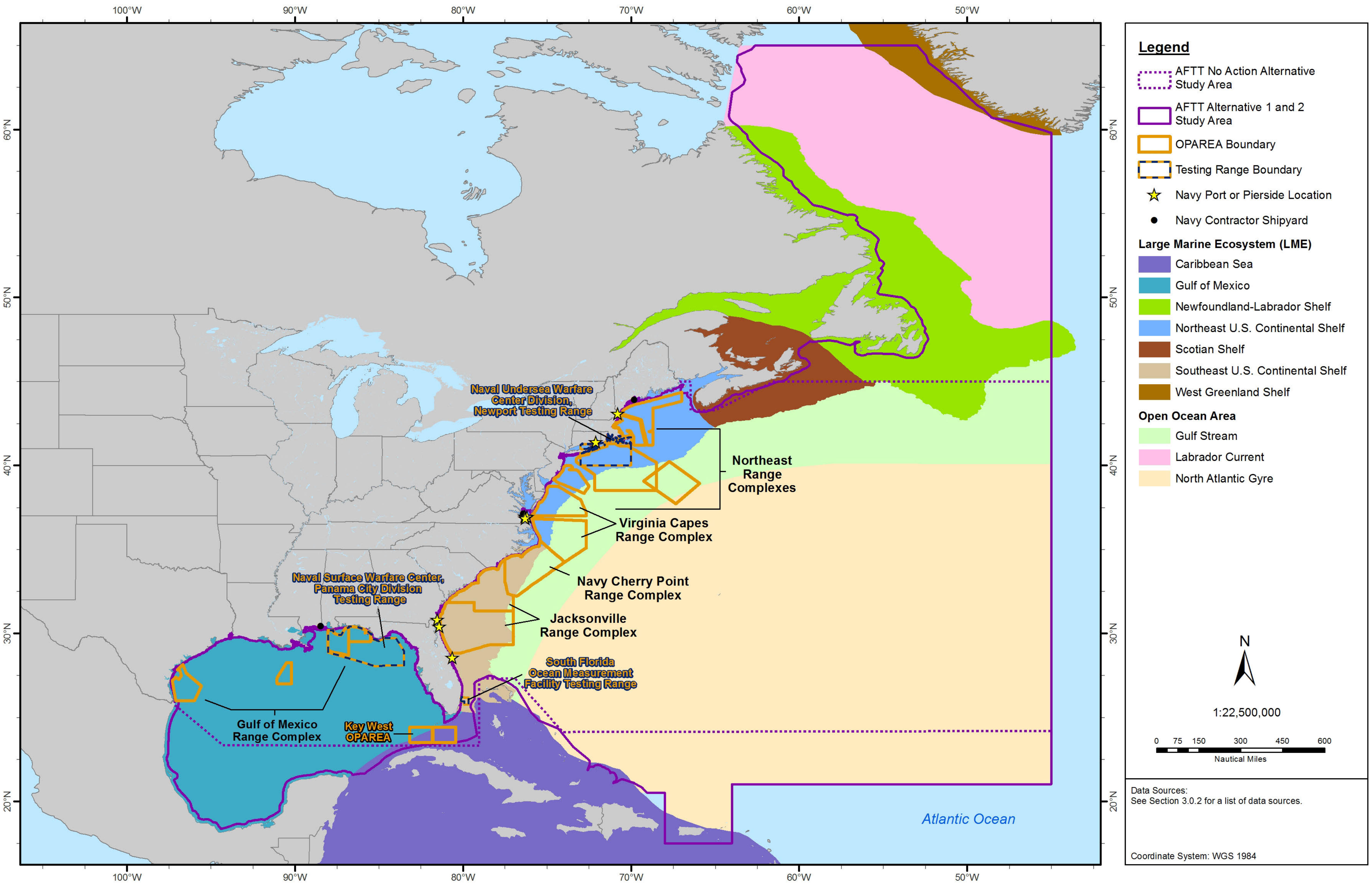

Figure 3.0-1: The Study Area with Large Marine Ecosystems and Open Ocean Areas

AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

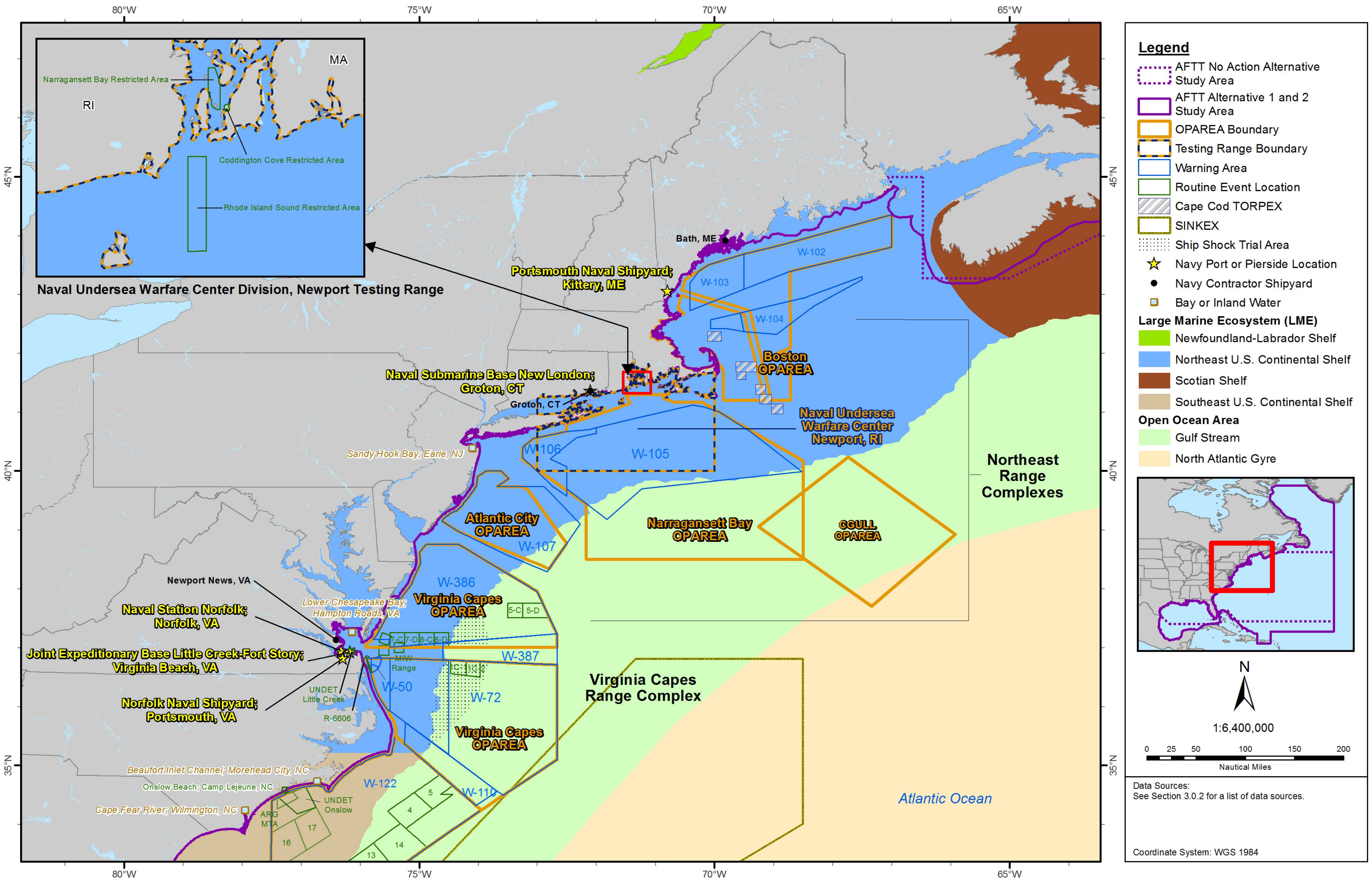

Figure 3.0-2: Navy Training and Testing Locations in the Northeast United States Continental Shelf Large Marine Ecosystem and Open Ocean Areas

AFTT: Atlantic Fleet Training and Testing; CT: Connecticut; ME: Maine; NC: North Carolina; NJ: New Jersey; OPAREA: Operating Area; RI: Rhode Island; SINKEX: Sinking Exercise; TORPEX: Torpedo Exercise; VA: Virginia

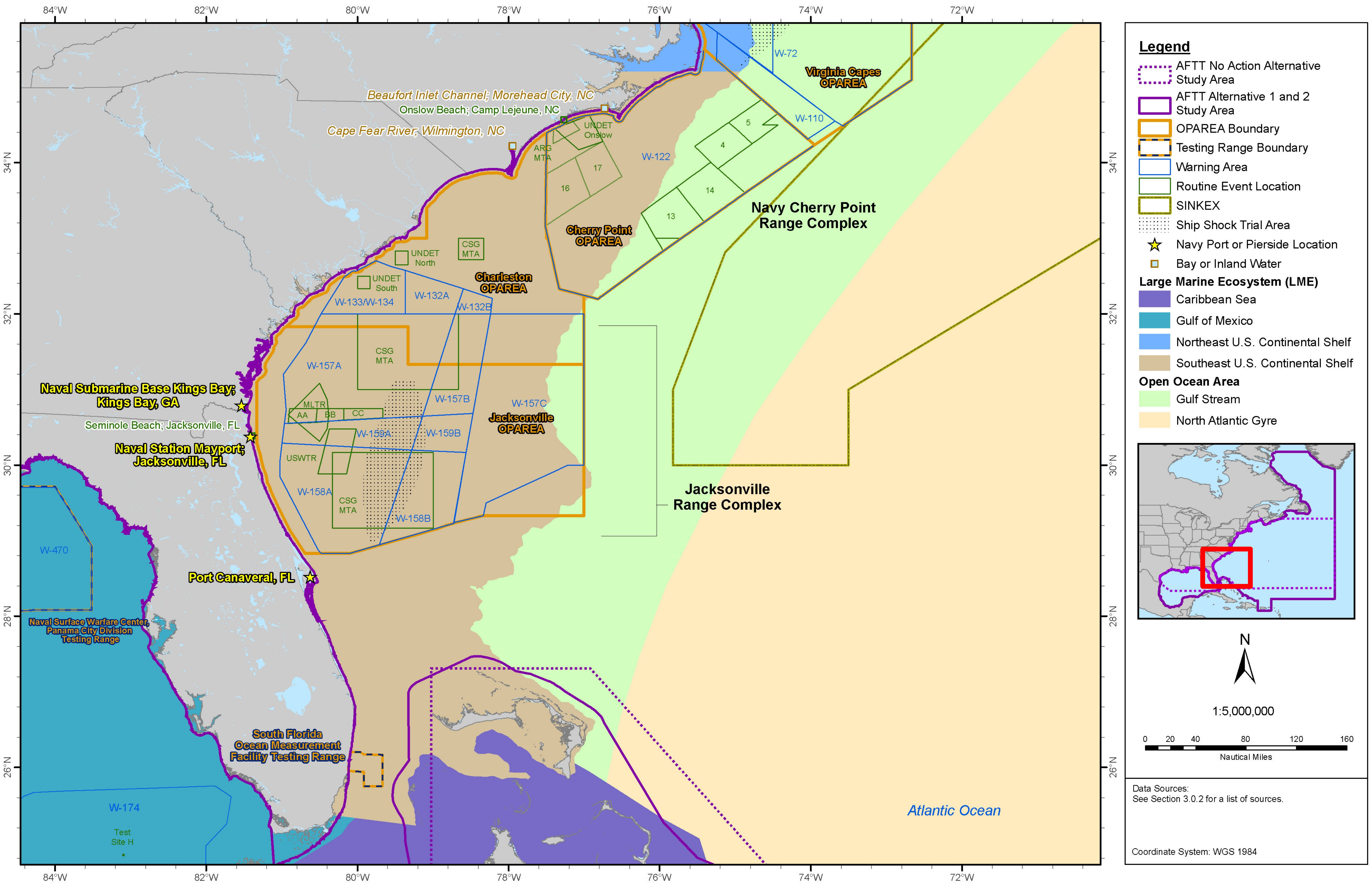

Figure 3.0-3: Navy Training and Testing Locations in the Southeast United States Continental Shelf and Caribbean Sea Large Marine Ecosystem and Open Ocean Areas

AFTT: Atlantic Fleet Training and Testing; ARG: Amphibious Readiness Group; CSG: Carrier Strike Group; GA: Georgia FL: Florida; MLTR: Missile Laser Training Range; MTA: Mine Training Area; NC: North Carolina; OPAREA: Operating Area; SINKEX: Sinking Exercise; UNDET: Underwater Detonation; USWTR: Undersea Warfare Training Area

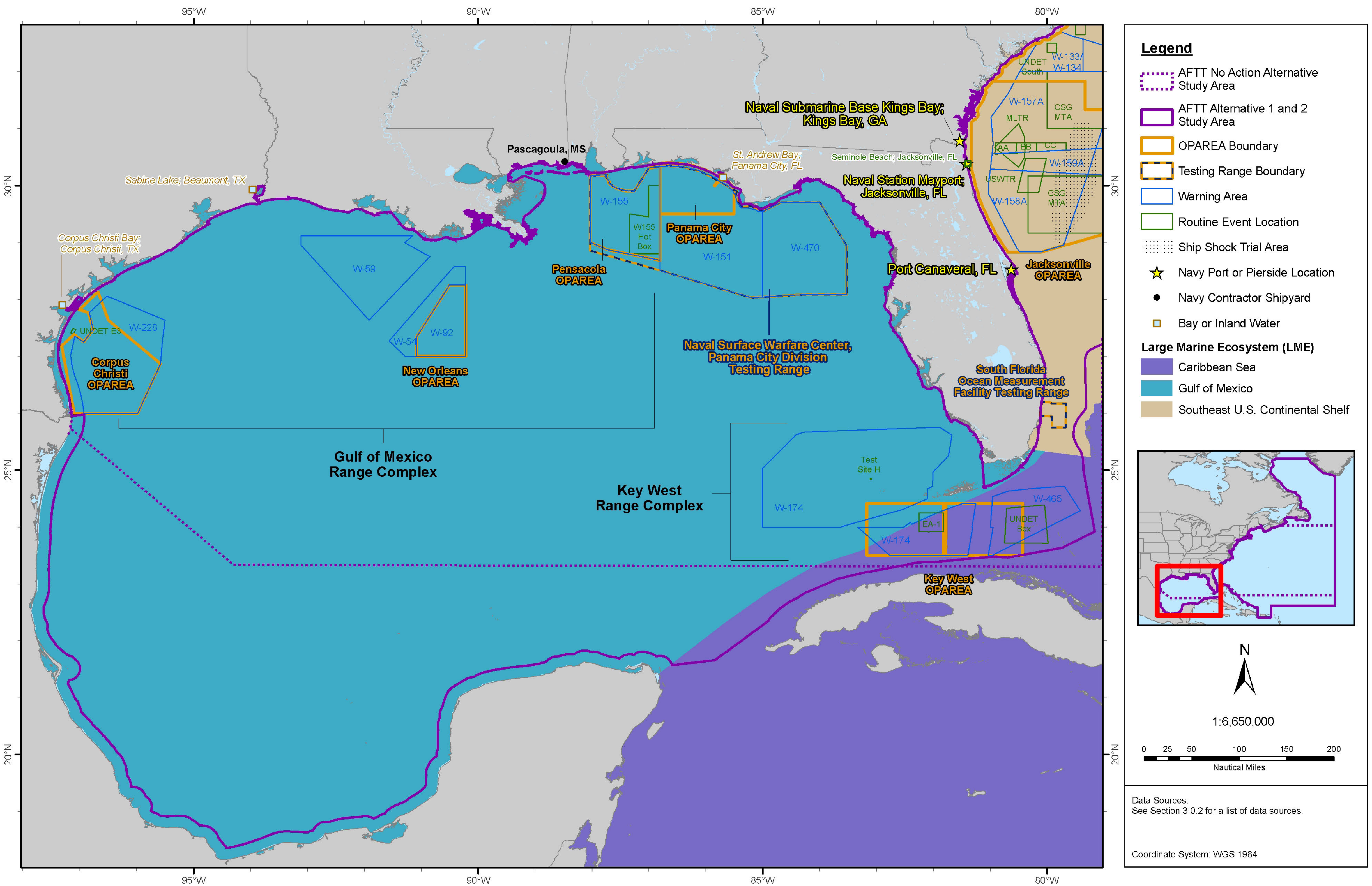

Figure 3.0-4: Navy Training and Testing Locations in the Gulf of Mexico and Caribbean Sea Large Marine Ecosystems

AFTT: Atlantic Fleet Training and Testing; CSG MTA: Carrier Strike Group Mine Training Area; GA: Georgia; FL: Florida; OPAREA: Operating Area; MLTR: Missile Laser Training Range; MS: Mississippi; TX: Texas; UNDET: Underwater Detonation; USWTR: Undersea Warfare Training Range

Table 3.0-2: Designated Training and Testing Areas in Relation to Large Marine Ecosystems and Open Ocean Areas

Training/Testing Location[1]	Northeast U.S. Continental Shelf Large Marine Ecosystem	Southeast U.S. Continental Shelf Large Marine Ecosystem	Gulf of Mexico Large Marine Ecosystem	Caribbean Sea Large Marine Ecosystem	Gulf Stream Open Ocean Area	North Atlantic Gyre Open Ocean Area
OPAREAs						
Boston (part of Northeast Range Complexes)	X					
Narragansett Bay (part of Northeast Range Complexes)	X				X	
Atlantic City (part of Northeast Range Complexes)	X				X	
CGULL (part of Northeast Range Complexes)					X	X
Virginia Capes (part of VACAPES)	X				X	
Cherry Point (part of Navy Cherry Point Range Complex)		X			X	
Charleston (part of JAX)		X				
Jacksonville (part of JAX)		X			X	
Corpus Christi (part of GOMEX)			X			
New Orleans (part of GOMEX)			X			
Pensacola (part of GOMEX)			X			
Panama City (part of GOMEX)			X			
Key West (part of Key West Range Complex)			X	X		
Testing Ranges						
Naval Undersea Warfare Center Division, Newport (NUWCDIVNPT)	X					
South Florida Ocean Measurement Facility (SFOMF)		X				
Naval Surface Warfare Center, Panama City Division (NSWC PCD)			X			

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; NSWC PCD: Naval Surface Warfare Center, Panama City Division; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport; OPAREA: Operating Area; SFOMF: South Florida Ocean Measurement Facility; VACAPES: Virginia Capes Range Complex

[1] No specifically designated training or testing areas fall within the West Greenland Shelf Large Marine Ecosystem, Newfoundland-Labrador Shelf Large Marine Ecosystem, Scotian Shelf Large Marine Ecosystem, and Labrador Current Open Ocean Area; however, training or testing may occasionally occur in these areas during transit.

Table 3.0-2: Designated Training and Testing Areas in Relation to Large Marine Ecosystems and Open Ocean Areas (Continued)

Training/Testing Location[1]	Northeast U.S. Continental Shelf Large Marine Ecosystem	Southeast U.S. Continental Shelf Large Marine Ecosystem	Gulf of Mexico Large Marine Ecosystem	Caribbean Sea Large Marine Ecosystem	Gulf Stream Open Ocean Area	North Atlantic Gyre Open Ocean Area
Naval Ports and Naval Shipyards						
Portsmouth Naval Shipyard; Kittery, ME	X					
Naval Submarine Base New London; Groton, CT	X					
Naval Station Norfolk; Norfolk, VA	X					
Norfolk Naval Shipyard; Portsmouth, VA	X					
Joint Expeditionary Base Little Creek—Fort Story; Virginia Beach, VA	X					
Naval Submarine Base Kings Bay; Kings Bay, GA		X				
Naval Station Mayport; Jacksonville, FL		X				
Port Canaveral, FL		X				
Navy Contractor Shipyards						
Bath, ME	X					
Groton, CT	X					
Newport News, VA	X					
Pascagoula, MS			X			
Bays and Inland Waters						
Sandy Hook Bay; Earle, NJ	X					
Lower Chesapeake Bay; Hampton Roads, VA	X					
Beaufort Inlet Channel; Morehead City, NC		X				
Cape Fear River; Wilmington, NC		X				
St. Andrew Bay; Panama City, FL			X			
Sabine Lake; Beaumont, TX			X			
Corpus Christi Bay; Corpus Christi, TX			X			

CT: Connecticut; FL: Florida; ME: Maine; MS: Mississippi; NC: North Carolina; NJ: New Jersey; TX: Texas; VA: Virginia

[1] No specifically designated training or testing areas fall within the West Greenland Shelf Large Marine Ecosystem, Newfoundland-Labrador Shelf Large Marine Ecosystem, Scotian Shelf Large Marine Ecosystem, and Labrador Current Open Ocean Area; however, training or testing may occasionally occur in these areas during transit.

Table 3.0-2: Designated Training and Testing Areas in Relation to Large Marine Ecosystems and Open Ocean Areas (Continued)

Training/Testing Location[1]	Northeast U.S. Continental Shelf Large Marine Ecosystem	Southeast U.S. Continental Shelf Large Marine Ecosystem	Gulf of Mexico Large Marine Ecosystem	Caribbean Sea Large Marine Ecosystem	Gulf Stream Open Ocean Area	North Atlantic Gyre Open Ocean Area
Event Locations						
Narragansett Bay Restricted Area	X					
Rhode Island Sound Restricted Area	X					
Coddington Cove Restricted Area	X					
Cape Cod TORPEX Boxes	X					
MIW Range	X					
1C-1 and 1C-2	X					
7-C, 7-D, 8-C, and 8-D	X					
5-C and 5-D						
W-50	X					
Restricted Area 6606 (R-6606)	X					
Onslow Beach; Camp Lejeune, NC		X				
Onslow Bay UNDET Area		X				
ARG MTA		X				
W-122 (16,17)		X				
W-122 (13,14)					X	
W-122 (4,5)					X	
Charleston UNDET Areas (North and South)		X				
Seminole Beach; Naval Station Mayport, Jacksonville, FL		X				
Carrier Strike Group (CSG) Mine Training Areas (MTA)		X				

ARG: Amphibious Readiness Group; CSG: Carrier Strike Group; FL: Florida; MIW: mine warfare; MTA: mine training area; NC: North Carolina; TORPEX: torpedo exercise; UNDET: underwater detonation; W: warning area

[1] No specifically designated training or testing areas fall within the West Greenland Shelf Large Marine Ecosystem, Newfoundland-Labrador Shelf Large Marine Ecosystem, Scotian Shelf Large Marine Ecosystem, and Labrador Current Open Ocean Area; however, training or testing may occasionally occur in these areas during transit.

Table 3.0-2: Designated Training and Testing Areas in Relation to Large Marine Ecosystems and Open Ocean Areas (Continued)

Training/Testing Location[1]	Northeast U.S. Continental Shelf Large Marine Ecosystem	Southeast U.S. Continental Shelf Large Marine Ecosystem	Gulf of Mexico Large Marine Ecosystem	Caribbean Sea Large Marine Ecosystem	Gulf Stream Open Ocean Area	North Atlantic Gyre Open Ocean Area
Event Locations (Continued)						
Surface Gunnery Areas AA, BB, CC		X				
Missile Laser Training Range (MLTR)		X				
Undersea Warfare Training Range (USWTR)		X				
SINKEX Box					X	X
Ship Shock Trial Locations	X	X			X	
W-155 Hotbox			X			
Corpus Christi UNDET Box E3			X			
Gulf of Mexico			X			
EA-1			X	X		
Test Site H			X			
UNDET Box (part of Key West Range Complex)				X		

MLTR: Missile Laser Training Range; SINKEX: sinking exercise; UNDET: underwater detonation; W: warning area

[1] No specifically designated training or testing areas fall within the West Greenland Shelf Large Marine Ecosystem, Newfoundland-Labrador Shelf Large Marine Ecosystem, Scotian Shelf Large Marine Ecosystem, and Labrador Current Open Ocean Area; however, training or testing may occasionally occur in these areas during transit.

3.0.3.1.1 West Greenland Shelf Large Marine Ecosystem

The West Greenland Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of 109,000 nm^2 (374,000 km^2) (Aquarone et al. 2009). No specifically designated training or testing areas fall within the West Greenland Shelf Large Marine Ecosystem; however, training or testing may occasionally occur in this area during transit (see Chapter 2 [Description of Proposed Action and Alternatives] for locations of activities within and outside of designated training and testing ranges). This large marine ecosystem extends off the west coast of Greenland adjacent to Baffin Bay and the Davis Strait. Most of this ecosystem extends outside the Study Area; only the southwestern portion occurs within the Study Area (Figure 3.0-1). Other oceanic influences on this area are the West Greenland Current Front and the East Greenland Current. Significant structural features of this ecosystem include the Fylass Bank and the Tasersuaq Estuary. Most of this large marine ecosystem is covered with ice during parts of the year (Sherman and Hempel 2009).

The West Greenland Shelf Large Marine Ecosystem provides resources for commercial fisheries (e.g., northern shrimp and flounder), and is an important feeding and migration area for the ESA-endangered Gulf of Maine Atlantic salmon (Fay et al. 2006). The average primary productivity within this large marine ecosystem is low: less than 410 milligrams (mg) of carbon per square meter per day (m^2/day) (Aquarone et al. 2009). Low primary productivity is a result of low numbers of primary producers (e.g., algae) which are responsible for most of the primary production in the ocean and form the base of the marine food web. Refer to U.S. Department of the Navy (2012) or Section 2.3.2 (Ecosystem Function) for more information. The productivity ranges for some typical global ecosystems are included in Table 3.0-3 for comparison with the values provided for large marine ecosystems. Less than 1 percent of the Study Area is in the West Greenland Shelf Large Marine Ecosystem.

Table 3.0-3: Net Primary Production for Several Ecosystem Types, for Comparison with the Primary Productivity Values Provided for Each Large Marine Ecosystem

Ecosystems (in descending order of productivity)	Net Primary Productivity g carbon/m^2/year (g carbon/m^2/day)	Large Marine Ecosystems with Equivalent Average Primary Productivity
Salt Marsh Wetland	4,100–23,000 (11.2–63.0)	None
Mangrove Wetland	3,000–14,800 (8.22–40.5)	None
Coral Reef	1,370–11,000 (3.75–30.14)	Scotian Shelf, Northeast U.S. Continental Shelf
Rain Forest	2,750–9,600 (7.53–26.3)	None
Open Ocean	5–1,100 (0.014–3.01)	West Greenland Shelf, Newfoundland-Labrador Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico, Caribbean Sea

Source: Mitsch and Gosselink 1993
g: grams; m^2: square meters

3.0.3.1.2 Newfoundland-Labrador Shelf Large Marine Ecosystem

The Newfoundland-Labrador Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 261,000 nm^2 (895,000 km^2) (Aquarone and Adams 2009a).

This large marine ecosystem extends off the east coast of Canada within the Labrador Current (Aquarone and Adams 2009a). Other oceanic influences on this area are the Gulf Stream, Labrador Shelf-Slope Front, and Labrador Mid-Shelf Front. Important structural features of this ecosystem include a structurally complex seabed, 14 estuaries, and the Grand Banks, which is a rich fishing ground (Sherman and Hempel 2009). The Newfoundland-Labrador Shelf Large Marine Ecosystem supplies an important ecosystem service by providing resources for commercial fisheries (e.g., cod, haddock, and pollock). The average primary productivity within this large marine ecosystem is moderate: 809 mg of carbon per m^2/day (Aquarone and Adams 2009a). This is comparable to productivity levels associated with the open ocean (Table 3.0-3).

No specifically designated training or testing areas fall within the Newfoundland-Labrador Shelf Large Marine Ecosystem; however, training or testing may occasionally occur in this area during transit (see Chapter 2 [Description of Proposed Action and Alternatives] for locations of activities within and outside of designated training and testing ranges). Approximately 5 percent of the Study Area is located in the Newfoundland-Labrador Shelf Large Marine Ecosystem.

3.0.3.1.3 Scotian Shelf Large Marine Ecosystem

The Scotian Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 82,500 nm^2 (283,000 km^2) (Aquarone and Adams 2009a). This large marine ecosystem is located off the coast of the Canadian province of Nova Scotia and extends to the shelf break (Aquarone and Adams 2009a). The Laurentian Channel in the north separates this large marine ecosystem from the Newfoundland-Labrador Shelf Large Marine Ecosystem. Oceanic influences in this area are the Gulf Stream, Nova Scotia Current, Cape North Front, Cabot Strait Front, Gully Front, and Shelf-Slope Front. Important structural features of this ecosystem include the St. Lawrence Estuary and the complex topography of the area, which includes deep, mid-shelf basins, and many off-shore shallow banks (Sherman and Hempel 2009). The Scotian Shelf Large Marine Ecosystem supplies an important ecosystem service by providing resources for commercial fisheries (e.g., cod, haddock, pollock, snow crab, northern shrimp, and short-finned squid). The average primary productivity within this large marine ecosystem is high: 1,395 mg of carbon per m^2/day (Aquarone and Adams 2009a). This is comparable to productivity levels associated with coral reef ecosystems (Table 3.0-3).

No specifically designated training or testing areas fall within the Scotian Shelf Large Marine Ecosystem; however, training or testing may occasionally occur in this area during transit (see Chapter 2 [Description of Proposed Action and Alternatives] for locations of activities within and outside of designated training and testing ranges). Approximately 1 percent of the Study Area is located in the Scotian Shelf Large Marine Ecosystem.

3.0.3.1.4 Northeast United States Continental Shelf Large Marine Ecosystem

The Northeast U.S. Continental Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 90,300 nm^2 (309,700 km^2) (Aquarone and Adams 2009b). This large marine ecosystem extends from the Gulf of Maine to Cape Hatteras, North Carolina. This area includes the Gerry E. Studds Stellwagen Bank National Marine Sanctuary. For additional details on marine protected areas and national marine sanctuaries, see Section 6.1.2 (Marine Protected Areas).

Oceanic influences in this large marine ecosystem are the Gulf Stream, Cape North Front, Georges Bank Front, Maine Coastal Front, Mid-Shelf Front, Nantucket Shoals Front, and Shelf-Slope Front (Aquarone and Adams 2009b). Important structural features of this ecosystem include 28 estuaries and river systems such as Penobscot Bay/River, Hudson River, Delaware Bay/River, and Chesapeake Bay (Sherman and Hempel 2009). This large marine ecosystem also supplies an important ecosystem service by providing resources for commercial fisheries (e.g., cod, flounder, mackerel, lobster, sea scallops, and red crab). The Northeast U.S. Continental Shelf Large Marine Ecosystem is one of the most productive large marine ecosystems in the world, with a high average primary productivity of 1,536 mg of carbon per m^2/day (Aquarone and Adams 2009b). While this is comparable to productivity levels associated with coral reef ecosystems (Table 3.0-3), a lower value of 760 mg of carbon per m^2/day was recently reported (National Marine Fisheries Service 2012).

A large proportion of Navy training and testing activities occur in the Northeast U.S. Continental Shelf Large Marine Ecosystem. To determine which designated training and testing areas (or portions of these areas) occur within this large marine ecosystem, refer to Table 3.0-2 and Figure 3.0-2, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.8-1 through 2.8-3. Approximately 2 percent of the Study Area is located in the Northeast U.S. Continental Shelf Large Marine Ecosystem.

3.0.3.1.5 Southeast United States Continental Shelf Large Marine Ecosystem

The Southeast U.S. Continental Shelf Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 87,000 nm^2 (298,000 km^2) (Aquarone 2009). This large marine ecosystem extends from Cape Hatteras, North Carolina to the Straits of Florida (Aquarone 2009). This area includes the Monitor and Gray's Reef National Marine Sanctuaries. For additional details on marine protected areas and national marine sanctuaries, see Section 6.1.2 (Marine Protected Areas).

Oceanic influences in this large marine ecosystem are the Gulf Stream, Inshore Gulf Stream Front, Mid-Shelf Front, and Offshore Gulf Stream Front. Important structural features of this ecosystem include many types of habitat such as coral reefs, estuaries, barrier islands, and coastal marshes (Sherman and Hempel 2009). The calving grounds for the North Atlantic right whale are located in this large marine ecosystem, as discussed in Section 3.4 (Marine Mammals). The Southeast U.S. Continental Shelf Large Marine Ecosystem supplies important ecosystem services by providing resources for commercial fisheries (e.g., mackerel, swordfish, tuna, white shrimp, brown shrimp) and by supporting these fisheries with estuarine nurseries for these species. The Southeast U.S. Continental Shelf Large Marine Ecosystem includes important breeding areas for sea turtles. This large marine ecosystem is a moderately productive ecosystem, with an average primary productivity of 721 mg of carbon per m^2/day (Aquarone 2009). This is comparable to productivity levels associated with the open ocean (Table 3.0-3).

A large proportion of Navy training and testing activities occur in the Southeast U.S. Continental Shelf Large Marine Ecosystem. To determine which designated training and testing areas (or portions of these areas) occur within this large marine ecosystem, refer to Table 3.0-2 and Figure 3.0-3, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.8-1 through 2.8-3. Approximately 2 percent of the Study Area is located in the Southeast U.S. Continental Shelf Large Marine Ecosystem.

3.0.3.1.6 Gulf of Mexico Large Marine Ecosystem

The Gulf of Mexico Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 430,000 nm^2 (1,475,000 km^2) (Heileman and Rabalais 2009). This large marine ecosystem is a semi-enclosed sea that borders the United States, Mexico, and Cuba. This area includes the Florida Keys and Flower Garden Banks National Marine Sanctuaries. For additional details on marine protected areas and national marine sanctuaries, see Section 6.1.2 (Marine Protected Areas).

Oceanic influences in this large marine ecosystem are the Loop Current, Campeche Bank Coastal Front, Campeche Bank Shelf-Slope Front, Inner Shelf Front, Louisiana-Texas Shelf Front, and West Florida Shelf Front. Important structural features of this ecosystem include the extensive continental shelf, numerous estuaries, and a large amount of freshwater input from the Mississippi River (Sherman and Hempel 2009). The Gulf of Mexico Large Marine Ecosystem supplies an important ecosystem service by providing resources for commercial fisheries (e.g., Gulf menhaden, king mackerel, red grouper, brown shrimp, white shrimp, and pink shrimp). This large marine ecosystem has a low average primary productivity of 201 mg of carbon per m^2/day (Heileman and Rabalais 2009). This is comparable to productivity levels associated with the open ocean (Table 3.0-3). Other human uses in this large marine ecosystem include off-shore oil and gas exploration. The oil spill from BP's *Deepwater Horizon* occurred in the Gulf of Mexico between April and August 2010.

A large proportion of Navy training and testing activities occur in the Gulf of Mexico Large Marine Ecosystem. To determine which designated training and testing areas (or portions of these areas) occur within this large marine ecosystem, refer to Table 3.0-2 and Figure 3.0-4, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.8-1 through 2.8-3. Approximately 13 percent of the Study Area is located in the Gulf of Mexico Large Marine Ecosystem.

3.0.3.1.7 Caribbean Sea Large Marine Ecosystem

The Caribbean Sea Large Marine Ecosystem (Figure 3.0-1) encompasses an area of approximately 960,000 nm^2 (3,290,000 km^2). This large marine ecosystem is bordered by the southern part of Florida, Central and South America, and the Antilles (Heileman and Mahon 2009). Oceanic influences in this area are the Loop Current, North Equatorial Current, and Windward Passage Front. Important structural features of this ecosystem include coral reefs, sea mounts, and major input of freshwater from large rivers (Sherman and Hempel 2009). The Caribbean Sea Large Marine Ecosystem supplies an important ecosystem service by providing resources for commercial fisheries (e.g., king mackerel, Spanish mackerel, dolphinfish, spiny lobster, queen conch, and shrimp). The Caribbean Sea Large Marine Ecosystem includes important breeding areas for sea turtles, as discussed in Section 3.5 (Sea Turtles). This region has a low average primary productivity of 478 mg of carbon per m^2/day (Heileman and Mahon 2009). This is comparable to productivity levels associated with the open ocean (Table 3.0-3).

To determine which designated training and testing areas (or portions of these areas) occur within the portion of the Caribbean Sea Large Marine Ecosystem that falls within the Study Area, refer to Table 3.0-2 and Figures 3.0-3 and 3.0-4, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.8-1 through 2.8-3. Approximately 1 percent of the Study Area is located in the Caribbean Sea Large Marine Ecosystem.

3.0.3.1.8 Labrador Current Open Ocean Area

The Labrador Current Open Ocean Area (Figure 3.0-1) lies between Labrador (Canada) and Greenland, and is characterized by the cold water of the Labrador Current that flows north to south from the Arctic Ocean, down along the eastern coast of Canada (Reverdin et al. 2003). The Labrador Current then joins the Gulf Stream Current to form the North Atlantic Current (Gould 1985; Reverdin et al. 2003). The Labrador Current has an average width of 26 to 50 nm, with typical velocities of 1.0 to 1.6 feet per second (ft./s) (0.3 to 0.5 meters per second [m/s]), and flows to a maximum depth of 500 ft. (150 m) (Halkin and Rossby 1985; Reverdin et al. 2003; Tomczak and Godfrey 2003).

The Arctic influence, combined with the southward-flowing current, results in an abundance of icebergs in this open ocean area, particularly during the spring and early summer months (Reverdin et al. 2003;

Schmitz and McCartney 1993; Tomczak and Godfrey 2003). The cold-water Labrador Current influences the species assemblages found within this open ocean area (Valiela 1995). However, farther south where this cold water current combines with the warm waters of the Gulf Stream (offshore of the Newfoundland-Labrador Shelf, Scotian Shelf, and Northeast U.S. Continental Shelf Large Marine Ecosystems), the species assemblage reflects both warm- and cold-water organisms (Aquarone 2009; Aquarone and Adams 2009a; Valiela 1995). The Labrador Current Open Ocean Area is an important feeding and migration area for the Gulf of Maine Atlantic salmon (Fay et al. 2006).

No specifically designated training or testing areas fall within the Labrador Current Open Ocean Area; however, training or testing may occasionally occur in this area during transit (see Chapter 2 [Description of Proposed Action and Alternatives] for locations of activities within and outside of designated training and testing ranges). Approximately 10 percent of the Study Area is located in the Labrador Current Open Ocean Area.

3.0.3.1.9 Gulf Stream Open Ocean Area

The major western boundary current of the North Atlantic, the Gulf Stream, characterizes the Gulf Stream Open Ocean Area (Figure 3.0-1). The Gulf Stream forms where the Loop Current in the Gulf of Mexico (Reverdin et al. 2003) and the Florida Current (Atkinson et al. 1984) combine in the Atlantic Ocean. The Gulf Stream begins where the Florida Current ceases to follow the continental shelf, flowing northeast along the southeastern United States from Cape Canaveral, Florida, to Cape Hatteras, North Carolina (Atkinson and Targett 1983). As the Gulf Stream moves away from Cape Hatteras it flows northeast toward Europe (Garrison 1998).

The Gulf Stream has a maximum width of 108 miles (mi.) (200 kilometers [km]), with typical velocities exceeding 3.3 ft./s (1.0 m/s), and flows to a maximum depth of 660 ft. (200 m) (Halkin and Rossby 1985; Reverdin et al. 2003; Tomczak and Godfrey 2003). The Gulf Stream flows over the shelf break south of 32° N at water depths less than 2,950 ft. (800 m) (Atkinson et al. 1984; Halkin and Rossby 1985). North of 32° N, the Gulf Stream is displaced 54 nm offshore, at which point it abruptly turns east near the Charleston Bump (a deep-water outcropping) (Reverdin et al. 2003). From there, the Gulf Stream continues northeast, joining the Labrador Current to form the Slope Jet Current at 41° N–42° N. This branch of the Gulf Stream, along with the Labrador and Slope Jet Current, continues northeast as the North Atlantic Current (Gould 1985; Reverdin et al. 2003).

The Gulf Stream is an important migratory corridor for many different marine species, including marine mammals, sea turtles, and fishes. The influence of the warm waters of the Gulf Stream also provides passive dispersal of tropical species from southern portions of the Study Area into the northern portions of the Study Area.

A large proportion of Navy training and testing activities occur in this open ocean area. To determine which designated training and testing areas (or portions of these areas) occur within the Gulf Stream Open Ocean Area, refer to Table 3.0-2 and Figures 3.0-2 and 3.0-3, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.8-1 through 2.8-3. Approximately 11 percent of the Study Area is located in the Gulf Stream Open Ocean Area.

3.0.3.1.10 North Atlantic Gyre Open Ocean Area

North Atlantic Ocean circulation is driven by the anticyclonic (clockwise) motion of the North Atlantic Subtropical Gyre (Figures 3.0-1, 3.0-2, and 3.0-3). The North Atlantic Gyre Open Ocean Area occurs from 10° N to 40° N and is delimited by the westward-flowing Canary Current, North Equatorial Current, the

Caribbean Current, Loop Current in the Gulf of Mexico, Florida Current, Gulf Stream (Talwani et al. 1971), and the eastward-flowing North Atlantic Current (Schmitz and McCartney 1993). The North Atlantic Subtropical Gyre is transected by the eastward-flowing Azores Current (Juliano and Alves 2007). Only the northwestern portion of the North Atlantic Gyre is located in the Study Area. The North Atlantic Gyre, like all large subtropical gyres in the ocean, has extremely low rates of primary productivity (Valiela 1995). The observed low productivity is caused by a persistent thermocline (a layer of water that separates warm water from cold deep water) that prevents the vertical mixing of water. This thermocline results in dilute (nutrient-poor) surface waters in the gyre, which limits the growth of phytoplankton throughout the year (Valiela 1995). The Sargasso Sea is a unique feature contained within this gyre, and despite the nutrient limitations of the area, is characterized by dense mats of floating *Sargassum*, a type of marine vegetation (seaweed) that provides important cover habitat for a variety of marine organisms (see Section 3.7 [Marine Vegetation] for more details).

To determine which designated training and testing areas (or portions of these areas) occur within the North Atlantic Gyre Open Ocean Area, refer to Table 3.0-2 and Figures 3.0-2 and 3.0-3, and for more information on the types of activities that will occur in an ecosystem, refer to Tables 2.8-1 through 2.8-3. Although approximately 50 percent of the Study Area is located in the North Atlantic Gyre Open Ocean Area, the majority of Navy training and testing activities do not occur here.

3.0.3.2 Bathymetry

This section provides a description of the bathymetry (water depth) of the Study Area. Given that the bathymetry of an area reflects the topography (surface features) of the seafloor, it is an important factor in understanding the potential impacts of Navy training and testing activities on the seafloor, the propagation of underwater sound (Section 3.0.4.4.1, Sound Attenuation and Transmission Loss), and species diversity (see Sections 3.3, Marine Habitats–3.9, Fish). The discussion of bathymetry includes a general overview of the Study Area followed by more detailed sections organized by biogeographic classification area. Table 3.0-4 provides a description of the bathymetry of Navy training and testing areas within each large marine ecosystem and open ocean area.

Table 3.0-4: Summary of Bathymetry within Large Marine Ecosystems and Open Ocean Areas in Navy Training and Testing Areas

Range/Component	Description	General Bathymetry
West Greenland Shelf Large Marine Ecosystem		
No Navy designated training or testing areas fall within this large marine ecosystem.[1]	Located off the southwest coast of Greenland	Depth ranges from 25 to 2,000 m
Newfoundland-Labrador Shelf Large Marine Ecosystem		
No Navy designated training or testing areas fall within this large marine ecosystem.[1]	Located off the coast of Newfoundland and Labrador, Canada in part of the Labrador current	Depth ranges from 25 to 2,000 m
Scotian Shelf Large Marine Ecosystem		
No Navy designated training or testing areas fall within this large marine ecosystem.[1]	Located off the coast of Nova Scotia	Depth ranges from 25 to 2,000 m

m: meters

[1] This Environmental Impact Statement/Overseas Environmental Impact Statement (EIS/OEIS) would provide the flexibility for Navy to conduct specific training and testing activities, or vessel transits, within the entire Study Area (see Chapter 2 [Description of Proposed Action and Alternatives] for locations of activities within and outside of designated training and testing ranges).

Table 3.0-4: Summary of Bathymetry Features within Large Marine Ecosystems and Open Ocean Areas in Navy Training and Testing Areas (Continued)

Range/Component	Description	General Bathymetry
Northeast U.S. Continental Shelf Large Marine Ecosystem		
OPAREAs		
Boston (part of Northeast Range Complexes)	Located largely in the Gulf of Maine, but also in Cape Cod and Massachusetts Bays	Average depth of the Gulf of Maine is 150 m. Depth ranges from 1 to 292 m
Narragansett Bay (part of Northeast Range Complexes)	Located east of Narragansett Bay	Depth ranges from 1 to 1,596 m
Atlantic City (part of Northeast Range Complexes)	Located mostly over the continental shelf	Depth ranges from 8 to 1,728 m
Virginia Capes (part of VACAPES)	Located along the coast from Delaware to North Carolina; ranges in width from 24 nm off Cape Hatteras to about 87 nm off Delaware Bay	Depth ranges from 5 to 2,100 m
Testing Ranges		
Naval Undersea Warfare Center Division, Newport	Includes shallow estuarine waters of Buzzards Bay, Vineyard Sound, Narragansett Bay, Rhode Island Sound, Block Island Sound, and Long Island Sound	Depths range from 18 to 55 m
Naval Ports and Naval Shipyards		
Portsmouth Naval Shipyard; Kittery, ME	Located on Seavey's Island in an estuary 2.1 nm up the Piscataqua River from the open ocean	Depth ranges from 6 to 16 m in the immediate vicinity of the facility
Naval Submarine Base New London; Groton, CT	Located on Thames River 2.1 nm up river from Long Island Sound	Depth ranges from 5 to 12 m in the immediate vicinity of the facility
Naval Station Norfolk; Norfolk, VA	Located near the mouth of the Chesapeake Bay	Depth ranges from 2 to 13 m in the immediate vicinity of the facility
Joint Expeditionary Base Little Creek—Fort Story; Virginia Beach, VA	Located near the mouth of the Chesapeake Bay	Depth ranges from 3 to 7 m in the immediate vicinity of the facility
Norfolk Naval Shipyard; Portsmouth, VA	Located on the Elizabeth River near the mouth of the Chesapeake Bay	Depth ranges from 1 to 15 m in the immediate vicinity of the facility
Navy Contractor Shipyards		
Bath, ME	Located on Kennebec River estuary 10 nm up river from the ocean; shallow system of estuarine channels	Depth ranges from 5 to 14 m in the immediate vicinity of the facility
Groton, CT	Located on Thames River 2.1 nm up river from Long Island Sound	Depth ranges from 5 to 12 m in the immediate vicinity of the facility
Newport News, VA	Located 9.7 nm from an open-ocean inlet within the Chesapeake Bay	Depth ranges from 6 to 15 m in the immediate vicinity of the facility
Bays and Inland Waters		
Sandy Hook Bay; Earle, NJ	Located in Sandy Hook Bay, NJ	Depth ranges from 1 to 13 m in the immediate vicinity of the facility
Lower Chesapeake Bay; Hampton Roads, VA	Estuarine waters located in the southern portion of Chesapeake Bay	The average depth is 6.4 m, depth range is from 1 to 30 m

CT: Connecticut; m: meter(s); ME: Maine; NJ: New Jersey; VA: Virginia; VACAPES: Virginia Capes Range Complex

Table 3.0-4: Summary of Bathymetry Features within Large Marine Ecosystems and Open Ocean Areas in Navy Training and Testing Areas (Continued)

Range/Component	Description	General Bathymetry
Event Locations		
Narragansett Bay Restricted Area	Located in Narragansett Bay between Conanicut and Prudence Islands	Depth ranges from 6 to 15 m
Rhode Island Sound Restricted Area	Located 3 nm east of Point Judith	Depth ranges from 30 to 36 m
Coddington Cove Restricted Area	Located in a cove on the west coast of Aquidneck Island, RI	Depth ranges from 8 to 9 m
Cape Cod TORPEX Boxes	Located east of Cape Cod within and adjacent to the Boston OPAREA	Depth ranges from 30 to 150 m
MIW Range	Located 25 nm east of the mouth of Chesapeake Bay	Depth ranges from 25 to 50 m
1C-1 and 1C-2	Located 75 nm east of the mouth of Chesapeake Bay	Depth ranges from 100 to 130 m
7-C, 7-D, 8-C, and 8-D	Located 25 nm east of the mouth of Chesapeake Bay	Depth ranges from 25 to 50 m
Warning Area 50 (W-50)	Located 7 nm from the mouth of the Chesapeake Bay	Depth ranges from 10 to 20 m
Restricted Area 6606 (R-6606)	Located 7 nm from the mouth of the Chesapeake Bay; borders the western limit of W-50	Depth is less than 10 m
Ship Shock Trial Locations	Located 75 nm east of the mouth of Chesapeake Bay	Depth ranges from 182 to 2,700 m
Southeast U.S. Continental Shelf Large Marine Ecosystem		
OPAREAs		
Cherry Point (part of Navy Cherry Point Range Complex)	Located off the coast of North Carolina	Depth ranges from 2 to 2,194 m
Charleston (part of JAX)	Located off the coast of North and South Carolina	Depth ranges from 2 to 1,050 m
Jacksonville (JAX)	Located off the coasts of Georgia and northern Florida	Depth ranges from 2 to 2,613 m
Testing Ranges		
South Florida Ocean Measurement Facility	Located off the coast of Port Everglades, FL	Depth ranges from 1 to 762 m
Naval Ports and Naval Shipyards		
Naval Submarine Base Kings Bay; Kings Bay, GA	Located 7 nm from an open-ocean inlet on the St. Mary's River and King's Bay	Depth ranges from 0.6 to 14 m in the vicinity of the facility. Shallow estuarine channel located close to the open ocean
Naval Station Mayport; Jacksonville, FL	Located 0.86 nm from an open-ocean inlet on the St. John's River	Depth ranges from 5 to 12 m in the vicinity of the facility
Port Canaveral, FL	Shallow dredged port located on the Banana River and connected to the open ocean 3 nm to the east	Depth ranges from 9 to 12 m in the dredged channels of the facility

FL: Florida; GA: Georgia; JAX: Jacksonville Range Complex; m: meter(s); MIW: mine warfare; RI: Rhode Island; TORPEX: torpedo exercise; W: warning area

Table 3.0-4: Summary of Bathymetry Features within Large Marine Ecosystems and Open Ocean Areas in Navy Training and Testing Areas (Continued)

Range/Component	Description	General Bathymetry
Bays and Inland Waters		
Beaufort Inlet Channel; Morehead City, NC	Located in estuarine waters adjacent to Bogue Sound	Depth ranges from 5 to 10 m
Cape Fear River; Wilmington, NC	This area includes the Cape Fear River and Cape Fear Estuary	Shallow with channel depths of up to 13 m
Event Locations		
Onslow Beach; Camp Lejeune, NC	Located in Onslow Bay area; 4 nm long	Shallow, sandy beach area
UNDET Onslow	Located off the coast of Onslow Beach; Camp Lejeune, NC	Depth ranges from 10 to 30 m
ARG MTA	Located off the coast of Onslow Beach; Camp Lejeune, NC	Depth ranges from 10 to 20 m
W-122 (16, 17)	Located off the coast of Onslow Beach; Camp Lejeune, NC	Depth ranges from 25 to 30 m
Charleston UNDET North and South	Located 12 nm off the coast of South Carolina	Depth ranges from 10 to 20 m
Seminole Beach; Naval Station Mayport, Jacksonville, FL	Located at the mouth of St. John's River, which flows into the Atlantic; the length is less than 2 nm	Shallow, sandy beach
CSG MTA	Located 60 nm east of Charleston, SC	Depth ranges from 25 to 165 m
Surface Gunnery Areas AA, BB, CC	Located east of the border between Georgia and Florida, 25 nm off the coast	Depth ranges from 20 to 680 m
MLTR	Located east of the border between Georgia and Florida, approximately 25 nm off the coast	Depth ranges from 20 to 680 m
Undersea Warfare Training Range	Located approximately 50 nm east of Jacksonville, FL	Depth ranges from 20 to 680 m
Ship Shock Trial Locations	Located approximately 90 nm east of the southern part of Georgia and northern part of Florida	Depth ranges from 182 to 800 m
Gulf of Mexico Large Marine Ecosystem		
OPAREAs		
Key West (part of Key West Range Complex)	Located approximately 50 nm southwest of the southern tip of Florida	Depth ranges from 15 to 1,651 m
Panama City (part of GOMEX)	Located off the coast of the Florida panhandle	Depth ranges from 2 to 328 m
Pensacola (part of GOMEX)	Located off the coast of Alabama and Florida panhandle	Depth ranges from 9 to 2,152 m

ARG MTA: amphibious readiness group mine training area; CSG MTA: carrier strike group mine training area; FL: Florida; GOMEX: Gulf of Mexico Range Complex; m: meters; MLTR: missile laser training range; NC: North Carolina; SC: South Carolina; UNDET: underwater detonation; W: warning area

Table 3.0-4: Summary of Bathymetry Features within Large Marine Ecosystems and Open Ocean Areas in Navy Training and Testing Areas (Continued)

Range/Component	Description	General Bathymetry
OPAREAs		
New Orleans (Part of GOMEX)	Most of the OPAREA is located beyond the shelf break	Depth ranges from 72 to 2,365 m
Corpus Christi (Part of GOMEX)	The shelf break runs through the middle of the area	Depth ranges from 11 to 1,433 m
Testing Ranges		
Naval Surface Warfare Center, Panama City Division	Located offshore of the Florida panhandle and Alabama. Most of the area is located on the continental shelf in waters less than 200 m.	Average depth is more than 1,000 m, and the maximum depth is 3,000 m
Navy Contractor Shipyards		
Pascagoula, MS	Deep water port located at Pascagoula Bay	Depth ranges from 3 to 17 m in the dredged channels of the facility
Bays and Inland Waters		
St. Andrew Bay, FL	Estuarine bay near Panama City, Florida	Depth ranges from 2 to 12 m in the dredged channels of the bay. Average depth is 4 m
Sabine Lake; Beaumont, TX	Estuary on the Texas and Louisiana border	Depth ranges from 1 to 3 m
Corpus Christi Bay; Corpus Christi, TX	Estuary separated from the Gulf of Mexico by Padre Island	Depth ranges from 0.3 to 4.5 m
Routine Event Locations		
Gulf of Mexico	Ocean basin bound by U.S. Gulf coast states and Mexico	Depth ranges from 0 to 4,000 m
W-155 Hotbox	Located in the eastern half of the OPAREA 22 nm from the coast	Depth ranges from 30 to 304 m
Corpus Christi UNDET E3	Located 9 nm from the coast on the continental shelf	Depth ranges from 10 to 90 m
Caribbean Sea Large Marine Ecosystem		
OPAREA		
Key West (part of Key West Range Complex)	Located approximately 50 nm southwest of the southern tip of Florida	Depth ranges from 2 to 2,010 m
Labrador Current Open Ocean Area		
No Navy-designated training or testing areas fall within this open ocean area.[1]	Located between south Greenland and Labrador, Canada	Depth ranges from 150 to 4,000 m
Gulf Stream Open Ocean Area		
OPAREAs		
Narragansett Bay (part of Northeast Range Complexes)	Located east of Narragansett Bay	Depth ranges from 142 to 3,915 m

EIS/OEIS: Environmental Impact Statement/Overseas Environmental Impact Statement; FL: Florida; m: meter(s); OPAREA: operating area; TX: Texas; UNDET: underwater detonation

[1] This EIS/OEIS would provide the flexibility for Navy to conduct specific training and testing activities, or vessel transits, within the entire Study Area (see Chapter 2 [Description of Proposed Action and Alternatives] for locations of activities within and outside of designated training and testing ranges).

Table 3.0-4: Summary of Bathymetry Features within Large Marine Ecosystems and Open Ocean Areas in Navy Training and Testing Areas (Continued)

Range/Component	Description	General Bathymetry
OPAREAs		
Atlantic City (Part of Northeast Range Complexes)	Located mostly over the continental shelf	Depth ranges from 753 to 2,627 m
CGULL OPAREA (Part of Northeast Range Complexes)	Located off the southern side of Georges Bank, a shallow underwater plateau	Depth is approximately 1,088 to 4,670 m
Virginia Capes (Part of VACAPES)	Located off the coast from Delaware to North Carolina	Depth ranges from 170 to 4,362 m
Cherry Point (Part of Navy Cherry Point Range Complex)	Located off the coast of North Carolina	Depth ranges from 300 to 4,124 m
Charleston (Part of JAX)	Located off the coasts of North and South Carolina	Depth ranges from 951 to 2,403 m
Jacksonville (Part of JAX)	Located off the coasts of South Carolina, Georgia, and Florida	Depth ranges from 912 to 2,786 m
Event Locations		
W-122 (13, 14)	Located less than 80 nm off the coast of North Carolina	Depth ranges from 20 to 30 m
W-122 (4, 5)	Located less than 80 nm off the coast of North Carolina	Depth ranges from 25 to 35 m
SINKEX Box	Northwest edge located 200 nm east of the border between Virginia and North Carolina; southwest edge located 200 nm southeast of Cape Fear, NC	Depth ranges from 3,100 to 5,000 m
Ship Shock Trial Locations	Located approximately 75 nm east of the mouth of Chesapeake Bay	Depth ranges from 100 to 130 m
North Atlantic Gyre Open Ocean Area		
OPAREA		
CGULL (Part of Northeast Range Complexes)	Located off the southern side of Georges Bank, a shallow underwater plateau	Depth is approximately 4,598 to 4,863 m
Routine Event Locations		
SINKEX Box	Northwest edge located 200 nm east of the border between Virginia and North Carolina; southwest edge located 200 nm southeast of Cape Fear, NC	Depth ranges from 3,800 to 5,400 m

Sources: (National Oceanic and Atmospheric Administration 2001; Navy Research Laboratory 2011). National Oceanic and Atmospheric Administration nautical charts were also reviewed to determine depth ranges at specific locations. Some "pierside activities" listed as taking place at these locations actually take place away from the coastal areas and are located inside ranges.

JAX: Jacksonville Range Complex; m: meters; NC: North Carolina; OPAREA: operating area; SINKEX: sinking exercise; VACAPES: Virginia Capes Range Complex; W: warning area

The contour of the ocean floor as it descends from the shoreline has an important influence on the distribution of organisms, as well as the structure and function of marine ecosystems (Madden et al. 2009). The continental shelf and slope make up the continental margin of oceans. The typical zonation of oceans is shown in Figure 3.0-5. The continental shelf gently slopes seaward hundreds of miles from shore from the low tide line to a maximum depth of 200 m (Tomczak and Godfrey 2003; United Nations Educational Scientific and Cultural Organization 2009). The continental slope is steep; it begins seaward of the shelf break and extends to a depth of approximately 3,000 m. The continental rise extends from the continental slope to a depth of approximately 4,000 m. The abyssal zone, a relatively flat or gently sloping ocean floor, continues from the continental rise to depths of up to approximately 6,500 m. The abyssal zones of the Atlantic Ocean reach depths greater than 6,000 m. Bathymetry of the entire Study Area is shown in Figures 3.0-6 through 3.0-9.

Bathymetric features associated with the continental margin and the deep seafloor of the Study Area include canyons, seamounts (underwater mountains), trenches, ridges, and plateaus. The continental shelf of the northwest Atlantic ranges in width from 5 to 17 nm at its narrowest point off the coast of North Carolina to 215 nm at its widest point off the coast of Newfoundland (Blanton et al. 2003; Slatt 1984).

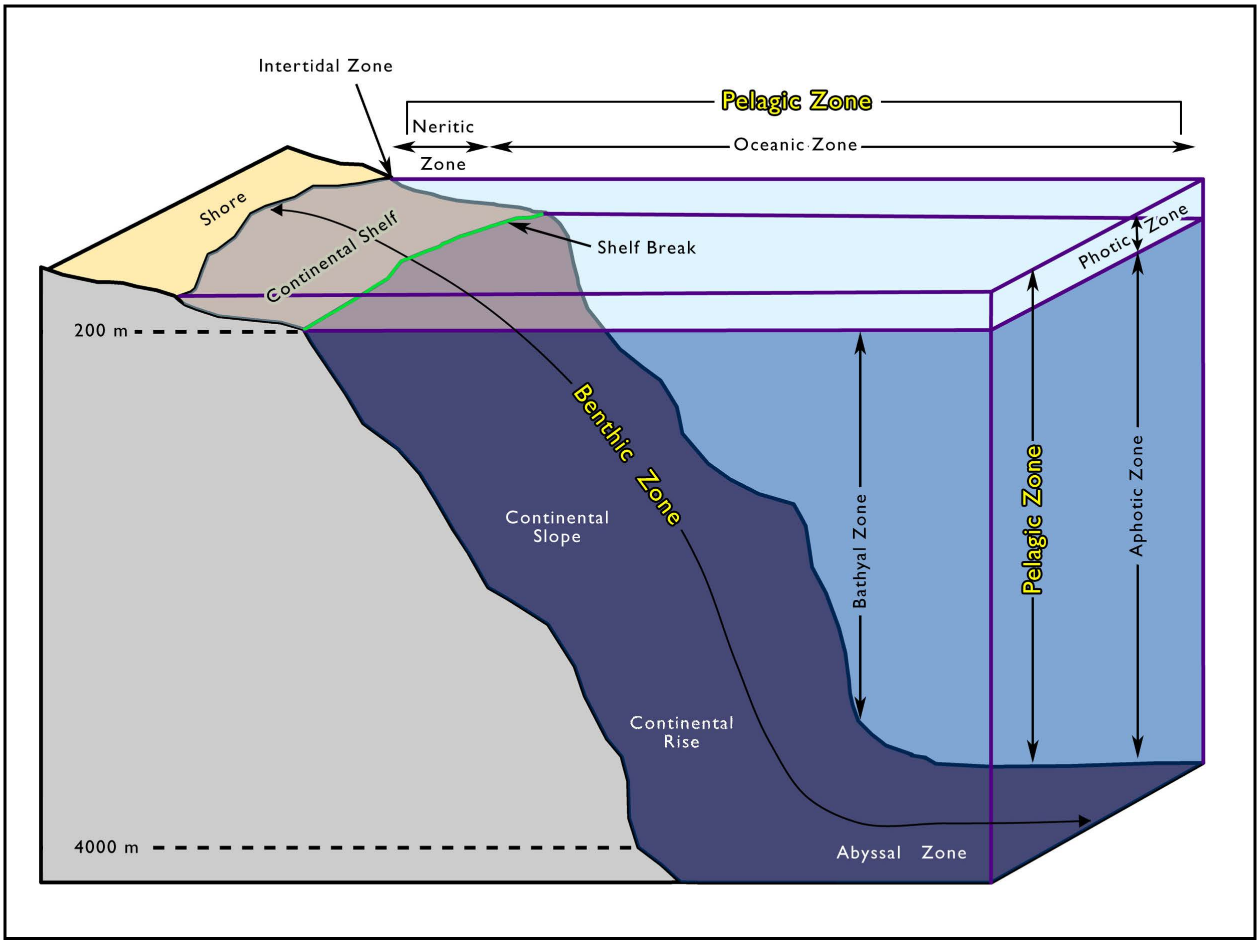

Figure 3.0-5: Three-Dimensional Representation of the Intertidal Zone (shoreline), Continental Margin, Abyssal Zone, and Water Column Zones
(U.S. Department of the Navy 2007)

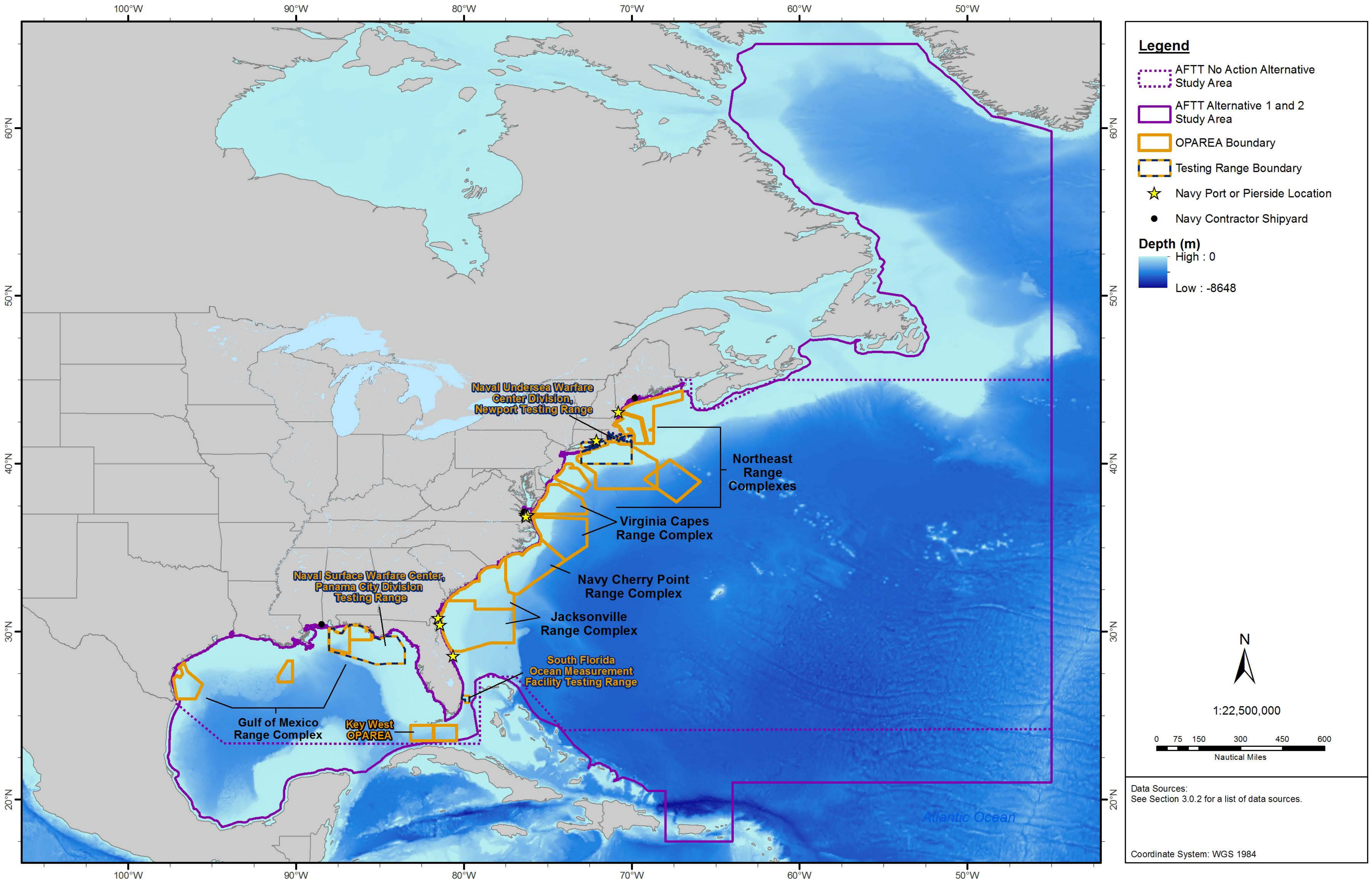

Figure 3.0-6: Bathymetry of the Entire Study Area

AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

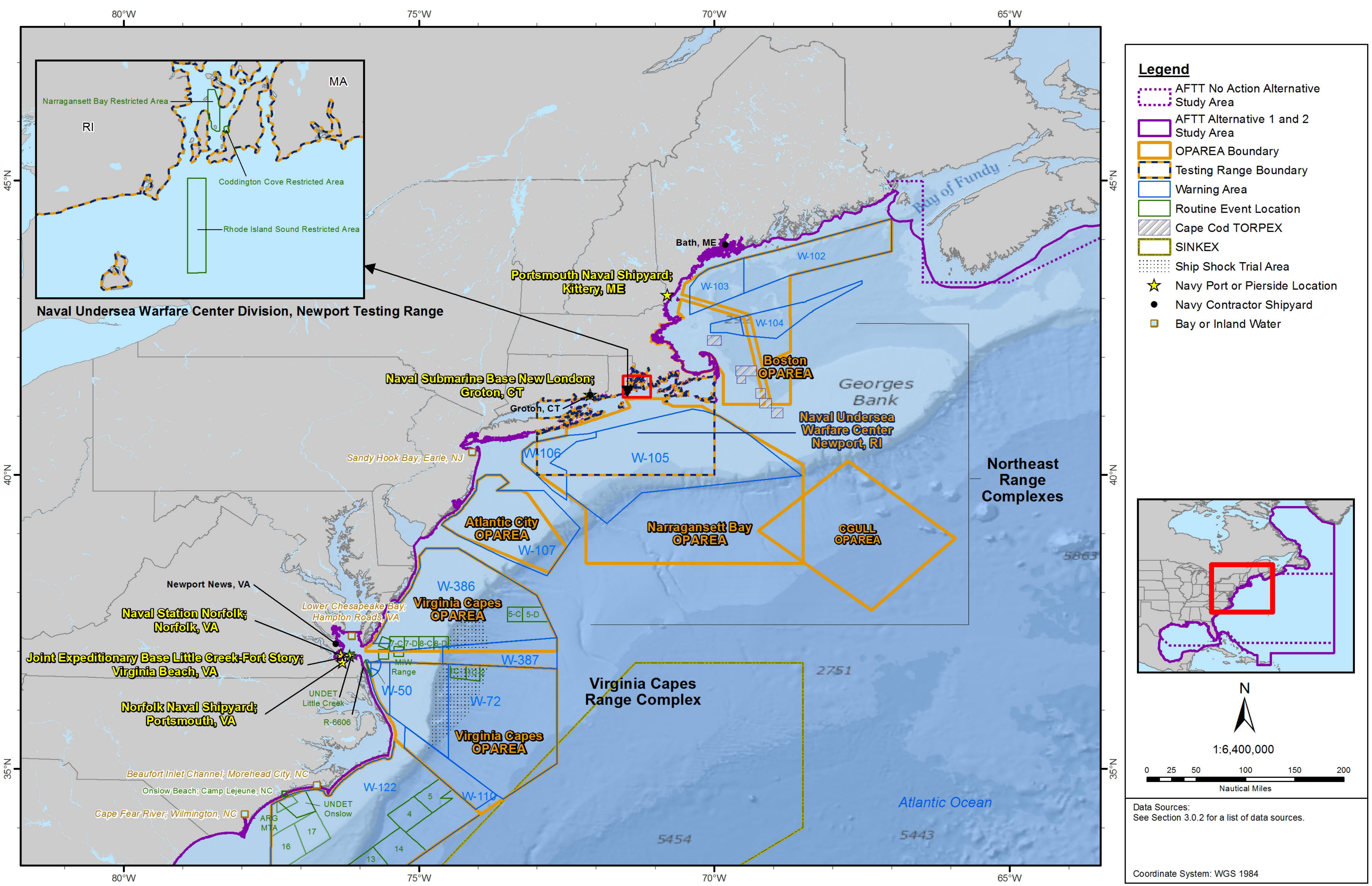

Figure 3.0-7: Bathymetry of the Northeast Portion of the Study Area

AFTT: Atlantic Fleet Training and Testing; ARG: Amphibious Readiness Group; CT: Connecticut; MA: Massachusetts; ME: Maine; MIW: Mine Warfare; MTA: Mine Training Area; NC: North Carolina; NJ: New Jersey; OPAREA: Operating Area; RI: Rhode Island; SINKEX: Sinking Exercise; TORPEX: Torpedo Exercise; UNDET: Underwater Detonation; VA: Virginia

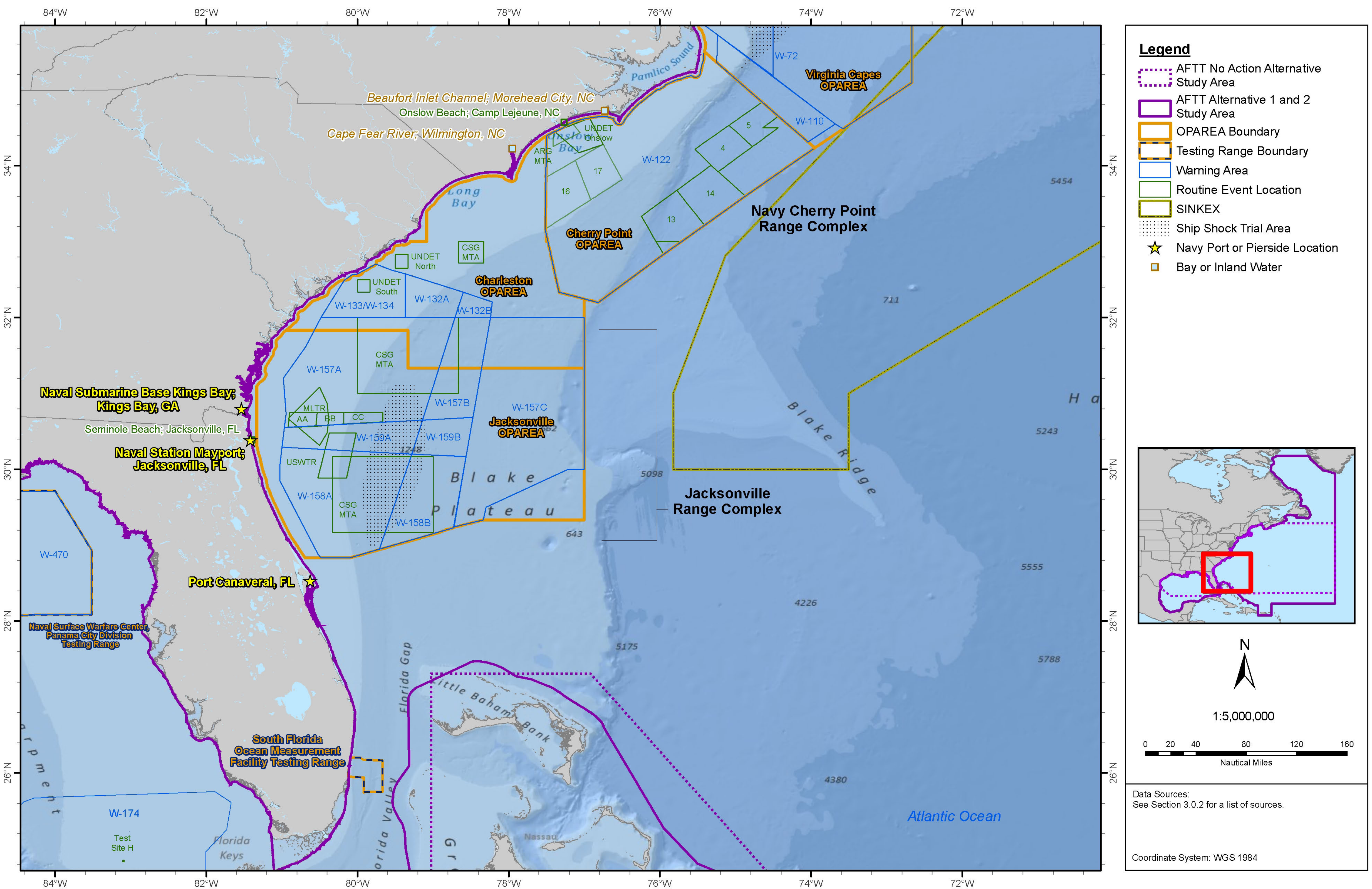

Figure 3.0-8: Bathymetry of the Southeast and Caribbean Portions of the Study Area

AFTT: Atlantic Fleet Training and Testing; ARG: Amphibious Readiness Group; CSG: Carrier Strike Group; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; MTA: Mine Training Area; OPAREA: Operating Area; RI: Rhode Island; SINKEX: Sinking Exercise; UNDET: Underwater Detonation; USWTR: Undersea Warfare Training Range; VACAPES: Virginia Capes

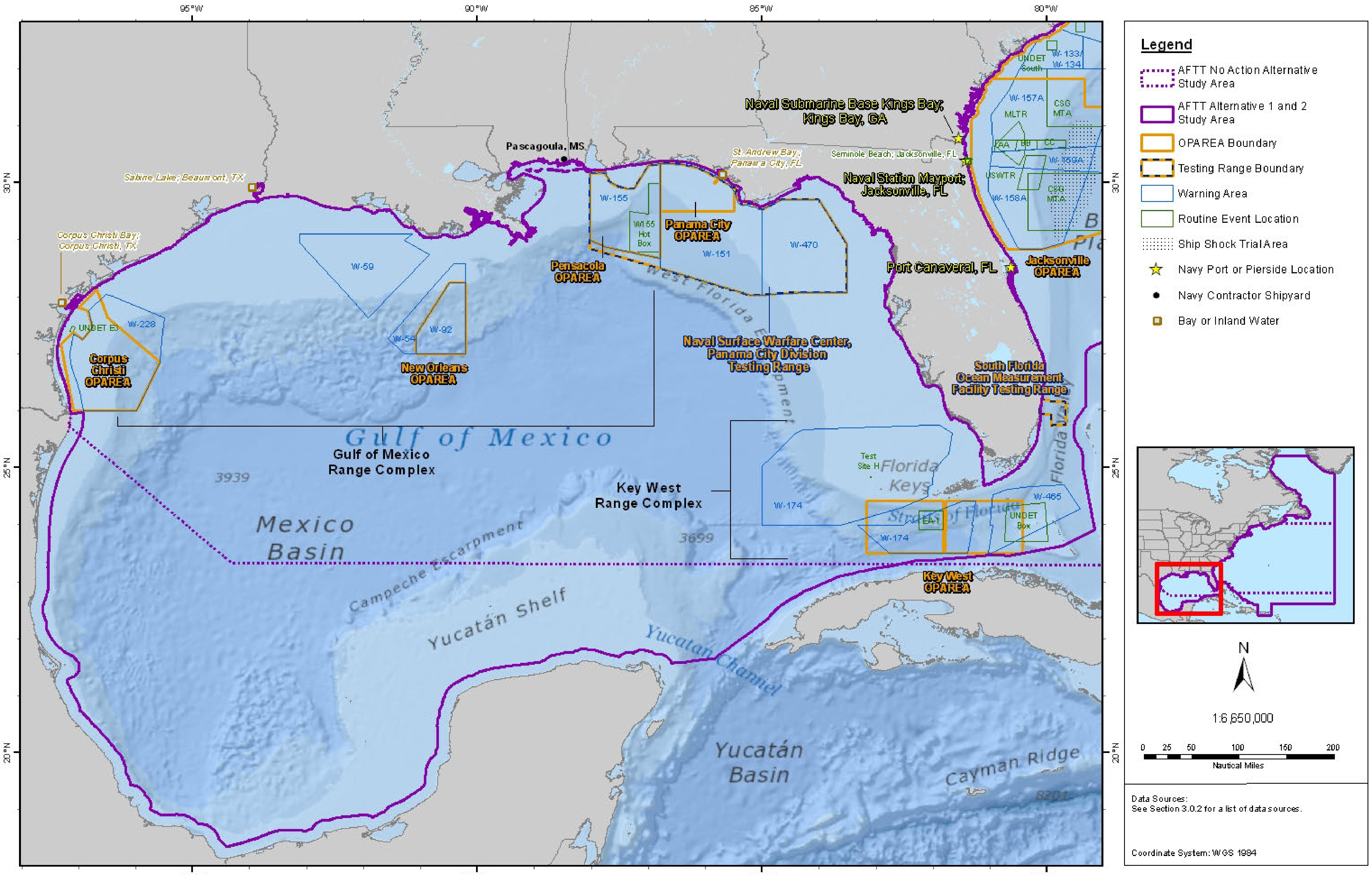

Figure 3.0-9: Bathymetry of the Gulf of Mexico and Caribbean Sea Portions of the Study Area

AFTT: Atlantic Fleet Training and Testing; CSG:Carrier Strike Grou ; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; MS: Mississippi; MTA: Mine Training Area; OPAREA: Operating Area; TX: Texas; UNDET: Underwater Detonation; USWTR: Undersea Warfare Training Range

Several bathymetric features are located in the Northeast U.S. Continental Shelf, the Scotian Shelf, and the Newfoundland-Labrador Shelf Large Marine Ecosystems. The Grand Banks are a group of shallow underwater plateaus on the eastern extent of the continental shelf in 25 to 100 m of water. South of the Grand Banks is the Newfoundland Rise, at 41° N, 50° W and the northernmost extent of the New England Seamount Chain (Reverdin et al. 2003). This chain includes more than 30 volcanic seamounts that extend south to Bermuda.

The Scotian Shelf extends 60 to 117 nm off the east coast of Nova Scotia (Slatt 1984). The continental shelf is relatively shallow, with an average depth of 90 m. However, in some areas it rapidly drops to depths greater than 3,000 m (Parks Canada - National Marine Conservation Areas of Canada 2010). Sable Island, located 160 nm southeast of Halifax, is surrounded by shallow banks (25 to 100 m).

The Gulf of Maine is a semi-enclosed continental sea with an area of 26,000 nm^2 (89,000 km^2) and average depth of 150 m (Ballard and Uchupi 1974). It is characterized by rocky shorelines of exposed bedrock from previous glacial scouring. Inland of the Gulf of Maine is the Bay of Fundy. It covers 4,810 nm^2 (16,500 km^2) with an average depth of 50 m (Wade et al. 1996). The Bay of Fundy and Gulf of Maine are known for having extreme tidal ranges as great as 15 m (Wade et al. 1996).

The Southeast U.S. Continental Shelf Large Marine Ecosystem includes the coastal area from southern Florida to Cape Hatteras, North Carolina (Shepard 2005). It includes the topographic feature known as the Blake Plateau, which covers 66,400 nm^2 (227,750 km^2) in water depths of 500 to 1,100 m (Popenoe and Manheim 2001). The Blake Plateau is bounded by the continental shelf on the west, Cape Hatteras on the north, the Bahama Banks on the south, and the abyssal plain on the east (Gorsline 1963; Popenoe and Manheim 2001). The Charleston Bump, a rocky, high-relief outcrop, occurs on the Blake Plateau between latitude 31° N and 32° N, and between longitude 77.5° W and 79.5° W (Popenoe and Manheim 2001). The continental shelf in this area gently slopes to 55 m (Atkinson et al. 1984), while the continental slope reaches depths of 1,400 m (Knebel 1984). Portions of the continental slope in this area are associated with deep-water coral communities at depths of 70 to 1,000 m (Reed and Ross 2005). At the boundary between the Northeast U.S. Continental Shelf and the Southeast U.S. Continental Shelf, the continental slope is divided by Hatteras Canyon, the most southerly canyon along the continental margin of the U.S. east coast. Offshore of Hatteras Canyon, the continental slope is steep and reaches 5,000 m (Rowe 1971). Other notable features are large sand shoals that extend from the barrier islands off North Carolina (Hunt et al. 1977; Oertel 1985).

The average depth of the Gulf of Mexico is 1,615 m, with a maximum depth of 3,850 m (Pequegnat et al. 1990). Dominant features of the Gulf of Mexico include the Sigsbee Escarpment (steep slope) and the Alaminos and Keathley Canyons, which divide the escarpment into western and eastern portions (Roberts et al. 2005). The eastern Gulf of Mexico is dominated by the Florida Escarpment, which is divided by a series of submarine canyons and contains more than 90 basins (Rowe and Kennicutt 2002). The western portion is underlain by the Louann Salt Formation, which creates faults and diapirs (salt domes) often associated with hydrocarbon seeps along the faults. Dominant features in the southern portion of the Gulf of Mexico are the Campeche Escarpment and the Mexican Ridge, which consists of a series of valleys and ridges (Escobar-Briones et al. 2008).

3.0.3.3 Currents, Circulation Patterns, and Water Masses

To analyze the impact of Navy training and testing activities on marine resources (e.g., vegetation and animals) it is important to know where they occur in the Study Area. Some of the major factors that influence the distribution of marine resources are currents, circulation patterns, and water masses.

Prevailing winds and the Coriolis effect (the deflection of objects caused by the rotation of the earth) cause surface waters to move in a gyre, or circular fashion, in ocean basins. In the North Atlantic Ocean, this gyre system is composed of the Gulf Stream, North Atlantic, Canary, and Equatorial Currents. In the Gulf of Mexico, the Florida Current is a strong, east-northeast-flowing current that connects the Loop Current to the Gulf Stream at the entrance to the Florida Straits (Figure 3.0-10).

Surface currents are horizontal movements of water primarily driven by the drag of the wind over the sea surface. Wind-driven circulation affects the upper 100 m of the water column and therefore drives the circulation over continental shelves (Hunter et al. 2007). Surface currents of the Atlantic Ocean have an annual average mean velocity of 1.64 ft./s (0.5 m/s) and include equatorial currents, circumpolar currents, eastern boundary currents, and western boundary currents (Juliano and Alves 2007). Refer to Figure 3.0-10 and Table 3.0-5 for a depiction and description of the major surface currents in the Study Area. Eastern boundary currents are relatively shallow, broad, and slow-moving and travel toward the equator along the eastern boundaries of ocean basins. Western boundary currents are narrow, deep, and swift and are a result of the trade winds and the westerlies. In general, eastern boundary currents carry cold waters from higher latitudes to lower latitudes, and western boundary currents carry warm waters from lower latitudes to higher latitudes (Reverdin et al. 2003).

In the northern hemisphere, including the Study Area, the influence of the westerlies and the northeasterly trade winds on North Atlantic currents produce the eastward-flowing Subtropical Counter Current (Tomczak and Godfrey 2003). Subpolar gyres are also present in the North Atlantic as a result of the polar easterlies and the westerlies. In the North Atlantic, subpolar gyres rotate counterclockwise (Tomczak and Godfrey 2003).

The western continental margin of any ocean basin is the location of intense boundary currents; the Gulf Stream Current is the western boundary current found in the North Atlantic Ocean (Figure 3.0-10). The Gulf Stream Current is part of a larger current system called the Gulf Stream System that also includes the Loop Current in the Gulf of Mexico, the Florida Current in the Florida Straits, and the North Atlantic Current in the central North Atlantic Ocean. The Gulf Stream Current is a powerful surface current, carrying warm water into the cooler North Atlantic just south of the Northeast Range Complexes (Pickard and Emery 1990; Verity et al. 1993). In general, the Gulf Stream flows roughly parallel to the coastline from the Florida Straits to Cape Hatteras, where it is deflected away from the North American continent and flows northeastward.

The temperature and salinity of water determines its density; density differences cause water masses to move both vertically and horizontally in relation to one another. Cold, salty, dense water at the surface will sink, and warm, less saline water will rise. Density differences also drive the horizontal circulation of deep-water masses throughout ocean basins.

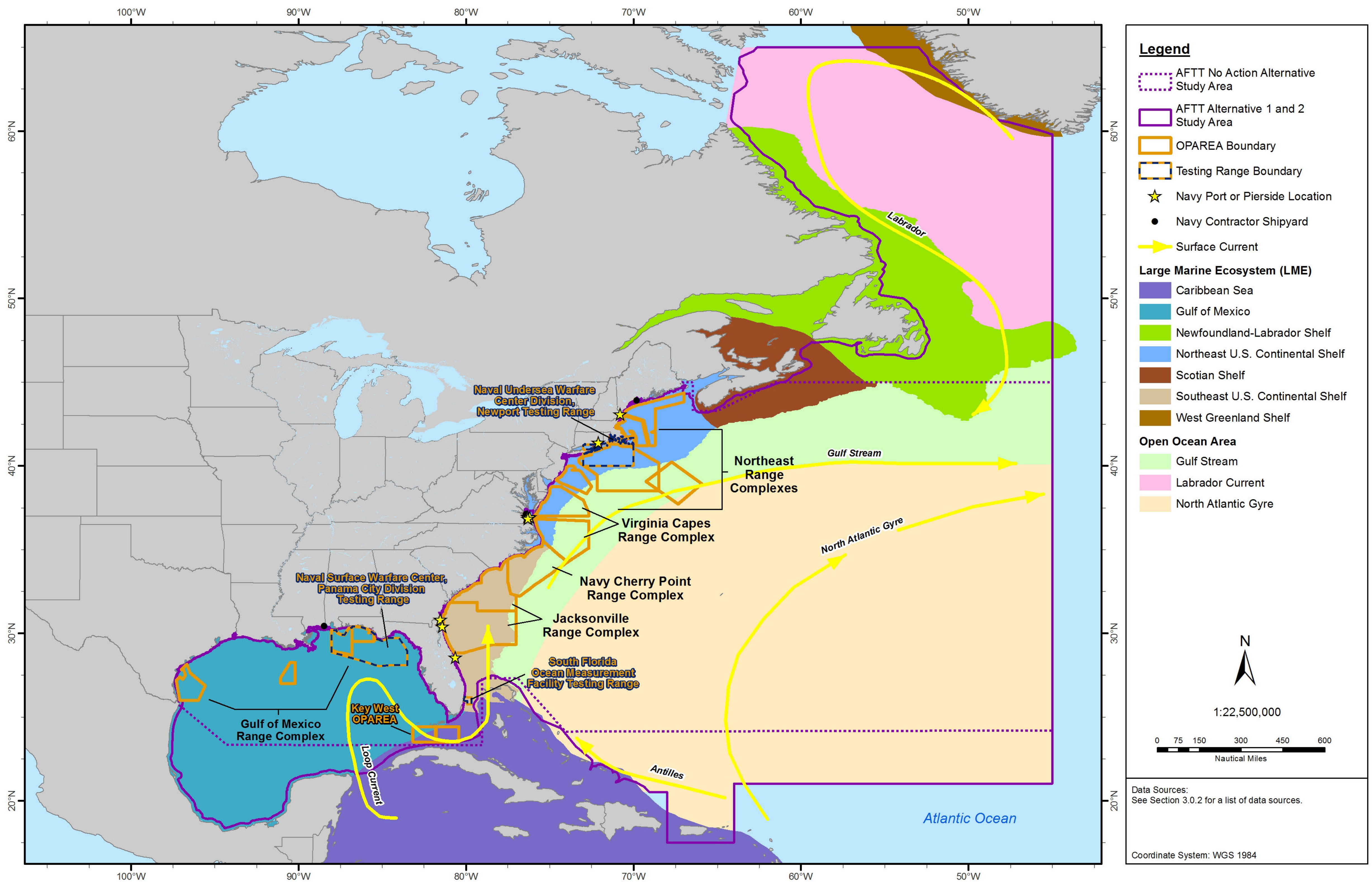

Figure 3.0-10: Major Currents in the Study Area

AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

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Table 3.0-5: Summary of Current Patterns in Areas Located Outside the Range Complexes

Component	Currents
Northeast U.S. Continental Shelf Large Marine Ecosystem	
Bath, ME	Riverine and tidal circulation patterns.
Portsmouth Naval Shipyard; Kittery, ME	
Naval Undersea Warfare Center Division, Newport Testing Range	Shallow water coastal currents generated by tidal action and wind. Currents are affected by open-ocean conditions as well as by tidal exchange and wind-generated currents in the estuaries.
Naval Submarine Base New London; Groton, CT	Riverine and tidal circulation patterns near mouth of estuary. Subject to the influence of larger open oceanic currents and circulation systems.
Newport News, VA	
Naval Station Norfolk; Norfolk, VA	
Joint Expeditionary Base Little Creek—Fort Story; Virginia Beach, VA	
Norfolk Naval Shipyard; Portsmouth, VA	
Southeast U.S. Continental Shelf Large Marine Ecosystem	
Naval Submarine Base Kings Bay; Kings Bay, GA	Riverine and tidal circulation patterns in middle part of estuary.
Naval Station Mayport, Jacksonville, FL	Riverine and tidal circulation patterns in the mouth of estuary inlet. Subject to the influence of larger open oceanic currents and circulation systems.
Port Canaveral, FL	Tidal mixing within shallow dredged channel, plus wind driven circulation.
Gulf of Mexico Large Marine Ecosystem	
Pascagoula, MS	Riverine and tidal circulation patterns in mouth of estuary/inlet. Offshore, near coastal areas subject to influence of larger open oceanic current/circulation.
Gulf of Mexico	The Louisiana coast current flows along the coast of the United States from the mouth of the Mississippi River to the western Gulf of Mexico. The Yucatan Current flows north, east, and west as it enters the Gulf of Mexico from the Caribbean Sea. The Loop Current originates as part of the Yucatan Current and spins in a clockwise direction and connects with the Florida Current from west to east through the Florida Straits. Warm and cold core eddy rings develop in the western half of the Gulf of Mexico between the Loop Current and the Texas/Mexico coast. Cold-core eddy rings develop off the Florida Current in the eastern Gulf.
Caribbean Sea Large Marine Ecosystem	
Other AFTT Areas (Outside the Range Complexes)	The Antilles Current flows southeast to northwest along the northern edge of the Turks and Caicos Islands and Bahama Islands. The Labrador Current flows south from Labrador Bay.
Labrador Current Open Ocean Area	
Other AFTT Areas (Outside the Range Complexes)	Labrador surface current and West Greenland surface current move water in a counter clockwise direction around the outer edges of the Labrador Sea. West Labrador surface current also moves water farther to the north. Portions of the deep North Atlantic Current return cold, more dense water back to the south, away from the Labrador Sea.

Source: (Stewart 2008)

CT: Connecticut; FL: Florida; GA: Georgia; ME: Maine; MS: Mississippi; VA: Virginia.

Thermohaline circulation—also called the ocean conveyor belt or meridional overturning—is the continuous horizontal circulation of water masses throughout the ocean. This cycle begins when dense waters sink and deep-water masses form. Deep-water masses form in the North Atlantic and Southern Oceans (Dickson and Brown 1994). North Atlantic Deep Water is formed in the Norwegian Sea between Iceland and Greenland. North Atlantic Deep Water is carried by the Deep Western Boundary Current along the western continental slope to join Antarctic Bottom Water (Dengler et al. 2004; Pickart 1992). At the surface, waters are heated and freshwater inputs result in lower salinity. As a result of density differences and higher sea levels in the Pacific Ocean and Indian Ocean, these surface water masses return to the Antarctic Ocean and North Atlantic Ocean. In the North Atlantic, these surface waters undergo evaporative cooling, which increases their densities, resulting in the sinking and formation of the North Atlantic Deep Water (Huang and Tiedemann 1998).

3.0.3.4 Ocean Fronts

The impacts of Navy training and testing activities are dependent on the intersection between where the marine resources and those activities occur. Ocean fronts are relevant to the analysis because they are characterized by increased productivity and biomass (e.g., marine vegetation and animals) (Bost et al. 2009). Fronts are the boundaries between two water masses with distinct temperatures or densities and are characterized by rapid changes in specific water properties over short distances. The Study Area is influenced by the Mid-Atlantic Bight (a curve in the coastline) shelf break front, the Gulf Stream front, and the Loop Current and Florida Current. As the Gulf Stream Current moves east from Cape Hatteras, North Carolina it carries warm equatorial waters into the cooler Atlantic Ocean. Cold water flowing north to south from coastal areas of the northeastern United States (as shown in Figure 3.0-10) converges with the warmer waters of the Gulf Stream off Cape Hatteras, creating a frontal system. These fronts can be depicted on maps that show the drastic changes in sea surface temperatures between water masses. Figure 3.0-11 shows the influence of ocean fronts on the sea surface temperatures of the Study Area.

A persistent feature that extends from the Mid-Atlantic Bight into New England waters is the front formed at the intersection of the continental shelf and slope. This front is biologically important and persists year-round. Phytoplankton (microscopic drifting plants) production is enhanced at this frontal boundary, often with twice the concentration of phytoplankton found in adjacent waters (Ryan et al. 1999).

North of Cape Hatteras, the Gulf Stream meanders in a wave-like fashion and becomes unstable. These instabilities in current flow lead to the pinching off of relatively warm or cool waters as either warm- or cold-core mesoscale eddies (Mann and Lazier 1996). Mesoscale eddies are large (54 to 108 nm wide) rotating water currents that separate from the main current. They cause cold, deep waters to rise to the surface (upwelling) or conversely, warm, surface waters to sink (downwelling), and consequently influence primary production (Sangrà et al. 2009) and facilitate the transfer of energy to higher trophic levels (Godø et al. 2012; Thompson et al. 2012). Warm-core eddies rotate clockwise (anticyclonic) and bring warm water and associated plankton (drifting organisms), including ichthyoplankton (fish eggs and larvae), to the colder areas of the northeast shelf. Cold-core eddies rotate counterclockwise (cyclonic) and deliver cold, nutrient-rich waters and plankton to the surface of the ocean. These types of mesoscale eddies form around the Gulf Stream and influence the sea surface temperature.

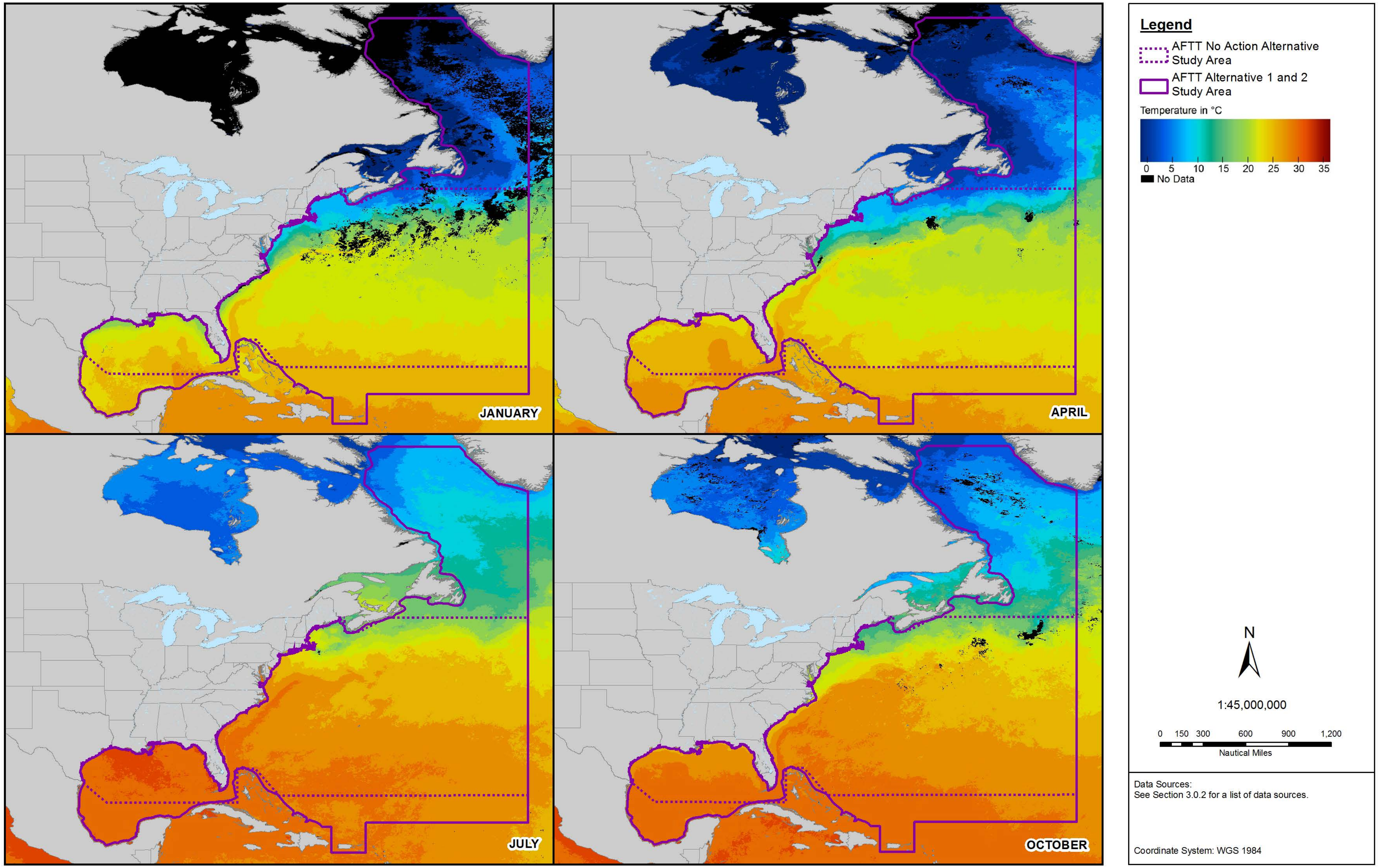

Figure 3.0-11: Sea Surface Temperature in the Study Area
AFTT: Atlantic Fleet Training and Testing

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Warm- and cold-core eddy rings develop in the western half of the Gulf of Mexico between the Loop Current and the Texas and Mexico coast. These eddies travel westward and southward in the Gulf (Elliot 1982; Gallaway et al. 2001; Hamilton 1990). The Loop Current and associated eddies are responsible for circulation in the deepest portions of the Gulf of Mexico (Hamilton 1990). Frontal eddies occur along the East Florida Shelf (Fiechter and Mooers 2003; Lee et al. 1992) when warm Florida Current front waters meander seaward beyond the shelf break, allowing colder slope waters to upwell onto the East Florida Shelf.

3.0.4 ACOUSTIC AND EXPLOSIVES PRIMER

This section introduces basic acoustic principles and terminology describing how sound travels or "propagates" in air and water. These terms and concepts are used when analyzing potential impacts due to acoustic sources and explosives used during naval testing and training. This section briefly explains the transmission of sound; introduces some of the basic mathematical formulas used to describe the transmission of sound; and defines acoustical terms, abbreviations, and units of measurement. Because seawater is a very efficient medium for the transmission of sound, the differences between transmission of sound in water and in air are discussed. Finally, it discusses the various sources of underwater sound, including physical, biological, and anthropogenic sounds.

3.0.4.1 Terminology/Glossary

Sound is an oscillation in pressure, particle displacement, or particle velocity, as well as the auditory sensation evoked by these oscillations, although not all sound waves evoke an auditory sensation (i.e., they are outside of an animal's hearing range) (American National Standards Institute 1994). Sound may be described in terms of both physical and subjective attributes. Physical attributes may be directly measured. Subjective (or sensory) attributes cannot be directly measured and require a listener to make a judgment about the sound. Physical attributes of a sound at a particular point are obtained by measuring pressure changes as sound waves pass. The following material provides a short description of some of the basic parameters of sound.

3.0.4.1.1 Particle Motion and Sound Pressure

Sound is produced when a medium (air or water in this analysis) is set into motion, often by a vibrating object within the medium. As the object vibrates, its motion is transmitted to adjacent particles of the medium. The motion of these particles is transmitted to adjacent particles, and so on. As the sound wave travels through the medium, the individual particles of the medium oscillate about their original positions but do not actually move with the sound wave. The result is a mechanical disturbance (the "sound wave") that propagates away from the source. The measurable properties of a sound are the pressure oscillations of the sound wave and the velocity, displacement amplitude, and direction of particle movements. The basic unit of sound pressure is the pascal (Pa) (1 Pa = 1.45×10^{-4} pounds per square inch), although the most commonly encountered unit is the micro Pa (μPa) (1 μPa = 1×10^{-6} Pa).

Animals with an eardrum or similar structure directly detect the pressure component of sound. Some marine fish also have specializations to detect pressure changes. Certain animals (e.g., most invertebrates and some marine fish) likely cannot detect sound pressure, only the particle motion component of sound. Because particle motion is most detectable near a sound source and at lower frequencies, this difference in acoustic energy sensing mechanisms limits the range at which these animals can detect most sound sources analyzed in this document.

3.0.4.1.2 Frequency

The number of oscillations or waves per second is called the frequency of the sound, and the metric is Hertz (Hz). One Hz is equal to one oscillation per second, and 1 kilohertz (kHz) is equal to 1,000 oscillations per second. The inverse of the frequency is the period or duration of one acoustic wave.

Frequency is the physical attribute most closely associated with the subjective attribute “pitch”; the higher the frequency, the higher the pitch. Human hearing generally spans the frequency range from 20 Hz to 20 kHz. The pitch based on these frequencies is subjectively “low” (at 20 Hz) or “high” (at 20 kHz).

Pure tones have a constant, single frequency. Complex tones contain multiple, discrete frequencies, rather than a single frequency. Broadband sounds are spread across many frequencies. The frequency range of a sound is called its bandwidth. A harmonic of a sound at a particular frequency is a multiple of that frequency (e.g., harmonic frequencies of a 2 kHz tone 4 kHz, 6 kHz, 8 kHz, etc.). A source operating at a nominal frequency may emit several harmonic frequencies at much lower sound pressure levels.

In this document, sounds are generally described as either low- (less than 1 kHz), mid- (1 kHz to 10 kHz), high- (greater than 10 kHz to 100 kHz), or very high- (greater than 100 kHz) frequency. Hearing ranges of marine animals (e.g., fish, birds, 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. Discussions of sound and potential impacts must therefore focus not only on the sound pressure, but the composite frequency of the sound and the species considered.

3.0.4.1.3 Duty Cycle

Duty cycle describes the portion of time that a sound source actually generates sound. It is defined as the percentage of the time during which a sound is generated over a total operational period. For example, if a sound navigation and ranging (sonar) source produces a one-second ping once every 10 seconds, the duty cycle is 10 percent. Duty cycles vary among different acoustic sources; in general, a low duty cycle is 20 percent or less and a high duty cycle is 80 percent or higher.

3.0.4.1.4 Categories of Sound

3.0.4.1.4.1 Signal versus Noise

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 echolocations, tones used in hearing experiments, and small sonobuoy explosions used for submarine detection.

Noise is undesired sound (American National Standards Institute 1994). Sounds produced by naval aircraft and vessel propulsion are considered noise because they represent possible inefficiencies and increased detectability, which are undesirable. Whether a sound is noise often depends on the receiver (i.e., the animal or system that detects the sound). For example, small explosives and 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.

Noise also refers to all sound sources that may interfere with detection of a signal (background noise) and the combination of all sounds at a particular location (ambient noise) (American National Standards Institute 1994).

3.0.4.1.4.2 Impulsive versus Non-Impulsive Sounds

Although no standard definitions exist, sounds may be broadly categorized as impulsive or non-impulsive. Impulsive sounds feature a very rapid increase to high pressures, followed by a rapid return to the static pressure. Impulsive sounds are often produced by processes involving a rapid release of energy or mechanical impacts (Hamernik and Hsueh 1991). Explosions, airgun detonations, and impact pile driving are examples of impulsive sound sources analyzed in this document. Non-impulsive sounds lack the rapid rise time and can have longer durations than impulsive sounds. Non-impulsive sound can be continuous or intermittent. Sonar pings, vessel noise, and underwater transponders are all examples of non-impulsive sound sources analyzed in this document.

3.0.4.1.4.3 Explosive Detonations

An explosive detonation generates a high-speed shock wave that rises almost instantaneously to a maximum pressure, then rapidly decays. At the instant of explosion, gas is instantaneously generated at high pressure and temperature, creating a bubble. In addition, the heat causes a certain amount of water to vaporize, adding to the volume of the bubble. This action immediately begins to force the water in contact with the blast front in an outward direction creating an intense pressure wave. This shock wave passes into the surrounding medium and travels faster than the speed of sound. The near-instantaneous rise from ambient to high pressures is what makes the shock wave potentially damaging. As the high pressure wave travels away from the source, it begins to slow and act like an acoustic wave similar to other impulsive sources that lack the strong shock wave (e.g., airguns). Noise associated with the blast is also transmitted into the surrounding medium as acoustic waves.

The peak pressure experienced by a receptor (i.e., an animal) is a function of the explosive material, the net explosive weight (the equivalent explosive energy expressed in weight of TNT), and the distance from the charge. The peak pressure is higher for larger charge weights at a given distance and decreases for increasing distances from a given charge. In general, shock wave effects near an explosive charge increase in proportion to the cube root of the explosive weight (Young 1991). For example, shock wave impacts will double when the explosive charge weight is increased by a factor of eight (i.e., cube root of eight equals two).

If the detonation occurs underwater and is not near the surface, gases released during the explosive chemical reaction form a bubble that pulsates as the gases expand and contract. These bubble pulsations create pressure waves that are weaker than the original shock wave but can still be damaging. If the detonation occurs at or just below the surface, a portion of the explosive power is released into the air and a pulsating gas bubble is not formed.

The detonation depth of an explosive is important because of the propagation effect known as surface-image interference. For underwater explosions near the sea surface, a distinct interference pattern arises from reflection from the water's surface. As the source depth or the source frequency decreases, these two paths increasingly, destructively interfere with each other, reaching total cancellation at the surface (barring surface reflection scattering loss). This effect can significantly reduce the peak pressures experienced near the water surface.

3.0.4.2 Sound Metrics

3.0.4.2.1 Pressure

Various sound pressure metrics are illustrated in Figure 3.0-12 for a hypothetical (a) pure tone (non-impulsive), and (b) an impulsive sound. Sound pressure varies differently with time for non-impulsive and impulsive sounds. As shown in the figure, the non-impulsive sound has a relatively gradual rise in pressure from static pressure (the ambient pressure without the added sound), while the impulsive sound has a near-instantaneous rise to a higher peak pressure. The peak pressure shown on both illustrations is the maximum absolute value of the instantaneous sound pressure during a specified time interval, which accounts for the values of peak pressures below the static pressure (American National Standards Institute 1994). Peak-to-peak pressure is the difference between the maximum and minimum sound pressures. The root mean square sound pressure is often used to describe the average pressure level of sounds. As the name suggests, this method takes the square root of the average squared sound pressure values over a time interval. The duration of this time interval can have a strong effect on the measured root mean square sound pressure for a given sound, especially where pressure levels vary significantly, as during an impulse. If the analysis duration includes a significant portion of the waveform after the impulse has ended and the pressure has returned to near static, the root mean square level would be relatively low. If the analysis duration includes the highest pressures of the impulse and excludes the portion of the waveform after the impulse has terminated, the root mean square level would be comparatively high. For this reason, it is important to specify the duration used to calculate the root mean square pressure for impulsive sounds.

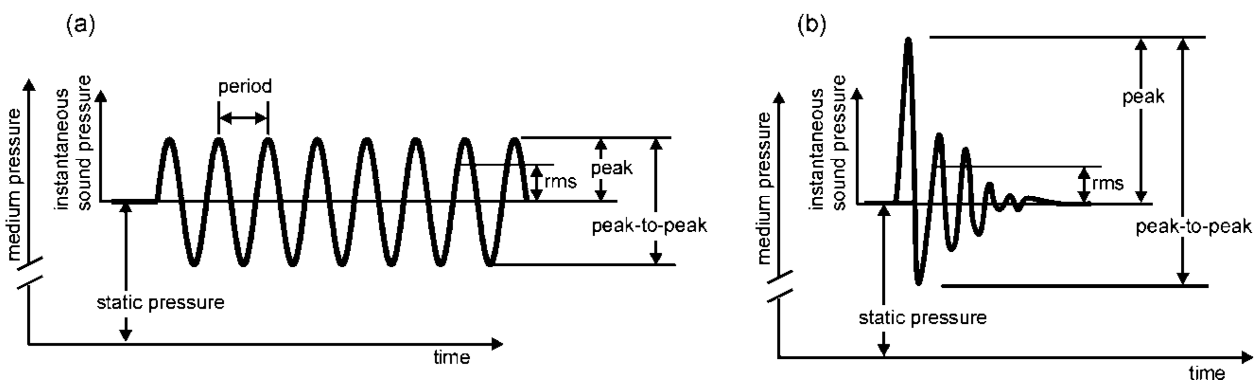

Figure 3.0-12: Various Sound Pressure Metrics for a Hypothetical (a) Pure Tone (Non-Impulsive) and (b) Impulsive Sound

3.0.4.2.1.1 Sound Pressure Level

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 pressure level is described by taking the logarithm of the ratio of the sound pressure to a reference pressure (American National Standards Institute 1994). Use of a logarithmic scale compresses the wide range of pressure values into a more usable numerical scale.

Sound levels are normally expressed in decibels (dB). To express a pressure X in decibels using a reference pressure X_{ref}, the equation is:

$$20\log_{10}\left(\frac{X}{X_{ref}}\right)$$

The pressure X is the root-mean-square value of the pressure. When a value is presented in decibels, it is important to specify the value and units of the reference pressure. Normally the decibel value is given, followed by the text "re," meaning "with reference to," and the value and unit of the reference pressure. The standard reference pressures are 1 µPa for water and 20 µPa for air (American National Standards Institute 1994). It is important to note that, because of the difference in reference units between air and water, the same absolute pressures would result in different decibel values for each medium.

3.0.4.2.1.2 Sound Exposure Level

When analyzing effects on marine animals from multiple moderate-level sounds, it is necessary to have a metric that quantifies cumulative exposures (American National Standards Institute 1994). The sound exposure level can be thought of as a composite metric that represents both the intensity of a sound and its duration. Individual time-varying noise events (e.g., a series of sonar pings) have two main characteristics: (1) a sound level that changes throughout the event and (2) a period of time during which the event is heard. Cumulative sound exposure level provides a measure of the net impact of the entire acoustic event, but it does not directly represent the sound level heard at any given time. Sound exposure level is determined by calculating the decibel level of the cumulative sum-of-squared pressures over the duration of a sound, with units of dB re 1 micro pascal-squared seconds (μPa^2-s) for sounds in water.

Some rules of thumb for sound exposure level are as follows:

- The numeric value of sound exposure level is equal to the sound pressure level of a one-second sound that has the same total energy as the exposure event. If the sound duration is one second, sound pressure level and sound exposure level have the same numeric value (but not the same reference quantities). For example, a one-second sound with a sound pressure level of 100 dB re 1 µPa has a sound exposure level of 100 dB re 1 squared micro pascal-second (μPa^2-s).
- If the sound duration is constant but the sound pressure level changes, sound exposure level will change by the same number of decibels as the sound pressure level.
- If the sound pressure level is held constant and the duration (T) changes, sound exposure level will change as a function of $10\log_{10}(T)$:
  - $10\log_{10}(10) = 10$, so increasing duration by a factor of 10 raises sound exposure level by 10 dB.
  - $10\log_{10}(0.1) = -10$, so decreasing duration by a factor of 10 lowers sound exposure level by 10 dB.
  - Since $10\log_{10}(2) \approx 3$, doubling the duration increases sound exposure level by 3 dB.
  - $10\log_{10}(1/2) \approx -3$, so halving the duration lowers sound exposure level by 3 dB.

Figure 3.0-13 illustrates the summation of energy for a succession of sonar pings. In this hypothetical case, each ping has the same duration and sound pressure level. The sound exposure level at a particular location from each individual ping is 100 dB re 1 μPa^2-s (red circles). The upper, blue curve shows the running total or cumulative sound exposure level.

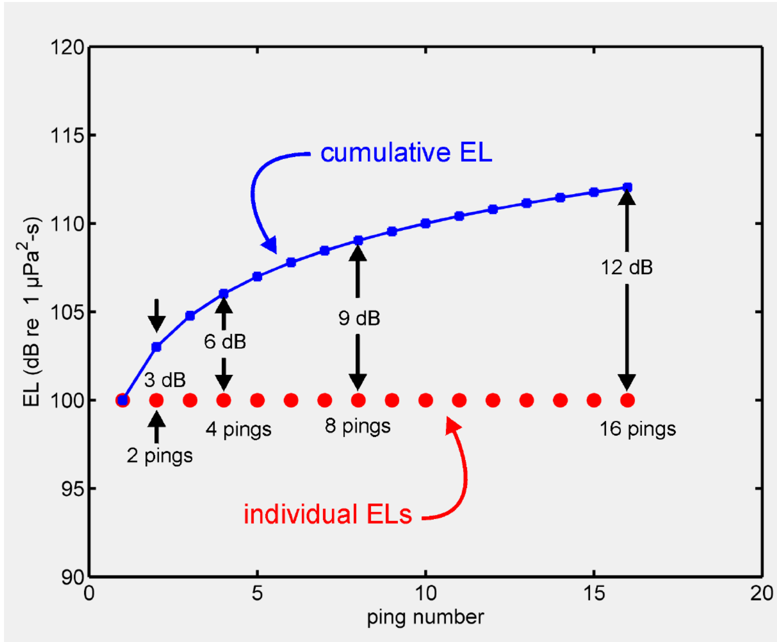

Figure 3.0-13: Summation of Acoustic Energy (Cumulative Exposure Level, or Sound Exposure Level) from a Hypothetical, Intermittently Pinging, Stationary Sound Source (EL = Exposure Level)

After the first ping, the cumulative sound exposure level is 100 dB re 1 µPa^2-s. Since each ping has the same duration and sound pressure level, receiving two pings is the same as receiving a single ping with twice the duration. The cumulative sound exposure level from two pings is therefore 103 dB re 1 µPa^2-s. The cumulative sound exposure level from four pings is 3 dB higher than the cumulative sound exposure level from two pings, or 106 dB re 1 µPa^2-s. Each doubling of the number of pings increases the cumulative sound exposure level by 3 dB.

Figure 3.0-14 shows a more realistic example where the individual pings do not have the same sound pressure level or sound exposure level. These data were recorded from a stationary hydrophone as a sound source approached, passed, and moved away from the hydrophone. As the source approached the hydrophone, the received sound pressure level from each ping increased, causing the sound exposure level of each ping to increase. After the source passed the hydrophone, the received sound pressure level and sound exposure level from each ping decreased as the source moved farther away (downward trend of red line), although the cumulative sound exposure level increased with each additional ping received (slight upward trend of blue line). The main contributions are from those pings with the highest individual sound exposure levels. Individual pings with sound exposure levels 10 dB or more below the ping with the highest level contribute little (less than 0.5 dB) to the total cumulative sound exposure level. This is shown in Figure 3.0-14 where only a small error is introduced by summing the energy from the eight individual pings with sound exposure level greater than 185 dB re 1 µPa^2-s (black line), as opposed to including all pings (blue line).

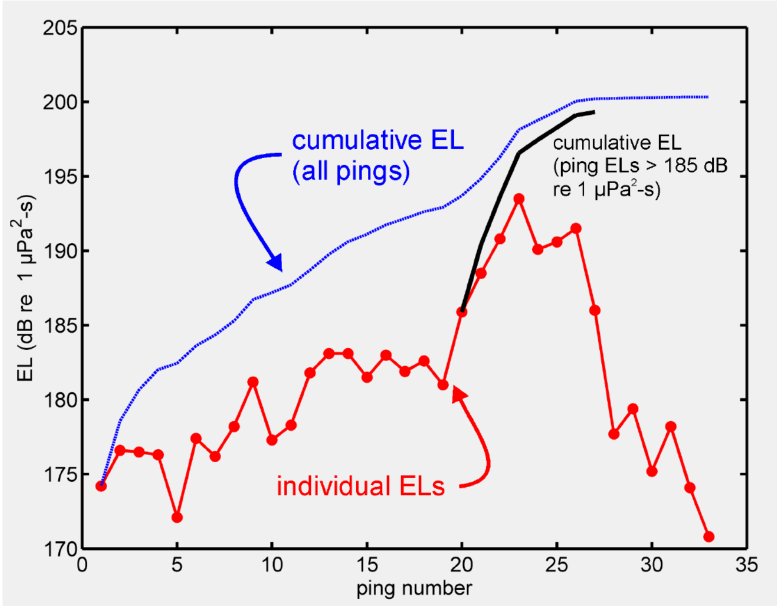

Figure 3.0-14: Cumulative Sound Exposure Level under Realistic Conditions with a Moving, Intermittently Pinging Sound Source (Cumulative Exposure Level = Sound Exposure Level)

3.0.4.2.1.3 Impulse (Pa-s)

Impulse is a metric used to describe the pressure and time component of an intense shock wave from an explosive source. The impulse calculation takes into account the magnitude and duration of the initial peak positive pressure, which is the portion of an impulsive sound most likely to be associated with damage. Specifically, impulse is the time integral of the initial peak positive pressure with units pascal-seconds (Pa-s). The peak positive pressure for an impulsive sound is shown in Figure 3.0-12b as the first and largest pressure peak above static pressure. This metric is used to assess potential injurious effects from explosives.

3.0.4.3 Loudness and Auditory Weighting Functions

Animals, including humans, are not equally sensitive to sounds across their entire hearing range. The subjective judgment of a sound level by a receiver such as an animal is known as loudness. Two sounds received at the same sound pressure level (an objective measurement), but at two different frequencies, may be perceived by an animal at two different loudness levels depending on its hearing sensitivity (lowest sound pressure level at which a sound is first audible) at the two different frequencies. Furthermore, two different species may judge the relative loudness of the two sounds differently.

Auditory weighting functions are a method common in human hearing risk analysis to account for differences in hearing sensitivity at various frequencies. This concept can be applied to other species as well. 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. A-weighted sound levels, often seen in units of “dBA,” (A-weighted decibels) are frequency-weighted to account for the sensitivity of the human ear to a barely audible sound. Many measurements of sound in air appear as A-weighted decibels in the literature because the intent of the authors is often to assess noise impacts on humans.

3.0.4.4 Predicting How Sound Travels

Sounds are produced throughout a wide range of frequencies, including frequencies beyond the audible range of a given receptor. Most sounds heard in the environment do not consist of a single frequency, but rather a broad band of frequencies differing in sound level. The intensities of each frequency add to generate perceptible sound.

The speed of sound is not affected by its intensity, amplitude, or frequency, but rather depends wholly on characteristics of the medium through which it is passing. Sound generally travels faster as the density of the medium increases. Speeds of sound through air are primarily influenced by air temperature, relative humidity, and pressure, averaging about 1,115 ft./s (340 m/s) at standard barometric pressure. Sound speeds in air increase as air temperature increases. Sound travels differently in the water than in air because seawater is a very efficient medium for the transmission of sound. Sound moves at a faster speed in water, about 4,921 ft./s (1,500 m/s). The speed of sound through water is influenced by temperature, pressure, and salinity because sound travels faster as any of these parameters increase.

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. As spherical propagation continues, the sound energy is distributed over an ever-larger area following the inverse square law: the intensity 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 intensity of the sound of one-fourth of its initial value; tripling the distance results in one-ninth of the original intensity, and so on (Figure 3.0-15). As expected, sound intensity drops at increasing distance from the point source. In spherical propagation, sound pressure levels drop an average of 6 dB for every doubling of distance from the source.

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 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 (Marine Species Modeling Team 2013).

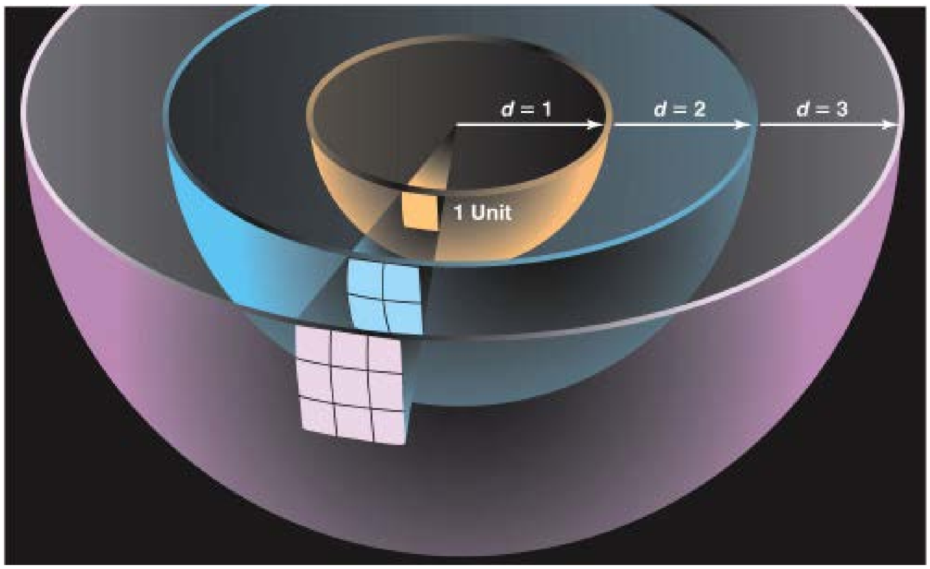

Figure 3.0-15: Graphical Representation of the Inverse-Square Relationship in Spherical Spreading

3.0.4.4.1 Sound Attenuation and Transmission Loss

As a sound wave passes through a medium, the intensity decreases with distance from the sound source. This phenomenon is known as attenuation or propagation loss. Sound attenuation may be described in terms of transmission loss (TL). The units of transmission loss are dB. The transmission loss is used to relate the source level (SL), defined as the sound pressure level produced by a sound source at a distance of 1 m, and the received level (RL) at a particular location, as follows:

$$RL = SL - TL.$$

The main contributors to sound attenuation are as follows:

- Geometrical spreading of the sound wave as it propagates away from the source
- Sound absorption (conversion of sound energy into heat)
- Scattering, diffraction, multipath interference, boundary effects
- Other nongeometrical effects (Urick 1983).

3.0.4.4.1.1 Spreading Loss

Spreading loss or divergence loss is a geometrical effect representing regular weakening of a sound wave as it spreads out from a source (Campbell et al. 1988). 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.

As described before, a point sound source in a homogeneous medium without boundaries will radiate spherical waves—the acoustic energy spreads out from the source in the form of a spherical shell. As the distance from the source increases, the shell surface area increases. If the sound power is fixed, the sound intensity must decrease with distance from the source (intensity is power per unit area). The surface area of a sphere is $4\pi r^2$, where r is the sphere radius, so the change in intensity is proportional to the radius squared. This relationship is known as the spherical spreading law. The transmission loss for spherical spreading is:

$$TL = 20\log_{10}r$$

where *r* is the distance from the source. This is equivalent to a 6 dB reduction in sound pressure level for each doubling of distance from the sound source. For example, calculated transmission loss for spherical spreading is 40 dB at 100 m and 46 dB at 200 m.

In cylindrical spreading, spherical waves expanding from the source are constrained by the water surface and the seafloor 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:

$$TL = 10\log_{10}r$$

Cylindrical spreading is an approximation to wave propagation in a water-filled channel with horizontal dimensions much larger than the depth. Cylindrical spreading predicts a 3 dB reduction in sound pressure level for each doubling of distance from the source. For example, calculated transmission loss for cylindrical spreading is 20 dB at 100 m and 23 dB at 200 m.

3.0.4.4.1.2 Reflection and Refraction

When a sound wave propagating in a medium encounters a second medium with a different density or sound speed (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). If the second medium has a different sound speed than the first, 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 sound speed varies in the medium.

Refraction of sound resulting from spatial variations in the sound speed is one of the most important phenomena that affects sound propagation in water (Urick 1983). The sound speed in the ocean primarily depends on hydrostatic pressure (i.e., depth) and temperature. Sound speed increases with both hydrostatic pressure and temperature. In seawater, temperature has the most important effect on sound speed for depths less than about 300 m. Below 1,500 m, the 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 speed profile.

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 deep 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 shipping noise. The deep sound channel or Sound Frequency and Ranging channel is another duct that exists where sound speeds are lowest in the water column (600 m–1,200 m depth at the mid-latitudes). Intense low-frequency underwater sounds, such as explosions, can be detected halfway around the world from their source via the Sound Frequency and Ranging channel (Baggeroer and Munk 1992).

3.0.4.4.1.3 Diffraction, Scattering, and Reverberation

Sound waves experience diffraction in much the same manner as light waves. Diffraction may be thought of as the bending of a sound wave around an obstacle. Common examples 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, or gas bubbles) in the path of a sound wave causes scattering if secondary sound spreads out from it in a variety of directions (Pierce 1989). Scattering is similar to diffraction. Normally diffraction is used to describe sound bending or scattering from a single object, and scattering is used when there are multiple objects. Reverberation, or echo, refers to the prolongation of a sound that occurs when sound waves in an enclosed space are repeatedly reflected from the boundaries defining the space, even after the source has stopped emitting.

3.0.4.4.1.4 Multipath Propagation

In multipath propagation, sound may not only travel a direct path from a source to a receiver, but also be reflected from the surface or bottom multiple times before reaching the receiver (Urick 1983). 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. A special case of multipath propagation loss is called the Lloyd mirror effect, where the sound field near the water's surface reaches a minimum because of the destructive interference (cancellation) between the direct sound wave and the sound wave being reflected from the surface. This can cause the sound level to decrease dramatically within the top few meters of the water column.

3.0.4.4.1.5 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.

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 and sound speed. The Lloyd mirror effect may also be observed from sound sources located near the sea bottom. 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, resulting in an increased sound pressure near the sea bottom.

3.0.4.4.2 Air-Water Interface

Sound from aerial sources, such as aircraft, muzzle blasts, and projectile sonic booms, can be transmitted into the water. 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 section above.

Transmission of sound from a moving airborne source to a receptor underwater is influenced by numerous factors and has been addressed by Urick (1983), Young (1973), 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.

Airborne sound is refracted upon transmission into water because sound waves move faster through water than through air (a ratio of about 0.23:1). Based on this difference, the direct sound path is reflected if the sound reaches the surface at an angle more than 13 degrees from vertical. As a result, most of the acoustic energy transmitted into the water from an aircraft arrives through a relatively narrow cone extending vertically downward from the aircraft (Figure 3.0-16). The intersection of this cone with the surface traces a "footprint" directly beneath the flight path, with the width of the footprint being a function of aircraft altitude. Sound may enter the water outside of this cone due to surface scattering and as evanescent waves, which travel laterally near the water surface.

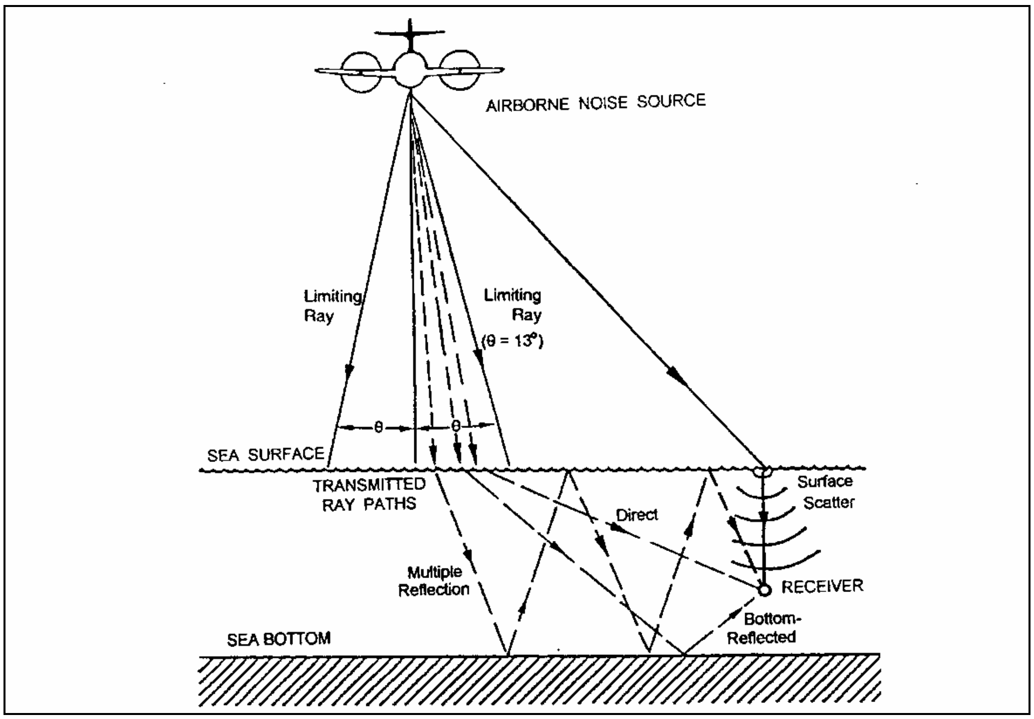

Figure 3.0-16: Characteristics of Sound Transmission through the Air-Water Interface
(Richardson et al. 1995)

The sound pressure field is actually doubled (+6 dB) at the air-to-water interface because of the large difference in the acoustic properties of water and air. For example, an airborne sound with a sound pressure level of 100 dB re 1 µPa at the sea surface becomes 106 dB re 1 µPa just below the surface. The pressure and sound levels then decrease with increasing distance as they would for any other in-water noise.

3.0.4.4.3 Sonic Booms

A sonic boom occurs when an object, such as an aircraft or projectile, exceeds the speed of sound (referred to as supersonic flight). When an object exceeds the speed of sound, air molecules are pushed aside with great force, forming a shock front much like a boat creates a bow wave. Supersonic aircraft can generate two shock fronts. One is immediately in front of the aircraft; the other is immediately behind it. These shock fronts "push" a sharply defined surge in air pressure in front of them, creating a sonic boom consisting of two very closely spaced impulses. The two impulses are usually heard as a single sonic boom.

Sonic booms differ from most other sounds because they are impulsive, there is no warning of their impending occurrence, and the peak levels of a sonic boom are higher than those for most other types of airborne noise. Although objects exceeding the speed of sound always create a sonic boom, not all sonic booms are heard near the water or ground surface. As altitude increases, air temperature normally decreases, and these layers of temperature change cause the shock front to be turned upward as it travels toward the ground. Depending on the altitude of the aircraft and its speed, the shock fronts of many sonic booms are bent upward sufficiently that they never reach the ground. This same phenomenon also acts to limit the width (area covered) of those sonic booms that actually do reach the ground.

3.0.4.5 Ambient Noise

Ambient noise is the collection of ever-present sounds of both natural and man-made origin. Ambient noise in the ocean comprises sound generated by natural physical, natural biological, and anthropogenic (human-generated) sources (Figure 3.0-17). Preindustrial physical and biological noise sources in marine environments were often not high enough to interfere with the hearing of marine animals (Richardson et al. 1995). However, the increase in anthropogenic noise sources in recent times is a concern.

Except for some sounds generated by marine mammals, most natural ocean sound is broadband (composed of a spectrum of numerous frequencies). Virtually the entire frequency spectrum is represented in ambient sound sources as shown in Figure 3.0-17 (National Research Council 2003 adapted from Wenz 1962). Earthquakes and explosions produce sound signals from 1 Hz to 100 Hz; marine species can produce signals from 100 Hz to more than 10,000 Hz; and commercial shipping, industrial activities, and naval ships have signals between 10 Hz and 10,000 Hz (Figure 3.0-17). Spray and bubbles associated with breaking waves are the major contributors to the ambient sound in the 500 Hz to 100,000 Hz range. At frequencies greater than 100,000 Hz, "thermal noise" caused by the random motion of water molecules is the primary source. Ambient sources, especially from wave and tidal action, can cause coastal environments to have particularly high ambient sound levels.

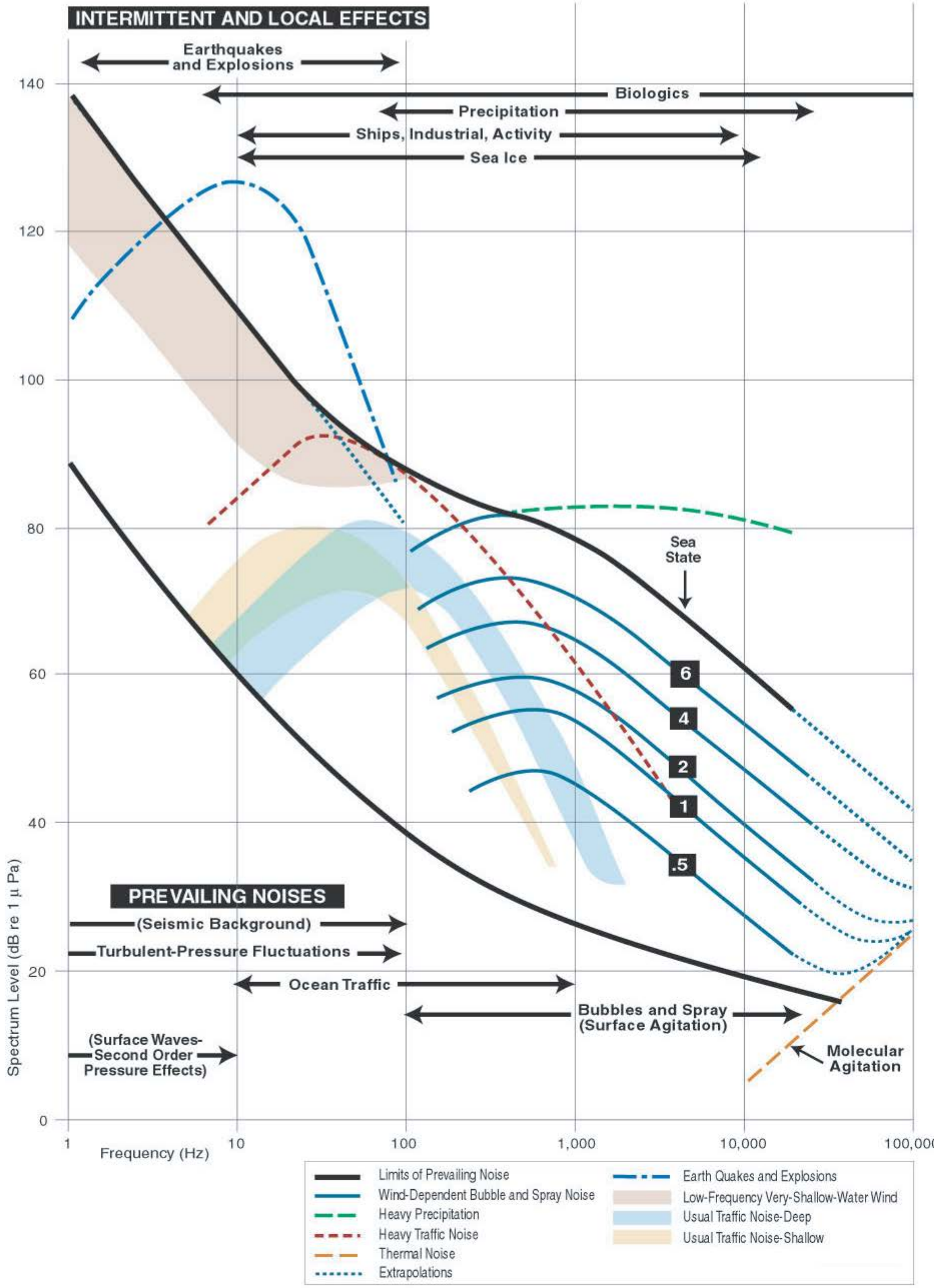

Figure 3.0-17: Oceanic Ambient Noise Levels from 1 Hz to 100,000 Hz, Including Frequency Ranges for Prevalent Noise Sources

From National Research Council (2003), adapted from Wenz (1964)

3.0.4.6 Underwater Sounds

Physical, biological, and anthropogenic sounds all contribute to the ambient underwater noise environment. Example source levels for various underwater sounds are shown in Table 3.0-6. Many naturally occurring sounds have source levels similar to anthropogenic sounds.

Table 3.0-6: Representative Source Levels of Common Underwater Sounds

Source	Source Level (dB re 1 µPa at 1 m)
Icebreaker Ship	193[1]
Large Tanker	186[1]
Seismic Airgun Array (32 guns)	259 (peak)[1]
Dolphin Whistles	125–173[1]
Dolphin Clicks	194–219[2]
Humpback Whale Song	144–174[3]
Snapping Shrimp	183–189[4]
Sperm Whale Click	236[5]
Naval Mid-Frequency Active Sonar (SQS-53)	235
Lightning Strike	260[6]
Seafloor Volcanic Eruption	255[7]

[1] (Richardson et al. 1995), [2] (Rasmussen et al. 2002), [3] (Payne and Payne 1985; Thompson et al. 1979), [4] (Au and Banks 1998), [5] (Levenson 1974; Watkins 1980), [6] (Hill 1985),[7] (Northrop 1974)

3.0.4.6.1 Physical Sources of Underwater Sound

Physical processes that create sound in the ocean include rain, wind, waves, sea ice, lightning strikes at the sea surface, undersea earthquakes, and eruptions from undersea volcanoes. Generally, these sound sources contribute to a rise in the ambient sound levels on an intermittent basis. Underwater sound from rain typically is between 1 and 10 kHz. Wind produces frequencies between 100 Hz and 30 kHz, while wave-generated sound is a significant contributor in the infrasonic range (i.e., 1 to 20 Hz) (Simmonds et al. 2003). Seismic activity results in the production of low-frequency sounds that can be heard for great distances.

3.0.4.6.2 Biological Sources of Underwater Sound

Marine animals use sound both passively and actively to navigate, communicate, locate food, reproduce, and detect predators and other important environmental cues. Sounds produced by marine species can increase ambient sound levels by nearly 20 dB over the range of a few kHz (e.g., crustaceans and fish) or over the range of tens to hundreds of kHz (e.g., dolphin clicks and whistles). For example, reproductive activity, including courtship and spawning, accounts for the majority of sounds produced by fish. During the spawning season, croakers (family Sciaenidae) vocalize for many hours and often dominate the acoustic environment (Ramcharitar et al. 2006). Other species, including baleen whales (Mysticetes) and toothed whales and dolphins (Odontocetes) produce a wide variety of sounds in many different behavioral contexts. These sounds can include tonal calls, clicks, whistles, and pulsed sounds, which cover a wide range of frequencies depending on the species and sound type produced. For instance, bottlenose dolphin clicks and whistles have a dominant frequency range of 110 to 130 kHz and 3.5 to 14.5 kHz, respectively (Au 1993). In addition, sperm whale clicks range in frequency from 0.1 kHz to 30 kHz, with dominant energy in two bands (2 to 4 kHz and 10 to 16 kHz) (Richardson et al. 1995). Blue and fin whales produce low-frequency moans at frequencies of 10 to 25 Hz. Colonies of snapping shrimp can generate sounds at frequencies of 2 to 15 kHz.

3.0.4.6.3 Anthropogenic Sources of Underwater Sound

In addition to sounds generated during Navy training and testing, anthropogenic (human-generated) sound is introduced into the ocean by a number of sources, including non-military vessel traffic, industrial operations onshore (pile driving), seismic profiling for oil exploration, oil drilling, and underwater explosions. Noise levels resulting from human activities in coastal and offshore areas are increasing; however, there are few historical records of ambient noise data to substantiate the level of increase. Some studies have documented increases in ambient noise off California over the last several decades (Andrew et al. 2002; McDonald et al. 2006; McDonald et al. 2008).

Commercial shipping is the most widespread source of human-made, low-frequency (0 to 1,000 Hz) noise in the oceans and may contribute more than 75 percent of all human-made sound in the sea (International Council for the Exploration of the Sea 2005), particularly in coastal areas and near shipping lanes (see Figure 3.11-3 for commercial shipping lanes in the Study Area). There are approximately 20,000 large commercial vessels at sea worldwide at any given time. Because low-frequency sounds carry for long distances, a large vessel can be detected 75 to 250 nm away (Polefka 2004). The dominant component of low-frequency ambient noise is commercial tankers, which contribute twice as much noise as cargo vessels and at least 100 times as much noise as research vessels (Hatch et al. 2008). Most of these sounds are produced as a result of propeller cavitation (when air spaces created by the motion of propellers collapse) (Southall et al. 2007).

High-intensity, low-frequency impulsive sounds are emitted during seismic surveys to determine the structure and composition of the geological formations below the sea bed to identify potential hydrocarbon reservoirs (i.e., oil and gas exploration) (Simmonds et al. 2003).

3.0.4.7 Aerial Sounds

Aerial sounds may be produced by physical, biological, or anthropogenic sources. These sounds may be transmitted across the air-water interface as well. Of the physical sources of sound, surf noise is one of the most dominant. The highest sound levels from surf are typically low frequency (below 100 Hz). Biological sources of sound can be a significant contribution to the noise level in coastal environments such as areas occupied by highly vocal sea lions. Anthropogenic noise sources like ships, industrial sites, cars, and airplanes are also potential contributors.

3.0.5 Overall Approach to Analysis

The overall approach to analysis in this EIS/OEIS included the following general steps:

- Identification of resources for analysis
- Resource-specific impacts analysis for individual stressors
- Resource-specific impacts analysis for multiple stressors
- Examination of potential population-level impacts
- Cumulative impacts analysis
- Consideration of mitigations to reduce identified potential impacts

Navy training and testing activities in the Proposed Action may create one or more stimuli that cause stress on a resource. Each proposed Navy activity was examined to determine its potential stressors (Table 3.0-7). Not all stressors affect every resource, nor do all proposed Navy activities produce all stressors (Table 3.0-8). The potential direct, indirect, and cumulative impacts of the Proposed Action were analyzed based on these potential stressors being present with the resource. 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 marine animals and public health and safety.

First, a preliminary analysis was conducted to determine the environmental resources potentially impacted and associated 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 physical, socioeconomic, or cultural resources. 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). Mitigation measures are discussed in detail in Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring).

In this phased 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. Each step is described in more detail below.

3.0.5.1 Resources and Issues Evaluated

Physical resources and issues evaluated include marine sediments, marine water quality, and air quality. Biological resources (including threatened and endangered species) evaluated include marine habitats, marine mammals, sea turtles and other marine reptiles, birds, marine vegetation, marine invertebrates, and fish. Human resources evaluated in this EIS/OEIS include cultural resources, socioeconomics, and public health and safety.

3.0.5.2 Resources and Issues Eliminated from Further Consideration

Resources and issues considered but not carried forward for further consideration include land use, demographics, environmental justice, and children’s health and safety. Land use was eliminated from further consideration because the offshore activities in the Proposed Action would not be relevant to land use issues and no new actions are being proposed that would include relevant land use. Demographics were eliminated from further consideration because implementation of the Proposed Action would not result in a change in the demographics within the Study Area of the counties of the coastal states that abut the Study Area. EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, was eliminated as an issue for further consideration because there were no disproportionately high and adverse human health or environmental impacts from the Proposed Action on minority populations and low-income populations. Similarly, EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, was eliminated as an issue for further consideration because there were no child protection concerns identified from implementation of the Proposed Action.

Table 3.0-7: List of Stressors Analyzed

Components and Stressors for Physical Resources
Sediments and Water Quality • Explosives and explosion byproducts • Metals • Chemicals other than explosives • Other materials
Air Quality • Criteria pollutants • Hazardous air pollutants
Components and Stressors for Biological Resources
Acoustic Stressors • Sonar and other active sources • Explosives • Pile driving • Swimmer defense airguns • Weapons firing noise • Vessel noise • Aircraft noise
Energy Stressors • Electromagnetic devices • High energy lasers
Physical Disturbance and Strike Stressors • Vessels • In-water devices • Aircraft and aerial targets • Military expended materials • Seafloor devices
Entanglement Stressors • Fiber optic cables and guidance wires • Parachutes
Ingestion Stressors • Military expended materials from munitions • Military expended materials other than munitions
Secondary Stressors • Habitat (sediments and water quality; air quality) • Prey
Components and Stressors for Human Resources
Cultural Resources Stressors • Acoustic • Physical disturbance
Socioeconomic Stressors • Accessibility • Airborne acoustics • Physical disturbance and strikes • Secondary impacts from availability of resources
Public Health and Safety Stressors • Underwater energy • In-air energy • Physical interactions • Secondary stressors (sediments and water quality)

Table 3.0-8: Stressors by Warfare and Testing Area

Warfare Area/Testing Area	Acoustic Stressors	Energy Stressors	Physical Disturbance and Strike Stressors	Entanglement Stressors	Ingestion Stressors	Accessibility	Underwater Energy	In-Air Energy	Physical Interactions	Secondary Stressors	
										Sediments and Water Quality	Air Quality
Training Activities											
Anti-Air Warfare	✓		✓	✓	✓	✓		✓	✓	✓	✓
Amphibious Warfare	✓		✓		✓	✓			✓	✓	✓
Strike Warfare	✓		✓		✓	✓		✓	✓	✓	✓
Anti-Surface Warfare	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Anti-Submarine Warfare	✓		✓	✓	✓	✓	✓		✓	✓	✓
Electronic Warfare	✓		✓		✓			✓	✓	✓	✓
Mine Warfare	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Major Exercises	✓		✓	✓	✓	✓	✓		✓	✓	✓
Other Training Activities	✓		✓		✓	✓	✓		✓	✓	✓
Testing Activities											
Anti-Air Warfare	✓		✓	✓	✓	✓		✓	✓	✓	✓
Anti-Surface Warfare	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Electronic Warfare	✓		✓		✓				✓	✓	✓
Anti-Submarine Warfare	✓		✓	✓	✓	✓	✓		✓	✓	✓
Mine Warfare	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
New Ship Construction	✓		✓	✓	✓	✓	✓		✓	✓	✓
Shock Trials	✓		✓		✓	✓	✓		✓	✓	✓
Life Cycle Activities	✓		✓	✓	✓	✓	✓		✓	✓	✓
Naval Surface Warfare Center Panama City Activities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Naval Undersea Warfare Center Division, Newport Testing Range Activities	✓		✓	✓		✓	✓		✓		✓
South Florida Ocean Measurement Facility Activities	✓	✓	✓			✓	✓	✓	✓		✓
Anti-Surface/Anti-Submarine Warfare Testing	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Mine Warfare Testing	✓	✓	✓		✓	✓	✓		✓	✓	✓
Shipboard Protections Systems and Swimmer Defense Testing	✓		✓		✓	✓	✓		✓	✓	✓
Unmanned Vehicle Testing	✓		✓		✓	✓	✓		✓	✓	✓
Other Testing Activities	✓		✓			✓	✓		✓	✓	✓
Martha's Vineyard Coastal Observatory Acoustic Communications Experiment	✓					✓	✓		✓		
Sediment Acoustics	✓					✓	✓		✓		
Northwestlant Tomography Experiment	✓					✓	✓		✓		
East Coast Shallow Water Experiment	✓					✓	✓		✓		

3.0.5.3 Identification of Stressors for Analysis

The proposed training and testing activities were evaluated to identify specific components that could act as stressors (Table 3.0-7) by having direct or indirect impacts on the environment. This analysis included identification of the spatial variation of the identified stressors. The warfare and testing areas along with their associated environmental stressors are identified in Table 3.0-8. Matrices were prepared to identify associations between stressors, resources, training and testing activities, warfare and testing areas, range complexes, and alternatives. The following subsections describe the environmental stressors for biological resources in more detail. Each description contains a list of activities in which the stressor may occur. Refer to Appendix F (Training and Testing Activities Matrices) for more information on stressors associated with each training and testing activity. Resources that may occur or are known to occur within the Study Area and that may be exposed to the identified stressors are also listed in Appendix F (Training and Testing Activities Matrices). Stressors for physical resources (sediments and water quality, air quality) and human resources (cultural resources, socioeconomic resources, and public health and safety) are described in their respective sections of Chapter 3 (Affected Environment and Environmental Consequences).

A preliminary analysis identified the stressor/resource interactions that warrant further analysis in the EIS/OEIS based on scoping, previous NEPA analyses, and opinions of subject matter experts. Stressor/resource interactions that were determined to have negligible or no impacts were not carried forward for analysis in the EIS/OEIS.

3.0.5.3.1 Acoustic Stressors

This section describes the characteristics of sounds produced during naval training and testing and the relative magnitude and location of these sound-producing activities. This provides the basis for analysis of acoustic and explosive impacts on resources in the remainder of Chapter 3 (Affected Environment and Environmental Consequences). For additional details on the properties of sound and explosives, see Section 3.0.4 (Acoustic and Explosives Primer).

3.0.5.3.1.1 Sonar and Other Active Acoustic Sources

Sonar and other non-impulsive sound sources emit sound waves into the water to detect objects, safely navigate, and communicate. Most systems operate within specific frequencies (although some harmonic frequencies may be emitted at lower sound pressure levels). Sonar use associated with anti-submarine warfare would emit the most non-impulsive sound underwater during training and testing activities. Sonar use associated with mine warfare would also contribute a notable portion of overall non-impulsive sound. Other sources of non-impulsive sound include acoustic communications, sonar used in navigation, and other sound sources used in testing. General categories of sonar systems are described in Section 2.3.1 (Sonar Systems and Other Acoustic Sensors). The use of each acoustic source class proposed under each alternative is shown in Table 3.0-9. The proposed use of some acoustic source classes changed after publication of the AFTT Draft EIS/OEIS due to refinement of training and testing model inputs and changes to the tempo or location of certain proposed activities (see Foreword).

Table 3.0-9: Sonar and Other Active Acoustic Source Classes for Each Alternative

For Annual Training and Testing Activities								
Source Class Category	Source Class	Units	Annual Hours					
			No Action Alternative		Alternative 1		Alternative 2	
			Training	Testing	Training	Testing	Training	Testing
Low-Frequency (LF) Sources that produce signals less than 1 kHz	LF3	Hours	0	0	0	0	0	0
	LF4	Hours	0	100	0	218	0	254
	LF5	Hours	0	33	0	325	0	370
Mid-Frequency (MF) Tactical and nontactical sources that produce signals from 1 to 10 kHz	MF1	Hours	4,370	18	9,844	206	9,844	220
	MF1K	Hours	156	5	163	18	163	19
	MF2	Hours	1,498	0	3,150	36	3,150	36
	MF2K	Hours	59	0	61	0	61	0
	MF3	Hours	1,706	32	2,058	371	2,058	434
	MF4	Hours	647	126	927	698	927	776
	MF5	Count	10,112	1,099	14,556	3,802	14,556	4,184
	MF6	Count	0	69	0	255	0	303
	MF8	Hours	0	80	0	72	0	90
	MF9	Hours	0	299	0	11,825	0	13,034
	MF10	Hours	0	12	0	1,066	0	1,067
	MF11	Hours	0	0	800	0	800	0
	MF12	Hours	23	0	687	144	687	144
High-Frequency (HF) Tactical and nontactical sources that produce signals greater than 10kHz but less than 180kHz	HF1	Hours	410	26	1,676	1,104	1,676	1,243
	HF2	Hours	0	0	0	0	0	0
	HF3	Hours	0	26	0	307	0	384
	HF4	Hours	6,680	692	8,464	4,841	8,464	5,572
	HF5	Hours	0	219	0	1,135	0	1,206
	HF6	Hours	0	433	0	1,754	0	1,974
	HF7	Hours	0	30	0	321	0	366
	HF8	Hours	0	0	0	0	0	0
Anti-Submarine Warfare (ASW) Tactical sources used during anti-submarine warfare training and testing activities	ASW1	Hours	0	0	128	96	128	96
	ASW2[1]	Hours	0	0	0	200	0	274
	ASW2[1]	Count	1450	1115	2,620	2,378	2,620	2,743
	ASW3	Hours	5,202	89	13,586	901	13,586	948
	ASW4	Count	1,006	144	1,365	400	1,365	483
Doppler Sonar (DS) Sonar using Doppler effect to aid in navigation/collect oceanographic information	DS1	Hours	0	0	0	0	0	0
Acoustic Modems (M) Transmit data acoustically through the water	M3	Hours	0	46	0	392	0	461

ASW: anti-submarine warfare; DS: Doppler sonar; HF: high-frequency; LF: low-frequency; M: acoustic modem; MF: mid-frequency

[1] The ASW2 bin contains both sources that are analyzed by hours and those that are analyzed by count. There is no overlap of the numbers in the two rows.

Table 3.0-9: Sonar and Other Active Acoustic Source Classes for each Alternative (Continued)

For Annual Training and Testing Activities (Continued)								
Source Class Category	Source Class	Units	Annual Hours					
			No Action Alternative		Alternative 1		Alternative 2	
			Training	Testing	Training	Testing	Training	Testing
Synthetic Aperture Sonar (SAS) Post-processed signals form high-resolution images of the seafloor	SAS1	Hours	0	5	0	6	0	6
	SAS2	Hours	0	108	0	3,042	0	3,424
	SAS3	Hours	0	0	0	0	0	0
Swimmer Detection Sonar (SD) Used to detect divers and submerged swimmers	SD1-SD2	Hours	0	80	0	200	0	230
Forward Looking Sonar (FLS) Forward or upward looking object avoidance sonar.	FLS2-FLS3	Hours	0	30	0	320	0	365
Torpedoes (TORP) Source classes associated with active acoustic signals produced by torpedoes	TORP1	Count	42	86	54	540	54	581
	TORP2	Count	93	143	80	464	80	521
For Non-Annual Training and Testing Activities[1]								
Source Class Category	Source Class	Units	Hours over a 5-year Period					
			No Action Alternative		Alternative 1		Alternative 2	
			Training	Testing	Training	Testing	Training	Testing
Low-Frequency (LF) Sources that produce low-frequency (less than 1 kHz) signals	LF5	Hours	0	129	0	240	0	240
Mid-Frequency (MF) Tactical and nontactical sources that produce mid-frequency (1 to 10 kHz) signals	MF9	Hours	0	259	0	480	0	480
High-Frequency (HF) Tactical and nontactical sources that produce high-frequency (greater than 10 kHz but less than 180 kHz) signals	HF4	Hours	0	0	192	0	192	0
	HF5	Hours	0	129	0	240	0	240
	HF6	Hours	0	388	0	720	0	720
	HF7	Hours	0	129	0	240	0	240
Forward Looking Sonar (FLS) Forward or upward looking object-avoidance sonar	FLS2 – FLS3	Hours	0	129	0	240	0	240
Synthetic Aperture Sonar (SAS) Sonar in which active acoustic signals are post-processed to form high-resolution images of the seafloor	SAS2	Hours	0	388	0	720	0	720

[1] The portion of this table describing use of sonar and other active acoustic sources during non-annual activities was inadvertently left out of the AFTT Draft EIS/OEIS. The impacts due to the activities, however, were analyzed in the AFTT Draft EIS/OEIS.
FLS: forward looking sonar; SAS: synthetic aperture sonar; SD: swimmer detection sonar; TORP: torpedoes

Underwater sound propagation is highly dependent upon environmental characteristics such as bathymetry, bottom type, water depth, temperature, and salinity. The sound received at a particular location will be different than near the source due to the interaction of many factors, including propagation loss; how the sound is reflected, refracted, or scattered; the potential for reverberation; and interference due to multi-path propagation (Section 3.0.4.4, Predicting How Sound Travels).

A very simple estimate of sonar transmission loss can be calculated using the spherical spreading law, $TL = 20 \log_{10} r$, where r is the distance from the sound source and TL is the transmission loss in decibels (Section 3.0.4.4.1, Sound Attenuation and Transmission Loss). While a simple example is provided here for illustration, the Navy Acoustic Effects Model takes into account the influence of multiple factors to predict acoustic propagation (Marine Species Modeling Team 2013). The simplified estimate of spreading loss for a ping from a hull-mounted tactical sonar with a representative source level of 235 dB re 1 µPa is shown in Figure 3.0-18. The figure shows that sound levels drop off significantly near the source, followed by a more steady reduction with distance. Most non-impulsive sound sources used during training and testing have sound source levels lower than this example.

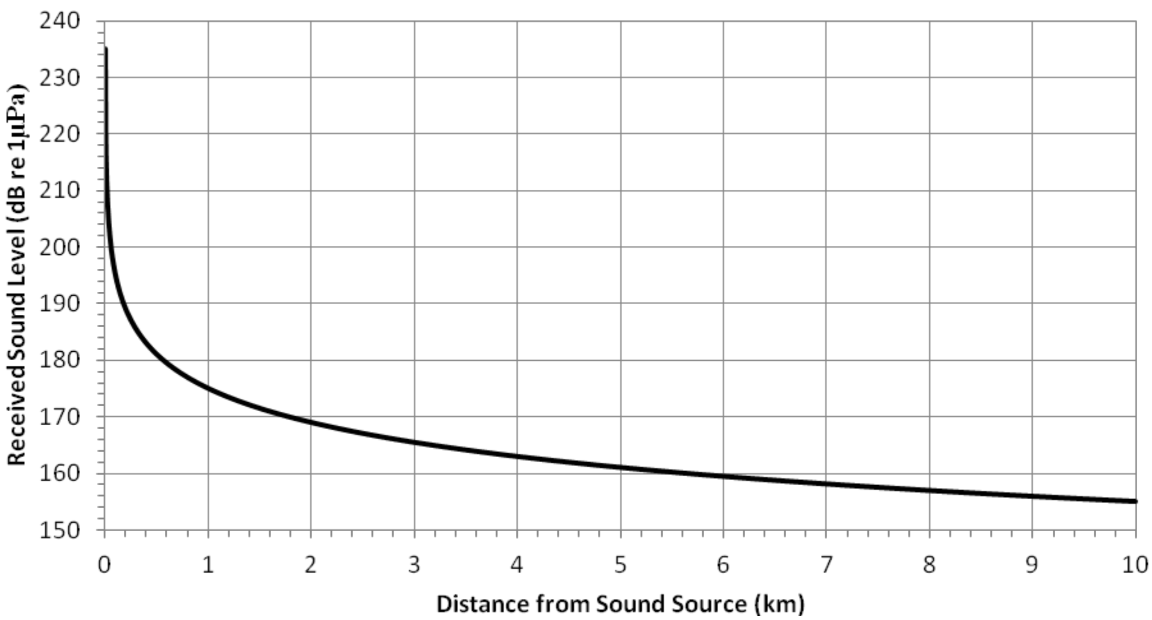

Figure 3.0-18: Estimate of Spreading Loss for a 235 dB re 1 µPa Sound Source Assuming Simple Spherical Spreading Loss

Most use of active acoustic sources involves a single unit or several units (ship, submarine, aircraft, or other platform) employing a single active sonar source in addition to sound sources used for communication, navigation, and measuring oceanographic conditions. Anti-submarine warfare activities may also use an acoustic target or an acoustic decoy.

Anti-Submarine Warfare Sonar

Sonar used in anti-submarine warfare is deployed on many platforms and is operated in various ways. Anti-submarine warfare active sonar is usually mid-frequency (1–10 kHz) because mid-frequency sound balances sufficient resolution to identify targets and distance within which threats can be identified.

- Ship tactical hull-mounted sonar contributes the largest portion of overall non-impulsive sound. Duty cycle can vary from about a ping per minute to continuously active. Sonar can be wide-ranging in a search mode or highly directional in a track mode.
- A submarine's mission revolves around its stealth; therefore, a submarine's mid-frequency sonar is used infrequently because its use would also reveal a submarine's location.
- Aircraft-deployed, mid-frequency, anti-submarine warfare systems include omnidirectional dipping sonar (deployed by helicopters) and omnidirectional sonobuoys (deployed from various aircraft), which have a typical duty cycle of several pings per minute.
- Acoustic decoys that continuously emulate broadband vessel sound or other vessel acoustic signatures may be deployed by ships and submarines.
- Torpedoes use directional high-frequency sonar when approaching and locking onto a target. Practice targets emulate the sound signatures of submarines or repeat received signals.

Anti-submarine warfare activities for all platforms typically would occur within and adjacent to existing east coast OPAREAs beyond 12 nm, with the exception of sonar dipping activities conducted by helicopters closer to shore. In addition, hull-mounted sonar may occasionally be used in port during system maintenance. Most anti-submarine warfare activities involving submarines or submarine targets would occur in waters greater than 183 m (600 ft.) deep due to safety concerns about running aground at shallower depths.

Most events usually occur over a limited area and are completed in less than one day, often within a few hours. Multi-day anti-submarine warfare events requiring coordination of movement and effort between multiple platforms with active sonar over a larger area occur less often, but constitute a large portion of the overall non-impulsive underwater noise that would be imparted by Navy activities. For example, the largest event, a composite training unit exercise, would have periods of concentrated, near-continuous anti-submarine warfare sonar use by several platforms during a several-week period.

Mine Warfare Sonar

Sonar used to locate mines and other small objects is typically high-frequency, which provides higher resolution. Mine detection sonar is deployed at variable depths on moving platforms to sweep a suspected mined area (towed by ships, helicopters, or unmanned underwater vehicles). Mid-frequency hull-mounted sonar can also be used in an object detection mode known as "Kingfisher" mode. Mine detection sonar use would be concentrated in areas where practice mines are deployed, typically in water depths less than 200 ft. (61 m). Most events usually occur over a limited area and are completed in less than one day, often within a few hours.

Other Active Acoustic Sources

Active sound sources used for navigation and obtaining oceanographic information (e.g., depth, bathymetry, and speed) are typically directional, have high duty cycles, and cover a wide range of frequencies, from mid-frequency to very high-frequency. These sources are similar to the navigation systems on standard large commercial and oceanographic vessels. Sound sources used in communications are typically high-frequency or very high-frequency. These sound sources could be used by vessels during most activities and while transiting throughout the Study Area.

Use of Sonar During Training

Anti-submarine Warfare training activities using sonar would be concentrated in the Southeast U.S. Continental Shelf Large Marine Ecosystem and the Gulf Stream Open Ocean Area, although these activities could occur anywhere in the Study Area. These activities would typically occur in the Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. Tracking exercises/torpedo exercises typically consist of a single unit conducting anti-submarine warfare; however, other events could include multiple units conducting anti-submarine warfare concurrently.

Mine warfare training activities using sonar would occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico Large Marine Ecosystems, and in the Gulf Stream and North Atlantic Gyre Open Ocean Areas. These activities would typically occur in the VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes.

In general, sonar use would increase under Alternatives 1 and 2 compared to the No Action Alternative. Many of these changes would be to increases in the number of similar activities at similar locations as under the No Action Alternative. The most notable changes in activities using sonar that were analyzed under Alternatives 1 and 2 compared to the No Action Alternative include:

- Reduced use of sonar during:
  - Anti-Submarine Warfare Tactical Development Exercise in JAX Range Complex.
  - Tracking exercises/torpedo exercises in Navy Cherry Point and GOMEX Range Complexes.

- Increased use of sonar during:
  - Mine warfare training in VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes.
  - Composite training unit exercises in VACAPES, JAX, and GOMEX Range Complexes.
  - Group Sail in VACAPES, Navy Cherry Point, and JAX Range Complexes.
  - Joint task force exercises/sustainment exercises in JAX Range Complex.
  - Tracking exercises/torpedo exercises in VACAPES and JAX Range Complexes.

- New use of sonar during:
  - Composite training unit exercises in Navy Cherry Point Range Complex.
  - Submarine under ice certification in Northeast, VACAPES, Navy Cherry Point, and JAX Range Complexes.

The number of training activities using sonar and their proposed locations under each alternative are shown in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives).

Use of Sonar During Testing

Anti-submarine warfare testing activities using sonar could occur in multiple locations in the Study Area, typically in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems and the Gulf Stream and North Atlantic Gyre Open Ocean Areas. These activities could occur in all training range complexes; at Naval Undersea Warfare Center Division, Newport Testing Range, Rhode Island; at Naval Surface Warfare Center, Panama City Division Testing Range; and at the South Florida Ocean Measurement Facility Testing Range.

Mine warfare training activities using sonar could occur in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Gulf of Mexico Large Marine Ecosystems, and in the Gulf Stream and North Atlantic Gyre Open Ocean Areas. These activities would typically occur in the VACAPES, JAX, and GOMEX Range Complexes.

In general, sonar use would increase under Alternatives 1 and 2 compared to the No Action Alternative. Many of these changes would be to amounts of similar activities at similar locations as under the No Action Alternative. Notable changes in activities using sonar that were analyzed under Alternatives 1 and 2 compared to the No Action Alternative include:

- Increased use of sonar during:
    - Anti-submarine warfare tracking test- helicopter at Northeast, VACAPES, JAX, and GOMEX Range Complexes.
    - Anti-submarine warfare torpedo test- helicopter at VACAPES Range Complex.
    - Unmanned underwater vehicle testing at Naval Surface Warfare Center, Panama City Division Testing Range and Naval Undersea Warfare Center Division, Newport Testing Range, Rhode Island.
    - Surface ship and submarine sonar testing and maintenance throughout the Study Area.
    - New ship construction activities while pierside.
    - Non-explosive torpedo testing at Northeast, VACAPES, JAX, and GOMEX Range Complexes.

- New use of sonar during:
    - Mission package testing in VACAPES and JAX Range Complexes.
    - Submarine sea trials at Northeast, VACAPES, JAX, and GOMEX Range Complexes.
    - Surface combatant sea trials at Northeast, VACAPES, JAX, and GOMEX Range Complexes.
    - Testing activities at the South Florida Ocean Measurement Facility Testing Range.
    - Sonobuoy lot acceptance testing in Key West Range Complex.
    - Combat system ship qualification trials in JAX Range Complex.
    - Countermeasure testing at Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes, and at Naval Surface Warfare Center, Panama City Division Testing Range.
    - Special warfare testing and stationary source testing at Naval Surface Warfare Center, Panama City Division Testing Range.
    - Unmanned vehicle development and payload testing at Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes.

The number of testing activities using sonar and their proposed locations under each alternative are shown in Table 2.8-2 and Table 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives).

3.0.5.3.1.2 Explosives

Explosive detonations during testing and training activities are associated with high-explosive munitions (including bombs, missiles, torpedoes, and naval gun shells), mines, demolition charges, explosive sonobuoys, and ship shock trial charges. Most explosive detonations during training and testing would be in the air or near the water surface, although charges associated with mine neutralization could occur anywhere within the water column or on the sea floor. Most detonations would occur in waters greater than 200 ft. (61 m) in depth and greater than 3 nm from shore, although mine warfare, demolition, and some testing detonations could occur closer to shore. Detonations associated with anti-submarine warfare would typically occur in waters greater than 600 ft. (180 m) depth. The numbers of explosions in each explosive source class proposed under each alternative are shown in Table 3.0-10 through Table 3.0-14. The proposed use of some explosive source classes changed after publication of the AFTT

Draft EIS/OEIS due to refinement of training and testing model inputs and changes to the tempo or location of certain proposed activities.

Table 3.0-10: Explosives for Annual Training and Testing Activities in the Study Area (Annual Usage)

Source Class (Net Explosive Weight)	Number of Explosives (Annual) for Training Activities			Number of Explosives (Annual) for Testing Activities		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
E1 (0.1 – 0.25 lb.)	103	124,552	124,552	7,000	22,802	25,501
E2 (0.26 – 0.5 lb.)	32	856	856	0	0	0
E3 (0.6 – 2.5 lb.)	100	3,132	3,132	734	2,128	2,912
E4 (2.6 – 5 lb.)	2,130	2,190	2,190	479	1,143	1,432
E5 (6 – 10 lb.)	1,400	14,370	14,370	94	448	495
E6 (11 – 20 lb.)	140	500	500	8	49	54
E7 (21 – 60 lb.)	30	322	322	0	0	0
E8 (61 – 100 lb.)	54	77	77	4	10	11
E9 (101 – 250 lb.)	7	2	2	0	0	0
E10 (251 – 500 lb.)	5	8	8	0	8	10
E11 (501 – 650 lb.)	4	1	1	20	25	27
E12 (651 – 1,000 lb.)	27	133	133	0	0	0
E13 (1,001 – 1,740 lb.)	0	0	0	0	0	0
E14 (1,741 – 3,625 lb.)	0	0	0	3	3	4

lb.: pound(s)

Table 3.0-11: Explosives for Non-Annual Training and Testing Activities in the Study Area over a 5-Year Period (Including Ship Shock Trial Testing)[1]

Source Class (Net Explosive Weight)	Number of Explosives (per activity) for Training Activities			Number of Explosives (per activity) for Testing Activities		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
E1 (0.1-0.25 lb.)	0	0	0	0	600	600
E2 (0.26-0.5 lb.)	0	2	2	0	0	0
E4 (2.6-5 lb.)	0	2	2	0	0	0
E16[2] (7,251 – 14,500 lb.)	0	0	0	0	12	12
E17[2] (14,501 – 58,000 lb.)	0	0	0	0	4	4

lb.: pound(s)

[1] The portion of this table describing use of explosive during non-annual activities other than ship shock trials was inadvertently left out of the AFTT Draft EIS/OEIS. The impacts due to the activities, however, were analyzed in the AFTT Draft EIS/OEIS.

[2] Up to one aircraft carrier full ship shock trial (source class E17), one DDG full ship shock trial (source class E16), and two Littoral Combat Ship full ship shock trials (source class E16) could occur within a five-year period. Each full ship shock trial would include up to four detonations spaced approximately one week apart.

Table 3.0-12: Number and Location of In-Air Explosions

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Missiles						
Northeast	0	4	4	0	0	0
VACAPES	72	72	72	0	38	38
Navy Cherry Point	20	51	51	0	0	0
JAX	15	52	52	0	9	9
Key West	0	8	8	0	0	0
GOMEX	0	8	8	0	0	0
Total	**107**	**195**	**195**	**0**	**47**	**47**
Large-Caliber Projectiles						
VACAPES	0	1,760	1,760	0	1,797	1,797
JAX	0	1,100	1,100	0	339	339
Key West	0	0	0	0	339	339
Total	**0**	**2,860**	**2,860**	**0**	**2,475**	**2,475**

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; VACAPES: Virginia Capes Range Complex

Table 3.0-13: Number and Location of Surface Explosions

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
100 lb. NEW Charges						
VACAPES	0	4	4	0	0	0
Total	**0**	**4**	**4**	**0**	**0**	**0**
60 lb. NEW Charges						
VACAPES	0	144	144	0	0	0
Navy Cherry Point	0	4	4	0	0	0
JAX	0	4	4	0	0	0
Key West	0	2	2	0	0	0
GOMEX	0	2	2	0	0	0
Total	**0**	**156**	**156**	**0**	**0**	**0**
20 lb. NEW Charges						
VACAPES (W-50)	12	0	0	0	0	0
VACAPES	0	112	112	0	0	0
Navy Cherry Point (UNDET Area)	10	0	0	0	0	0
Navy Cherry Point	0	2	2	0	0	0
JAX (UNDET Areas North and South)	6	0	0	0	0	0
JAX	0	4	4	0	0	0
Key West	0	2	2	0	0	0
GOMEX	0	2	2	0	0	0
Total	**28**	**122**	**122**	**0**	**0**	**0**
10 lb. NEW Charges						
VACAPES	0	4	4	0	0	0
Navy Cherry Point	0	2	2	0	0	0
JAX	0	2	2	0	0	0
Key West	0	2	2	0	0	0
GOMEX	0	2	2	0	0	0
Total	**0**	**12**	**12**	**0**	**0**	**0**

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; lb.: pound(s); NEW: Net Explosive Weight; UNDET: underwater detonation; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area.

Table 3.0-13: Number and Location of Surface Explosions (Continued)

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Bombs						
VACAPES (Air-K)	20	0	0	0	0	0
VACAPES	0	64	64	0	0	0
Navy Cherry Point	0	32	32	0	0	0
JAX	0	32	32	0	0	0
GOMEX (W-155 Hotbox)	4	0	0	0	0	0
GOMEX	0	4	4	0	0	0
Other AFTT Areas (SINKEX Box)	1	1	1	0	0	0
Total	**25**	**133**	**133**	**0**	**0**	**0**
Rockets						
Northeast	0	0	0	0	0	0
VACAPES	0	3,800	3,800	0	184	202
Navy Cherry Point	0	0	0	0	0	0
JAX	0	3,800	3,800	0	184	202
Key West	0	0	0	0	0	0
GOMEX	0	380	380	0	0	0
Total	**0**	**7,980**	**7,980**	**0**	**368**	**404**
Missiles						
Northeast	0	0	0	0	8	8
VACAPES (W-386, W-72, R-6604)	0	0	0	5	0	0
VACAPES [W-386 (Air E, F, I, J, K), W-72A]	106	0	0	0	0	0
VACAPES	0	118	118	0	56	60
Navy Cherry Point [W-122 (16/17, 18/19/20/21)]	24	0	0	0	0	0
Navy Cherry Point	0	40	40	0	0	0
JAX (MLTR)	73	0	0	5	0	0
JAX	0	126	126	0	27	30
Gulf of Mexico	0	0	0	0	4	4
Other AFTT Areas (SINKEX Box)	11	11	11	0	0	0
Total	**214**	**295**	**295**	**10**	**94**	**101**

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; MLTR: Missile Laser Training Range; Northeast: Northeast Range Complexes; SINKEX: sinking exercise; VACAPES: Virginia Capes Range Complex; W: warning area

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area.

Table 3.0-13: Number and Location of Surface Explosions (Continued)

Activity Area	Training			Testing		
	No Action Alternative	**Alternative 1**	**Alternative 2**	**No Action Alternative**	**Alternative 1**	**Alternative 2**
Large-Caliber Projectiles						
VACAPES (5-C/D, 7-C/D, 8-C/D, 1C-1/2)	858	0	0	0	0	0
VACAPES	0	4,884	4,884	0	0	0
Navy Cherry Point [W-122 (4/5, 13/14)]	78	0	0	0	0	0
Navy Cherry Point	0	866	866	0	0	0
JAX (BB,CC)	390	0	0	0	0	0
JAX	0	3,348	3,348	0	0	0
NSWC PCD	0	0	0	0	40	50
GOMEX	0	284	284	0	0	0
Other AFTT Areas (SINKEX Box)	700	700	700	0	0	0
Other AFTT Areas	0	96	96	0	0	0
AFTT Study Area	0	0	0	0	3,920	4,900
Total	**2,026**	**10,178**	**10,178**	**0**	**3,960**	**4,950**
Medium-Caliber Projectiles						
VACAPES	0	49,936	49,936	0	10,200	11,200
Navy Cherry Point	0	21,226	21,226	0	200	200
JAX	0	46,120	46,120	0	10,200	11,200
GOMEX	0	6,352	6,352	0	0	0
Other AFTT Areas	0	320	320	0	0	0
AFTT Study Area	0	0	0	0	2,800	3,500
Total	**0**	**123,954**	**123,954**	**0**	**23,400**	**26,100**

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; SINKEX: sinking exercise; VACAPES: Virginia Capes Range Complex; W: warning area

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area.

Table 3.0-14: Number and Location of Underwater Explosions

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Torpedoes						
Other AFTT Areas (SINKEX Box)	1	1	1	8	0	0
AFTT Study Area	0	0	0	0	8	8
Total	**1**	**1**	**1**	**8**	**8**	**8**
Sonobuoys						
Northeast	340	170	170	224	320	514
VACAPES	360	443	443	172	796	950
Cherry Point	360	183	183	112	112	204
JAX	360	1,113	1,113	152	152	244
Key West	0	0	0	0	1,312	1,512
GOMEX	0	0	0	112	112	204
Gulf of Mexico	351	70	70	0	0	0
Other AFTT Areas	0	0	0	184	184	368
Total	**1,771**	**1,979**	**1,979**	**956**	**2,988**	**3,996**
Anti-Swimmer Grenades						
Northeast	0	52	52	0	0	0
VACAPES	0	74	74	0	0	0
Cherry Point	0	28	28	0	0	0
JAX (Charleston OPAREA UNDET Boxes North and South)	80	0	0	0	0	0
JAX	0	24	24	0	0	0
GOMEX (CC UNDET Box E3)	20	0	0	0	0	0
GOMEX	0	28	28	0	0	0
Total	**100**	**206**	**206**	**0**	**0**	**0**
Line Charges						
NSWC PCD	0	0	0	3	3	4
Total	**0**	**0**	**0**	**3**	**3**	**4**
LCS/DDG Ship Shock Charge						
VACAPES or JAX	0	0	0	0	12	12
Total	**0**	**0**	**0**	**0**	**12**	**12**

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; LCS/DDG: Littoral Combat Ships/Destroyers; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; OPAREA: operating area; SINKEX: sinking exercise; UNDET: underwater detonation; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area.

Table 3.0-14: Number and Location of Underwater Explosions (Continued)

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Aircraft Carrier Ship Shock Charge						
VACAPES or JAX	0	0	0	0	4	4
Total	**0**	**0**	**0**	**0**	**4**	**4**
650 lb. NEW Charges						
VACAPES	0	0	0	0	5	6
NSWC PCD	0	0	0	24	16	16
Total	**0**	**0**	**0**	**24**	**21**	**22**
100 lb. NEW Charges						
VACAPES	0	4	4	0	0	0
Gulf of Mexico	0	0	0	0	6	7
Total	**0**	**4**	**4**	**0**	**6**	**7**
75 lb. NEW Charges						
NSWC PCD	0	0	0	3	0	0
Total	**0**	**0**	**0**	**3**	**0**	**0**
60 lb. NEW Charges						
VACAPES (Little Creek)	0	6	6	0	0	0
VACAPES	0	144	144	0	0	0
Cherry Point	0	4	4	0	0	0
JAX	0	4	4	0	0	0
Key West	0	2	2	0	0	0
GOMEX	0	2	2	0	0	0
Total	**0**	**162**	**162**	**0**	**0**	**0**
20 lb. NEW Charges						
Northeast	0	1	1			
VACAPES (W-50)	12	0	0	0	0	0
VACAPES (Little Creek)	0	60	60	0	0	0
VACAPES	0	113	113	0	0	0
Cherry Point (Onslow Bay UNDET Area)	10	0	0	0	0	0
Cherry Point	0	3	3	0	0	0
JAX (Charleston OPAREA UNDET Boxes North and South)	6	0	0	0	0	0
JAX	0	5	5	0	0	0
Key West	0	2	2	0	0	0
NSWC PCD	0	0	0	4	4	4
GOMEX	0	3	3	0	0	0
Total	**28**	**187**	**187**	**4**	**4**	**4**

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; lb.: pound(s); NEW: Net Explosive Weight; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; OPAREA: operating area; SINKEX: sinking exercise; UNDET: underwater detonation; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area.

Table 3.0-14: Number and Location of Underwater Explosions (Continued)

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
10 lb. NEW Charges						
VACAPES	0	4	4	0	0	0
Cherry Point	0	2	2	0	0	0
JAX	0	2	2	0	20	20
Key West	0	2	2	0	0	0
NSWC PCD	0	0	0	51	0	0
GOMEX	0	2	2	0	0	0
Gulf of Mexico	0	0	0	0	20	20
Total	**0**	**12**	**12**	**51**	**40**	**40**
5 lb. NEW Charges						
VACAPES (W-50)	30	0	0	0	0	0
VACAPES (W-50, W-72)	0	0	0	90	0	0
VACAPES (Little Creek)	0	12	12	0	0	0
VACAPES	0	60	60	0	126	145
JAX	0	0	0	0	24	32
NSWC PCD	0	0	0	40	161	171
GOMEX	0	20	20	0	0	0
Gulf of Mexico	0	0	0	0	12	14
Total	**30**	**92**	**92**	**130**	**323**	**362**
.25 lb. NEW Charges						
VACAPES (Little Creek)	0	1,440	1,440	0	0	0
Total	**0**	**1,440**	**1,440**	**0**	**0**	**0**

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; lb.: pound(s); NEW: New Explosive Weight; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; VACAPES: Virginia Capes Range Complex; W: warning area

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area.

Explosives introduce loud, impulsive, broadband sounds into the marine environment. Three source parameters influence the effect of an explosive: (1) the weight of the explosive warhead, (2) the type of explosive material, and (3) the detonation depth. The net explosive weight, the explosive power of a charge expressed as the equivalent weight of trinitrotoluene (TNT), accounts for the first two parameters. The properties of explosive detonations are discussed in Section 3.04 (Acoustic and Explosives Primer).

In general, explosive events would consist of a single explosion or multiple explosions over a short period. Detonations of projectiles during anti-air warfare would occur far above the water surface; with the exception of high-speed anti-radiation missiles and 5 in. round air bursts, both of which would occur approximately 30 m above the surface. During training, all large, high-explosive bombs would be detonated near the surface over deep water. High-explosive bombs would be fused to detonate on contact with the water. Other detonations would occur near but above the surface upon impact with a target; these detonations are conservatively assumed to occur at a depth of 1 m (3 ft.) for purposes of analysis. Table 3.0-15 shows the depths at which representative explosive source classes are assumed to detonate underwater for purposes of analysis.

Table 3.0-15: Representative Ordnance, Net Explosive Weights, and Detonation Depths

Representative Ordnance	Explosive Source Class (Net Explosive Weight)	Representative Underwater Detonation Depth[1]
Medium-Caliber Projectiles	E1 (0.1-0.25 lb.)	1 m (3 ft.)
Medium-Caliber Projectiles	E2 (0.26-0.5 lb.)	1 m (3 ft.)
Large-Caliber Projectiles	E3 (0. 6-2.5 lb.)	1 m (3 ft.)
Improved Extended Echo Ranging Sonobuoy	E4 (2.6-5 lb.)	20 m (66 ft.), 198 m (650 ft.)
5 in. Projectiles	E5 (6-10 lb.)	1 m (3 ft.)
15 lb. Shaped Charge	E6 (11-20 lb.)	1 m (3 ft.)
Demo Block/Shaped Charge	E7 (21-60 lb.)	15 m (50 ft.)
250 lb. Bomb	E8 (61-100 lb.)	1 m (3 ft.)
500 lb. Bomb	E9 (101-250 lb.)	1 m (3 ft.)
1,000 lb. Bomb	E10 (251-500 lb.)	1 m (3 ft.)
650 lb. Mine	E11 (501-650 lb.)	6 m (20 ft.), 10 m (33 ft.)
2,000 lb. Bomb	E12 (651-1,000 lb.)	1 m (3 ft.)
Ship Shock Charge	E15 (3,626-7,250 lb.)	61 m (200 ft.)
	E16 (7,251-14,500 lb.)	
	E17 (14,501-58,000 lb.)	

ft.: feet; in.: inch; lb.: pound(s); m: meters

[1] Underwater detonation depths listed are those assumed for purposes of acoustic impacts modeling. Detonations assumed to occur at a depth of 3 ft. (1 m) include detonations that would actually occur at or just above the water surface.

Since most explosive sources used in military activities are munitions that detonate essentially upon impact, the effective source depths are quite shallow and, therefore, the surface-image interference effect can be pronounced (Section 3.04, Acoustic and Explosives Primer). This effect would reduce peak pressures and potential impacts near the water surface.

The locations for training and testing in the Study Area are shown in Figures 2.6-2 through 2.6-4.

Explosives in Training

Training activities using explosives would be concentrated in the Northeast U.S. Continental Shelf, Southeast U.S Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, as well as the Gulf Stream Open Ocean Area. Most explosions would occur in the VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes. In general, use of explosives would increase under Alternatives 1 and 2 compared to the No Action Alternative. Many of these changes would be to amounts of similar activities at similar locations as under the No Action Alternative. The most notable changes in activities using explosives under Alternatives 1 and 2 compared to the No Action Alternative include:

- Reduced use of sonobuoys (source class E4) in Navy Cherry Point and GOMEX Range Complexes.
- Increased use of explosives during:
  - Bombing exercises (air-to-surface) (source class E12) in VACAPES, Navy Cherry Point, and JAX Range Complexes.

  - Firing exercises (source class E5) at VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes.
  - Anti-submarine warfare using explosive sonobuoys (source class E4) in VACAPES and JAX Range Complexes.
  - Gunnery exercises (source classes E1, E2, E3, and E5) in VACAPES, Navy Cherry Point, JAX, and Gulf of Mexico Range Complexes.
  - Mine neutralization (source classes E4, E5, E6, E7, and E8) in VACAPES Range Complex.

- New explosives use during mine neutralization in Key West Range Complex (source classes E5, E6, and E7).

The number of training activities using explosives and their proposed locations under each alternative are shown in Table 2.8-1 of Chapter 2 (Description of Proposed Action and Alternatives).

Explosives in Testing

Testing activities using explosives would be concentrated in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Living Marine Ecosystems, as well as the Gulf Stream Open Ocean Area. Activities would also occur in the Caribbean Sea Large Marine Ecosystem under Alternatives 1 and 2. Most explosions associated with testing activities would occur at Naval Surface Warfare Center, Panama City Division Testing Range, and in the Northeast, VACAPES, JAX, and GOMEX Range Complexes, plus the Key West Range Complex under Alternatives 1 and 2. Most detonations would occur away from shorelines, with the exception of testing events at Naval Surface Warfare Center, Panama City Division Testing Range, which could occur up to the surf line. Use of explosives would increase under Alternatives 1 and 2 compared to the No Action Alternative. Some increases would be to similar activities at similar locations as under the No Action Alternative. The most notable changes analyzed under Alternatives 1 and 2 compared to the No Action Alternative include:

- Increased use of explosives during:
  - Air-to-surface gunnery tests (source class E1) at VACAPES and JAX Range Complexes.
  - Anti-submarine warfare tracking test- sonobuoy (source classes E3 and E4) throughout the Study Area.
  - Rocket testing (source class E5) at VACAPES and JAX Range Complexes.
  - Air-to-surface missile test (source class E6) at VACAPES and JAX Range Complexes.
- New explosive use during:
  - Aircraft carrier sea trial gun testing (source class E1) and missile testing (source class E6) at VACAPES, Navy Cherry Point, and JAX Range Complexes.
  - At-sea explosives testing (source class E5) at JAX and GOMEX Range Complexes.
  - Mission package testing (source classes E4 and E6) in VACAPES and JAX Range Complexes.
  - Sonobuoy lot acceptance testing (source classes E3 and E4) at Key West Range Complex.
  - Mine countermeasure/neutralization testing at GOMEX Range Complex (source class E8) and VACAPES Range Complex (source class E4).
  - Full Ship Shock Trial Testing of the Littoral Combat Ships (source class E16), DDG 1000 destroyer (source class E16), and aircraft carrier (source class E17) in the VACAPES and JAX Range Complexes.

The number of testing activities using explosives and their proposed locations under each alternative are shown in Tables 2.8-2 and 2.8-3 of Chapter 2 (Description of Proposed Action and Alternatives).

Ship Shock Trials

Because the largest proposed detonations would occur during a ship shock trial testing event (see Section 2.4.2.2.2, Shock Trials), these detonations are discussed in further detail. Ship shock trials consist of a series of underwater detonations that propagate a shock wave through a ship's hull under deliberate and controlled conditions simulating near misses from underwater explosions.
A representative ship from a new ship class is exposed to four detonations at a rate of up to two per week to allow time to perform detailed inspections of the ship's systems and assess the ability of the ship and crew to withstand near-miss situations.

Some parameters of past ship shock explosions using 10,000 lb. (4,536 kg) high blast explosive charges (source class E16) were predicted under prior analyses (U.S. Department of the Navy 2008a). The shock wave would reach the seafloor and be reflected from it without any major sediment disturbance. The spherical bubble produced by each explosion would expand to a maximum radius of 62 ft. (19 m). The bubble would migrate upward and collapse beneath the surface, where it would re-expand and emerge into the atmosphere. The water that would be ejected would form a roughly hemispherical mass of plumes with an estimated maximum height of 540 ft. (165 m).

In addition to impacts due to propagation of the shock wave and acoustic waves, these large underwater detonations may cause a region of bulk cavitation near the surface due to the reflected shock wave. Cavitation occurs when compression (shock) waves propagate to the surface and are reflected back into the water as rarefaction (or negative pressure) waves. This causes a state of tension, or very low pressure, to occur within a large region of water. Since water cannot ordinarily sustain a significant amount of tension, it cavitates and the surrounding pressure drops to the vapor pressure of water. A water hammer pulse is generated when the upper and lower layers of the cavitation region rejoin (close). As an example, Figure 3.0-19 shows that estimated bulk cavitation region for an explosive source class E16 (7,251-14,500 lb. net explosive weight) detonation at a depth of 200 ft. (61 m)(U.S. Department of the Navy 2008a). The maximum lateral extent (radius) of this cavitation area is predicted to be 2,250 ft. (686 m). A charge of this size or greater would only be detonated during ship shock trials.

Two potential locations for the proposed shock trials are the Norfolk, Virginia and Jacksonville, Florida locations defined in the Final EIS for the Mesa Verde (LPD 19) ship shock trial (U.S. Department of the Navy 2008a). Selection of these locations for the proposed shock trials was based on operational requirements (proximity to support, munition storage/loading, and repair facilities), environmental features (avoidance of hard bottom and coral reefs), safety considerations, Gulf Stream avoidance, and water depth. In both locations the minimum water depth is 600 ft. (183 m). The charges are detonated at 200 ft. (61 m) below the water surface.

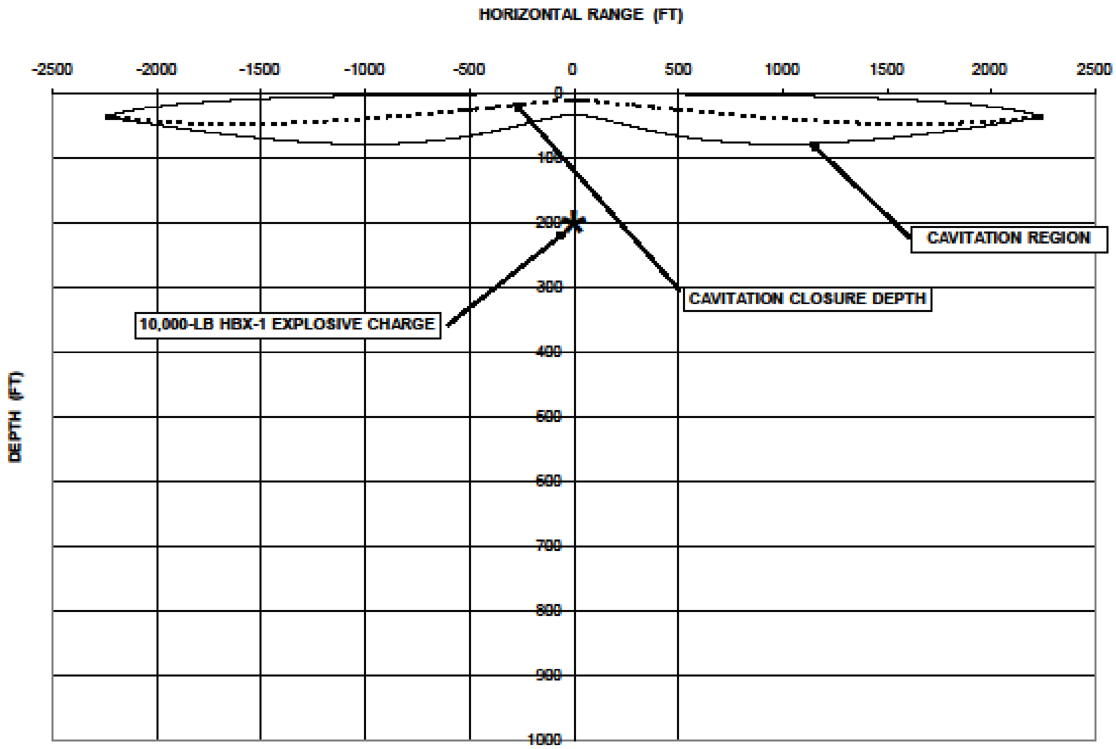

Figure 3.0-19: Calculated Bulk Cavitation Region and Closure Depth for a 10,000 lb. (4,536 kg) High Blast Explosive Charge (Source Class E16) Detonated at a Depth of 200 ft. (61 m)
(U.S. Department of the Navy 2008a)

3.0.5.3.1.3 Pile Driving

Impact pile driving and vibratory pile removal would occur during construction of an elevated causeway system during Joint Logistics Over-the-Shore training. A separate environmental assessment has been prepared to address impacts due to all activities that occur during Joint Logistics Over-the-Shore training, with the exception of impacts due to in-water noise generated during construction of the elevated causeway. This EIS/OEIS includes analysis of the impact of underwater noise generated by pile driving during elevated causeway construction to facilitate holistic analysis of impacts due to all underwater noise generated during testing and training in the Study Area.

Construction of the elevated causeway system, a temporary pier allowing offloading of supply ships, would require pile driving and pile removal. Construction of the elevated causeway system during training would occur once per year under Alternatives 1 and 2 at one of the following locations: in the VACAPES Range Complex (Joint Expeditionary Base West [Little Creek], Virginia or Joint Expeditionary Base East [Fort Story], Virginia) or in the Navy Cherry Point Range Complex (Marine Corps Base Camp Lejeune, North Carolina). The length of the pier, and therefore the number of piles required, would be determined by the distance from shore to the appropriate water depth for ship off-loading. Construction of the elevated causeway system would involve intermittent impact pile driving of 24-inch (in.), uncapped, steel pipe piles over approximately two weeks. Crews work 24 hours a day and can drive approximately eight piles in that period. Each pile takes about 10 minutes to drive. When training events that use the elevated causeway system are complete, the structure would be removed using vibratory methods over approximately six days. Crews can remove about 14 piles per 24-hour period, each taking about six minutes to remove. Table 3.0-16 summarizes the pile driving and pile removal activities that would occur during a 24-hour period.

Impact pile driving creates repetitive impulsive sound. An impact pile driver generally operates in the range of 36 to 50 blows per minute. Vibratory pile driving creates a nearly continuous sound made up of a series of short duration rapid impulses at a much lower source level than impact pile driving. The sounds are emitted both in the air and in the water.

Table 3.0-16: Summary of Pile Driving and Removal Activities Per 24-Hour Period

Method	Piles Per 24-Hour Period	Time Per Pile	Total Estimated Time of Noise Per 24-Hour Period
Pile Driving (Impact)	8	10 minutes	80 minutes
Pile Removal (Vibratory)	14	6 minutes	84 minutes

Pile driving for elevated causeway system training would occur in shallower water, and sound could be transmitted on direct paths through the water, be reflected at the water surface or bottom, or travel through bottom substrate. Soft substrates such as sand bottom at the proposed elevated causeway system locations, would absorb or attenuate the sound more readily than hard substrates (rock), which may reflect the acoustic wave. Most acoustic energy would be concentrated below 1,000 Hz. Average underwater sound levels for driving piles similar to those that would be installed for elevated causeway systems are shown in Table 3.0-17.

Table 3.0-17: Average Pile Driving Underwater Sound Levels

Pile Size &Type	Installation Method	Water Depth	Average Sound Pressure Level (peak)*	Average Sound Pressure Level (rms)*
0.61-m (24 in.) Steel Pipe Pile	Impact	5 m (15 ft.)	203 dB re 1 µPa (peak) at 10 m	190 dB re 1 µPa (rms) at 10 m
1-m (36 in.) Steel Pipe Pile	Vibratory	5 m (15 ft.)	180 dB re 1 µPa (peak) at 10 m	170 dB re 1 µPa (rms) at 10 m

dB: decibel; ft.: feet; in.: inch; m: meter(s); µPa: micro pascal; rms: root mean square
*(California Department of Transportation 2009)

3.0.5.3.1.4 Swimmer Defense Airguns

Swimmer defense airguns would be used for pierside integrated swimmer defense testing (at pierside locations at Joint Expeditionary Base West [Little Creek] and in the Rhode Island Sound Restricted Areas) and during stationary source testing at Naval Surface Warfare Center, Panama City Division Testing Range. Airguns would be fired a limited number of times (up to 100) during each activity at an irregular interval as required for the testing objectives. These areas adjacent to Navy pierside integrated swimmer defense testing locations are industrialized, and the waterways carry a high volume of vessel traffic in addition to Navy vessels using the pier.

Underwater impulses would be generated using small (approximately 60 cubic inch [$in.^3$]) airguns, which are essentially stainless steel tubes charged with high-pressure air via a compressor. An impulsive sound is generated when the air is almost instantaneously released into the surrounding water, an effect similar to popping a balloon in air. Generated impulses would have short durations, typically a few hundred milliseconds. The root mean square sound pressure level and sound exposure level at a distance 1 m from the airgun would be approximately 200–210 dB re 1 µPa and 185–195 dB re 1 μPa^2-s, respectively. Swimmer defense airguns lack the strong shock wave and rapid pressure increase that would be expected from explosive detonations.

3.0.5.3.1.5 Weapons Firing, Launch, and Impact Noise

Noise associated with weapons firing and the impact of non-explosive practice munitions could happen at any location within the Study Area but generally would occur at locations greater than 12 nm from shore for safety reasons. These testing and training events are concentrated in the VACAPES, Navy Cherry Point, and JAX Range Complexes, but could occur throughout the Study Area, including while ships are in transit. Weapons noise associated with training would occur with less frequency in the GOMEX and Northeast Range Complexes. Testing activities involving weapons firing noise would be those events involved with testing weapons and launch systems. These activities would also take place throughout the Study Area but would be more concentrated in the GOMEX and Northeast Range Complexes.

The firing of a weapon may have several components of associated noise. Firing of guns could include sound generated by firing the gun (muzzle blast), vibration from the blast propagating through a ship's hull, and sonic booms generated by the projectile flying through the air (Table 3.0-18). Missiles and targets would produce noise during launch. In addition, the impact of non-explosive practice munitions at the water surface can introduce sound into the water. Detonations of high-explosive projectiles are considered in Section 3.0.4.1.4 (Categories of Sound).

Table 3.0-18: Representative Weapons Noise Characteristics

Noise Source	Sound Level
In-Water	
Naval Gunfire Muzzle Noise (5-inch/54-caliber)	Approximately 200 dB re 1 µPa directly under gun muzzle at 5 ft. (1.5 m) below the water surface[1]
Airborne	
Naval Gunfire Muzzle Noise (5-inch/54-caliber)	178 dB re 20 µPa directly below the gun muzzle above the water surface[1]
Hellfire Missile Launch from Aircraft	149 dB re 20 µPa at 15 ft. (4.5 m)[2]
7.62-millimeter M-60 Machine Gun	90 dBA re 20 µPa at 50 ft. (15 m)[3]
0.50-Caliber Machine Gun	98 dBA re 20 µPa at 50 ft. (15 m)[3]

db: decibel; dBA: decibel, A-weighted; ft.: feet; m: meters; µPa: micro pascal; re: referenced to
[1] Yagla and Stiegler (2003) [2] U.S. Department of the Army (1999) [3] Investigative Science and Engineering (1997)

Naval Gunfire Noise

Firing a ship deck gun produces a muzzle blast in air that propagates away from the muzzle in all directions, including toward the water surface. As explained in Section 3.0.4 (Acoustic and Explosives Primer) most sound enters the water in a narrow cone beneath the sound source (within 13° of vertical). In-water sound levels were measured during the muzzle blast of a 5 in. deck-mounted gun, the largest caliber gun currently used in proposed Navy activities. The highest sound level in the water (on average 200 dB re 1 µPa measured 5 ft. below the surface) was obtained when the gun was fired at the lowest angle, placing the blast closest to the water surface (U.S. Department of the Navy 2000; Yagla and Stiegler 2003). The average impulse at that location was 19.6 Pa-s. The corresponding average peak in-air pressure was 178 dB re 20 µPa, measured at the water surface below the firing point.

Gunfire also sends energy through the ship structure, into the water, and away from the ship. This effect was investigated in conjunction with the measurement of 5-in. gun blasts described above. The energy transmitted through the ship to the water for a typical round was about 6 percent of that from the air blast impinging on the water. Therefore, sound transmitted from the gun through the hull into the water is a minimal component of overall weapons firing noise.

The projectile shock wave in air by a shell in flight at supersonic speeds propagates in a cone (generally about 65°) behind the projectile in the direction of fire (Pater 1981). Measurements of a 5-in. projectile shock wave ranged from 140 to 147 dB re 20 µPa taken at the surface at 0.59 nm distance from the firing location and 10° off the line of fire for safety (approximately 623 ft. [190 m] from the shell's trajectory). Sound level intensity decreases with increased distance from the firing location and increased angle from the line of fire (Pater 1981). Like sound from the gun firing blast, sound waves from a projectile in flight would enter the water primarily in a narrow cone beneath the sound source. The region of underwater sound influence from a single traveling shell would be relatively narrow, the duration of sound influence would be brief at any point, and sound level would diminish as the shell gains altitude and loses speed. Multiple, rapid gun firings would occur from a single firing point toward a target area. Vessels participating in gunfire activities would maintain enough forward motion to maintain steerage, normally at speeds of a few knots. Acoustic impacts from weapons firing would often be concentrated in space and duration.

Launch Noise

Missiles can be rocket or jet propelled. Sound due to missile and target launches is typically at a maximum at initiation of the booster rocket. It rapidly fades as the missile or target reaches optimal thrust conditions and the missile or target reaches a downrange distance where the booster burns out and the sustainer engine continues. Launch noise level for the Hellfire missile, which is launched from aircraft, is about 149 dB re 20 µPa at 14.8 ft. (4.5 m) (U.S. Department of the Army 1999).

Non-Explosive Munitions Impact Noise

Large-caliber non-explosive projectiles, non-explosive bombs, and intact missiles and targets could produce a large impulse upon impact with the water surface (McLennan 1997). 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. Sound associated with impact events is typically of low frequency (less than 250 Hz) and of short duration.

3.0.5.3.1.6 Vessel Noise

Naval vessels (including ships, small craft, and submarines) would produce low-frequency, broadband underwater sound. In the east coast Exclusive Economic Zone, Navy ships are estimated to contribute roughly 1 percent of the total energy due to large vessel broadband noise (Mintz and Filadelfo 2011).

Exposure to vessel noise would be greatest in the areas of highest naval vessel traffic. The locations and concentration areas of Navy vessel use is discussed in 3.0.5.3.3.1 (Vessels). In summary, naval vessel traffic is heaviest in the VACAPES and JAX Range Complexes, although vessels would be used during many of testing and training activities proposed throughout the Study Area. Noise exposure due to naval vessels would be greatest near naval port facilities, especially around and between the ports of Norfolk, Virginia, and Jacksonville, Florida (Mintz and Parker 2006).

Radiated noise from Navy ships ranges over several orders of magnitude. The quietest Navy warships radiate much less broadband noise than a typical fishing vessel, while the loudest Navy ships are almost on par with large oil tankers (Mintz and Filadelfo 2011). For comparison, a typical commercial cargo vessel radiates broadband noise at a source level around 172 dB re 1 µPa and a typical fishing vessel radiates noise at a source level of about 158 dB re 1 µPa (Richardson et al. 1995; Urick 1983). Typical large vessel ship-radiated noise is dominated by tonals related to blade and shaft sources at frequencies below about 50 Hz and by broadband components related to cavitation and flow noise at higher frequencies (approximately around the one-third octave band centered at 100 Hz) (Richardson et al. 1995; Urick 1983).

The acoustic signatures of naval vessels are classified information. Anti-submarine warfare platforms (such as guided missile destroyers and Ticonderoga-class guided missile cruisers) and submarines make up a large part of Navy traffic but contribute little noise to the overall sound budget of the oceans as these vessels are designed to be quiet to minimize detection. These platforms are much quieter than Navy oil tankers, for example, which have a smaller presence but contribute substantially more broadband noise than anti-submarine warfare platforms (Mintz and Filadelfo 2011). Sound produced by vessels will typically increase with speed. During training, speeds of most larger naval vessels (greater than 60 ft. [18 m]) generally operate at speeds in the range of 10 to 15 knots for fuel conservation; however, ships will, on occasion, operate at higher speeds within their specific operational capabilities.

A variety of smaller craft, such as service vessels for routine operations and opposition forces used during training events, would be operating within the Study Area. These small craft types, sizes, and speeds vary, but in general, they will emit higher-frequency noise than larger ships.

While commercial traffic (and, therefore, broadband noise generated by it) is relatively steady throughout the year, Navy traffic is episodic in the ocean. Vessels engaged in training and testing may consist of a single vessel involved in unit-level activity for a few hours or multiple vessels involved in a major training exercise that could last a few days within a given area. Activities involving vessel movements occur intermittently and are variable in duration, ranging from a few hours to up to two weeks. Navy vessels do contribute to the overall increased ambient noise in inland waters near Navy ports, although their contribution to the overall noise in these environments is minimal because these areas typically have large amounts of commercial and recreational vessel traffic.

3.0.5.3.1.7 Aircraft Overflight Noise

Fixed- and rotary-wing aircraft are used for a variety of training and testing activities throughout the Study Area, contributing both airborne and underwater sound to the ocean environment. Aircraft used in training and testing generally have reciprocating, turboprop, or jet engines. Motors, propellers, and rotors produce the most noise, with some noise contributed by aerodynamic turbulence. Aircraft sounds have more energy at lower frequencies. Takeoffs and landings occur at established airfields as well as on vessels at sea throughout the Study Area. Most aircraft noise would be produced around air stations in the range complexes. Military activities involving aircraft generally are dispersed over large expanses of open ocean but can be highly concentrated in time and location. Source levels for some typical aircraft used during training and testing in the Study Area are shown in Table 3.0-19.

Table 3.0-19: Representative Aircraft Sound Characteristics

Noise Source	Sound Pressure Level
In-Water	
F/A-18 Subsonic at 1,000 ft. (300 m) Altitude	148 dB re 1 µPa at 6 ft. (2 m) below water surface[1]
F/A-18 Subsonic at 10,000 ft. (3,000 m) Altitude	128 dB re 1 µPa at 6 ft. (2 m) below water surface[1]
H-60 Helicopter Hovering at 82 ft. (25 m) Altitude	Approximately 145 dB re 1 µPa at 3 ft. (1 m) below water surface[2]
Airborne	
Jet Aircraft under Military Power	144 dBA re 20 µPa at 50 ft.(15 m) from source[3]
Jet Aircraft under Afterburner	148 dBA re 20 µPa at 50 ft. (15 m) from source[3]
H-60 Helicopter Hovering	113 dBA re 20 µPa at 82 ft. (25 m) from source[3]

dB: decibel; dBA: decibel, A-weighted; ft.: feet; m: meter(s); µPa: micro pascal; re: referenced to
[1]Eller and Cavanagh (2000) [2]estimate based on in-air level [3] Bousman and Kufield (2005)

Fixed-Wing Aircraft

Noise generated by fixed-wing aircraft is transient in nature and extremely variable in intensity. Most fixed-wing aircraft sorties would occur above 3,000 ft. (900 m). Air combat maneuver altitudes generally range from 5,000 to 30,000 ft. (1.5 to 9.1 km) and typical airspeeds range from very low (less than 100 knots) to high subsonic (less than 600 knots). Sound exposure levels at the sea surface from most air combat maneuver overflights are expected to be less than 85 dBA (based on an FA-18 aircraft flying at an altitude of 5,000 ft. [1,500 m] and at a subsonic airspeed [400 knots])(U.S. Department of the Navy 2009). Exposure to fixed-wing aircraft noise would be brief (seconds) as an aircraft quickly passes overhead.

Helicopters

Noise generated from helicopters is transient 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). Helicopter sounds contain dominant tones from the rotors that are generally below 500 Hz. Helicopters often radiate more sound forward than backward. The underwater noise produced is generally brief when compared with the duration of audibility in the air.

Helicopter unit level training typically entails a high volume of single-aircraft sorties over water that start and end at an air station, although flights may occur from ships at sea. Individual flights typically last about two to four hours. Some events require low-altitude flights over a defined area, such as mine countermeasure activities deploying towed systems. Most helicopter sorties associated with mine countermeasures would occur at altitudes as low as 75 to 100 ft. (23 to 31 m). Likewise, in some anti-submarine warfare events, a dipping sonar is deployed from a line suspended from a helicopter hovering at low altitudes over the water.

Underwater Transmission of Aircraft Noise

Sound generated in air is transmitted to water primarily in a narrow area directly below the aircraft (Section 3.0.4, Acoustic and Explosives Primer). A sound wave propagating from an aircraft must enter the water at an angle of incidence of 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 (Urick 1983). Water depth and bottom conditions strongly influence propagation and levels of underwater noise from passing aircraft. For low-altitude flights, sound levels reaching the water surface would be higher, but the transmission area would be smaller. As an aircraft gains altitude, sound reaching the water surface diminishes, but the possible transmission area increases. Estimates of underwater sound pressure level are provided for representative aircraft in Table 3.0-19.

Underwater sound from aircraft overflights has been modeled for some airframes. Eller and Cavanagh (2000) modeled underwater sound pressure level as a function of time at various depths (2, 10, and 50 m) for F/A-18 Hornet aircraft subsonic overflights (250 knots) at various altitudes (300; 1,000; and 3,000 m). For the worst modeled case of an F/A-18 at the lowest altitude (300 m), the sound level at two meters below the surface peaked at 152 dB re 1 µPa, and the sound level at 50 meters below the surface peaked at 148 dB re 1 µPa. When F/A-18 flight was modeled at 3,000 meters altitude, peak sound level at 2 meters depth dropped to 128 dB re 1 µPa.

Sonic Booms

An intense but infrequent type of aircraft noise is the sonic boom, produced when an aircraft exceeds the speed of sound. Supersonic aircraft flights are usually limited to altitudes above 30,000 ft. (9,100 m) or locations more than 30 nm from shore. Several factors influence sonic booms: weight, size, 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 aircraft. Therefore, larger aircraft create sonic booms that are stronger and louder than those of smaller, lighter aircraft. Consequently, the larger and heavier the aircraft, the stronger the shock waves (U.S. Department of the Navy and Department of Defense 2007).

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 (1.6 km) for each 1,000 ft. (300 m) of altitude. For example, an aircraft flying supersonic, straight, and level at 50,000 ft. (15,000 m) can produce a sonic boom carpet about 50 miles (80 km) wide. The sonic boom, however, would not be uniform, and its intensity at the 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 until shock waves refract away from the ground and the sonic boom attenuates. 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 and Department of Defense 2007).

F/A-18 Hornet supersonic flight was modeled to obtain peak sound pressure levels and energy flux density at the water surface and at depth (Laney and Cavanagh 2000). These results are shown in Table 3.0-20.

Table 3.0-20: Sonic Boom Underwater Sound Levels Modeled for F/A-18 Hornet Supersonic Flight

Mach Number*	Aircraft Altitude (km)	Peak Pressure (dB re 1 µPa)			Energy Flux Density (dB re 1 µPa²-s)		
		At surface	50 m Depth	100 m Depth	At surface	50 m Depth	100 m Depth
1.2	1	176	138	126	160	131	122
	5	164	132	121	150	126	117
	10	158	130	119	144	124	115
2	1	178	146	134	161	137	128
	5	166	139	128	150	131	122
	10	159	135	124	144	127	119

dB: decibel; km: kilometer(s); m: meters; µPa: micro pascal; µPa²-s: squared micro pascal-second; re: referenced to

* Mach number equals aircraft speed divided by the speed of sound.

3.0.5.3.2 Energy Stressors

This section describes the characteristics of energy introduced into the water through Navy training and testing activities and the relative magnitude and location of these activities to provide the basis for analysis of potential electromagnetic and laser impacts on resources in the remainder of Chapter 3 (Affected Environment and Environmental Consequences).

3.0.5.3.2.1 Electromagnetic Devices

Electromagnetic energy emitted from magnetic influence mine neutralization systems is analyzed in this document. The training and testing activities that involve the use of magnetic influence mine neutralization systems are detailed in Tables 3.0-21 – 3.0-22. The number and location of events that use these electromagnetic devices are detailed in Table 3.0-23.

Table 3.0-21: Training Activities That Involve the Use of Electromagnetic Devices

Training
Mine Warfare
• Airborne Mine Countermeasures (Towed-Mine Neutralization) • Coordinated Unit Level Helicopter Airborne Mine Countermeasure Exercises • Civilian Port Defense

Table 3.0-22: Testing Activities That Involve the Use of Electromagnetic Devices

Testing
Mine Warfare
• Airborne Towed Minesweeping Test • Mine Countermeasure/Neutralization Testing
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Electromagnetic Operations • Mine Countermeasure/Neutralization Testing
South Florida Ocean Measurement Facility Testing Range Activities
• Mine Research, Development, Testing, and Evaluation Activities

Table 3.0-23: Annual Number and Location of Events Using Electromagnetic Devices

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
VACAPES (W-50, Lower Chesapeake Bay)	980	0	0	0	0	0
VACAPES (W-50, W-72)	0	0	0	30	0	0
VACAPES	0	882	882	0	36	40
Navy Cherry Point (ARG Mine Training Area)	183	0	0	0	0	0
Navy Cherry Point	0	185	185	0	0	0
JAX (CSG Mine Training Areas)	134	0	0	0	0	0
JAX	0	157	157	0	0	0
SFOMF	0	0	0	0	21	33
NSWC PCD	0	0	0	99	78	87
GOMEX	0	96	96	0	0	0
Gulf of Mexico	0	0	0	0	12	14
Northeast, VACAPES, Navy Cherry Point, JAX, GOMEX	0	1	1		0	0
Total	**1,297**	**1,321**	**1,321**	**129**	**147**	**174**

ARG: Amphibious Readiness Group; CSG: Carrier Strike Group; GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Navy Cherry Point: Navy Cherry Point Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes Range Complex

The majority of devices involved in the activities described above include towed or unmanned mine warfare systems that simply mimic the electromagnetic signature of a vessel passing through the water. None of the devices include any type of electromagnetic "pulse." An example of a representative device is the Organic Airborne and Surface Influence Sweep that would be used by a MH-60S helicopter at sea. The Organic Airborne and Surface Influence Sweep is towed from a forward flying helicopter and works by emitting an electromagnetic field and mechanically generated underwater sound to simulate the presence of a ship. The sound and electromagnetic signature cause nearby mines to detonate.

Generally, voltage used to power these systems is around 30 volts relative to seawater. This amount of voltage is comparable to two automobile batteries. Since saltwater is an excellent conductor, only very moderate voltages of 35 volts (capped at 55 volts) are required to generate the current. These small levels represent no danger of electrocution in the marine environment, because the difference in electric charge is very low in saltwater.

The static magnetic field generated by the electromagnetic devices is of relatively minute strength. Typically, the maximum magnetic field generated would be approximately 23 gauss (G). 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 (150-200 G) and a standard household can opener (up to 4 G at 4 in.). The strength of the electromagnetic field decreases quickly away from the cable. The magnetic field generated at a distance of 13.12 ft. (4 m) from the source is comparable to the earth's magnetic field, which is approximately 0.5 G. The strength of the field at just under 26 ft. (8 m) is only 40 percent of the earth's field, and only 10 percent at 79 ft. (24 m). At a radius of 656 ft. (200 m) the magnetic field would be approximately 0.002 G (U.S. Department of the Navy 2005).

The kinetic energy weapon (commonly referred to as the rail gun) is under development and will likely be tested and eventually used in training events aboard surface vessels, firing non-explosive projectiles at land or sea-based targets. The system uses stored electrical energy to accelerate the projectiles, which are fired at supersonic speeds over great distances. The system charges for two minutes, and fires in less than a second, therefore, any electromagnetic energy released would be done so over a very short period. Also, the system would likely be shielded so as not to affect shipboard controls and systems. The amount of electromagnetic energy released from this system would likely be low and contained on the surface vessel. Therefore, this device is not expected to result in any impacts and will not be further analyzed for biological resources in this document.

3.0.5.3.2.2 Lasers

The devices discussed here include lasers that can be organized into two categories: (1) low energy lasers and (2) high energy lasers. Low energy lasers are used to illuminate or designate targets, to guide weapons, and to detect or classify mines. High energy lasers are used as weapons to disable surface targets.

Low Energy Lasers

Within the category of low energy lasers, the highest potential level of exposure would be from an airborne laser beam directed at the ocean's surface. An assessment on the use of low energy lasers by the Navy determined that low energy lasers, including those involved in the training and testing activities in this EIS/OEIS, have an extremely low potential to impact marine biological resources (Swope 2010). The assessment determined that the maximum potential for laser exposure is at the ocean's surface, where laser intensity is greatest (Swope 2010). As the laser penetrates the water, 96 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 the greatest potential for impact would be to the eye of a marine mammal or sea turtle. However, an animal's eye would have to be exposed to a direct laser beam for at least 10 seconds or longer to sustain damage. Swope (2010) 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 further analyzed in this document for biological resources.

High Energy Lasers

There are no training activities that involve the use of high energy lasers. Testing activities involving high energy lasers include the high energy laser weapons test.

High energy laser weapons testing involves an approximately 25 kilowatt high energy laser intended to be used as a weapon against stationary and mobile, small surface vessels. The high energy laser would be employed from a hovering or forward flight helicopter and is designed to disable the surface or air target, rendering it immobile. The high energy laser would have a range of up to 4 mi. (6 km). Typically, small boats or other unmanned surface targets would be used during the high energy laser test.

These high energy laser weapons tests would be conducted only in the VACAPES Range Complex. The number of events and locations involving high energy laser weapons tests are detailed in Table 3.0-24: Number and Location of High Energy Laser Events.

Table 3.0-24: Annual Number and Location of High Energy Laser Events

Activity Area	Training			Testing		
	No Action	Alternative 1	Alternative 2	No Action	Alternative 1	Alternative 2
Northeast U.S. Continental Shelf Large Marine Ecosystem						
VACAPES	0	0	0	0	98	108

VACAPES: Virginia Capes Range Complex

3.0.5.3.3 Physical Disturbance and Strike Stressors

This section describes the characteristics of physical disturbance and strike stressors from Navy training and testing activities. It also describes the relative magnitude and location of these activities to provide the basis for analyzing the potential physical disturbance and strike impacts on resources in the remainder of Chapter 3.

3.0.5.3.3.1 Vessels

Vessels used as part of the Proposed Action include ships (e.g., aircraft carriers, surface combatants), support craft, and submarines ranging in size from 5 to over 300 m. Table 3.0-25: Representative Vessel Types, Lengths, and Speeds provides examples of the types of vessels, length, and speeds used in both testing and training activities. The U.S. Navy Fact Files on the World Wide Web provide the latest information on the quantity and specifications of the vessels operated by the Navy.

Navy ships transit at speeds that are optimal for fuel conservation or to meet operational requirements. Large Navy ships (greater than 60 ft. [18 m] in length) generally operate at average speeds in the range of 10 to 15 knots, and submarines generally operate at speeds in the range of 8 to 13 knots. Small craft (for purposes of this discussion – less than 60 ft. [18 m] in length), which are all support craft, have much more variable speeds (dependent on the mission). While these speeds are considered averages and representative of most events, some vessels need to operate outside of these parameters. For example, to produce the required relative wind speed over the flight deck, an aircraft carrier vessel group engaged in flight operations must adjust its speed through the water accordingly. Conversely, there are other instances such as launch and recovery of a small rigid hull inflatable boat, vessel boarding, search, and seizure training events or retrieval of a target when vessels would be dead in the water or moving slowly ahead to maintain steerage. There are a few specific events, including high speed tests of newly constructed vessels such as aircraft carriers, amphibious assault ships and the joint high speed vessel (which would operate at an average speed of 35 knots) where vessels would operate at higher speeds.

The number of Navy vessels in the Study Area at any given time varies and is dependent on local training or testing requirements. Most activities include either one or two vessels and may last from a few hours up to two weeks. Vessel movement as part of the Proposed Action would be widely dispersed throughout the Study Area, but more concentrated in portions of the Study Area near ports, naval installations, range complexes, and testing ranges.

Table 3.0-25: Representative Vessel Types, Lengths, and Speeds

Type	Example(s)	Length	Typical Operating Speed	Max Speed
Aircraft Carrier	Aircraft Carrier (CVN)	>300 m	10 to 15 knots	30+ knots
Surface Combatant	Cruisers (CG), Destroyers (DDG), Frigates (FFG), Littoral Combat Ships (LCS)	100-200 m	10 to 15 knots	30+ knots
Amphibious Warfare Ship	Amphibious Assault Ship (LHA, LHD), Amphibious Transport Dock (LPD), Dock Landing Ship (LSD)	100-300 m	10 to 15 knots	20+ knots
Combat Logistics Force Ships	Fast Combat Support Ship (T-AOE), Dry Cargo/Ammunition Ship (T-AKE), Fleet Replenishment Oilers (T-AO)	200-230 m	8 to 12 knots	25 knots
Support Craft/Other	Amphibious Assault Vehicle (AAV); Combat Rubber Raiding Craft (CRRC); Landing Craft, Mechanized (LCM); Landing Craft, Utility (LCU); Submarine Tenders (AS); Yard Patrol Craft (YP)	5-45 m	Variable	20 knots
Support Craft/Other – Specialized High Speed	High Speed Ferry/Catamaran; Patrol Coastal Ships (PC); Rigid Hull Inflatable Boat (RHIB)	20-40 m	Variable	50+ knots
Submarines	Fleet Ballistic Missile Submarines (SSBN), Attack Submarines (SSN), Guided Missile Submarines (SSGN)	100-200 m	8 to 13 knots	20+ knots

AAV: amphibious assault ship; AS: submarine tenders; CRRC: combat rubber raiding craft; CVN: aircraft carrier; DDG: destroyers; FFG: frigates; LCM: landing craft, mechanized; LCS: littoral combat ship; LCU: landing craft, utility; LHA, LHD: amphibious assault ships; LPD: amphibious transport dock; LSD: dock landing ship; m: meters; PC: patrol coastal ships; RHIB: rigid hull inflatable boat; SSBN: fleet ballistic missile submarines; SSGN: guided missile submarines; SSN: attack submarines; T-AKE: dry cargo/ammunition ship; T-AO: fleet replenishment oilers; T-AOE: fast combat support ship; YP: yard patrol craft

In an attempt to determine traffic patterns for Navy and non-Navy vessels, the Center for Naval Analysis (Mintz and Parker 2006) conducted a review of historic data for commercial vessels, coastal shipping patterns, and Navy vessels. Commercial and non-Navy traffic, which included cargo vessels, bulk carriers, passenger vessels, and oil tankers (all over 65 ft. [20 m] in length), was heaviest near the major shipping ports from the Gulf of Maine to southern Florida, as well as in specific international shipping lanes. Compared to coastal vessel activity, there was relatively little concentration of vessels in the other portions of the Study Area (Mintz and Parker 2006). Navy traffic was heaviest just offshore of Norfolk, Virginia and Jacksonville, Florida, as well as along the coastal waters between the two ports.

Data from 2009 were analyzed by Mintz and Filadelfo (2011) and indicated that along the Atlantic U.S. Exclusive Economic Zone, Navy vessels accounted for slightly less than 6 percent of the total large vessel traffic (from estimated hours) in that area. In the VACAPES and JAX Range Complexes where Navy vessel activity is concentrated, the Navy vessels accounted for seven and 9 percent (respectively) of the total large vessel traffic. Barco et al. (2009) found that military vessels were approximately 18 percent of the total vessels transiting (inbound and outbound) the Chesapeake Bay channel, an area of highly concentrated Navy activity because of the proximity of Naval Station Norfolk. Military vessels would probably comprise an even smaller proportion of total vessels, if smaller vessels (less than 65 ft. [20 m] in length) were factored into these analyses.

The training and testing activities listed in Tables 3.0-26 through 3.0-35 involve the use of vessels.

Table 3.0-26: Training Activities That Involve the Use of Aircraft Carriers

Training
Anti-Air Warfare
• Air Defense Exercises
Anti-Submarine Warfare
• Anti-Submarine Warfare for Composite Training Unit Exercise • Anti-Submarine Warfare for Joint Task Force Exercise/Sustainment Exercise

Table 3.0-27: Testing Activities That Involve the Use of Aircraft Carriers

Testing
Other Testing
• Test and Evaluation Catapult Launch
Ship Construction and Maintenance
New Ship Construction
• Aircraft Carrier Sea Trial – Propulsion Testing • Aircraft Carrier Sea Trial – Gun Testing – Small-Caliber; Medium-Caliber • Aircraft Carrier Sea Trial – Missile Testing • Aircraft Carrier Sea Trial – Bomb Testing • Post-Homeporting Testing (All Classes)
Ship Shock Trials
• Aircraft Carrier Full Ship Shock Trial
Life Cycle Activities
• Ship Signature Testing • Surface Ship Sonar Testing/Maintenance (in OPAREAs and Ports)
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Countermeasure Testing – Acoustic System Testing

Table 3.0-28: Training Activities That Involve the Use of Surface Combatants

Training
Anti-Air Warfare
• Air Defense Exercises • Gunnery Exercise (Surface-to-Air) – Large-Caliber • Gunnery Exercise (Surface-to-Air) – Medium-Caliber • Missile Exercise (Surface-to-Air)
Amphibious Warfare
• Naval Surface Fire Support Exercise – Land-Based Target • Naval Surface Fire Support Exercise – At Sea • Marine Expeditionary Unit Certification Exercise
Anti-Surface Warfare
• Maritime Security Operations • Gunnery Exercise Surface-to-Surface (Ship) – Small-Caliber; Medium-Caliber; Large-Caliber • Missile Exercise (Surface-to-Surface) • Laser Targeting • Sinking Exercise
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Surface • Tracking Exercise/Torpedo Exercise – Helo • Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft • Anti-Submarine Warfare Tactical Development Exercise • Integrated Anti-Submarine Warfare Course • Group Sail • Submarine Command Course • Anti-Submarine Warfare for Composite Training Unit Exercise • Anti-Submarine Warfare for Joint Task Force Exercise/Sustainment Exercise
Electronic Warfare
• Electronic Warfare Operations • Counter Targeting Chaff Exercise – Ship

Table 3.0-29: Testing Activities That Involve the Use of Surface Combatants

Testing
Anti-Submarine Warfare
• Sonobuoy Lot Acceptance test
Ship Construction and Maintenance
New Ship Construction
• Surface Combatant Sea Trials – Propulsion Testing • Surface Combatant Sea Trials – Gun Testing – Large-Caliber • Surface Combatant Sea Trials – Missile Testing • Surface Combatant Sea Trials – Decoy Testing • Surface Combatant Sea Trials – Surface Warfare Testing – Large-Caliber
• Surface Combatant Sea Trials – Anti-Submarine Warfare Testing • Other Class Ship Sea Trial – Propulsion Testing • Other Class Ship Sea Trial – Gun Testing Small-Caliber • Anti-Submarine Warfare Mission Package Testing • Surface Warfare Mission Package Testing – Gun Testing Small-Caliber; Medium-Caliber; Large-Caliber • Surface Warfare Mission Package Testing – Missile/Rocket Testing • Mine Countermeasure Mission Package Testing • Post-Homeporting Testing (all classes)
Ship Shock Trials
• DDG 1000 Zumwalt Class Destroyer Full Ship Shock Trial • Littoral Combat Ship Full Ship Shock Trial
Life Cycle Activities
• Ship Signature Testing • Surface Ship Sonar Testing/Maintenance (in OPAREAs and Ports) • Combat System Ship Qualification Trial – Air Defense • Combat System Ship Qualification Trial – Surface Warfare • Combat System Ship Qualification Trial – Undersea Warfare

Table 3.0-28: Training Activities That Involve the Use of Surface Combatants (Continued)

Training
Mine Warfare
• Mine Countermeasures Exercise – Ship Sonar • Airborne Mine Countermeasures – Towed Mine Neutralization • Airborne Mine Countermeasures – Mine Detection • Mine Countermeasures – Mine Neutralization Small- and Medium-Caliber • Mine Countermeasures – Mine Neutralization – Remotely Operated Vehicle • Civilian Port Defense
Other Training Exercises
• Precision Anchoring • Surface Ship Object Detection • Surface Ship Sonar Maintenance (in OPAREAs and Ports)

Table 3.0-29: Testing Activities That Involve the Use of Surface Combatants (Continued)

Testing
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Surface Operations • Sonar Operations • Electromagnetic Operations • Ordnance Operations • Projectile Firing • Mine Countermeasure/Neutralization Testing • Countermeasure Testing
Naval Undersea Warfare Center Division, Newport Testing Range Activities
• Torpedo Testing
South Florida Ocean Measurement Facility Testing Range Activities
• Signature Analysis Activities • Mine Testing Activities
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Missile Testing • Kinetic Energy Weapon Testing • Torpedo (Non-Explosive) Testing • Torpedo (Explosive) Testing • Countermeasure Testing – Acoustic System Testing • Countermeasure Testing • At-Sea Sonar Testing
Mine Warfare Testing
• Mine Detection and Classification • Mine Countermeasure/Neutralization Testing
Shipboard Protection Systems and Swimmer Defense Testing
• Shipboard Protection Systems Testing • Chemical/Biological Simulant Testing
Other Testing
• Radio Frequency Communications Testing

Table 3.0-30: Training Activities That Involve the Use of Amphibious Warfare Ships

Training
Anti-Air Warfare
• Air Defense Exercises
Amphibious Warfare
• Marine Expeditionary Unit Certification Exercise • Amphibious Assault • Amphibious Raid/Humanitarian Assistance Operations

Table 3.0-31: Testing Activities That Involve the Use of Amphibious Warfare Ships

Testing
Ship Construction and Maintenance
New Ship Construction
• Other Class Ship Sea Trial – Propulsion Testing • Other Class Ship Sea Trial – Gun Testing Small-Caliber • Post-Homeporting Testing (All Classes)
Life Cycle Activities
• Ship Signature Testing • Combat System Ship Qualification Trial – Air Defense • Combat System Ship Qualification Trial – Surface Warfare
South Florida Ocean Measurement Facility Testing Range Activities
• Signature Analysis Activities
Mine Warfare Testing
• Mine Detection and Classification • Mine Countermeasure/Neutralization Testing

Table 3.0-32: Training Activities That Involve the Use of Support Craft

Training
Amphibious Warfare
• Naval Surface Fire Support Exercise – At Sea • Marine Expeditionary Unit Certification Exercise • Amphibious Assault • Amphibious Raid/Humanitarian Assistance Operations
Strike Warfare
• High-Speed Anti-Radiation Missile Exercise (Air-to- Surface)
Anti-Surface Warfare
• Maritime Security Operations • Maritime Security Operations- Anti-swimmer Grenades • Gunnery Exercise Surface-to-Surface (Boat) – Small-Caliber; Medium-Caliber • Laser Targeting
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Submarine • Tracking Exercise/Torpedo Exercise – Surface • Tracking Exercise/Torpedo Exercise – Helo • Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft
Mine Warfare
• Mine Neutralization/Explosive Ordnance Disposal • Underwater Mine Countermeasure Raise, Tow, Beach, and Exploitation Operations • Airborne Mine Countermeasures – Towed Mine Neutralization • Airborne Mine Countermeasures – Mine Detection • Civilian Port Defense
Other Training Exercises
• Search and Rescue

Table 3.0-33: Testing Activities That Involve the Use of Support Craft

Testing
Anti-Surface Warfare
• High Energy Laser Weapon Test
Ship Construction and Maintenance
New Ship Construction
• Surface Combatant Sea Trials – Missile Testing • Other Class Ship Sea Trial – Propulsion Testing • Other Class Ship Sea Trial – Gun Testing Small-Caliber • Post-Homeporting Testing (All Classes)
Ship Shock Trials
• Aircraft Carrier Full Ship Shock Trial • DDG 1000 Zumwalt Class Destroyer Full Ship Shock Trial • Littoral Combat Ship Full Ship Shock Trial
Life Cycle Activities
• Ship Signature Testing
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Surface Operations • Subsurface Operations • Sonar Operations • Electromagnetic Operations • Ordnance Operations • Projectile Firing • Unmanned Underwater Vehicle Demonstration • Mine Detection and Classification Testing • Stationary Source Testing • Unmanned Underwater Vehicle Testing • Ordnance Testing – Line Charge Testing
Naval Undersea Warfare Center Division, Newport Testing Range Activities
• Launcher Testing • Torpedo Testing • Towed Equipment Testing • Unmanned Underwater Vehicle Testing • Unmanned Surface Vehicle Testing • Unmanned Aerial System Testing • Semi-Stationary Equipment Testing • Unmanned Underwater Vehicle Demonstrations • Pierside Integrated Swimmer Defense Testing

Table 3.0-33: Testing Activities That Involve the Use of Support Craft (Continued)

South Florida Ocean Measurement Facility Testing Range Activities
• Mine Testing Activities • Surface Testing Activities • Subsurface Testing Activities • Unmanned Underwater Vehicle Demonstrations
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Torpedo (Non-Explosive) Testing • Torpedo (Explosive) Testing
Shipboard Protection Systems and Swimmer Defense Testing
• Pierside Integrated Swimmer Defense
Unmanned Vehicle Testing
• Unmanned Vehicle Development and Payload Testing
Other Testing
• Special Warfare • Radio-Frequency Communications Testing

Table 3.0-34: Training Activities That Involve the Use of Submarines

Training
Anti-Surface Warfare
• Sinking Exercise
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Submarine • Tracking Exercise/Torpedo Exercise – Surface • Tracking Exercise/Torpedo Exercise – Helo • Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft • Tracking Exercise – Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys • Anti-Submarine Warfare Tactical Development Exercise • Integrated Anti-Submarine Warfare Course • Group Sail • Submarine Command Course • Anti-Submarine Warfare for Composite Training Unit Exercise • Anti-Submarine Warfare for Joint Task Force Exercise/Sustainment Exercise
Other Training Exercises
• Submarine Navigational • Submarine Under Ice Certification • Submarine Sonar Maintenance (in OPAREAs and Ports)

Table 3.0-35: Testing Activities That Involve the Use of Submarines

Testing
Ship Construction and Maintenance
New Ship Construction
• Submarine Sea Trial – Propulsion Testing • Submarine Sea Trial – Weapons System Testing • Submarine Sea Trial – Anti-Submarine Warfare Testing
Life Cycle Activities
• Ship Signature Testing • Submarine Sonar Testing/Maintenance (in OPAREAs and Ports)
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Subsurface Operations • Mine Detection and Classification Testing • Special Warfare Testing
South Florida Ocean Measurement Facility Testing Range Activities
• Signature Analysis Activities • Mine Research, Development, Testing, and Evaluation Activities
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Anti-Submarine Warfare Torpedo Test • Anti-Submarine Warfare Tracking Test – Helicopter • Anti-submarine Warfare Tracking Test – Maritime Patrol Aircraft • Missile Testing • Electronic Warfare Testing • Torpedo (Non-Explosive) Testing • Torpedo (Explosive) Testing • At-Sea Sonar Testing
Unmanned Vehicle Testing
• Underwater Deployed Unmanned Aerial System Testing
Other Testing
• Special Warfare • Radio–Frequency Communications Testing • Hydrodynamic Testing

Figures 3.0-20 and 3.0-21 provide estimates of relative vessel use by location, the Preferred Alternative, which is based on the estimated number of events that include the use of vessels for each alternative (See Table 3.0-36: Number and Location of Events Including Vessel Movement). The location and hours of Navy vessel usage for testing and training activities are most dependent upon the locations of Navy

ports, piers and established at-sea testing and training areas. With the exception of the establishment of the Undersea Warfare Training Range, these areas have not appreciably changed in the last decade and are not expected to change in the foreseeable future.

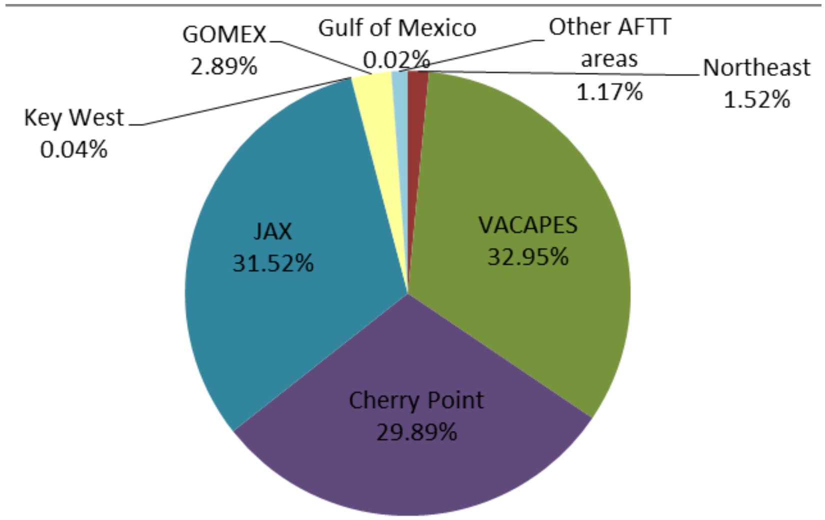

Figure 3.0-20: Vessel Use by Area for Training Under the Preferred Alternative

AFTT: Atlantic Fleet Training and Testing; Gulf of Mexico refers to the body of water; Navy Cherry Point: Navy Cherry Point Range Complex; GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area.

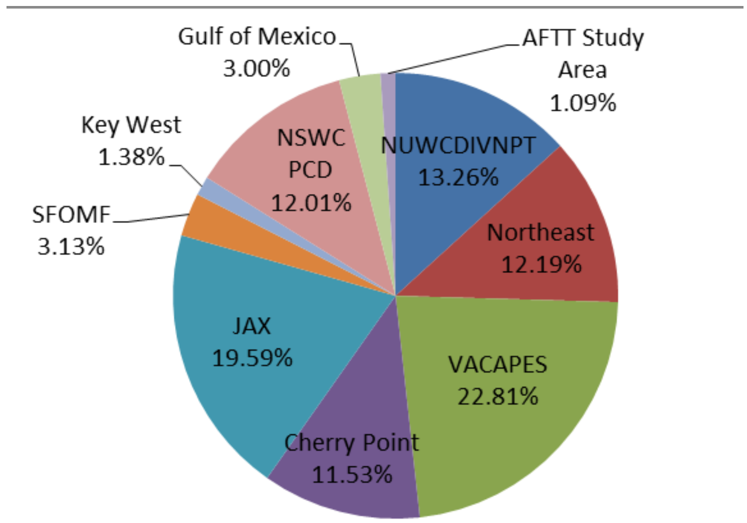

Figure 3.0-21: Vessel Use by Area for Testing Under the Preferred Alternative

AFTT: Atlantic Fleet Training and Testing; Navy Cherry Point: Navy Cherry Point Range Complex; Gulf of Mexico refers to the body of water; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area. AFTT Study Area means it could occur anywhere within the Study Area.

Table 3.0-36: Annual Number and Location of Events Including Vessel Movement

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
NUWCDIVNPT	0	0	0	0	452	499
Northeast	533	470	470	321	417	459
VACAPES	4,957	10,206	10,210	225	803	859
Navy Cherry Point	4,013	9,261	9,263	0	410	434
JAX	3,395	9,759	9,767	2	706	738
SFOMF	0	0	0	0	98	118
Key West	0	12	12	2	45	52
NSWC PCD	0	0	0	365	397	452
GOMEX	222	895	895	17	0	0
Gulf of Mexico	49	5	5	0	101	113
Other AFTT areas	6	361	363	2	0	0
AFTT Study Area	0	0	0	0	36	41
Total	**13,176**	**30,969**	**30,985**	**934**	**3,465**	**3,765**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; Northeast: Northeast Range Complexes; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area. AFTT Study Area means it could occur anywhere within the Study Area, typically to those events that occur while vessels are in transit.

While these estimates provide the average distribution of vessels; actual locations and hours of Navy vessel usage are dependent upon requirements, deployment schedules, annual budgets, and other unpredictable factors. Consequently, vessel use can be highly variable. The difference between the No Action Alternative and Alternatives 1 and 2 includes an expansion of the Study Area and an increase in the number of activities. Multiple activities usually occur from the same vessel, so the increased number of activities is not expected to result in an increase in vessel use or transit. The concentration of use in and the manner in which the Navy uses vessels to accomplish its training and testing activities are likely to remain consistent with the range of variability observed over the last decade. Consequently, the Navy is not proposing appreciable changes in the levels, frequency, or locations where vessels have been used over the last decade.

3.0.5.3.3.2 In-Water Devices

In-water devices as discussed in this analysis include unmanned vehicles such as remotely operated vehicles, unmanned surface vehicles, unmanned underwater vehicles, and towed devices. These devices are self-propelled and unmanned or towed through the water from a variety of platforms, including helicopters, unmanned underwater vehicles, and surface ships. In-water devices are generally smaller than most Navy vessels ranging from several inches to about 15 m (49 ft.). See Table 3.0-37 for a range of in-water devices used. These devices can operate anywhere from the water surface to the benthic zone. Certain devices do not have a realistic potential to strike living marine resources because they either move slowly through the water column (e.g., most unmanned undersurface vehicles) or are closely monitored by observers manning the towing platform (e.g., most towed devices). Because of their size and potential operating speed, unmanned surface vehicles are the in-water devices that operate in a manner with the potential to strike living marine resources.

Table 3.0-37: Representative Types, Sizes, and Speeds of In-Water Devices

Type	Example(s)	Length	Typical Operating Speed
Towed Device	Minehunting SONAR (AQS) Systems; Improved Surface Tow Target (ISTT); Towed SONAR System; MK-103, MK-104 and MK-105 Minesweeping Systems; Organic Airborne and Surface Influence Sweep (OASIS), Orion, Shallow Water Intermediate Search System, Towed Pinger Locator 30	< 10 m	10-40 knots
Unmanned Surface Vehicle	MK-33 Seaborne Power Target (SEPTAR) Drone Boat, QST-35A Seaborne Powered Target, Ship Deployable Seaborne Target (SDST), Small Waterplane Area Twin Hull (SWATH), Unmanned Influence Sweep System (UISS)	< 15 m	Variable, up to 50+ knots
Unmanned Undersea Vehicle	Acoustic Mine Targeting System, Airborne Mine Neutralization System (AMNS), AN/AQS Systems, Archerfish Common Neutralizer, Crawlers, CURV 21, Deep Drone 8000, Deep Submergence Rescue Vehicle, Gliders, Expendable Mobile Anti-Submarine Warfare Training Targets (EMATTs), Light and Heavy Weight Torpedoes, Magnum Remotely Operated Vehicle (ROV), Manned Portables, MINIROVs, MK 30 ASW Targets, Remote Multi-Mission Vehicle (RMMV), Remote Minehunting System (RMS), Unmanned Influence Sweep System (UISS)	< 15 m	1-15 knots

AMNS: airborne mine neutralization system; AQS: minehunting sonar system; ASW: anti-submarine warfare; EMATTs: expendable mobile anti-submarine warfare training targets; ISTT: improved surface tow target; OASIS: orgainic airborne and surface influence sweep; RMMV: remote multi-mission vehicle; RMS: remote minehunting system; ROV: remotely operated vehicle; SDST: ship deployable seaborne target; SEPTAR: seaborne power target; SWATH: small waterpane area twin hull; UISS: unmanned influence sweep system

Training and testing activities that employ towed in-water devices are listed in Tables 3.0-38 through 3.0-43.

Table 3.0-38: Training Activities That Involve the Use of Towed Devices

Training
Anti-Surface Warfare
• Gunnery Exercise Surface-to-Surface (Ship) – Small-Caliber; Medium-Caliber • Gunnery Exercise Surface-to-Surface (Boat) – Medium-Caliber • Missile Exercise (Surface-to-Surface) • Gunnery Exercise (Air-to-Surface) – Small-Caliber; Medium-Caliber • Missile Exercise (Air-to-Surface) – Rocket • Missile Exercise (Air-to-Surface)
Anti-Submarine Warfare
• Integrated Anti-Submarine Warfare Course • Group Sail
Mine Warfare
• Mine Countermeasures Exercise – Ship Sonar • Airborne Mine Countermeasures – Towed Mine Neutralization • Airborne Mine Countermeasures – Mine Detection • Coordinated Unit Level Helicopter Airborne Mine Counter Measure Exercises • Civilian Port Defense

Table 3.0-39: Testing Activities That Involve the Use of Towed Devices

Testing
Mine Warfare
• Airborne Towed Minesweeping Test • Airborne Towed Minehunting Sonar Test
Ship Construction and Maintenance
New Ship Construction
• Mine Countermeasure Mission Package Testing
Life Cycle Activities
• Combat System Ship Qualification Trial – Surface Warfare
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Electromagnetic Operations • Countermeasure Testing – Acoustic Systems Testing
Naval Undersea Warfare Center Division, Newport Testing Range Activities
• Towed Equipment Testing • Unmanned Underwater Vehicle Testing
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Countermeasure Testing – Acoustic System Testing

Table 3.0-40: Training Activities That Involve the Use of Unmanned Surface Vehicles

Training
Amphibious Warfare
• Amphibious Raid/Humanitarian Assistance Operations
Anti-Surface Warfare
• Maritime Security Operations • Gunnery Exercise Surface-to-Surface (Ship) – Small-Caliber; Medium-Caliber; Large-Caliber • Missile Exercise (Surface-to-Surface) • Gunnery Exercise (Air-to-Surface) – Small-Caliber; Medium-Caliber • Missile Exercise (Air-to-Surface)
Mine Warfare
• Airborne Mine Countermeasures – Towed Mine Neutralization • Airborne Mine Countermeasures – Mine Detection • Civilian Port Defense

Table 3.0-41: Testing Activities That Involve the Use of Unmanned Surface Vehicles

Testing
Anti-Surface Warfare
• High Energy Laser Weapon Test
Ship Construction and Maintenance
New Ship Construction
• Surface Combatant Sea Trials – Surface Warfare Testing – Large-Caliber
Naval Undersea Warfare Center Division, Newport Testing Range Activities
• Towed Equipment Testing • Unmanned Surface Vehicle Testing • Unmanned Aerial System Testing
South Florida Ocean Measurement Facility Testing Range Activities
• Mine Testing Activities • Surface Testing Activities
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Missile Testing
Shipboard Protection Systems and Swimmer Defense Testing
• Shipboard Protection Systems Testing
Unmanned Vehicle Testing
• Unmanned Vehicle Development and Payload Testing

Table 3.0-42: Training Activities That Involve the Use of Unmanned Underwater Vehicles

Training
Anti-Surface Warfare
• Sinking Exercise
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Submarine • Tracking Exercise/Torpedo Exercise – Surface • Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft • Integrated Anti-Submarine Warfare Course • Group Sail • Submarine Command Course Operations • Anti-Submarine Warfare for Composite Training Unit Exercise • Anti-Submarine Warfare for Joint Task Force Exercise/Sustainment Exercise
Mine Warfare
• Mine Countermeasures Exercise – Ship Sonar • Underwater Mine Countermeasure Raise, Tow, Beach, and Exploitation Operations • Airborne Mine Countermeasures – Mine Detection • Mine Countermeasures – Mine Neutralization – Remotely Operated Vehicle • Coordinated Unit Level Helicopter Airborne Mine Countermeasures Exercises • Civilian Port Defense

Table 3.0-43: Testing Activities That Involve the Use of Unmanned Underwater Vehicles

Testing
Anti-Submarine Warfare
• Anti-Submarine Warfare Torpedo Test • Anti-Submarine Tracking Test – Helicopter • Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft
Mine Warfare
• Airborne Mine Neutralization Systems Test – ASQ-235 • Airborne Laser-Based Mine Detection and Classification • Mine Countermeasure/Neutralization Testing
Ship Construction and Maintenance
New Ship Construction
• Surface Combatant Sea Trials – Anti-Submarine Warfare Testing • Submarine Sea Trial – Weapons System Testing • Submarine Sea Trial – Anti-Submarine Warfare Testing • Anti-Submarine Warfare Mission Package Testing • Mine Countermeasure Mission Package Testing
Life Cycle Activities
• Combat System Ship Qualification Trial – Undersea Warfare
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Subsurface Operations • Unmanned Underwater Vehicle Demonstrations • Mine Detection and Classification Testing • Mine Countermeasure/Neutralization Testing • Unmanned Underwater Vehicle Testing
Naval Undersea Warfare Center Division, Newport Testing Range Activities
• Launcher Testing • Torpedo Testing • Unmanned Underwater Vehicle Testing • Unmanned Underwater Vehicle Demonstrations
South Florida Ocean Measurement Facility Testing Range Activities
• Signature Analysis Activities • Mine Testing, Activities • Subsurface Testing Activities • Unmanned Underwater Vehicle Demonstrations

Table 3.0-43: Testing Activities That Involve the Use of Unmanned Underwater Vehicles (Continued)

Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Torpedo (Non-Explosive) Testing • Torpedo (Explosive) Testing • Countermeasure Testing
Unmanned Vehicle Testing
• Underwater Deployed Unmanned Aerial System Testing

Table 3.0-44 provides estimates of relative in-water device use and location, for each of the alternatives. These are based on the estimated number of events that include the use of in-water devices for each alternative. While these estimates provide the average distribution of in-water devices, actual locations and hours of Navy in-water device usage are dependent upon military training and testing requirements, deployment schedules, annual budgets, and other unpredictable factors.

Table 3.0-44: Annual Number and Location of Events Including In-Water Devices

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
NUWCDIVNPT	0	0	0	0	312	345
Northeast	268	111	111	207	67	75
VACAPES	3,869	7,470	7,474	124	513	556
Navy Cherry Point	1,233	1,502	1,504	0	20	22
JAX	1,984	3,425	3,433	10	291	296
SFOMF	0	0	0	0	98	118
Key West	0	0	0	0	9	9
NSWC PCD	0	0	0	445	550	621
GOMEX	138	798	798	4	0	0
Gulf of Mexico	15	5	5	0	39	43
Other AFTT Areas	0	284	286	2	0	0
AFTT Study Area	0	0	0	0	4	4
Total	**7,508**	**13,595**	**13,611**	**792**	**1,903**	**2,089**

Navy Cherry Point: Navy Cherry Point Range Complex; GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes Range Complex
Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area. AFTT Study Area means it could occur anywhere within the Study Area, typically to those events that occur while vessels are in transit.

3.0.5.3.3.3 Military Expended Materials

Military expended materials include: (1) all sizes of non-explosive practice munitions, (2) fragments from high-explosive munitions, and (3) expended materials other than munitions, such as sonobuoys, ship hulks, expendable targets and unrecovered aircraft stores (fuel tanks, carriages, dispensers, racks, or similar types of support systems on aircraft).

While disturbance or strike from any material as it falls through the water column is possible, it is not likely because the object will slow in velocity as it sinks toward the bottom and can be avoided by highly mobile organisms. For living marine resources in the water column, the discussion of military expended material strikes focuses on the potential of a strike at the surface of the water. The effect of materials settling on the bottom will be discussed as an alteration of the bottom substrate and associated organisms (i.e., invertebrates and vegetation).

Training and testing activities that involve the use of non-explosive practice munitions (small-, medium-, and large-caliber missiles, rockets, bombs, torpedoes, and neutralizers), fragments from high-explosives, and materials other than munitions (flares, chaff, sonobuoys, parachutes, aircraft stores and ballast, and targets) are detailed in Tables 3.0-45 through 3.0-71.

Table 3.0-45: Training Activities That Expend Non-Explosive Small-Caliber Projectiles

Training
Anti-Surface Warfare
• Gunnery Exercise Surface-to-Surface (Ship) – Small-Caliber
• Gunnery Exercise Surface-to-Surface (Boat) – Small-Caliber
• Gunnery Exercise Air-to-Surface – Small-Caliber
• Sinking Exercise
Mine Warfare
• Mine Countermeasures – Mine Neutralization, Small- and Medium-Caliber

Table 3.0-46: Testing Activities That Expend Non-Explosive Small-Caliber Projectiles

Testing
Anti-Air Warfare
• Air Platform Weapons Integration Test
• Air to Air Weapons Systems Test
Mine Warfare
• Airborne Projectile-Based Mine Clearance System
Ship Construction and Maintenance
New Ship Construction
• Aircraft Carrier Sea Trials – Gun Testing Small-Caliber
• Other Class Ship Sea Trials – Gun Testing Small-Caliber
• Surface Warfare Mission Package Testing – Gun Testing Small-Caliber
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Projectile Firing
• Ordnance Testing – Gun Testing Small-Caliber
Shipboard Protection Systems and Swimmer Defense Testing
• Shipboard Protection Systems Testing

Table 3.0-47: Training Activities That Expend Non-Explosive Medium-Caliber Projectiles

Training
Anti-Air Warfare
• Gunnery Exercise (Air-to-Air) - Medium-Caliber • Gunnery Exercise (Surface-to-Air) – Medium-Caliber
Anti-Surface Warfare
• Gunnery Exercise Surface-to-Surface (Ship) – Medium-Caliber • Gunnery Exercise Surface-to-Surface (Boat) – Medium-Caliber • Gunnery Exercise (Air-to-Surface) – Medium-Caliber • Sinking Exercise
Mine Warfare
• Mine Countermeasures – Mine Neutralization, Small- and Medium-Caliber

Table 3.0-48: Testing Activities That Expend Non-Explosive Medium-Caliber Projectiles

Testing
Anti-Air Warfare
• Air Platform Weapons Integration Test • Air to Air Weapons Systems Test • Air to Air Gunnery Test – Medium-Caliber
Anti-Surface Warfare
• Air-to-Surface Gunnery Test
Mine Warfare
• Airborne Projectile-Based Mine Clearance System
Ship Construction and Maintenance
New Ship Construction
• Aircraft Carrier Sea Trial – Gun Testing Medium-Caliber • Surface Warfare Mission Package Testing – Gun Testing – Medium-Caliber
Life Cycle Activities
• Combat System Ship Qualification Trial – Air Defense • Combat System Ship Qualification Trial – Surface Warfare
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Projectile Firing • Ordnance Testing – Gun Testing – Medium-Caliber

Table 3.0-49: Training Activities That Expend Non-Explosive Large-Caliber Projectiles

Training
Anti-Air Warfare
• Gunnery Exercise (Surface-to-Air) – Large-Caliber
Amphibious Warfare
• Naval Surface Fire Support Exercise – At Sea
Anti-Surface Warfare
• Gunnery Exercise Surface-to-Surface (Ship) – Large-Caliber
• Sinking Exercise

Table 3.0-50: Testing Activities That Expend Non-Explosive Large-Caliber Projectiles

Testing
Ship Construction and Maintenance
New Ship Construction
• Surface Combatant Sea Trials – Gun Testing – Large-Caliber
• Surface Combatant Sea Trials – Surface Warfare Testing – Large-Caliber
• Surface Warfare Mission Package Testing – Gun Testing Large-Caliber
Life Cycle Activities
• Combat System Ship Qualification Trial – Air Defense
• Combat System Ship Qualification Trial – Surface Warfare
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Projectile Firing
• Ordnance Testing – Gun Testing – Large-Caliber
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Kinetic Energy Weapon Testing

Table 3.0-51: Training Activities That Expend Non-Explosive Bombs

Training
Anti-Surface Warfare
• Bombing Exercise (Air-to-Surface)
• Sinking Exercise

Table 3.0-52: Testing Activities That Expend Non-Explosive Bombs

Testing
Anti-Air Warfare
• Air Platform Weapons Integration Test
Anti-Surface Warfare
• Air-to-Surface Bombing Test
Ship Construction and Maintenance
New Ship Construction
• Aircraft Carrier Sea Trial – Bomb Testing

Table 3.0-53: Training Activities That Expend Non-Explosive Missiles or Rockets

Training
Anti-Air Warfare
• Missile Exercise (Air-to-Air) • Missile Exercise (Surface-to-Air)
Anti-Surface Warfare
• Missile Exercise (Surface-to-Surface) • Missile Exercise (Air-to-Surface)-Rocket • Sinking Exercise

Table 3.0-54: Testing Activities That Expend Non-Explosive Missiles or Rockets

Testing
Anti-Air Warfare
• Air Platform Weapons Integration Test • Air to Air Weapons Systems Test • Air to Air Missile Test
Anti-Surface Warfare
• Air-to-Surface Missile Test • Rocket Test
Ship Construction and Maintenance
New Ship Construction
• Surface Combatant Sea Trials – Missile Testing • Surface Warfare Mission Package Testing – Missile/Rocket Testing
Life Cycle Activities
• Combat System Ship Qualification Trial – Air Defense • Combat System Ship Qualification Trial – Surface Warfare
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Missile Testing

Table 3.0-55: Testing Activities That Expend Aircraft Stores

Testing
Anti-Air Warfare
• Air Platform/Vehicle Test • Air Platform Weapons Integration Test

Table 3.0-56: Training Activities That Expend Non-Explosive Sonobuoys

Training
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft • Tracking Exercise/Torpedo Exercise – Helo • Tracking Exercise/Torpedo Exercise – Maritime Patrol Advanced Extended Echo Ranging Sonobuoys • Anti-Submarine Warfare Tactical Development Exercise • Integrated Anti-Submarine Warfare Course • Group Sail • Anti-Submarine Warfare for Composite Training Unit Exercise • Anti-Submarine Warfare for Joint Task Force Exercise/Sustainment Exercise

Table 3.0-57: Testing Activities That Expend Non-Explosive Sonobuoys

Testing
Anti-Submarine Warfare
• Anti-Submarine Warfare Torpedo Test • Sonobuoy Lot Acceptance Test • Anti-Submarine Tracking Test – Helicopter • Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft
Ship Construction and Maintenance
New Ship Construction
• Surface Combatant Sea Trials – Anti-Submarine Warfare Testing • Anti-Submarine Warfare Mission Package Testing
Life Cycle Activities
• Combat System Ship Qualification Trial – Undersea Warfare
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Torpedo (Non-Explosive) Testing

Table 3.0-58: Training Activities That Expend Parachutes

Training
Anti-Air Warfare
• Missile Exercise (Air-to-Air)
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft
• Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys
• Anti-Submarine Warfare Tactical Development Exercise
• Integrated Anti-Submarine Warfare Course
• Group Sail
• Anti-Submarine Warfare for Composite Training Unit Exercise
• Anti-Submarine Warfare for Joint Task Force Exercise /Sustainment Exercise

Table 3.0-59: Testing Activities That Expend Parachutes

Testing
Anti-Air Warfare
• Air to Air Missile Test
Anti-Submarine Warfare
• Anti-submarine Warfare Torpedo Test
• Sonobuoy Lot Acceptance test
• Anti-Submarine Tracking Test – Helicopter
• Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft
Ship Construction and Maintenance
New Ship Construction
• Anti-Submarine Warfare Mission Package Testing
Life Cycle Activities
• Combat System Ship Qualification Trial – Undersea Warfare
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Torpedo (Non-Explosive) Testing
• Torpedo (Explosive) Testing
• Countermeasure Testing

Table 3.0-60: Training Activities That Expend Chaff

Training
Electronic Warfare
• Counter Targeting Chaff Exercise – Ship
• Counter Targeting Chaff Exercise – Aircraft

Table 3.0-61: Testing Activities That Expend Chaff

Testing
Electronic Warfare
• Chaff Test

Table 3.0-62: Training Activities That Expend Flares

Training
Electronic Warfare
• Missile Exercise (Air-to-Air)
• Missile Exercise (Surface-to-Air)
• Counter Targeting Flare Exercise

Table 3.0-63: Testing Activities That Expend Flares

Testing
Electronic Warfare
• Flare Test

Table 3.0-64: Training Activities That Expend Fragments from High-Explosive Munitions

Training
Anti-Air Warfare
• Missile Exercise (Air-to-Air) • Gunnery Exercise (Surface-to-Air) – Large-Caliber • Missile Exercise (Surface-to-Air)
Amphibious Warfare
• Naval Surface Fire Support Exercise – At Sea
Strike Warfare
• High-Speed Anti-Radiation Missile Exercise (Air-to-Surface)
Anti-Surface Warfare
• Maritime Security Operations – Anti-Swimmer Grenades • Gunnery Exercise Surface-to-Surface (Ship) – Medium-Caliber • Gunnery Exercise Surface-to-Surface (Ship) – Large-Caliber • Gunnery Exercise Surface-to-Surface (Boat) – Medium-Caliber • Missile Exercise (Surface-to-Surface) • Gunnery Exercise (Air-to-Surface) – Medium-Caliber • Missile Exercise (Air-to-Surface) – Rocket • Missile Exercise (Air-to-Surface) • Bombing Exercise (Air-to-Surface) • Sinking Exercise
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys • Group Sail • Anti-Submarine Warfare for Composite Training Unit Exercise • Anti-Submarine Warfare for Joint Task Force Exercise /Sustainment Exercise
Mine Warfare
• Mine Neutralization/Explosive Ordnance Disposal • Mine Countermeasure – Mine Neutralization – Remotely Operated Vehicles • Civilian Port Defense

Table 3.0-65: Testing Activities That Expend Fragments from High-Explosive Munitions

Testing
Anti-Surface Warfare
• Air-to-Surface Missile Test • Air-to-Surface Gunnery Test • Rocket Test
Anti-Submarine Warfare
• Sonobuoy Lot Acceptance Test • Anti-Submarine Tracking Test – Helicopter • Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft
Mine Warfare
• Airborne Mine Neutralization Systems Test – ASQ-235 • Airborne Projectile-Based Mine Clearance System • Airborne Towed Minesweeping Test
Ship Construction and Maintenance
New Ship Construction
• Aircraft Carrier Sea Trial – Gun Testing Medium-Caliber; Missile Testing • Surface Warfare Mission Package Testing – Missile/Rocket Testing
Ship Shock Trials
• Aircraft Carrier Full Ship Shock Trial • DDG 1000 Zumwalt Class Destroyer Full Ship Shock Trial • Littoral Combat Ship Full Ship Shock Trial
Life Cycle Activities
• Combat System Ship Qualification Trial – Air Defense • Combat System Ship Qualification Trial – Surface Warfare
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Ordnance Operations • Mine Countermeasure/Neutralization Testing • Ordnance Testing – Line Charge Testing • Ordnance Testing – Gun Testing – Large-Caliber
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Torpedo (Explosive) Testing
Other Testing
• At-Sea Explosives Testing

Table 3.0-66: Training Activities That Expend Targets

Training
Anti-Surface Warfare (ASUW)
• Gunnery Exercise (Surface to-Surface) – Ship Small-Caliber; Medium-Caliber; Large-Caliber • Gunnery Exercise (Surface-to-Surface) – Boat Small-Caliber; Medium-Caliber • Gunnery Exercise (Air-to-Surface) – Small-Caliber; Medium-Caliber • Missile Exercise (Air-to-Surface) • Bombing Exercise (Air-to-Surface) • Sinking Exercise
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Surface • Tracking Exercise/Torpedo Exercise – Helicopter • Tracking Exercise/Torpedo Exercise - Maritime Patrol Aircraft • Tracking Exercise - Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys • Anti-Submarine Warfare Tactical Development Exercise • Integrated Anti-Submarine Warfare Course • Group Sail • Submarine Command Course Operations • Anti-Submarine Warfare For Composite Training Unit Exercise • Anti-Submarine Warfare For Joint Task Force Exercise/Sustainment Exercise
Mine Warfare (MIW)
• Mine Laying • Mine Neutralization – Explosive Ordnance Disposal

Table 3.0-67: Testing Activities That Expend Targets

Testing
Anti-Air Warfare
• Air-to-Air Weapons System Test • Air-to-Air Gunnery Test – Medium-Caliber • Air-to-Air Missile Test
Anti-Surface Warfare (ASUW)
• Air-to-Surface Missile Test • Air-to-Surface Gunnery Test • Rocket Test • Air-to-Surface Bombing Test
Anti-Submarine Warfare (ASW)
• Anti-Submarine Warfare Torpedo Test • Anti-Submarine Warfare Tracking Test – Helicopter • Anti-Submarine Warfare Tracking Test - Maritime Patrol Aircraft
Mine Warfare (MIW)
• Airborne Mine Neutralization Systems Test – AQS-235 • Airborne Projectile-Based Mine Clearance System • Airborne Towed Minesweeping Test • Mine Laying Test
Ship Construction and Maintenance
New Ship Construction
• Surface Combatant Sea Trials – Anti-Submarine Warfare Testing • Submarine Sea Trials - Anti-Submarine Warfare Testing • Anti-Submarine Warfare Mission Package Testing • Surface Combatant Sea Trials – Surface Warfare Testing – Large-Caliber • Aircraft Carrier Sea Trial – Bombing Test • Mine Countermeasure Mission Package Testing
Anti-Surface Warfare (ASUW)/Anti-Submarine Warfare (ASW) Testing
• Kinetic Energy Weapon Testing • Torpedo (Explosive) Testing • Torpedo (Non-Explosive) Testing

Table 3.0-67 Testing Activities That Expend Targets (Continued)

Testing
Mine Warfare (MIW) Testing
• Mine Detection and Classification Testing • Mine Countermeasure/Neutralization Testing
Shipboard Protection Systems and Swimmer Defense Testing
• Shipboard Protection Systems Testing

Table 3.0-68: Training Activities That Expend Torpedo Accessories

Training
Anti-Surface Warfare
• Sinking Exercise
Anti-Submarine Warfare (ASW)
• Tracking Exercise/Torpedo Exercise – Submarine • Tracking Exercise/ Torpedo Exercise – Surface • Tracking Exercise/Torpedo Exercise-Helicopter • Tracking Exercise/Torpedo Exercise-Maritime Patrol Aircraft • Submarine Command Course

Table 3.0-69: Testing Activities That Expend Torpedo Accessories

Testing
Anti-Submarine Warfare (ASW)
• Anti-Submarine Warfare Torpedo Test
Ship Construction and Maintenance
New Ship Construction
• Anti-Submarine Warfare Mission Package Testing
Life Cycle Activities
• Combat System Ship Qualification Trial - Undersea Warfare
Naval Undersea Warfare Center Division, Newport Testing Range
• Torpedo Testing
Anti-Surface Warfare (ASUW)/Anti-Submarine Warfare (ASW) Testing
• Torpedo (Non-Explosive) Testing • Torpedo (Explosive) Testing • Countermeasure Testing

Table 3.0-70: Annual Number and Location of Non-Explosive Practice Munitions Expended

Location	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Airborne Mine Neutralization System Neutralizers						
VACAPES	180	570	570	0	24	77
Navy Cherry Point	27	71	71	0	0	0
JAX	27	71	71	0	24	32
NSWC PCD	0	0	0	80	120	140
GOMEX	0	112	112	0	0	0
Total	**234**	**824**	**824**	**80**	**168**	**249**
Torpedoes						
VACAPES	0	0	0	2	28	30
JAX	0	0	0	2	6	7
Total	**0**	**0**	**0**	**4**	**34**	**37**
Bombs						
VACAPES	555	610	610	655	823	905
Navy Cherry Point	811	1,163	1,163	0	0	0
JAX	696	1,261	1,261	0	240	240
GOMEX	292	335	335	0	0	0
Total	**2,354**	**3,369**	**3,369**	**655**	**1,063**	**1,145**
Rockets						
VACAPES	3,700	0	0	264	1,897	2,102
JAX	0	0	0	113	496	561
Total	**3,700**	**0**	**0**	**377**	**2,393**	**2,663**
Missiles						
Northeast	0	0	0	4	0	0
VACAPES	112	2	2	128	591	658
Navy Cherry Point	8	0	0	0	0	0
JAX	15	2	2	5	57	62
Key West	0	0	0	0	3	3
GOMEX	0	0	0	4	8	10
AFTT Study Area	0	0	0	0	1	1
Total	**135**	**4**	**4**	**141**	**660**	**734**

Table 3.0-70: Annual Number and Location of Non-Explosive Practice Munitions Expended (Continued)

Location	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Large-Caliber Projectiles						
Northeast	0	0	0	148	296	296
VACAPES	3,844	1,644	1,804	0	4,611	4,811
Navy Cherry Point	1,392	854	934	0	0	0
JAX	2,372	1,672	1,832	0	769	769
Key West	0	0	0	0	561	561
NSWC PCD	0	0	0	300	260	280
GOMEX	1,240	1,276	1,276	148	0	0
Gulf of Mexico	0	0	0	0	148	148
Other AFTT Areas	0	457	537	0	0	0
AFTT Study Area	0	0	0	0	6,680	7,100
Total	**8,848**	**5,903**	**6,383**	**596**	**13,325**	**13,965**
Medium-Caliber Projectiles						
Northeast	0	700	700	0	1,400	1,400
VACAPES	226,750	807,810	807,810	42,210	153,670	162,590
Navy Cherry Point	39,075	215,149	215,149	0	22,200	22,200
JAX	68,825	415,075	415,075	16,000	65,600	68,600
Key West	36,000	56,000	56,000	0	6,000	6,000
NSWC PCD	0	0	0	5,272	17,030	18,718
GOMEX	34,880	24,388	24,388	0	0	0
Gulf of Mexico	0	0	0	0	1,400	1,400
Other AFTT Areas	0	33,520	33,520	0	0	0
AFTT Study Area	0	0	0	0	2,800	3,500
Total	**405,530**	**1,552,642**	**1,552,642**	**63,482**	**270,100**	**284,408**
Small-Caliber Projectiles						
Northeast	0	27,500	27,500	0	0	0
VACAPES	1,299,600	3,857,600	3,857,600	800	6,334	7,634
Navy Cherry Point	199,240	543,740	543,740	0	3,333	3,333
JAX	502,440	1,534,500	1,534,500	0	3,333	3,333
NSWC PCD	0	0	0	6,000	6,000	7,000
GOMEX	39,600	73,200	73,200	2,000	0	0
Gulf of Mexico	0	0	0	0	24,000	28,000
Other AFTT Areas	0	227,500	227,500	0	0	0
AFTT Study Area	0	0	0	0	2,000	2,500
Total	**2,040,880**	**6,264,040**	**6,264,040**	**8,800**	**45,000**	**51,800**

Source data: Tables 2.8-1 through 2.8-3

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Multiple: any combination of locations; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Events in Other AFTT Areas typically refer to those events that occur while vessels are in transit.

Table 3.0-71: Annual Number and Location of High-Explosives That May Result in Fragments

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Torpedoes						
Other AFTT Areas (SINKEX Box)	1	1	1	8	0	0
AFTT Study Area	0	0	0	0	8	8
Total	**1**	**1**	**1**	**8**	**8**	**8**
Sonobuoys						
Northeast	340	170	170	224	320	514
VACAPES	340	443	443	172	796	950
Navy Cherry Point	340	183	183	112	112	204
JAX	340	1,113	1,113	152	152	244
Key West	0	0	0	0	1312	1,512
GOMEX	0	0	0	112	112	204
Gulf of Mexico	340	70	70	0	0	0
Other AFTT Areas	0	0	0	184	184	368
Total	**1,700**	**1,979**	**1,979**	**956**	**2,988**	**3,996**
Neutralizers						
VACAPES (W-50)	30	0	0	0	0	0
VACAPES (W-50, W-72)	0	0	0	90	0	0
VACAPES (Little Creek)	0	12	12	0	0	0
VACAPES	0	60	60	0	126	145
JAX	0	0	0	0	24	32
NSWC PCD	0	0	0	40	161	171
GOMEX	0	20	20	0	0	0
Gulf of Mexico	0	0	0	0	12	14
Total	**30**	**92**	**92**	**130**	**323**	**362**
Anti-Swimmer Grenades						
Northeast	0	52	52	0	0	0
VACAPES	0	74	74	0	0	0
Navy Cherry Point	0	28	28	0	0	0
JAX (Charleston OPAREA UNDET Boxes North and South)	80	0	0	0	0	0
JAX	0	24	24	0	0	0
GOMEX (CC UNDET Box E3)	20	0	0	0	0	0
GOMEX	0	28	28	0	0	0
Total	**100**	**206**	**206**	**0**	**0**	**0**

Source data: Tables 2.8-1 through 2.8-3

CC: Corpus Christi; GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; MLTR: Missile Laser Training Range; Multiple: any combination of locations; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; OPAREA: operating area; SINKEX: sinking exercise; SFOMF: South Florida Ocean Measurement Facility Testing Range; UNDET: underwater detonation; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Events in Other AFTT Areas typically refer to those events that occur while vessels are in transit.

Table 3.0-71: Annual Number and Location of High-Explosives That May Result in Fragments (Continued)

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Bombs						
VACAPES (Air-K)	20	0	0	0	0	0
VACAPES	0	64	64	0	0	0
Navy Cherry Point	0	32	32	0	0	0
JAX	0	32	32	0	0	0
GOMEX (W-155 Hotbox)	4	0	0	0	0	0
GOMEX	0	4	4	0	0	0
Other AFTT Areas (SINKEX Box)	1	1	1	0	0	0
Total	**25**	**133**	**133**	**0**	**0**	**0**
Rockets						
Northeast	0	0	0	0	0	0
VACAPES	0	3,800	3,800	0	184	202
Navy Cherry Point	0	0	0	0	0	0
JAX	0	3,800	3,800	0	184	202
Key West	0	0	0	0	0	0
GOMEX	0	380	380	0	0	0
Total	**0**	**7,980**	**7,980**	**0**	**368**	**404**
Missiles						
Northeast	0	4	4	0	8	8
VACAPES (W-386, W-72, R-6604)	0	0	0	5	0	0
VACAPES [W-386 (Air E, F, I, J, K), W-72A]	106	0	0		0	0
VACAPES	72	190	190	0	94	98
Navy Cherry Point [W-122 (16/17, 18/19/20/21)]	24	0	0	0	0	0
Navy Cherry Point	20	91	91	0	0	0
JAX (MLTR)	73	0	0	5	0	0
JAX	15	178	178	0	36	39
Key West	0	8	8	0	0	0
GOMEX	0	8	8	0	0	0
AFTT Study Area	0	0	0	0	4	4
Other AFTT Areas (SINKEX Box)	11	11	11	0	0	0
Total	**321**	**490**	**490**	**10**	**142**	**149**

Source data: Tables 2.8-1 through 2.8-3

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; MLTR: Missile Laser Training Range; Multiple: any combination of locations; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SINKEX: sinking exercise; SFOMF: South Florida Ocean Measurement Facility Testing Range; UNDET: underwater detonation; VACAPES: Virginia Capes Range Complex; W: warning area

Note: Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Events in Other AFTT Areas typically refer to those events that occur while vessels are in transit.

Table 3.0-71: Annual Number and Location of High-Explosives That May Result in Fragments (Continued)

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Large-Caliber Projectiles						
VACAPES (5-C/D, 7-C/D, 8-C/D, 1C-1/2)	858	0	0	0	0	0
VACAPES	0	6,644	6,644	0	1,797	1,797
Navy Cherry Point [W-122 (4/5, 13/14)]	78	0	0	0	0	0
Navy Cherry Point	0	866	866	0	0	0
JAX (BB,CC)	390	0	0	0	0	0
JAX	0	4,448	4,448	0	339	339
Key West	0	0	0	0	339	339
NSWC PCD	0	0	0	0	40	50
GOMEX	0	284	284	0	0	0
Other AFTT Areas (SINKEX Box)	700	700	700	0	0	0
Other AFTT Areas	0	96	96	0	0	0
AFTT Study Area	0	0	0	0	3,920	4,900
Total	**2,026**	**13,038**	**13,038**	**0**	**6,435**	**7,425**
Medium-Caliber Projectiles						
VACAPES	0	49,936	49,936	0	10,200	11,200
Navy Cherry Point	0	21,226	21,226	0	200	200
JAX	0	46,120	46,120	0	10,200	11,200
GOMEX	0	6,352	6,352	0	0	0
Other AFTT Areas	0	320	320	0	0	0
AFTT Study Area	0	0	0	0	2,800	3,500
Total	**0**	**123,954**	**123,954**	**0**	**23,400**	**26,100**

Source data: Tables 2.8-1 through 2.8-3

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SINKEX: sinking exercise; SFOMF: South Florida Ocean Measurement Facility Testing Range; UDNET: underwater detonation; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Events in Other AFTT Areas typically refer to those events that occur while vessels are in transit.

Table 3.0-72: Annual Number and Location of Targets Expended

Location	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Sub-Surface Targets						
Northeast	272	116	116	16	111	128
VACAPES	210	444	444	71	428	471
VACAPES, Navy Cherry Point, JAX	6	8	8	0	0	0
Navy Cherry Point	266	122	122	8	5	9
JAX	818	1,489	1,489	27	181	199
GOMEX	0	0	0	7	29	35
Gulf of Mexico	48	5	5	0	4	4
Other AFTT Areas	0	122	122	5	8	16
Total	**1,621**	**2,306**	**2,306**	**134**	**766**	**862**
Surface Targets						
Northeast	0	11	11	2	4	4
VACAPES	667	1,538	1,538	360	850	936
Navy Cherry Point	187	364	364	0	0	0
JAX	519	1,067	1,067	40	273	287
GOMEX	67	92	92	2	8	10
Gulf of Mexico	0	0	0	0	2	2
Other AFTT Areas	0	44	44	2	0	0
AFTT Study Area	0	0	0	0	3	3
Total	**1,440**	**3,116**	**3,116**	**406**	**1,140**	**1,242**
Air Targets						
VACAPES	0	0	0	110	110	121
Total	**0**	**0**	**0**	**110**	**110**	**121**
Mine Shapes						
VACAPES	0	48	48	42	98	114
Navy Cherry Point	0	24	24	0	0	0
JAX	0	12	12	50	108	118
NSWC PCD	0	0	0	112	395	435
Gulf of Mexico	0	0	0	0	6	7
Total	**0**	**84**	**84**	**204**	**607**	**674**
Ship Hulk						
Other AFTT Areas (SINKEX Box)	6	1	1	0	0	0
Total	**6**	**1**	**1**	**0**	**0**	**0**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; SINKEX: sinking exercise; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Events in Other AFTT Areas typically refer to those events that occur while vessels are in transit.

Table 3.0-73: Annual Number and Location of Other Military Expended Materials Expended

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Anchor Blocks						
VACAPES	12	422	422	164	203	230
Cherry Point	10	20	20	0	0	0
JAX	6	38	38	50	53	64
SFOMF	0	0	0	0	51	66
Key West	0	6	6	0	0	0
NSWC PCD	0	0	0	378	1,079	1,203
GOMEX	0	36	36	0	0	0
Total	**28**	**522**	**522**	**592**	**1,386**	**1,563**
Lightweight Torpedo Accessories						
Northeast	5	1	1	9	127	127
VACAPES	8	5	5	13	227	249
Cherry Point	9	2	2	0	0	0
JAX	31	25	25	17	166	185
Gulf of Mexico	2	1	1	0	12	12
Other AFTT Areas	0	2	2	12	0	0
AFTT Study Area	0	0	0	0	20	20
Total	**55**	**36**	**36**	**51**	**554**	**593**
Heavyweight Torpedo Accessories						
Northeast	22	19	19	34	122	122
VACAPES	7	6	6	0	41	54
Cherry Point	10	1	1	0	0	0
JAX	32	20	20	25	222	271
Gulf of Mexico	1	0	0	0	44	44
Other AFTT Areas	0	34	34	17	0	0
AFTT Study Area	0	0	0	0	28	28
Total	**72**	**80**	**80**	**75**	**455**	**519**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; ; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are areas outside of named range complexes and testing ranges, but still within the AFTT Study Area. Events in Other AFTT Areas typically refer to those events that occur while vessels are in transit.

Table 3.0-73: Annual Number and Location of Other Military Expended Materials Expended (Continued)

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Non-Explosive Sonobuoys						
Northeast	2,134	2,055	2,055	460	1,549	1,977
VACAPES	4,444	4,501	4,501	1,076	5,292	5,923
Navy Cherry Point	1,472	1,464	1,464	224	200	360
JAX	19,837	20,360	20,360	526	2,313	2,647
Key West	0	0	0	0	2,640	3,120
GOMEX	0	0	0	206	488	672
Gulf of Mexico	66	149	149	0	36	36
Other AFTT Areas	428	438	438	620	320	640
AFTT Study Area	0	0	0	0	420	420
Total	**28,381**	**28,967**	**28,967**	**3,112**	**13,258**	**15,795**
Parachutes						
Northeast	2,985	2,426	2,426	474	1,652	2,097
VACAPES	5,394	5,666	5,666	1,270	6,050	6,756
Cherry Point	2,276	1,897	1,897	231	205	369
JAX	21,530	23,898	23,898	561	2,526	2,883
Key West	0	12	12	0	2,640	3,120
GOMEX	0	12	12	211	517	707
Gulf of Mexico	472	221	224	0	38	38
Other AFTT Areas	428	584	584	625	328	656
AFTT Study Area	0	0	0	0	432	432
Total	**33,085**	**34,716**	**34,719**	**3,372**	**14,388**	**17,058**
Aircraft Stores, Ballast, Weapon Carriages						
VACAPES	0	0	0	4,830	6,330	6,576
JAX	0	0	0	516	516	567
Key West	0	0	0	30	30	36
GOMEX	0	0	0	75	75	84
AFTT Study Area	0	0	0	1,275	1,275	1,404
Total	**0**	**0**	**0**	**6,726**	**8,226**	**8,667**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; ; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Events in Other AFTT Areas typically refer to those events that occur while vessels are in transit.

Table 3.0-73: Annual Number and Location of Other Military Expended Materials Expended (Continued)

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Pistons or Endcaps						
Northeast	0	6	6	72	144	144
VACAPES	20,654	2,420	2,420	3,852	6,592	7,172
Cherry Point	6,741	9,266	9,266	155	1,400	1,565
JAX	5,199	7,456	7,456	155	1,652	1,817
Key West	34,500	34,512	34,512	0	0	0
GOMEX	5,604	2,580	2,580	1,560	8,200	9,020
Gulf of Mexico	0	0	0	0	72	72
Total	**72,698**	**56,240**	**56,240**	**5,794**	**18,060**	**19,790**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; VACAPES: Virginia Capes Range Complex

3.0.5.3.3.4 Seafloor Devices

Seafloor devices represent items used during training or testing activities that are deployed onto the seafloor. These items include moored mine shapes, anchors, bottom placed instruments, and robotic vehicles referred to as "crawlers." Seafloor devices are either stationary or move very slowly along the bottom and do not pose a threat to highly mobile organisms. The effect of devices on the bottom will be discussed as an alteration of the bottom substrate and associated living resources (i.e., invertebrates and vegetation).

Training and testing activities that include the deployment of seafloor devices are listed in Tables 3.0-74 and 3.0-75. The location and number of events including seafloor devices are summarized in Table 3.0-76.

Table 3.0-74: Training Activities That Deploy Sea Floor Devices

Training
Mine Warfare
• Mine Countermeasure Exercise – Ship Sonar • Mine Neutralization/Explosive Ordnance Disposal • Underwater Mine Countermeasure – Raise, Tow, Beach, and Exploitation Operations • Airborne Mine Countermeasures – Towed Mine Neutralization • Airborne Mine Countermeasures – Mine Detection • Mine Countermeasures – Mine Neutralization, Small- and Medium-Caliber • Mine Countermeasures – Mine Neutralization – Remotely Operated Vehicles • Coordinated Unit Level Helicopter Airborne Mine Countermeasure • Civilian Port Defense
Other Training Exercises
• Precision Anchoring

Table 3.0-75: Testing Activities That Deploy Sea Floor Devices

Testing
Mine Warfare
• Airborne Mine Neutralization Systems Test – ASQ-235 • Airborne Projectile-Based Mine Clearance System • Airborne Towed Minesweeping Test • Mine Laying Test
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Subsurface Operations • Unmanned Underwater Vehicle Demonstration • Unmanned Underwater Vehicle Testing
Naval Undersea Warfare Center Division, Newport Testing Range Activities
• Unmanned Underwater Vehicle Demonstrations • Pierside Integrated Swimmer Defense Testing
South Florida Ocean Measurement Facility Testing Range Activities
• Mine Testing Activities • Subsurface Testing Activities • Unmanned Underwater Vehicle Demonstrations
Shipboard Protection Systems and Swimmer Defense Testing
• Pierside Integrated Swimmer Defense
Unmanned Vehicle Testing
• Unmanned Vehicle Development and Payload Testing

Table 3.0-76: Annual Number and Location of Events Including Seafloor Devices

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
NUWCDIVNPT	0	0	0	5	1	1
Northeast	0	0	0	1	20	22
VACAPES	2,532	3,854	3,854	164	183	203
Navy Cherry Point	630	656	656	0	20	22
JAX	678	831	831	0	78	80
SFOMF	0	0	0	0	52	67
NSWC PCD	0	0	0	549	1,040	1,171
GOMEX	0	566	566	0	0	0
Gulf of Mexico	0	0	0	0	27	30
Pierside	0	0	0	5	7	9
Total	**3,840**	**5,908**	**5,908**	**724**	**1,428**	**1,605**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes Range Complex

3.0.5.3.3.5 Aircraft Strikes

Aircraft involved in Navy training and testing activities are separated into three categories: (1) fixed-wing aircraft, (2) rotary-wing aircraft, and (3) unmanned aerial systems. Fixed-wing aircraft include, but are not limited to, planes such as F-35, P-8, F/A-18, and F/A-18G. Rotary-wing aircraft are generally helicopters (e.g., MH-60), but also include other platforms (e.g., MV-22). Unmanned aerial systems include a variety of platforms, including but not limited to, STUAS/Tier II, MQ-4C Triton Broad Area Maritime Survelliance, MQ-8 Fire Scout, and Unmanned Combat Air System Demonstration. Aircraft strikes are only applicable to birds.

Tables 3.0-77 through 3.0-82 list the training and testing activities that include the use of various types of aircraft. The location and number of events, including aircraft movement are summarized in Table 3.0-83.

Table 3.0-77: Training Activities That Include Fixed-Wing Aircraft

Training
Anti-Air Warfare
• Air Combat Maneuver • Air Defense Exercises • Gunnery Exercise (Air-to-Air) – Medium-Caliber • Missile Exercise (Air-to-Air)
Amphibious Warfare
• Marine Expeditionary Unit Certification Exercise
Strike Warfare
• High Speed Anti-Radiation Missile Exercise (Air-to-Surface)
Anti-Surface Warfare
• Gunnery Exercise (Air-to-Surface) – Medium-Caliber • Missile Exercise (Air-to-Surface) – Rocket • Missile Exercise (Air-to-Surface) • Bombing Exercise (Air-to-Surface) • Laser Targeting • Sinking Exercise
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Maritime Patrol Aircraft • Tracking Exercise – Maritime Patrol Aircraft Extended Echo Ranging Sonobuoys • Anti-Submarine Warfare Tactical Development Exercise • Integrated Anti-Submarine Warfare Course • Anti-Submarine Warfare for Joint Task Force Exercise /Sustainment Exercise
Electronic Warfare
• Electronic Warfare Operations • Counter Targeting – Flare Exercise • Counter Targeting Chaff Exercise – Aircraft
Mine Warfare
• Mine Laying

Table 3.0-78: Testing Activities That Include Fixed-Wing Aircraft

Testing
Anti-Air Warfare
• All Activities
Anti-Surface Warfare
• Air-to-Surface Missile Test • Air-to-Surface Gunnery Test – Medium-Caliber • Rocket Test • Air-to-Surface Bombing Test • Laser Targeting
Electronic Warfare
• Electronic Systems Evaluation • Chaff Test • Flare Test
Anti-Submarine Warfare
• Anti-Submarine Warfare Torpedo Test • Sonobuoy Lot Acceptance Test • Anti-Submarine Warfare Tracking Test – Maritime Patrol Aircraft
Mine Warfare
• Mine Laying Test
Other Testing
• Test and Evaluation Catapult Launch • Air Platform Shipboard Integrate Test • Shipboard Electronic Systems Evaluation • Maritime Security
Ship Construction and Maintenance
New Ship Construction
• Aircraft Carrier Sea Trial – Gun Testing Medium-Caliber • Aircraft Carrier Sea Trial – Bomb Testing
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Air Operations
South Florida Ocean Measurement Facility Testing Range
• Mine Testing Activities
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Torpedo (Non-Explosive) Testing • Torpedo (Explosive) Testing
Shipboard Protection Systems and Swimmer Defense Testing
• Chemical/Biological Simulant Testing

Table 3.0-79: Training Activities That Include Rotary-Wing Aircraft

Training
Amphibious Warfare
• Marine Expeditionary Unit Certification Exercise • Amphibious Assault
Anti-Surface Warfare
• Maritime Security Operations • Gunnery Exercise (Air-to-Surface) – Small-Caliber • Gunnery Exercise (Air-to-Surface) – Medium-Caliber • Missile Exercise (Air-to-Surface) – Rocket • Missile Exercise (Air-to-Surface) • Laser Targeting • Sinking Exercise
Anti-Submarine Warfare
• Anti-Submarine Warfare Tactical Development Exercise • Integrated Anti-Submarine Warfare Course • Group Sail • Anti-Submarine Warfare for Composite Training Unit Exercise • Anti-Submarine Warfare for Joint Task Force Exercise/Sustainment Exercise
Electronic Warfare
• Electronic Warfare Operations • Counter Targeting – Flare Exercise • Counter Targeting Chaff Exercise – Aircraft
Mine Warfare
• Mine Neutralization/Explosive Ordnance Disposal • Underwater Mine Countermeasure – Raise, Tow, Beach, and Exploitation Operations • Airborne Mine Countermeasures – Towed Mine Neutralization • Airborne Mine Countermeasures – Mine Detection • Mine Countermeasures – Mine Neutralization, Small and Medium-Caliber • Mine Countermeasures – Mine Neutralization – Remotely Operated Vehicles • Coordinated Unit Level Helicopter Airborne Mine Countermeasure Exercise • Civilian Port Defense
Other Training Exercises
• Search and Rescue

Table 3.0-80: Testing Activities That Include Rotary-Wing Aircraft

Testing
Anti-Air Warfare
• Air Platform/Vehicle Test • Air Platform Weapons Integration Test • Air to Air Weapons Systems Test
Anti-Surface Warfare
• Air-to-Surface Missile Test; Gunnery Test • Rocket Test • Laser Targeting • High Energy Laser Weapon Test
Electronic Warfare
• Electronic System Evaluation • Chaff Test • Flare Test
Anti-Submarine Warfare
• Anti-Submarine Warfare Torpedo Test • Kilo Dip • Anti-Submarine Tracking Test – Helicopter
Mine Warfare
• Airborne Mine Neutralization Systems Test – ASQ-235 • Airborne Projectile-Based Mine Clearance System • Airborne Towed Minesweeping Test • Airborne Towed Minehunting Sonar Test • Airborne Laser-Based Mine Detection System Test • Mine Detection and Classification • Mine Countermeasure/Neutralization Testing
Other Testing
• Shipboard Electronic Systems Evaluation • Maritime Security
Ship Construction and Maintenance
New Ship Construction
• Anti-Submarine Warfare Mission Package Testing • Surface Warfare Mission Package Testing – Missile/Rocket Testing • Mine Countermeasure Mission Package Testing

Table 3.0-80: Testing Activities That Include Rotary-Wing Aircraft (Continued)

Life Cycle Activities
• Combat System Ship Qualification Trial – Undersea Warfare
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Air Operations • Electromagnetic Operations • Ordnance Operations • Mine Detection and Classification Testing • Mine Countermeasure/Neutralization Testing • Ordnance Testing – Gun Testing – Small-Caliber; Gun Testing – Medium-Caliber; Gun Testing – Large-Caliber
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Torpedo (Non-Explosive) Testing • Torpedo (Explosive) Testing

Table 3.0-81: Training Activities That Include Unmanned Aerial Systems

Training
Anti-Air Warfare
• Air Defense Exercises • Missile Exercise (Air-to-Air) • Missile Exercise (Surface-to-Air)
Amphibious Warfare
• Naval Surface Fire Support Exercise – Land-Based Target • Amphibious Raid/Humanitarian Assistance Operations
Anti-Surface Warfare
• Maritime Security Operations • Missile Exercise (Air-to-Surface) – Rocket
Anti-Submarine Warfare
• Anti-Submarine Warfare for Composite Training Unit Exercise • Anti-Submarine Warfare for Joint Task Force Exercise /Sustainment Exercise

Table 3.0-82: Testing Activities That Include Unmanned Aerial Systems

Testing
Anti-Air Warfare
• Air Platform/Vehicle Test • Air Platform Weapons Integration Test • Air to Air Weapons Systems Test • Air to Air Missile Test • Air to Air Gunnery Test • Intelligence, Surveillance, and Reconnaissance Test
Ship Construction and Maintenance
New Ship Construction
• Surface Combatant Sea Trials – Missile Testing • Aircraft Carrier Sea Trial – Missile Testing
Life Cycle Activities
• Combat System Ship Qualification Trial – Air Defense
Naval Surface Warfare Center, Panama City Division Testing Range Activities
• Mine Detection and Classification Testing
Naval Undersea Warfare Center Division, Newport Testing Range Activities
• Unmanned Aerial System Testing
Mine Warfare Testing
• Mine Detection and Classification
Unmanned Vehicle Testing
• Underwater Deployed Unmanned Aerial System Testing • Unmanned Vehicle Development and Payload Testing

Table 3.0-83: Annual Number and Location of Events Including Aircraft Movement

Activity Area	Training Activities			Testing Activities		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
NUWCDIVNPT	0	0	0	0	15	17
Northeast	302	147	147	17	362	406
VACAPES	9,728	11,613	11,613	6,135	6,194	6,705
Navy Cherry Point	5,029	11,508	11,508	3,107	1,487	1,660
JAX	3,669	11,572	11,576	3,347	2,203	2,431
SFOMF	0	0	0	0	21	33
Key West	9,636	9,690	9,690	10	43	51
NSWC PCD	0	0	0	548	1,138	1,257
GOMEX	959	1,303	1,303	177	311	348
Gulf of Mexico	49	5	5	0	37	41
Other AFTT Areas	6	181	181	7	8	16
AFTT Study Area	0	0	0	425	9,662	10,629
Total	**29,378**	**46,019**	**46,022**	**13,773**	**21,481**	**23,594**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area. AFTT Study Area means it could occur anywhere within the Study Area, typically to those events that occur while vessels are in transit.

3.0.5.3.4 Entanglement Stressors

This section describes the entanglement stressors introduced into the water through naval training and testing and the relative magnitude and location of these activities to provide the basis for analysis of potential impacts on resources in the remainder of Chapter 3 (Affected Environment and Environmental Consequences). To assess the entanglement risk of materials expended during training and testing, the Navy examined the characteristics of these items (such as size and rigidity) for their potential to entangle marine animals. For a constituent of military expended materials to entangle a marine animal, it must be long enough to wrap around the appendages of marine animals. Another critical factor is rigidity; the item must be flexible enough to wrap around appendages or bodies. This analysis includes the potential impacts from two types of military expended materials including: (1) fiber optic cables and guidance wires, and (2) parachutes.

Unlike typical fishing nets and lines the Navy's equipment is not designed for trapping or entanglement purposes. 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 sea.

3.0.5.3.4.1 Fiber Optic Cables and Guidance Wires

Fiber Optic Cables

The only type of cable expended during Navy training and testing is a fiber optic cable. Fiber optic cable is flexible, durable, and abrasion or chemical-resistant and the physical characteristics of the fiber optic material render the cable brittle and easily broken when kinked, twisted, or bent sharply (i.e., to a radius greater than 360 degrees). The cable is often designed with controlled buoyancy to minimize the cable's effect on vehicle movement. The fiber optic cable would be suspended within the water column during the activity, and then be expended to sink to the sea floor.

Tables 3.0-84 and 3.0-85 list the training and testing activities that include the use of fiber optic cables. The estimated location and number of expended fiber optic cables are detailed below in Table 3.0-86.

Table 3.0-84: Training Activities That Expend Fiber Optic Cables

Training
Mine Warfare
• Mine Countermeasure – Mine Neutralization – Remotely Operated Vehicle • Coordinated Unit Level Helicopter Airborne Mine Countermeasure

Table 3.0-85: Testing Activities That Expend Fiber Optic Cables

Testing
Mine Warfare
• Airborne Mine Neutralization Systems Test – AQS-235

Table 3.0-86: Annual Number and Location of Fiber Optic Cables Expended

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
VACAPES (W-50)	840	0	0	0	0	0
VACAPES (W-50, W-72)	0	0	0	480	0	0
VACAPES	0	2,520	2,520	0	720	888
Navy Cherry Point (Onslow Bay UNDET Area)	108	0	0	0	0	0
Navy Cherry Point	0	284	284	0	0	0
JAX (Charleston OPAREA UNDET Boxes North and South)	108	0	0	0	0	0
JAX	0	284	284	0	192	256
NSWC PCD	0	0	0	480	1,124	1,244
GOMEX	0	528	528	0	0	0
Gulf of Mexico	0	0	0	0	48	56
Total	**1,056**	**3,616**	**3,616**	**960**	**2,084**	**2,444**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Navy Cherry Point: Navy Cherry Point Range Complex; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; OPAREA: operating area; UNDET: underwater detonation; VACAPES: Virginia Capes Range Complex; W: warning area

Guidance Wires

The only types of wires expended during Navy training and testing activities are guidance wires from heavy-weight torpedoes and tube-launched, optically tracked, wire guided missiles. Guidance wires are used to help the firing platform control and steer the torpedo or missile. They trail behind the torpedo or missile as it moves through the water or air. Finally, the guidance wire is released from both the firing platform and the torpedo or tube-launched, optically tracked, wire guided missile and sinks to the ocean floor.

The torpedo guidance wire is a single-strand, thin gauge, coated copper alloy. The tensile breaking strength of the wire is a maximum of 42 lb. (19 kg) and can be broken by hand (Environmental Sciences Group 2005), contrasting with the rope or lines associated with commercial fishing towed gear (trawls), stationary gear (traps), or entanglement gear (gillnets) that utilize lines with substantially higher (up to 500–2,000 lb. [227–907 kg]) breaking strength as their "weak links" to minimize entanglement of marine animals (National Marine Fisheries Service 2008). The physical characteristics of the wire prevent it from tangling, unlike the monofilament fishing lines and polypropylene ropes identified in the literature (U.S. Department of the Navy 1996). Torpedo guidance wire sinks at an estimated rate of 0.7 ft. (0.2 m) per second.

The tube-launched, optically tracked, wire guided missile system has two thin (5.75 mils or 0.146 mm diameter) wires. Two wire dispensers containing several thousand meters each of single-strand wire with a minimum tensile strength of 10 lb. are mounted on the rear of the missile. The length of wire dispensed would generally be equal to the distance the missile travels to impact the target and any undispensed wire would be contained in the dispensers upon impact. While degradation rates for the wire may vary because of changing environmental conditions in seawater, assuming a sequential failure or degradation of the enamel coating (degradation time is about two months), the copper plating (degradation time is about 1.5–25 months), and the carbon-steel core (degradation time is about 8–18 months), degradation of the tube-launched, optically tracked, wire guided missile guide wire would take 12–45 months. Tables 3.0-87 and 3.0-88 list the training and testing activities that include the use of guidance wires. The estimated number of wires and where they would be expended are detailed below in Table 3.0-89.

Table 3.0-87: Training Activities That Expend Guidance Wires

Training
Anti-Surface Warfare
• Sinking Exercise • Missile Exercise (Air-to-Surface)- Navy Cherry Point Range Complex only
Anti-Submarine Warfare
• Tracking Exercise/Torpedo Exercise – Submarine • Submarine Command Course Operations

Table 3.0-88: Testing Activities That Expend Guidance Wires

Testing
Anti-Submarine Warfare
• Anti-Submarine Warfare Torpedo Test
Naval Undersea Warfare Center Division, Newport Testing Range Activities
• Torpedo Testing
Anti-Surface Warfare/Anti-Submarine Warfare Testing
• Torpedo (Non-Explosive) Testing • Torpedo (Explosive) Testing

Table 3.0-89: Annual Number and Location of Guidance Wires Expended

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Northeast	22	19	19	52	146	152
VACAPES	7	6	6	13	225	256
Navy Cherry Point [W-122 (16/17)]	8	0	0	0	0	0
Navy Cherry Point	10	17	17	0	0	0
JAX	32	20	20	35	262	316
Gulf of Mexico	1	0	0	0	44	44
Other AFTT Areas	0	35	35	11	16	16
Total	**80**	**97**	**97**	**111**	**693**	**784**

Gulf of Mexico refers to the body of water; JAX: Jacksonville Range Complex; Navy Cherry Point: Navy Cherry Point Range Complex; Northeast: Northeast Range Complexes; TORPEX: Torpedo Exercise; VACAPES: Virginia Capes Range Complex; W: warning area

Note: Other AFTT Areas are those areas outside of named range complexes and testing ranges but still within the AFTT Study Area.

3.0.5.3.4.2 Parachutes

Aircraft-launched sonobuoys, lightweight torpedoes (such as the MK 46 and MK 54), illumination flares, and targets use nylon decelerators or parachutes ranging in size from 18 to 48 in. (46 to 122 cm) in diameter. The majority of expended parachutes are cruciform decelerators (hereafter referred to as parachutes) associated with sonobuoys, which are relatively small (18 in.), and have short attachment lines. Parachutes are made of cloth and nylon, and many have weights attached to the lines for rapid sinking. At water impact, the parachute assembly is expended, and it sinks away from the unit. The parachute assembly may remain at the surface for 5 to 15 seconds before the parachute and its housing sink to the seafloor, where it becomes flattened (Environmental Sciences Group 2005). Some parachutes are weighted with metal clips that facilitate their descent to the seafloor. Once settled on the bottom the canopy may temporarily billow if bottom currents are present. Training and testing activities that expend parachutes are listed in Tables 3.0-58 and 3.0-59. The estimated number of parachutes and locations where they would be expended were detailed above in Table 3.0-73.

3.0.5.3.5 Ingestion Stressors

This section describes the ingestion stressors introduced into the water through naval training and testing and the relative magnitude and location of these activities to provide the basis for analysis of potential impacts on resources in the remainder of Chapter 3 (Affected Environment and Environmental Consequences). To assess the ingestion risk of materials expended during training and testing, the Navy examined the characteristics of these items (such as buoyancy and size) for their potential to be ingested by marine animals in the Study Area. The Navy expends the following types of materials that could become ingested during training and testing in the Study Area: non-explosive practice munitions (small- and medium-caliber), fragments from high-explosives, fragments from targets, chaff, flare casings (including plastic end caps and pistons), and parachutes. Other military expended materials such as targets, large-caliber projectiles, intact training and testing bombs, guidance wires, 55-gallon drums, sonobuoy tubes, and marine markers are too large for marine organisms to consume and are eliminated from further discussion.

Solid metal materials, such as small-caliber projectiles, or fragments from high-explosive munitions, sink rapidly to the seafloor. Lighter items may be caught in currents and gyres or entangled in floating *Sargassum* and could remain in the water column for hours to weeks or indefinitely before sinking (e.g., plastic end caps or pistons).

3.0.5.3.5.1 Non-Explosive Practice Munitions

Only small- or medium-caliber projectiles would be small enough for marine animals to ingest. This would vary depending on the resource and will be discussed in more detail within each resource section. Small- and medium-caliber projectiles include all sizes up to and including those that are 2.25 in. (57 mm) in diameter. These solid metal materials would quickly move through the water column and settle to the sea floor.

The training and testing activities that involve the use of small- and medium-caliber non-explosive practice munitions are listed in Tables 3.0-45 through 3.0-48.

The overall number of events per year that expend small- and medium-caliber non-explosive practice munitions and locations where they occur are detailed below in Table 3.0-90.

3.0.5.3.5.2 Fragments from High-Explosive Munitions

Many different types of high-explosive munitions can result in fragments that are expended at sea during training and testing activities.

Types of high-explosive munitions that can result in fragments include demolition charges, grenades, projectiles, missiles, and bombs. Fragments would result from fractures in the munition casing and would vary in size depending on the size of the net explosive weight and munition type; however, typical sizes of fragments are unknown. These solid metal materials would quickly sink through the water column and settle to the seafloor. Training and testing activities that involve fragments from high-explosives are listed in Tables 3.0-64 and 3.0-65. The overall number of events per year that expend fragments from high-explosive munitions and locations where they occur were detailed above in Table 3.0-71.

3.0.5.3.5.3 Military Expended Materials Other Than Munitions

Several different types of materials other than munitions are expended at sea during training and testing activities.

Table 3.0-90: Annual Number and Location of Small- and Medium-Caliber Non-Explosive Practice Munitions Expended

Location	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Small-Caliber Projectiles						
Northeast	0	27,500	27,500	0	0	0
VACAPES	1,299,600	3,857,600	3,857,600	800	6,334	7,634
Navy Cherry Point	199,240	543,740	543,740	0	3,333	3,333
JAX	502,440	1,534,500	1,534,500	0	3,333	3,333
NSWC PCD	0	0	0	6,000	6,000	7,000
GOMEX	39,600	73,200	73,200	2,000	0	0
Gulf of Mexico	0	0	0	0	24,000	28,000
Other AFTT Areas	0	227,500	227,500	0	0	0
AFTT Study Area	0	0	0	0	2,000	2,500
Total	**2,040,880**	**6,264,040**	**6,264,040**	**8,800**	**45,000**	**51,800**
Medium-Caliber Projectiles						
Northeast	0	700	700	0	1,400	1,400
VACAPES	226,750	807,810	807,810	42,210	153,670	162,590
Navy Cherry Point	39,075	215,149	215,149	0	22,200	22,200
JAX	68,825	415,075	415,075	16,000	65,600	68,600
Key West	36,000	56,000	56,000	0	6,000	6,000
NSWC PCD	0	0	0	5,272	17,030	18,718
GOMEX	34,880	24,388	24,388	0	0	0
Gulf of Mexico	0	0	0	0	1,400	1,400
Other AFTT Areas	0	33,520	33,520	0	0	0
AFTT Study Area	0	0	0	0	2,800	3,500
Total	**405,530**	**1,552,642**	**1,552,642**	**63,482**	**270,100**	**284,408**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Northeast: Northeast Range Complexes; Navy Cherry Point: Navy Cherry Point Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Events in Other AFTT Areas typically refer to those events that occur while vessels are in transit.

Target-Related Materials

At-sea targets are usually remotely operated airborne, surface, or subsurface traveling units, most of which are designed to be recovered for reuse. However, if they are used during activities that utilize high-explosives then they may result in fragments. Expendable targets that may result in fragments would include air-launched decoys, surface targets (such as marine markers, paraflares, cardboard boxes, and 10 ft. diameter red balloons), and mine shapes. Most target fragments would sink quickly to the seafloor. Floating material, such as Styrofoam, may be lost from target boats and remain at the surface for some time (see Section 2.3.3, Targets, for additional information on targets). Only targets that may result in smaller fragments are included in the analyses of ingestion potential.

The training and testing activities that may expend targets are listed in Tables 3.0-66 and 3.0-67. There are additional types of targets discussed previously, but only surface targets, air targets, and mine shapes would be expected to result in fragments when high-explosive munitions are used. The number and location per year of targets used during training and testing activities with the potential to result in small fragments are detailed below in Table 3.0-91.

Table 3.0-91: Annual Number and Location of Targets That May Result in Fragments

Location	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Surface Targets						
Northeast	0	11	11	2	4	4
VACAPES	667	1,538	1,538	360	850	936
Navy Cherry Point	187	364	364	0	0	0
JAX	519	1,067	1,067	40	273	287
GOMEX	67	92	92	2	8	10
Gulf of Mexico	0	0	0	0	2	2
Other AFTT Areas	0	44	44	2	0	0
AFTT Study Area	0	0	0	0	3	3
Total	**1,440**	**3,116**	**3,116**	**406**	**1,140**	**1,242**
Air Targets						
VACAPES	0	0	0	110	110	121
Total	**0**	**0**	**0**	**110**	**110**	**121**
Mine Shapes						
VACAPES	0	48	48	42	98	114
Navy Cherry Point	0	24	24	0	0	0
JAX	0	12	12	50	108	118
NSWC PCD	0	0	0	112	395	435
Gulf of Mexico	0	0	0	0	6	7
Total	**0**	**84**	**84**	**204**	**607**	**674**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); JAX: Jacksonville Range Complex; Navy Cherry Point: Navy Cherry Point Range Complex; Northeast: Northeast Range Complexes; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; VACAPES: Virginia Capes Range Complex

Note: Other AFTT Areas are areas outside of named range complexes and testing ranges but still within the AFTT Study Area. Events in Other AFTT Areas typically refer to those events that occur while vessels are in transit.

Chaff

Chaff consists of reflective, aluminum-coated glass fibers used to obscure ships and aircraft from radar-guided systems. Chaff, which is stored in canisters, is either dispensed from aircraft or fired into the air from the decks of surface ships when an attack is imminent. The glass fibers create a radar cloud that mask the position of the ship or aircraft. Chaff is composed of an aluminum alloy coating on glass fibers of silicon dioxide (U.S. Air Force 1997). Chaff is released or dispensed in cartridges or projectiles 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 et al. 2002; U.S. Air Force 1997). Doppler radar has tracked chaff plumes containing approximately 900 g of chaff drifting 200 mi. (322 km) from the point of release, with the plume covering greater than 400 $mi.^3$ (1,667 km^3) (Arfsten et al. 2002).

The chaff concentrations that marine animals could be exposed to following the release of multiple cartridges (e.g., following a single day of training) is difficult to accurately estimate because it depends on several factors. First, specific release points are not recorded and tend to be random, and chaff dispersion in air depends on prevailing atmospheric conditions. After falling from the air, chaff fibers would be expected to float on the sea surface for some period, depending on wave and wind action. The fibers would be dispersed farther by sea currents as they float and slowly sink toward the bottom. Chaff concentrations in benthic habitats following the release of a single cartridge would be lower than the values noted in this section, based on dispersion by currents and the dilution capacity of the ocean.

Several literature reviews and controlled experiments indicate that chaff poses little risk to organisms, except at concentrations substantially higher than those that could reasonably occur from military training (Arfsten et al. 2002; Hullar et al. 1999; U.S. Air Force 1997). Nonetheless, some marine animal species within the Study Area could be exposed to chaff through direct body contact, inhalation, and ingestion. 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 marine animals would occasionally come in direct contact with chaff fibers while either at the water's surface or while submerged, but 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. 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. Air Force 1997). The potential exists for marine animals to inhale chaff fibers if they are at the surface while chaff is airborne. Arfsten et al. (2002), Hullar et al. (1999), and U.S. Air Force (1997) reviewed the potential impacts of chaff inhalation on humans, livestock, and other animals and concluded that the fibers are too large to be inhaled into the lungs. The fibers were predicted to be deposited in the nose, mouth, or trachea and are either swallowed or expelled.

In laboratory studies conducted by the University of Delaware (Hullar et al. 1999), blue crabs and killifish were fed a food-chaff mixture daily for several weeks and no significant mortality was observed at the highest exposure treatment. Similar results were found when chaff was added directly to exposure chambers containing filter-feeding menhaden. Histological examination indicated no damage from chaff exposures. A study on cow calves that were fed chaff found no evidence of digestive disturbance or other clinical symptoms (U.S. Air Force 1997).

Chaff cartridge plastic end caps and pistons would also be released into the marine environment, where they would persist for long periods and could be ingested by marine animals. Chaff end caps and pistons sink in saltwater (Spargo 2007).

The training and testing activities that involve chaff are listed in Tables 3.0-60 and 3.0-61. The estimated number of events per year that would involve expending chaff and locations where they occur are detailed below in Table 3.0-92.

Table 3.0-92: Annual Number and Location of Chaff Cartridges and Canisters Expended

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Northeast	0	0	0	72	144	144
VACAPES	19,978	1,792	1,792	2,000	3,592	3,872
Navy Cherry Point	6,164	7,304	7,304	120	1,200	1,345
JAX	4,684	5,788	5,788	120	1,452	1,597
Key West	30,000	30,000	30,000	0	0	0
GOMEX	3,764	728	728	672	4,200	4,620
Gulf of Mexico	0	0	0	0	72	72
Total	**64,590**	**45,612**	**45,612**	**2,984**	**10,660**	**11,650**

GOMEX: Gulf of Mexico Range Complex (Gulf of Mexico refers to the body of water); Navy Cherry Point: Navy Cherry Point Range Complex; Northeast: Northeast Range Complexes; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; VACAPES: Virginia Capes Range Complex

Flares

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 and fired from ships. The flare device consists of a cylindrical cartridge approximately 1.4 in. (3.6 cm) in diameter and 5.8 in. (14.7 cm) in length. Flares are designed to burn completely. The only material that would enter the water would be a small, round, plastic end cap (approximately 1.4 in. [3.6 cm] in diameter).

An extensive literature review and controlled experiments conducted by the U.S. Air Force revealed that self-protection flare use poses little risk to the environment or animals (U.S. Air Force 1997).

The training and testing activities that involve the use of flares are listed in Tables 3.0-62 and 3.0-63. The overall number of events per year that expend flares is detailed below in Table 3.0-93.

Table 3.0-93: Annual Number and Location of Flares Expended

Activity Area	Training			Testing		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Northeast	0	6	6	0	0	0
VACAPES	676	628	628	1,852	3,000	3,300
Navy Cherry Point	577	1,962	1,962	35	200	220
JAX	515	1,668	1,668	35	200	220
Key West	4,500	4,512	4,512	0	0	0
GOMEX	1,840	1,852	1,852	888	4,000	4,400
Total	**8,108**	**10,628**	**10,628**	**2,810**	**7,400**	**8,140**

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; Key West: Key West Range Complex; Navy Cherry Point: Navy Cherry Point Range Complex; Northeast: Northeast Range Complexes; VACAPES: Virginia Capes Range Complex

Parachutes

Aircraft-launched sonobuoys, lightweight torpedoes (such as the MK 46 and MK 54), and targets use nylon parachutes ranging in size from 18 to 48 in. (46 to 122 cm) in diameter. Training and testing activities that expend parachutes were listed above in Tables 3.0-58 and 3.0-59. The estimated number of parachutes and locations where they would be expended were detailed above in Table 3.0-73.

3.0.5.4 Resource-Specific Impacts Analysis for Individual Stressors

The direct and indirect impacts of each stressor carried forward for further analysis were analyzed for each resource in their respective section. Quantitative and semi-quantitative methods were used to the extent possible, but inherent scientific limitations required the use of qualitative methods for most stressor/resource interactions. Resource-specific methods are described in sections of Chapter 3, 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. The frequency of exposure to stressors or frequency of a proposed activity was characterized as intermittent or continuous, 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., $ft.^2$, nm^2) 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. For example, exposure of an organism to sound produced by an underwater explosion could result in no response, a physiological response such as increased heart rate, a behavioral response such as being startled, injury, or mortality.
- 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. For biological resources, the analysis started with individual organisms and their habitats, and then addressed populations, species, communities, and representative ecosystem characteristics, as appropriate.

3.0.5.5 Resource-Specific Impacts Analysis for Multiple Stressors

The stressors associated with the proposed training and testing 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 that resource. 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). In some ways, this analysis is similar to the cumulative impacts analysis described below, but it only considers the activities in the alternatives and not other past, present, and reasonably foreseeable future actions. This step helps focus the next steps of the approach (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 is such that mitigation would be necessary to offset adverse impacts.

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

- Information obtained from the analysis of individual stressors was used to develop a conceptual model to predict the combined impacts of all stressors on each resource. This conceptual model incorporated factors such as the co-occurrence of stressors in space and time; the 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 was only possible for stressors with identical and quantifiable assessment endpoints. For example, if one stressor disturbed 0.25 nm^2 of benthic habitat, a second stressor disturbed 0.5 nm^2, and all other stressors did not disturb benthic habitat, then the total benthic habitat disturbed would be 0.75 nm^2. For stressors with identical but not quantifiable assessment endpoints, available scientific knowledge, best professional judgment, and the general assumptions outlined above were used to evaluate potential additive impacts.
- For stressors with differing impacts and assessment endpoints, the potential for additive, synergistic, and antagonistic effects were evaluated based on available scientific knowledge, professional judgment, and the general assumptions outlined above.

3.0.5.6 Cumulative Impacts

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 4, Cumulative Impacts) considers other actions regardless of what agency (federal or nonfederal) or person undertakes the actions. Cumulative impacts result when individual actions combine with similar actions taking place over a period of time to produce conditions that frequently alter the historical baseline (40 C.F.R. § 1508.7). The goal of the analysis is to provide the decision makers with information relevant to reasonably foresee potentially significant impacts. See Chapter 4 (Cumulative Impacts) for the specific approach used for determining cumulative impacts.

3.0.5.7 Biological Resource Methods

The analysis of impacts on biological resources focused on the likelihood of encountering the stressor, the primary stimulus, response, and recovery of individual organisms. Where appropriate, the differential potential of biological resources to overlap with stressors was considered at the level of specific geographic areas (large marine ecosystems, open ocean areas, range complexes, operating areas, and other training and testing areas). Additionally, the different aspects of training versus testing activities were considered with regard to how they may impact the resource.

3.0.5.7.1 Conceptual Framework for Assessing Effects from Sound-Producing Activities

This conceptual framework describes the different types of effects that are possible and the potential relationships between sound stimuli and long-term consequences for the individual and population. The conceptual framework is central to the assessment of acoustic-related effects and is consulted multiple times throughout the process. It describes potential effects and the pathways by which an acoustic stimulus or sound-producing activity can potentially affect animals. The conceptual framework qualitatively describes costs to the animal (e.g., expended energy or missed feeding opportunity) that may be associated with specific reactions. Finally, the conceptual framework outlines the conditions that may lead to long-term consequences for the individual and population if the animal cannot fully recover from the short-term effects. Within each biological resource section (e.g., marine mammals, birds, and fish) the detailed methods to predict effects on specific taxa are derived from this 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 may result from exposure to sound-producing activities. The severity of these effects can vary greatly between minor effects that have no real cost to the animal, to more severe effects that may have lasting consequences. Whether a marine animal is significantly affected must be determined from the best available scientific data regarding the potential physiological and behavioral responses to sound-producing activities and the possible costs and long-term consequences of those responses.

The major categories of potential effects are:

- Direct trauma
- Auditory fatigue
- Auditory masking
- Behavioral reactions
- Physiological stress

Direct trauma refers to injury to organs or tissues of an animal as a direct result of an intense sound wave or shock wave impinging upon or passing through its body. Potential impacts on an animal’s internal tissues and organs are assessed by considering the characteristics of the exposure and the response characteristics of the tissues. Trauma can be mild and fully recoverable, with no long-term repercussions to the individual or population, or more severe, with the potential for lasting effects or, in some cases, mortality.

Auditory fatigue may result from over-stimulation of the delicate hair cells and tissues within the auditory system. The most familiar effect of auditory fatigue is hearing loss, also called a noise-induced threshold shift, meaning an increase in the hearing threshold.

Audible natural and artificial sounds can potentially result in auditory masking, a condition that occurs when noise interferes with an animal's ability to hear other sounds. Masking occurs when the perception of a sound is interfered with by a second sound, and the probability of masking increases as the two sounds increase in similarity and the masking sound increases in level. It is important to distinguish auditory fatigue, which persists after the sound exposure, from masking, which only occurs during the sound exposure.

Marine animals naturally experience physiological stress as part of their normal life histories. Changing weather and ocean conditions, exposure to diseases and naturally occurring toxins, lack of prey availability, social interactions with conspecifics (members of the same species), and interactions with predators all contribute to the stress a marine animal naturally experiences. 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. However, too much of a stress response can be harmful to an animal, resulting in physiological dysfunction. In some cases, naturally occurring stressors can have profound impacts on animals. Sound-producing activities have the potential to provide additional stress, which must be considered, not only for its direct impact on an animal's behavior but also for contributing to an animal's chronic stress level.

A sound-producing activity can cause a variety of behavioral reactions in animals ranging from very minor and brief, to more severe reactions such as aggression or prolonged flight. The acoustic stimuli can cause a stress reaction (i.e., startle or annoyance); they may act as a cue to an animal that has experienced a stress reaction in the past to similar sounds or activities, or that acquired a learned behavioral response to the sounds from conspecifics. An animal may choose to deal with these stimuli or ignore them based on the severity of the stress response, the animal's past experience with the sound, as well as other stimuli present in the environment. If an animal chooses to react to the acoustic stimuli, then the behavioral responses fall into two categories: alteration of natural behavior patterns or avoidance. The specific type and severity of these reactions helps determine the costs and ultimate consequences to the individual and population.

3.0.5.7.1.1 Flowchart

Figure 3.0-22 is a flowchart that diagrams the process used to evaluate the potential effects on marine animals from sound-producing activities. The shape and color of each box on the flowchart represent either a decision point in the analysis (green diamonds); specific processes such as responses, costs, or recovery (blue rectangles); external factors to consider (purple parallelograms); and final outcomes for the individual or population (orange ovals and rectangles). Each box is labeled for reference throughout the following sections. For simplicity, *sound* is used here to include not only acoustic waves but also shock waves generated from explosive sources. The supporting text clarifies those instances where it is necessary to distinguish between the two phenomena.

Box A1, the *Sound-Producing Activity*, is the source of the sound stimuli and therefore the starting point in the analysis. Each of the five major categories of potential effects (i.e., direct trauma, auditory fatigue, masking, behavioral response, and stress) are presented as pathways that flow from left to right across the diagram. Pathways are not exclusive, and each must be followed until it can be concluded that an animal is not at risk for that specific effect. The vertical columns show the steps in the analysis used to examine each of the effects pathways. These steps proceed from the *Stimuli,* to the *Physiological Responses*, to any potential *Behavioral Responses*, to the *Costs to the Animal*, to the *Recovery* of the animal, and finally to the *Long-Term Consequences* for the *Individual* and *Population*.

3.0.5.7.1.2 Stimuli

The first step in predicting whether a sound-producing activity is capable of causing an effect on a marine animal is to define the *Stimuli* experienced by the animal. The *Stimuli* include the *sound-producing activity*, the surrounding acoustical environment, the characteristics of the sound when it reaches the animal, and whether the animal can detect the sound.

Sounds emitted from a *sound-producing activity* (Box A1) travel through the environment to create a spatially variable sound field. There can be any number of individual sound sources in a given activity, each with its own unique characteristics. For example, a Navy training exercise may involve several ships and aircraft, several types of sonar, and several types of munition. Each of the individual sound sources has unique characteristics: source level, frequency, duty cycle, duration, and rise-time (i.e., impulsive vs. non-impulsive). Each source also has a range, depth/altitude, bearing and directionality, and movement relative to the animal. Environmental factors such as temperature, salinity, bathymetry, bottom type, and sea state all impact how sound spreads through the environment and how sound decreases in amplitude between the source and the receiver (individual animal). Mathematical calculations and computer models are used to predict how the characteristics of the sound will change between the source and the animal under a range of realistic environmental conditions for the locations where sound-producing activities occur.

The details of the overall activity may also be important to place the potential effects into context and help predict the range of severity of the probable reactions. The overall activity level (e.g., number of ships and aircraft involved in exercise); the number of sound sources within the activity; the activity duration; and the range, bearing, and movement of the activity relative to the animal are all considered.

The *received sound at the animal* and the number of times the sound is experienced (i.e., repetitive exposures) (Box A2) determines the range of possible effects. Sounds that are higher than the ambient noise level and within an *animal's hearing sensitivity* range (Box A3) have the potential to cause effects. Very high exposure levels may have the potential to cause trauma; high-level exposures, long-duration exposures, or repetitive exposures may potentially cause auditory fatigue; lower-level exposures may potentially lead to masking; all perceived levels may lead to stress; and many sounds, including sounds that are not detectable by the animal, would have *no* e*ffect* (Box A4).

3.0.5.7.1.3 Physiological Responses

Physiological Responses include direct trauma, hearing loss, auditory masking, and stress. The magnitude of the involuntary response is predicted based on the characteristics of the acoustic stimuli and the characteristics of the animal (species, susceptibility, life history stage, size, and past experiences).

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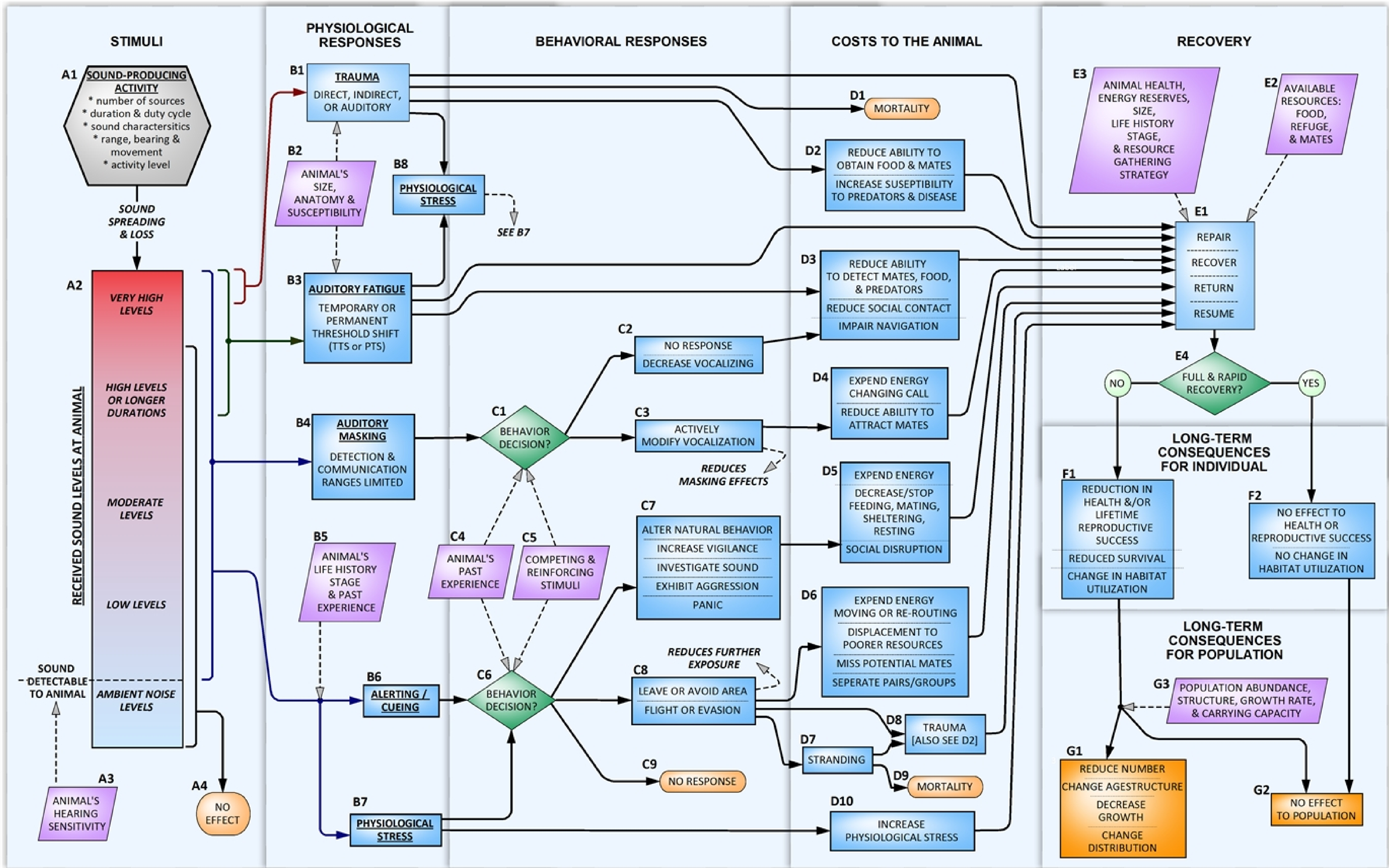

Figure 3.0-22: Flow Chart of the Evaluation Process of Sound-Producing Activities
PTS: permanent threshold shift; TTS: temporary threshold shift

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Trauma

Physiological responses to sound stimulation may range from mechanical vibration (with no resulting adverse effects) to tissue trauma (injury). Direct *trauma* (Box B1) refers to the direct injury of tissues and organs by sound waves impinging upon or traveling through an animal's body. Marine animals' bodies, especially their auditory systems, are well adapted to large hydrostatic pressures and large, but relatively slow, pressure changes that occur with changing depth. However, mechanical trauma may result from exposure to very-high-amplitude sounds when the elastic limits of the auditory system are exceeded or when animals are exposed to intense sounds with very rapid rise times, such that the tissues cannot respond adequately to the rapid pressure changes. Trauma to marine animals from sound exposure requires high received levels. Trauma effects therefore normally only occur with very-high-amplitude, often impulsive, sources, and at relatively close range, which limits the number of animals likely exposed to trauma-inducing sound levels.

Direct *trauma* includes both auditory and non-auditory trauma. Auditory trauma is the direct mechanical injury to hearing-related structures, including tympanic membrane rupture, disarticulation of the middle ear ossicles, and trauma to the inner ear structures such as the organ of Corti and the associated hair cells. Auditory *trauma* differs from auditory fatigue in that the latter involves the overstimulation of the auditory system at levels below those capable of causing direct mechanical damage. Auditory *trauma* is always injurious but can be temporary. One of the most common consequences of auditory trauma is hearing loss (see Auditory Fatigue section below for a description of hearing loss).

Non-auditory trauma can include hemorrhaging of small blood vessels and the rupture of gas-containing tissues such as the lung, swim bladder, or gastrointestinal tract. After the ear (or other sound-sensing organs), these are usually the most sensitive organs and tissues to acoustic trauma. An *animal's size and anatomy* are important in determining its *susceptibility to trauma* (Box B2), especially non-auditory trauma. Larger size indicates more tissue to protect vital organs that might be otherwise susceptible (i.e., there is more attenuation of the received sound before it impacts non-auditory structures). Therefore, larger animals should be less susceptible to trauma than smaller animals. In some cases, acoustic resonance of a structure may enhance the vibrations resulting from noise exposure and result in an increased susceptibility to trauma. Resonance is a phenomenon that exists when an object is vibrated at a frequency near its natural frequency of vibration, or the particular frequency at which the object vibrates most readily. The size, geometry, and material composition of a structure determine the frequency at which the object will resonate. The potential for resonance is determined by comparing the sound frequencies with the resonant frequency and damping of the tissues. Because most biological tissues are heavily damped, the increase in susceptibility from resonance is limited.

Vascular and tissue bubble formation resulting from sound exposure is a hypothesized mechanism of indirect *trauma* to marine animals. The risk of bubble formation from one of these processes, called rectified diffusion, is based on the amplitude, frequency, and duration of the sound (Crum and Mao 1996) and an animal's tissue nitrogen gas saturation at the time of the exposure. Rectified diffusion is the growth of a bubble that fluctuates in size because of the changing pressure field caused by the sound wave. An alternative, but related hypothesis has also been suggested: stable microbubbles could be destabilized by high-level sound exposures such that bubble growth then occurs through static diffusion of gas out of gas-supersaturated tissues. Bubbles have also been hypothesized to result from changes in the dive behavior of marine mammals as a result of sound exposure (Jepson et al. 2003). Vascular bubbles produced by this mechanism would not be a physiological response to the sound exposure, but a cost to the animal because of the change in behavior (3.0.5.7.1.5, Costs to the Animal).

Under either of these hypotheses, several things could happen: (1) bubbles could grow to the extent that vascular blockage (emboli) and tissue hemorrhage occur; (2) bubbles could develop to the extent that a complement immune response is triggered or the nervous tissue is subjected to enough localized pressure that pain or dysfunction occurs; or (3) the bubbles could be cleared by the lung without negative consequence to the animal. Although rectified diffusion is a known phenomenon, its applicability to diving marine animals exposed to sound is questionable; animals would need to be highly supersaturated with gas and very close to a high-level sound source (Crum et al. 2005). The other two hypothesized phenomena are largely theoretical and have not been demonstrated under realistic exposure conditions.

Auditory Fatigue

Auditory fatigue is a reduction in hearing ability resulting from overstimulation to sounds. The mechanisms responsible for auditory fatigue differ from auditory trauma and may consist of a variety of mechanical and biochemical processes, including physical damage or distortion of the tympanic membrane (not including tympanic membrane rupture) and cochlear hair cell stereocilia, oxidative stress-related hair cell death, changes in cochlear blood flow, and swelling of cochlear nerve terminals resulting from glutamate excitotoxicity (Henderson et al. 2006; Kujawa and 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). Auditory fatigue is possibly the best studied type of effect from sound exposures in marine and terrestrial animals, including humans. The characteristics of the received sound stimuli are used and compared to the *animal's hearing sensitivity* and susceptibility to noise (Box A3) to determine the potential for auditory fatigue.

Auditory fatigue manifests itself as hearing sensitivity loss, called a noise-induced threshold shift. A threshold shift may be either permanent threshold shift (PTS), or temporary threshold shift (TTS). Note that the term "auditory fatigue" is often used to mean a TTS; however, in this analysis, a more general meaning to differentiate fatigue mechanisms (e.g., metabolic exhaustion and distortion of tissues) from auditory trauma mechanisms (e.g., physical destruction of cochlear tissues occurring at the time of exposure) is used.

The distinction between PTS and TTS is based on whether there is a complete recovery of hearing sensitivity following a sound exposure. 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, then that remaining threshold shift is a PTS. Figure 3.0-23 shows one hypothetical threshold shift that completely recovers, a TTS, and one that does not completely recover, leaving some PTS.

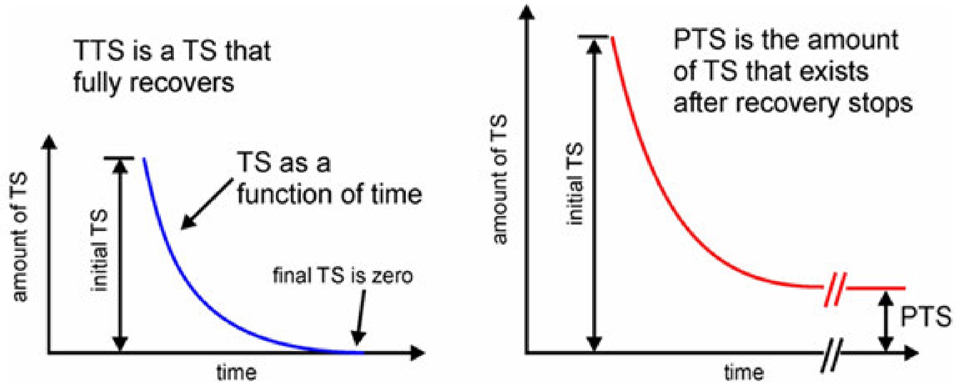

Figure 3.0-23: Two Hypothetical Threshold Shifts
PTS: permanent threshold shift; TS: threshold shift; TTS: temporary threshold shift

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 40–50 dB measured 2 minutes after exposure) will recover with no apparent long-term effects; however, terrestrial mammal studies revealed that large amounts of TTS (e.g., approximately 40 dB measured 24 hours after exposure) can result in permanent neural degeneration, despite the hearing thresholds returning to normal (Kujawa and Liberman 2009). The amounts of TTS induced by Kujawa and Liberman were described as being "at the limits of reversibility." It is unknown whether smaller amounts of TTS can result in similar neural degeneration, or if effects would translate to other species such as marine animals.

The amplitude, frequency, duration, and temporal pattern of the sound exposure are important parameters for predicting the potential for auditory fatigue. Duration is particularly important because auditory fatigue is exacerbated with prolonged exposure time. The frequency of the sound also plays an important role in susceptibility to hearing loss. Experiments show that animals are most susceptible to *fatigue* (Box B3) within their most sensitive hearing range. Sounds outside of an animal's audible frequency range do not cause fatigue.

The greater the degree of threshold shift, the smaller the ocean space within which an animal can detect biologically relevant sounds and communicate. This is referred to as reducing an animal's "acoustic space." This reduction can be estimated given the amount of threshold shift incurred by an animal.

Auditory Masking

Auditory masking occurs if the noise from an activity interferes with an animal's ability to detect, understand, or recognize biologically relevant sounds of interest (Box B4). "Noise" refers to unwanted or unimportant sounds that mask an animal's ability to hear "sounds of interest." A sound of interest refers to a sound that is potentially being detected. Sounds of interest include those from conspecifics 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 frequency, received level, and duty cycle of the noise determine the potential degree of auditory masking. Similar to hearing loss, the greater the degree of masking, the smaller the ocean space within which an animal can detect biologically relevant sounds.

Physiological Stress

If a sound is detected (i.e., heard or sensed) by an animal, a *stress* response can occur (Box B7); or the sound can *cue or alert* the animal (Box B6) without a direct, measurable stress response. If an animal suffers trauma or auditory fatigue, a *physiological stress* response will occur (Box B8). A stress response is a physiological change resulting from a stressor that is meant to help the animal deal with the stressor. The generalized stress response is characterized by a release of hormones (Reeder and Kramer 2005); however, it is now acknowledged that other chemicals produced in a stress response (e.g., stress markers) exist. For example, a release of reactive oxidative compounds, as occurs in noise-induced hearing loss (Henderson et al. 2006), occurs in response to some acoustic stressors. Stress hormones include those produced by the sympathetic nervous system, norepinephrine and epinephrine (i.e., the 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 produced by the adrenal gland. These hormones are classically used as an indicator of a stress response and to characterize the magnitude of the stress response (Hennessy et al. 1979). Oxidative stress occurs when reactive molecules, called reactive oxygen species, are produced in excess of molecules that counteract their activity (i.e., antioxidants).

An acute stress response is traditionally considered part of the startle response and is hormonally characterized by the release of the 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. Alternatively, a stimulus may not cause a measurable stress response but may act as an alert or cue to an animal to change its behavior. This response may occur because of learned associations; the animal may have experienced a stress reaction in the past to similar sounds or activities (Box C4), or it may have learned the response from conspecifics. The severity of the stress response depends on the *received sound level* at the animal (Box A2); the details of the *sound-producing activity* (Box A1); the *animal's life history stage* (e.g., juvenile or adult; breeding or feeding season) (Box B5); and the *animal's past experience* with the stimuli (Box B5). These factors would be subject to individual variation, as well as variation within an individual over time.

An *animal's life history stage* is an important factor to consider when predicting whether a stress response is likely (Box B5). 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. Animals engaged in a critical life activity such as mating or feeding may have a lesser stress response than an animal engaged in a more flexible activity such as resting or migrating (i.e., an activity that does not necessarily depend on the availability of resources). The animal's past experiences with the stimuli or similar stimuli are another important consideration. 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 and Dierauf 2001) or increase the response via sensitization.

3.0.5.7.1.4 Behavioral Responses

Any number of *Behavioral Responses* can result from a physiological response. An animal responds to the stimulus based on a number of factors in addition to the severity of the physiological response. An animal's experience with the sound (or similar sounds), the context of the acoustic exposure, and the presence of other stimuli contribute to determining its reaction from a suite of possible behaviors.

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.

Trauma and Auditory Fatigue

Direct trauma and auditory fatigue increases the animal's *physiological stress* (Box B8), which feeds into the *stress* response (Box B7). Direct trauma and auditory fatigue increase the likelihood or severity of a behavioral response and *increase* an animal's overall physiological stress level (Box D10).

Auditory Masking

A behavior decision is made by the animal when the animal detects increased background noise, or possibly when the animal recognizes that biologically relevant sounds are being masked (Box C1). An *animal's past experience* with the sound-producing activity or similar acoustic stimuli can affect its choice of behavior during auditory masking (Box C4). *Competing and reinforcing stimuli* may also affect its decision (Box C5).

An animal may exhibit a passive behavioral response when coping with auditory masking (Box C2). 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, auditory masking will continue, depending on the acoustic stimuli.

An animal may actively compensate for auditory masking (Box C3). An animal can vocalize more loudly to make its signal heard over the masking noise. An animal may also shift the frequency of its vocalizations away from the frequency of the masking noise. This shift can actually reduce the masking effect for the animal and other animals that are "listening" in the area. For example, in marine mammals, vocalization changes have been reported from exposure to anthropogenic noise sources such as sonar, vessel noise, and seismic surveying. Changes included mimicry of the sound, cessation of vocalization, increases and decreases in vocalization length, increases and decreases in vocalization rate, and increases in vocalization frequency and level, while other animals showed no significant changes in the presence of anthropogenic sound.

An *animal's past experiences* can be important in determining what behavior decision it may make when dealing with auditory masking (Box C4). Past experience can be with the sound-producing activity itself or with similar acoustic stimuli. 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 (Box C5). These stimuli can be other acoustic stimuli not directly related to the sound-producing activity; they can be visual, olfactory, or tactile stimuli; the stimuli can be conspecifics or predators in the area; or the stimuli can be the strong drive to engage in a natural behavior. In some cases, natural motivations may suppress any behavioral reactions elicited by the acoustic stimulus. For example, an animal involved in mating or foraging may not react with the same degree of severity as it may have otherwise. Reinforcing stimuli reinforce the behavioral reaction caused by acoustic stimuli. For example, awareness of a predator in the area coupled with the acoustic stimuli may elicit a stronger reaction than the acoustic stimuli itself otherwise would have. The visual stimulus of seeing ships and aircraft, coupled with the acoustic stimuli, may also increase the likelihood or severity of a behavioral response.

Behavioral Reactions and Physiological Stress

A *physiological stress* response (Box B7) such as an annoyance or startle reaction, or a *cueing or alerting* reaction (Box B6) may cause an animal to make a *behavior decision* (Box C6). Any exposure that produces an injury or auditory fatigue is also assumed to produce a *stress* response (Box B7) and increase the severity or likelihood of a behavioral reaction. Both an animal's past experience (Box C4) and *competing and reinforcing stimuli* (Box C5) can affect an animal's behavior decision. The decision can result in three general types of behavioral reactions: *no response* (Box C9), *area avoidance* (Box C8), or *alteration of a natural behavior* (Box C7).

Little data exist that correlate specific behavioral reactions with specific stress responses. Therefore, in practice the likely range of behavioral reactions is estimated from the acoustic stimuli instead of the magnitude of the stress response. It is assumed that a stress response must exist to alter a natural behavior or cause an avoidance reaction. Estimates of the types of behavioral responses that could occur for a given sound exposure can be determined from the literature.

An *animal's past experiences* can be important in determining what behavior decision it may make when dealing with a stress response (Box C4). Past experience can be with the sound-producing activity itself or with similar sound stimuli. Habituation is the process by which an animal learns to ignore or tolerate stimuli over some period of time and return to a normal behavior pattern, perhaps after being exposed to the stimuli with no negative consequences. A habituated animal may have a lesser behavioral response than the first time it encountered the stimuli. Sensitization is when an animal becomes more sensitive to a set of stimuli over time, perhaps as a result of a past, negative experience with the stimuli or similar stimuli. A sensitized animal may have a stronger behavioral response than the first time it encountered the stimuli.

Other *stimuli* (Box C5) present in the environment can influence an animal's *behavior decision* (Box C6). These stimuli may not be directly related to the sound-producing activity, such as visual stimuli; the stimuli can be conspecifics or predators in the area, or the stimuli can be the strong drive to engage or continue in a natural behavior. In some cases, natural motivations (i.e., competing stimuli) may suppress any behavioral reactions elicited by the acoustic stimulus. tend to suppress any potential behavioral reaction. For example, an animal involved in mating or foraging may not react with the same degree of severity as an animal involved in less-critical behavior. Reinforcing stimuli reinforce the behavioral reaction caused by acoustic stimuli. For example, the awareness of a predator in the area coupled with the acoustic stimuli may elicit a stronger reaction than the acoustic stimuli themselves otherwise would have.

The visual stimulus of seeing human activities such as ships and aircraft maneuvering, coupled with the acoustic stimuli, may also increase the likelihood or severity of a behavioral response. It is difficult to separate the stimulus of the sound from the stimulus of the ship or platform creating the sound. The sound may act as a cue, or as one stimulus of many that the animal is considering when deciding how to react. An activity with several platforms (e.g., ships and aircraft) may elicit a different reaction than an activity with a single platform, both with similar acoustic footprints. The total number of vehicles and platforms involved, the size of the activity area, and the distance between the animal and activity are important considerations when predicting behavioral responses.

An animal may reorient or become more *vigilant* if it detects a sound-producing activity (Box C7). Some animals may *investigate* the sound using other sensory systems (e.g., vision), and perhaps move closer to the sound source. *Reorientation, vigilance, and investigation* all require the animal to divert attention and resources and therefore slow or stop their presumably beneficial natural behavior. This can be a very brief diversion, after which the animal continues its natural behavior, or an animal may not resume its natural behaviors until after a longer period when the animal has habituated to the sound or the activity has concluded. An attentional change via an orienting response represents behaviors that would be considered mild disruption. More severe alterations of natural behavior would include *aggression or panic*.

An animal may choose to *leave or avoid an area* where a sound-producing activity is taking place (Box C8). Avoidance is the displacement of an individual from an area. A more severe form of this comes in the form of flight or evasion. A flight response is a dramatic change in normal movement to a directed and rapid movement away from the detected location of a sound source. Avoidance of an area can help the animal avoid further acoustic effects by avoiding or reducing further exposure.

An animal may choose *not to respond* to a sound-producing activity (Box C9). The physiological stress response may not rise to the level that would cause the animal to modify its behavior. The animal may have habituated to the sound or simply learned through past experience that the sound is not a threat. In this case a behavioral effect would not be predicted. An animal may choose not to respond to a sound-producing activity in spite of a physiological stress response. Some combination of competing stimuli may be present such as a robust food patch or a mating opportunity that overcomes the stress response and suppresses any potential behavioral responses. If the noise-producing activity persists over long periods or reoccurs frequently, the acute stress felt by animals could increase their overall chronic stress levels.

3.0.5.7.1.5 Costs to the Animal

The potential costs to a marine animal from an involuntary or behavioral response include no measurable cost, expended energy reserves, increased stress, reduced social contact, missed opportunities to secure resources or mates, displacement, and stranding or severe evasive behavior (which may potentially lead to secondary trauma or death). Animals suffer costs on a daily basis from a host of natural situations such as dealing with predator or competitor pressure. If the costs to the animal from an acoustic-related effect fall outside of its normal daily variations, then individuals must recover from significant costs to avoid long-term consequences.

Trauma

Trauma or injury to an animal may *reduce its ability to secure food* by *reducing its mobility* or the efficiency of its sensory systems, make the injured individual *less attractive to potential mates*, or increase *an individual's chances of contracting diseases or falling prey to a predator* (Box D2). A severe trauma can lead to the *death* of the individual (Box D1).

Auditory Fatigue and Auditory Masking

Auditory fatigue and masking can impair an animal's ability to hear biologically important sounds (Box D3), especially fainter and distant sounds. Sounds could belong to conspecifics such as other individuals in a social group (i.e., pod, school, etc.), potential mates, potential competitors, or parents/offspring.

Biologically important sounds could also be an animal's own biosonar echoes used to detect prey, sounds from predators, and sounds from the physical environment. Therefore, auditory masking or a hearing loss could reduce an animal's ability to contact social groups, offspring, or parents; and reduce opportunities to detect or attract more distant mates. Animals may also use sounds to gain information about their physical environment by detecting the reverberation of sounds in the underwater space or sensing the sound of crashing waves on a nearby shoreline. These cues could be used by some animals to migrate long distances or navigate their immediate environment. Therefore, an animal's ability to navigate may be impaired if the animal uses acoustic cues from the physical environment to help identify its location. Auditory masking and fatigue both effectively reduce the animal's acoustic space and the ocean volume in which detection and communication are effective.

An animal that modifies its vocalization in response to auditory masking could incur a cost (Box D4). Modifying vocalizations may cost the animal energy from its finite energy budget, 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 and Ripmeester 2008). Increasing the frequency of these vocalizations could reduce a signaler's attractiveness in the eyes of potential mates even as it improves the overall detectability of the call. Auditory masking or auditory fatigue 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. Auditory fatigue could also be inconsequential for an animal if the frequency range affected is not critical for that animal to hear within, or the auditory fatigue is of such short duration (e.g., a few minutes) that there are no costs to the individual.

Behavioral Reactions and Physiological Stress

An animal that alters its natural behavior in response to stress or an auditory cue may slow or cease its presumably beneficial natural behavior and instead *expend energy* reacting to the sound-producing activity (Box D5). Beneficial 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. The costs of a brief interruption to migrating or sheltering are less clear. Most behavior alterations also require the animal to expend energy for a nonbeneficial behavior. The amount of energy expended depends on the severity of the behavioral response.

An animal that avoids a sound-producing activity may expend additional energy moving around the area, be displaced to poorer resources, miss potential mates, or have social interactions affected (Box D6). Avoidance reactions can cause an animal to expend energy. The amount of energy expended depends on the severity of the behavioral response. Missing potential mates can result in delaying reproduction. Social groups or pairs of animals, such as mates or parent/offspring pairs, could be separated during a severe behavioral response such as flight. 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* (Box D7) or secondary *trauma* (Box D8). Animals that take prolonged flight, a severe avoidance reaction, may injure themselves or strand in an environment for which they are not adapted. Some *trauma* is likely to occur to an animal that strands (Box D8). Trauma can *reduce the animal's ability to secure food and mates*, and *increase the animal's* *susceptibility to predation and disease* (Box D2). An animal that strands and does not return to a hospitable environment quickly will likely *die* (Box D9).

Elevated stress levels may occur whether or not an animal exhibits a behavioral response (Box D10). Even while undergoing a stress response, competing stimuli (e.g., food or mating opportunities) may overcome an animal's initial stress response during the behavior decision. Regardless of whether the animal displays a behavioral reaction, this tolerated stress could incur a cost to the animal. Reactive oxygen species produced during normal physiological processes are generally counterbalanced by enzymes and antioxidants; however, excess stress can result in an excess production of reactive oxygen species, leading to damage of lipids, proteins, and nucleic acids at the cellular level (Berlett and Stadtman 1997; Sies 1997; Touyz 2004).

3.0.5.7.1.6 Recovery

The predicted recovery of the animal (Box E1) is based on the cost of any masking or behavioral response and the severity on any involuntary physiological reactions (e.g., direct trauma, hearing loss, or increased chronic stress). Many effects are fully recoverable upon cessation of the sound-producing activity, and the vast majority of effects are completely recoverable over time; whereas a few effects may not be fully recoverable. The availability of resources and the characteristics of the animal play a critical role in determining the speed and completeness of recovery.

Available resources fluctuate by season, location, and year and can play a major role in an animal's rate of recovery (Box E2). Plentiful *food* can aid in a quicker recovery, whereas recovery can take much longer if food resources are limited. If many potential *mates* are available, an animal may recover quickly from missing a single mating opportunity. *Refuge* or shelter is also an important resource that may give an animal an opportunity to recover or repair after an incurred cost or physiological response.

An *animal's health, energy reserves, size, life history stage, and resource gathering strategy* affect its speed and completeness of recovery (Box E3). Animals that are in good health and have abundant energy reserves before an effect will likely recover more quickly. Adult animals with stored energy reserves (e.g., fat reserves) may have an easier time recovering than juveniles that expend their energy growing and developing and have less in reserve. Large individuals and large species may recover more quickly, also due to having more potential for energy reserves. Animals that gather and store resources, perhaps fasting for months during breeding or offspring rearing seasons, may have a more difficult time recovering from being temporarily displaced from a feeding area than an animal that feeds year round.

Damaged tissues from mild to moderate trauma may heal over time. The predicted recovery of direct trauma is based on the severity of the trauma, availability of resources, and characteristics of the animal. After a sustained injury an animal's body attempts to *repair* tissues. The animal may also need to *recover* from any potential costs due to a decrease in resource gathering efficiency and any secondary effects from predators or disease (Box E1). Moderate to severe trauma that does not cause mortality may never fully heal.

Small to moderate amounts of hearing loss may recover over a period of minutes to days, depending on the nature of the exposure and the amount of initial threshold shift. Severe noise-induced hearing loss may not fully recover, resulting in some amount of permanent hearing loss.

Auditory masking only occurs when the sound source is operating; therefore, direct masking effects stop immediately upon cessation of the sound-producing activity (Box E1). Natural behaviors may *resume* shortly after or even during the acoustic stimulus after an initial assessment period by the animal. Any energetic expenditures and missed opportunities to find and secure resources incurred from masking or a behavior alteration may take some time to *recover*.

Animals displaced from their normal habitat due to an avoidance reaction may *return* over time and *resume* their natural behaviors, depending on the severity of the reaction and how often the activity is repeated in the area. In areas of repeated and frequent acoustic disturbance, some animals may habituate to the new baseline or fluctuations in noise level. More sensitive species, or animals that may have been sensitized to the stimulus over time due to past negative experiences, may not return to an area. Other animals may return but not resume use of the habitat in the same manner as before the acoustic-related effect. For example, an animal may return to an area to feed or navigate through it to get to another area, but that animal may no longer seek that area as refuge or shelter.

Frequent milder physiological responses to an individual may accumulate over time if the time between sound-producing activities is not adequate to give the animal an opportunity to fully recover. An increase in an animal's chronic stress level is also possible if stress caused by a sound-producing activity does not return to baseline between exposures. Each component of the stress response is variable in time, and stress hormones return to baseline levels at different rates. For example, adrenaline is released almost immediately and is used or cleared by the system quickly, whereas glucocorticoid and cortisol levels may take long periods (i.e., hours to days) to return to baseline.

3.0.5.7.1.7 Long-Term Consequences to the Individual and the Population

The magnitude and type of effect and the speed *and completeness of recovery* must be considered in predicting long-term consequences to the individual animal and its population (Box E). Animals that recover quickly and completely from explosive or acoustic-related effects will likely *not suffer reductions in their health or reproductive success, or experience changes in habitat utilization* (Box F2). *No population-level effects* would be expected if individual animals do not suffer reductions in their lifetime reproductive success or change their habitat utilization (Box G2).

Animals that do not recover quickly and fully could suffer *reductions in their health and lifetime reproductive success*; they could be permanently displaced or *change how they utilize the environment*; or they could *die* (Box F1).

Severe injuries can lead to reduced survivorship (longevity), elevated stress levels, and prolonged alterations in behavior that can reduce an animal’s lifetime reproductive success. An animal with decreased energy stores or a lingering injury may be less successful at mating for one or more breeding seasons, thereby decreasing the number of offspring produced over its lifetime.

An animal whose hearing does not recover quickly and fully could suffer a reduction in lifetime reproductive success (Box F1). An animal with decreased energy stores or a PTS may be less successful at mating for one or more breeding seasons, thereby decreasing the number of offspring it can produce over its lifetime.

As mentioned above, the direct effects of masking end when the acoustic stimuli conclude. The direct effects of auditory masking could have long-term consequences for individuals if the activity was continuous or occurred frequently enough; however, most of the proposed training and testing activities are normally spread over vast areas and occur infrequently in a specific area.

Missed mating opportunities can have a direct effect on reproductive success. Reducing an animal's energy reserves over longer periods can directly reduce its health and reproductive success. Some species may not enter a breeding cycle without adequate energy stores, and animals that do breed may have a decreased probability of offspring survival. Animals displaced from their preferred habitat, or those who utilize it differently, may no longer have access to the best resources. Some animals that leave or flee an area during a noise-producing activity, especially an activity that is persistent or frequent, may not return quickly or at all. This can further reduce an individual's health and lifetime reproductive success.

Frequent disruptions to natural behavior patterns may not allow an animal to fully recover between exposures, which increase the probability of causing long-term consequences to individuals. Elevated chronic stress levels are usually a result of a prolonged or repeated disturbance. Excess stress produces reactive molecules in an animal's body that can result in cellular damage (Berlett and Stadtman 1997; Sies 1997; Touyz 2004). Chronic elevations in the stress levels (e.g., cortisol levels) may produce long-term health consequences that can reduce lifetime reproductive success.

These long-term consequences to the individual can lead to consequences for the *population* (Box G1). Population *dynamics and abundance* play a role in determining how many individuals would need to suffer long-term consequences before there was an effect on the population (Box G1). Long-term abandonment or a change in the utilization of an area by enough individuals can *change the distribution* of the population. Death has an immediate effect in that no further contribution to the population is possible, which reduces the animal's lifetime reproductive success.

Carrying capacity describes the theoretical maximum number of animals of a particular species that the environment can support. When a population nears its carrying capacity, the lifetime reproductive success in individuals may decrease due to finite resources or predator-prey interactions. *Population growth* is naturally limited by available resources and predator pressure. If one, or a few animals, in a population are removed or gather fewer resources, then other animals 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 effects on a few individuals may not be affected overall.

Populations that exist well below their carrying capacity may suffer greater consequences from any lasting effects on 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. Changing the dynamics of a population (the proportion of the population within each age group) or their geographic distribution can also have secondary effects on population growth rates.

3.0.5.7.2 Conceptual Framework for Assessing Effects from Energy-Producing Activities

3.0.5.7.2.1 Stimuli

Magnitude of the Energy Stressor

Regulations do not provide threshold criteria to determine the significance of the potential effects from activities that involve the use of varying electromagnetic frequencies or high energy lasers. Many organisms, primarily marine vertebrates, have been studied to determine their thresholds for detecting electromagnetic fields, as reviewed by Normandeau (2011); however, there are no data on predictable responses to exposure above or below detection thresholds. The type of electromagnetic fields discussed is from mine neutralization activities (magnetic influence minesweeping). The only types of lasers considered for analysis were weaponized high energy lasers. Since the low to moderate energy lasers (e.g., targeting systems, detection systems, laser light detection and ranging) do not pose a risk to organisms (Swope 2010), they will not be discussed further.

Location of the Energy Stressor

Evaluation of potential energy exposure risks considered the spatial overlap of the resource occurrence and electromagnetic field and high energy laser use. Wherever appropriate, specific geographic areas of potential impact were identified. The greatest potential electromagnetic energy exposure is at the source, where intensity is greatest. The greatest potential for high energy laser exposure is at the ocean's surface, where high energy laser intensity is greatest. As the laser penetrates the water, 96 percent of the beam is absorbed, scattered, or otherwise lost (Swope 2010; Zorn et al. 2000).

Behavior of the Organism

Evaluation of potential energy exposure risk considered the behavior of the organism, especially where the organism lives and feeds (e.g., surface, water column, seafloor). The analysis for electromagnetic devices considered those species with the ability to perceive or detect electromagnetic signals. The analysis for high energy lasers particularly considered those species known to inhabit the surface of the ocean.

3.0.5.7.2.2 Immediate Response and Costs to the Individual

Many different types of organisms (e.g., some invertebrates, fishes, turtles, birds, mammals) are sensitive to electromagnetic fields (Normandeau et al. 2011). An organism that encounters a disturbance in an electromagnetic field could respond by moving toward the source, moving away from it, or not responding at all. The types of electromagnetic devices used in the Proposed Action simulate the electromagnetic signature of a vessel passing through the water column, so the expected response would be similar to that of vessel movement. However, since there would be no actual strike potential, a physiological response would be unlikely in most cases. Recovery of an individual from encountering electromagnetic fields would be variable, but since the physiological response would likely be minimal, as reviewed by Normandeau (2011), any recovery time would also be minimal.

Very little data or information are available to analyze potential impacts on organisms from exposure to high energy lasers. As with humans, the greatest laser-related concern for marine species is damage to an organism's ability to see. High energy lasers may also burn the skin, but the threshold energy level for eye damage is considerably lower, so the analysis considered that lower threshold. Recovery of the individual from eye damage or skin lesion caused by high energy lasers would be based on the severity of the injury and the incidence of secondary infection. Very few studies of this impact are available.

3.0.5.7.2.3 Long-Term Consequences to the Individual and Population

Long-term consequences are considered in terms of a resource's existing population level, growth and mortality rates, other stressors on the resource from the Proposed Action, cumulative impacts on the resource, and the ability of the population to recover from or adapt to impacts. Impacts of multiple or repeated stressors on individuals are cumulative. When stressors are chronic, an organism may experience reduced growth, health, or survival, which could have population-level impacts (Billard et al. 1981), especially in the case of endangered species.

3.0.5.7.3 Conceptual Framework for Assessing Effects from Physical Disturbance or Strike

3.0.5.7.3.1 Stimuli

Size and Weight of the Objects

To determine the likelihood of a strike and the potential impacts on an organism or habitat that would result from a physical strike, the size and weight of the striking object relative to the organism or habitat must be considered. Most small organisms and early life stages would simply be displaced by the movement generated by a large object moving through, or falling into, the water because they are planktonic (floating organisms) and move with the water; however, animals that occur at or near the surface could be struck. A larger nonplanktonic organism could potentially be struck by an object since it may not be displaced by the movement of the water. Sessile (nonmobile) organisms and habitats could be struck by the object, albeit with less force, on the seafloor. The weight of the object is also a factor that would determine the severity of a strike. A strike by a heavy object would be more severe than a strike by a low-weight object (e.g., a parachute, flare end cap, or chaff canister).

Location and Speed of the Objects

Evaluation of potential physical disturbance or strike risk considered the spatial overlap of the resource occurrence and potential striking objects. Analysis of impacts from physical disturbance or strike stressors focuses on proposed activities that may cause an organism or habitat to be struck by an object moving through the air (e.g., aircraft), water (e.g., vessels, in-water devices, towed devices), or dropped into the water (e.g., non-explosive practice munitions and seafloor devices). The area of operation, vertical distribution, and density of these items also play central roles in the likelihood of impact. Wherever appropriate, specific geographic areas of potential impact are identified. Analysis of potential physical disturbance or strike risk also considered the speed of vessels as a measure of intensity. Some vessels move slowly, while others are capable of high speeds.

Buoyancy of the Objects

Evaluation of potential physical disturbance or strike risk in the ocean considered the buoyancy of targets or expended materials during operation, which will determine whether the object will be encountered at the surface, within the water column, or on the seafloor. Once landed on the water surface, buoyant objects have the potential to strike plants and organisms that occur on the sea surface (e.g., drifting into *Sargassum* mats), and negatively buoyant objects may strike plants and organisms within the water column or on the seafloor.

Behavior of the Organism

Evaluation of potential physical disturbance or strike risk considered where organisms occur and if they occur in the same geographic area and vertical distribution as those objects that pose strike risks.

3.0.5.7.3.2 Immediate Response and Costs to the Individual

Before being struck, some organisms would sense a pressure wave through the water and respond by remaining in place, moving away from the object, or moving toward it. An organism displaced a small distance by movements from an object falling into the water nearby would likely continue on with no response. However, others could be disturbed and may exhibit a generalized stress response. If the object actually hit the organism, direct injury in addition to stress may result. The function of the stress response in vertebrates is to rapidly raise the blood sugar level 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 organisms 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.

The ability of an organism 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 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 organism that has reacted to a sudden disturbance by swimming at burst speed would tire after some time; its blood hormone and sugar levels may not return to normal for 24 hours. During the recovery period, the organism 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.

3.0.5.7.3.3 Long-Term Consequences to the Population

Long-term consequences are considered in terms of a resource's existing population level, growth and mortality rates, other stressors on the resource from the Proposed Action, cumulative impacts on the resource, and the ability of the population to recover from or adapt to impacts. Impacts of multiple or repeated stressors on individuals are cumulative. When stressors are chronic, an organism may experience reduced growth, health, or survival, which could have population-level impacts (Billard et al. 1981), especially in the case of endangered species.

3.0.5.7.4 Conceptual Framework for Assessing Effects from Entanglement

3.0.5.7.4.1 Stimuli

Physical Properties of the Objects

For an organism to become entangled in military expended materials, the materials must have certain properties, such as the ability to form loops and a high breaking strength. Some items could have a relatively low breaking strength on their own, but that breaking strength could be increased if multiple loops were wrapped around an entangled organism.

Location of the Objects

Evaluation of potential entanglement risk considered the spatial overlap of the resource occurrence and military expended materials. Distribution and density of expended items play a central role in the likelihood of impact. Wherever appropriate, specific geographic areas of potential impact are identified.

Buoyancy of Objects

Evaluation of potential entanglement risk considered the buoyancy of military expended materials to determine whether the object will be encountered within the water column (including the surface) or on the seafloor. Less buoyant materials, such as torpedo guidance wires, sink rapidly to the seafloor. More buoyant materials include less dense items (e.g., parachutes) that are weighted and would sink slowly to the seafloor and could be entrained in currents.

Behavior of the Organism

Evaluation of potential entanglement risk considered the general behavior of the organism, including where the organism typically occurs (e.g., surface, water column, seafloor). The analysis particularly considered those species known to become entangled in nonmilitary expended materials (e.g., "marine debris") such as fishing lines, nets, rope, and other derelict fishing gear that often entangle marine organisms.

3.0.5.7.4.2 Immediate Response and Costs to the Individual

The potential impacts of entanglement on a given organism depend on the species and size of the organism. Species that have protruding snouts, fins, or appendages are more likely to become entangled than smooth-bodied organisms. Also, items could get entangled by an organism's mouth, if caught on teeth or baleen, with the rest of the item trailing alongside the organism. 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 and in the process may become even more entangled, possibly leading to a stress response. The net result of being entangled by an object could be disruption of the normal behavior, injury due to lacerations, and other sublethal or lethal impacts.

3.0.5.7.4.3 Long-Term Consequences to the Individual and Population

Consequences of entanglement could range from an organism successfully freeing itself from the object or remaining entangled indefinitely, possibly resulting in lacerations and other sublethal or lethal impacts. Stress responses or infection from lacerations could lead to latent mortality. The analysis will focus on reasonably foreseeable long-term consequences of the direct impact, particularly those that could impact the fitness of an individual. Changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success could have population-level impacts if enough individuals are impacted. This population-level impact would vary among species and taxonomic groups.

3.0.5.7.5 Conceptual Framework for Assessing Effects from Ingestion

3.0.5.7.5.1 Stimuli

Size of the Objects

To assess the ingestion risk from military expended materials, this analysis considered the size of the object relative to the animal's ability to swallow it. Some items are too large to be ingested (e.g., non-explosive practice bombs and most targets) 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 are carried forward for analysis within each resource section where applicable.

Location of the Objects

Evaluation of potential ingestion risk considered the spatial overlap of the resource occurrence and military expended materials. The distribution and density of expended items play a central role in the likelihood of impact. Wherever appropriate, specific geographic areas of potential impact were identified.

Buoyancy of the Objects

Evaluation of potential ingestion risk considered the buoyancy of military expended materials to determine whether the object will be encountered within the water column (including the surface) or on the seafloor. Less buoyant materials, such as solid metal materials (e.g., projectiles or munition fragments), sink rapidly to the seafloor. More buoyant materials include less dense items (e.g., target fragments and parachutes) that may be caught in currents and gyres or entangled in floating *Sargassum*. These materials can remain in the water column for an indefinite period of time before sinking. However, parachutes are weighted and would generally sink, unless that sinking is suspended, in the scenario described here.

Feeding Behavior

Evaluation of potential ingestion risk considered the feeding behavior of the organism, including where (e.g., surface, water column, seafloor) and how (e.g., filter feeding) the organism feeds and what it feeds on. The analysis particularly considered those species known to ingest nonfood items (e.g., plastic or metal items).

3.0.5.7.5.2 Immediate Response and Costs to the Individual

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 were 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. An object may even be enclosed by a cyst in the gut lining. The net result of ingesting large foreign objects is disruption of the normal feeding behavior, which could be sublethal or lethal.

3.0.5.7.5.3 Long-Term Consequences to the Individual and Population

Consequences of ingesting nonfood items could be nutrient deficiency, bioaccumulation, uptake of toxic chemicals, compaction, and mortality. The analysis focused on reasonably foreseeable long-term consequences of the direct impact, particularly those that could impact the fitness of an individual. Changes in an individual's growth, survival, annual reproductive success, or lifetime reproductive success could have population-level impacts if enough individuals were impacted. This population-level impact would vary among species and taxonomic groups.

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3.1 SEDIMENTS AND WATER QUALITY

SEDIMENTS AND WATER QUALITY SYNOPSIS

The Navy considered all potential stressors and determined that military expended materials containing the following have the potential to impact sediments and water quality:

- Explosives and explosion byproducts
- Metals
- Chemicals other than explosives
- Other materials

Preferred Alternative (Alternative 2)
Impacts from explosion byproducts could be short-term and local; impacts from unconsumed explosives and metals could be long-term and local. In both situations, chemical, physical, or biological changes to sediments or water quality would be measurable but below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses. Impacts from chemicals other than explosives and from other materials could be both short- and long-term and local. Chemical, physical, or biological changes to sediments or water quality would not be detectable and would be below or within existing conditions or designated uses.

3.1.1 INTRODUCTION AND METHODS

3.1.1.1 Introduction

The following sections provide an overview of the characteristics of sediments and water quality in the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area), and describe in general terms the methods used to analyze potential impacts on these resources from the Proposed Action.

3.1.1.1.1 Sediments

The discussion of sediments begins with an overview of sediment sources and characteristics in the Study Area and considers factors that affect sediment quality.

3.1.1.1.1.1 Characteristics of Sediment

Sediment is the solid fragments of organic and inorganic matter created from weathering rock transported by water, wind, and ice (glaciers) and deposited at the bottom of bodies of water. Components of sediment range in size from boulders, cobble, and gravel to sand (particles 0.05 to 2.0 millimeters [mm] in diameter), silt (0.002 to 0.05 mm), and clay (less than or equal to 0.002 mm). Sediment deposited on the continental shelf is delivered mostly by rivers but also by local and regional currents and wind. Most sediment in nearshore areas and on the continental shelf is aluminum silicate derived from rocks on land that is deposited at rates of greater than ten centimeters per 1,000 years. Sediment may also be produced locally as nonliving particulate organic material ("detritus") that travels to the bottom (Hollister 1973; Milliman et al. 1972). Some areas of the deep ocean contain an accumulation of the shells of marine microbes composed of silicon and calcium carbonate, termed biogenic ooze (Chester 2003). Through the downward movement of organic and inorganic particles in the water column, substances that are otherwise scarce in the water column (e.g., metals) are concentrated in bottom sediment (Chapman et al. 2003; Kszos et al. 2003).

3.1.1.1.1.2 Factors Affecting Sediment Quality

The quality of sediment is influenced by its physical, chemical, and biological components, where it is deposited, the properties of seawater, and other inputs and sources of contamination. Because these factors interact to some degree, sediment tends to be dynamic and is not easily generalized. For this discussion, "contaminant" refers to biological, chemical, or physical materials normally absent in sediment but which, when present or when at high concentrations, can impact marine ecosystem processes.

3.1.1.1.1.3 Sediment Physical Characteristics and Processes

At any given site, the texture and composition of sediment are important physical factors that influence the types of substances retained in sediment and subsequent biological and chemical processes that occur. Clay-sized and smaller sediment and similarly sized organic particles tend to bind potential contaminants such as metals, hydrocarbons, and persistent organic pollutants. Through this attraction, these particles efficiently scavenge contaminants from the water column and the water between grains of sediment ("porewater") and may bind them so strongly that their movement in the environment is limited (U.S. Environmental Protection Agency 2008e). Conversely, fine-grained sediment is easily disturbed by currents and bottom-dwelling organisms (Hedges and Oades 1997), dredging (Eggleton and Thomas 2004), storms (Chang et al. 2001), and bottom trawling (Churchill 1989). Disturbance is also possible in some deeper areas where currents are minimal, such as from mass wasting events (e.g., underwater slides, debris flows; Coleman and Prior 1988). If resuspended, fine-grained sediment (and any substances bound to it) can be transported long distances.

3.1.1.1.1.4 Sediment Chemical Characteristics and Processes

The concentration of oxygen in sediment is a major influence on sediment quality by its effect on the binding of materials to sediment particles. At the sediment surface, the level of oxygen is usually the same as that of the overlying water. Deeper sediment layers, however, often have low oxygen levels ("hypoxic") or no oxygen ("anoxic") and a low oxidation-reduction ("redox") state. Certain substances combine in oxygen-rich environments and become less available for other chemical or biological reactions. If these combined substances settle into the low or no-oxygen sediment zone, subsequent reactions may release them into porewater, making them available for other chemical or biological reactions. Conversely, substances that remain in solution in oxygenated environments may combine with organic or inorganic substances under hypoxic or anoxic conditions and be removed from further chemical or biological reactions (Spencer and MacLeod 2002; Wang et al. 2002).

3.1.1.1.1.5 Sediment Biological Characteristics and Processes

Organic matter in sediment provides food for resident microbes. Their metabolism can change the chemical environment in sediment, thereby increasing or decreasing the mobility of various substances and influencing the ability of the sediment to retain and transform those substances (Mitsch and Gosselink 2007; U.S. Environmental Protection Agency 2008e). Bottom-dwelling animals often rework sediment in the process of feeding and burrowing ("bioturbation"). In this way, marine organisms can influence the structure, texture, and composition of sediment as well as the horizontal and vertical distribution of substances in sediment (Boudreau 1998). As noted above, moving substances out of or into low- or no-oxygen zones in sediment may alter the form and availability of various substances. The metabolic processes of bacteria also influence sediment components directly. For example, sediment microbes may alter mercury to methyl mercury, increasing its toxicity (Mitchell and Gilmour 2008).

3.1.1.1.1.6 Location

The quality of coastal and marine sediment is influenced substantially by inputs from adjacent watersheds (Turner and Rabalais 2003). Proximity to watersheds with large cities and intensively farmed areas increases the amount of both inorganic and organic contaminants that often find their way into coastal and marine sediment. Metals enter estuaries through weathering of natural rocks and mineralized deposits carried by rivers and through man-made inputs that often contribute amounts significantly above natural levels. Metals of greatest concern include cadmium, chromium, mercury, lead, selenium, arsenic, and antimony because they bioaccumulate, are toxic at low concentrations to biota, and mostly have no natural functions in biological systems—chromium is the exception (Summers et al. 1996). In addition to metals, a wide variety of organic substances toxic to marine organisms, such as polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and pesticides—often referred together as “persistent organic pollutants”—are discharged into coastal waters from both point and nonpoint urban, agricultural, and industrial sources in a watershed (U.S. Environmental Protection Agency 2008e). It should be noted that PAHs can be both man-made or naturally occurring, produced from forest fires or other natural burning events.

Natural processes that occur in estuaries retain and transform a wide variety of substances (Li et al. 2008; Mitsch and Gosselink 2007). Examples of these processes include the binding of materials to small particles in the water column and the settling of those particles on the bottom in calm areas. Thus, the concentration of various substances decreases with distance from shore. Once in the ocean, the locations of various substances may be a consequence of currents that travel parallel to the shore (Duursma and Gross 1971). Location on the ocean floor also influences the distribution and concentration of various elements through local geology and volcanic activity (Demina and Galkin 2009), as well as mass wasting events such as underwater slides and debris flows (Coleman and Prior 1988).

3.1.1.1.1.7 Other Contributions to Sediment

While the greatest mass of sediment is carried into marine systems by rivers (U.S. Environmental Protection Agency 2008e), wind and rain also deposit materials in coastal waters and contribute to the mass and quality of sediment. For instance, approximately 80 percent of the mercury released from human activities comes from burning of coal, mining and smelting, and solid waste incineration (Agency for Toxic Substances and Disease Registry 1999). These are generally considered the major sources of mercury in marine systems (Fitzgerald et al. 2007). Atmospheric deposition of lead is similar in that human activity is a major source of lead in sediment (Wu and Boyle 1997).

Hydrocarbons are common in sediment. In addition to washing in from land and shipping sources, they are deposited from the combustion of fuels (both wood and petroleum), are produced directly by marine and terrestrial biological sources, and arise from processes in sediment, including microbial activity and natural hydrocarbon seeps (Boehm and Requejo 1986; Geiselbrecht et al. 1998). Means (1995) noted that, because of the high binding capacities of organic-rich, fine-grained sediment found at many coastal and estuarine sites, “hydrocarbons may concentrate to levels far exceeding those observed in the water column of the receiving water body.”

Between World War I and 1970, a variety of weapons were disposed off the east coast of the United States and at two known sites in the Mississippi River in Louisiana. Such disposal practices ended in 1970; however, identifying disposal locations, specific weapons, and the quantities involved is not possible in most instances because of incomplete record-keeping and the possibility that items may have been moved by currents (Bearden 2006).

3.1.1.1.2 Water Quality

The discussion of water quality begins with an overview of the characteristics of marine waters, including pH, temperature, oxygen, nutrients, salinity, and other dissolved elements. The discussion then considers how those characteristics of marine waters are influenced by marine physical, chemical, and biological processes.

3.1.1.1.2.1 Characteristics of Marine Waters

The composition of water in the marine environment is determined by complex interactions between physical, chemical, and biological processes. Physical processes include region-wide currents and tidal flows, seasonal weather patterns and temperature, sediment characteristics, and unique local conditions, such as those created by the volume of freshwater delivered by large rivers. Chemical processes involve salinity, pH, dissolved minerals and oxygen, particulates, nutrients, trace minerals, dissolved ions, and pollutants. Biological processes involve the influence of living things on the physical and chemical environment. The two dominant biological processes in the ocean are photosynthesis in upper waters, and respiration, particularly by microorganisms. These processes involve the uptake, conversion, and excretion of waste products during growth, reproduction, and decomposition (Mann and Lazier 1996).

3.1.1.1.2.2 pH

pH is a measure of the degree to which a solution is either acidic (pH less than 7.0) or basic (pH greater than 7.0). Seawater has a relatively stable pH between 7.5 and 8.5 due to the presence of dissolved elements, particularly carbon and hydrogen. Most of the carbon in the sea is present as dissolved inorganic carbon that originates from the complex interaction of dissolved carbon dioxide in seawater. This carbon dioxide-carbonate equilibrium system is the major pH buffering system in seawater. Changes in pH outside the normal range for seawater can make it difficult for specialized marine animals (e.g., molluscs) to maintain their shells (Fabry et al. 2008).

3.1.1.1.2.3 Temperature

Temperature influences the speed at which chemical reactions take place in solution: warmer temperatures increase reaction speed and vice versa. In addition, seasonal changes in weather influence water temperatures that, in turn, influence the degree to which marine waters mix. The increase in surface water temperatures during summer creates three distinct layers in the water column, a process known as stratification. The warmer surface layer is separated from colder water toward the bottom by an intervening layer ("thermocline") across which the temperature changes rapidly. Stratification is important because it can limit the exchange of gases and nutrients as well as the onset and decline of phytoplankton blooms (Howarth et al. 2002). In fall and winter, lower air temperatures and cool surface waters break down this vertical stratification and promote mixing within the water column.

During most of the year, there is a clear north-to-south gradient of increasing temperatures on the sea surface (Figure 3.0-11). Temperatures in winter (February and March) range from 37° Fahrenheit (F); (3° Celsius [C]) off the coast of Maine to 41°F (5°C) off the coast of Delaware to 72°F (22°C) off the coast of Cape Canaveral, Florida. In summer (August), the temperatures range from about 63°F (17°C) to the north to 75°F (24°C) to the south to 82°F (28°C) at Cape Canaveral (National Data Buoy Center 2011). In the Gulf of Mexico, the surface water temperatures range from 64°F (18°C) to 88°F (31°C) during the same months. Currents cause fairly large temperature differences between the eastern and western parts of the Gulf of Mexico with warmer temperatures generally occurring in the eastern Gulf of Mexico (Muller-Karger et al. 1991).

3.1.1.1.2.4 Oxygen

Surface waters in the ocean are usually saturated or supersaturated with dissolved oxygen as a result of photosynthetic activity and wave mixing (4.49 to 5.82 milliliters per liter [ml/L]). As depth from the surface increases, dissolved oxygen content decreases from more than 4.4 ml/L to a minimum of 1.7 ml/L at intermediate depths between 984 and 2,953 ft. (300 and 900 m). Thereafter, dissolved oxygen content increases from 5.4 ml/L to 6.7 ml/L to a depth of approximately 6,562 ft. (2,000 m) and remains relatively constant (Seiwell 1934).

The amount of dissolved oxygen is considered poor if the concentration is less than 2 mg/L; 1 mg/L is approximately 1.3-1.4 ml/L depending on water temperature), a condition referred to as hypoxia (Rabalais et al. 2002; U.S. Environmental Protection Agency 2008e). Such low oxygen levels are natural in marine systems under certain conditions, such as oxygen minimum zones at intermediate depths, upwelling areas, deep ocean basins, and fjords (Helly and Levin 2004). (The term “upwellings” refers to the movement of colder, usually nutrient-rich, waters from deeper areas of the ocean to the surface.) However, the occurrence of hypoxia and anoxia in shallow coastal and estuarine areas can negatively affect fish, bottom-dwelling (“benthic”) creatures, and submerged aquatic vegetation. Hypoxia has been increasing in coastal waters and may affect more than half of the estuaries in the United States (Bricker et al. 1999; Diaz and Rosenberg 1995).

3.1.1.1.2.5 Nutrients

Nutrients are elements and compounds necessary to produce organic matter. In marine systems, basic nutrients include dissolved nitrogen, phosphates, silicates, and metals such as iron and copper. Dissolved inorganic nitrogen occurs in ocean water as nitrates, nitrites, and ammonia (Zehr and Ward 2002). Depending on local conditions, the productivity of marine ecosystems may be limited by the amount of phosphorus available or, more often, by the amount of nitrogen available (Anderson et al. 2002; Cloern 2001). Too much of either can lead to a harmful condition known as eutrophication. Too many nutrients can stimulate algal blooms—the rapid expansion of microscopic algae (phytoplankton). When excess nutrients are consumed, the algae population dies off and the remains are consumed by bacteria. Bacterial consumption causes dissolved oxygen in the water to decline to the point where creatures that depend on oxygen can no longer survive (Boesch et al. 1997). Sources of excess nutrients include fertilizers applied on land, wastewater, and atmospheric deposition from burning fossil fuels (Turner and Rabalais 2003). Biogeochemical processes in estuaries and on the continental shelf influence the extent to which nitrogen and phosphorus reach the open ocean. Much eventually resides in coastal sediment (Nixon et al. 1996).

3.1.1.1.2.6 Salinity, Ions, and Other Dissolved Substances

The concentration of major ions in seawater determines salinity. Those ions include sodium, chloride, potassium, calcium, magnesium, and sulfate. Salinity over the continental shelf along the east coast ranges from 28 to 36 parts per thousand (ppt) and generally increases from north to south in the Study Area. Salinity of the surface water of the Gulf of Mexico ranges between 36.0 and 36.3 ppt. During summer when the water column is stratified, surface salinities often increase from shore to the continental shelf break. Below 984 ft. (300 m), salinity is more constant (Blanton et al. 2003). Salinity varies seasonally as well, especially in areas influenced by large rivers (Milliman et al. 1972). Table 3.1-1 provides estimates of the concentration of select elements in open ocean waters (Nozaki 1997).

Table 3.1-1: Estimated Average Concentrations of Select Elements in Seawater

Element	Estimated Average Concentration in Seawater (ng/kg)
Magnesium	1,280,000,000
Silicon	2,800,000
Lithium	180,000
Phosphorus	62,000
Molybdenum	10,000
Uranium	3,200
Nickel	480
Zinc	350
Chromium (VI)	210
Copper	150
Cadmium	70
Aluminum	30
Iron	30
Manganese	20
Tungsten	10
Titanium	6.5
Lead	2.7
Chromium (III)	2
Silver	2
Cobalt	1.2
Tin	0.5
Mercury	0.14
Platinum	0.05
Gold	0.02

ng/kg: nanograms per kilogram

The presence of extremely small organic particles (less than 0.63 micrometers [µm]), carbonates, sulfides, phosphates, and metals will influence the dominant form of some substances and determine whether they remain dissolved or form solids.

3.1.1.1.2.7 Influence of Marine Processes on Seawater Characteristics

Ocean currents and tides mix and redistribute seawater. In doing so, they alter surface water temperatures, transport and deposit sediment, and concentrate and dilute substances that are dissolved and suspended in the water. These processes operate to varying degrees from nearshore areas to the deep ocean waters. Salinity also affects the density of seawater and, therefore, its movement relative to the sea surface (Libes 2009). Upwellings, such as those associated with the Gulf Stream, bring cold, nutrient-rich waters from deeper areas, increasing the productivity of local surface waters (Mann and Lazier 1996). Storms and hurricanes also result in strong mixing of marine waters (Li et al. 2006). Additional information on ocean currents in the Study Area is included in Section 3.0.3 (Ecological Characterization of the Study Area).

Temperature and pH influence behavior of trace metals in seawater, such as the extent to which they dissolve in water ("solubility") or their tendency to bind to organic and inorganic particles. However, the degree of influence differs widely among metals (Byrne et al. 1988). The concentration of a given element may change with position in the water column. For instance, some metals have low concentrations in surface waters and higher concentrations at depth, such as cadmium (Bruland 1992), while others decline quickly below the surface (e.g., zinc and iron; Morel and Price 2003; Nozaki 1997). On the other hand, dissolved aluminum exhibits a maximum concentration at the surface, a minimum concentration at mid-depths, and increasing concentrations below 3,300 ft. (1,000 m) (Li et al. 2008). In the northwest Atlantic Ocean, Yeats and Campbell (1983) found that the availability of zinc, cadmium, and nickel were predominantly controlled by biological processes, while copper was predominantly controlled by the extent of surface input and the extent of scavenging by small particles in the water.

Substances like nitrogen, carbon, silicon, and trace metals are extracted from the water by biological processes; others, like oxygen and carbon dioxide, are produced. Metabolic waste products add organic compounds to the water and may also bind to trace metals, removing those metals from the water. Those organic compounds may then be consumed or they may aggregate with other particles and sink toward the bottom (Mann and Lazier 1996; Wallace and Lopez 1997).

Runoff from coastal watersheds influences local and regional coastal water conditions, especially near large rivers like the Hudson and Mississippi. Influences include increased sediment and pollutants, and decreased salinity (Turner and Rabalais 2003; Wiseman and Garvine 1995). Coastal bays and large estuaries, such as Pamlico and Albemarle Sounds on the southeast coast, filter river outflows and reduce total discharge of water to the ocean (Edwards et al. 2006; Mitsch and Gosselink 2007). Depending on their structure and components, estuaries can directly or indirectly affect coastal water quality by recycling various compounds (e.g., excess nutrients), sequestering elements in more inert forms (e.g., trace metals), or altering them, such as the conversion of mercury to methylmercury (Mitchell and Gilmour 2008; Mitsch and Gosselink 2007).

3.1.1.1.2.8 Coastal Water Quality

A recent coastal condition report (U.S. Environmental Protection Agency 2008e) evaluated the condition of U.S. coastal water quality. According to the report, most water quality problems in coastal waters of the United States are associated with degraded water clarity or increased concentrations of phosphates or chlorophyll *a* (a measure of turbidity). Water quality indicators measured included dissolved inorganic nitrogen, dissolved inorganic phosphorus, water clarity and turbidity, dissolved oxygen, and chlorophyll *a*. Chlorophyll *a* is an indicator of microscopic algae (phytoplankton) abundance used to judge nutrient availability (e.g., phosphates and nitrates). Excess phytoplankton or algae can decrease water clarity and lower concentrations of dissolved oxygen. Most sources of these negative impacts arise from onshore point and nonpoint sources.

3.1.1.1.2.9 Hydrocarbons, Trace Metals, and Persistent Organic Pollutants

In addition to the characteristics discussed above, other substances influence seawater quality, including hydrocarbons, metals, and persistent organic pollutants such as pesticides, PCBs, organotins, polycyclic aromatic hydrocarbons, and similar synthetic organic compounds. Sources of these contaminants include commercial and recreational vessels; oil and gas exploration, processing, and spills; industrial and municipal discharges (point source pollution); runoff from urban and agricultural areas (nonpoint source pollution); legal and illegal ocean dumping; poorly or untreated sewage; and atmospheric deposition of combustion residues (U.S. Environmental Protection Agency 2008e).

Various physical, chemical, and biological processes work to remove many of these substances from seawater; thereafter, they become part of nearshore and continental shelf sediment. Additional discussion of contaminants in sediment is provided in Section 3.1.1.1.1 (Sediments).

Hydrocarbons. Hydrocarbons are common in marine ecosystems. They arise from man-made sources, from natural hydrocarbon seeps, and as a result of microbial activity (Boehm and Requejo 1986; Geiselbrecht et al. 1998). According to Kvenvolden and Cooper (2003), during the 1980s, about 10 percent of crude oil entering the marine environment came from natural sources, 27 percent came from oil production, transportation, and refining, and the remaining 63 percent came from atmospheric emissions, municipal and industrial sources, and urban and river runoff. These sources produce many thousands of chemically different hydrocarbon compounds. When hydrocarbons enter the ocean, the lighter-weight components evaporate, degrade by sunlight ("photolysis"), and undergo chemical degradation. A wide range of constituents are consumed by microbes ("biodegradation"). Higher-weight molecular compounds such as asphaltenes are more resistant to degradation and tend to persist after these processes have occurred (Blumer et al. 1973; Mackay and McAuliffe 1988).

Trace metals. The level of dissolved metals in seawater is normally quite low because some are extracted for use by organisms (e.g., iron), many tend to precipitate with various ions already present in the water, and others bind to various metal oxides and small organic and inorganic particles in the water (Turekian 1977). These processes transform the metal from a dissolved state to a solid (particulate) state and substantially decrease the concentration of dissolved metals in seawater (Wallace et al. 1977). The concentration of heavy metals normally decreases with distance from shore (Wurl and Obbard 2004) and varies with depth (Li et al. 2008). A certain amount of trace metals is natural in marine waters due to dissolution of geological formations on land by rain and runoff. However, the additional amounts produced by human activity often have negative consequences for marine ecosystems (Summers et al. 1996), such as the atmospheric deposition of lead in marine systems (Wu and Boyle 1997).

Persistent organic pollutants. Persistent organic pollutants have long half-lives in the environment. They resist degradation, do not readily dissolve in water, and tend to adhere to organic solids and lipids (fats) (Jones and de Voogt 1999). Although they are present in the open ocean and deep ocean waters (Tanabe and Tatsukawa 1983), they are more common and in higher concentrations in nearshore areas and estuaries (Means 1995; Wurl and Obbard 2004). The surface layer of the ocean represents an important microhabitat for a variety of microbes, larvae, and fish eggs. Because of the tendency of hydrocarbons and persistent organic pollutants to float in this surface microlayer, they can be significantly more toxic to those organisms than the adjacent subsurface water (Wurl and Obbard 2004). Sauer et al. (1989) noted that concentrations of PCBs and dichlorodiphenyltrichloroethane (DDT) have been declining in the open ocean for the past several decades.

PCBs are mixtures of up to 209 individual chlorinated compounds known as congeners. They were used widely as coolants and lubricants in transformers, capacitors, and other electrical equipment. The United States stopped manufacturing PCBs in 1977 (Agency for Toxic Substances and Disease Registry 2000). Marine sources include runoff from agricultural and urban areas and atmospheric deposition from industrialized locations (Kalmaz and Kalmaz 1979). PCBs do not readily degrade in the environment and tend to persist for many years. They can easily move between air, water, and soil, although in aquatic systems, they tend to adhere to fine-grained sediment and organic matter. PCBs have a variety of effects on aquatic organisms. The chemicals persist in the tissues of animals at the bottom of the food chain. Thereafter, consumers of those species tend to accumulate PCBs at levels that may be many times higher than in water. Microbial breakdown of PCBs (dechlorination) has been documented in estuarine and marine sediments (Agency for Toxic Substances and Disease Registry 2000).

3.1.1.2 Methods

Potential impacts on sediment and water quality are categorized into four stressors: (1) explosives and explosion byproducts; (2) metals; (3) chemicals other than explosives; and (4) a miscellaneous category of other materials. The term "stressor" is used because the military expended materials in these four categories may negatively affect sediment and water quality by altering their physical and chemical characteristics. Potential impacts of these stressors are evaluated based on the extent to which the release of these materials would directly or indirectly impact sediment or water quality. Existing laws, standards, and guidelines are used to evaluate potential impacts. The differences between standards and guidelines are described below.

- **Standards** are established by law or through government regulatory processes that have the force of law. Standards may be numerical or narrative. Numerical standards set allowable concentrations of specific pollutants (e.g., µg/L [ppb]) or levels for other parameters (e.g., pH) to protect the water's designated uses. Narrative standards describe water conditions that are not acceptable, such as nuisance algal blooms.
- **Guidelines** are nonregulatory and generally do not have the force of law. They reflect an agency's preference or suggest conditions that should prevail. Guidelines are often used to assess the condition of a resource to guide subsequent steps, such as the disposal of dredged materials. Terms such as screening criteria, impact levels, and recommendations are also used.

State standards and guidelines. State jurisdiction regarding sediment and water quality extends from the low tide line out 3 nautical miles (nm); jurisdiction for Texas and the west coast of Florida within the Gulf of Mexico extends from the low tide line out 9 nm. Creating state-level sediment and water quality standards and guidelines begins with each state establishing a use for the water, which is referred to as its "designated" use. Examples of such uses of marine waters include fishing, shellfish harvesting, and recreation. For this section, a water body is considered "impaired" if any one of its designated uses is not met. Once this use is designated, standards or guidelines are established to protect the water at the desired level of quality. Applicable state standards and guidelines specific to each stressor are detailed in Section 3.1.3 (Environmental Consequences).

Federal standards and guidelines. Federal jurisdiction regarding sediment and water quality extends from 3 to 200 nm along the east coast of the United States. However, as discussed in the prior paragraph, for Texas and the west coast of Florida within the Gulf of Mexico, federal jurisdiction would begin 9 nm from shore and extend out to 200 nm. These standards and guidelines are mainly the responsibility of the U.S. Environmental Protection Agency (USEPA), specifically ocean discharge provisions of the Clean Water Act (33 United States Code [U.S.C.] § 1343). Ocean discharges may not result in "unreasonable degradation of the marine environment." Specifically, disposal may not result in: (1) unacceptable negative effects on human health; (2) unacceptable negative effects on the marine ecosystem; (3) unacceptable negative persistent or permanent effects due to the particular volumes or concentrations of the dumped materials; and (4) unacceptable negative effects on the ocean for other uses as a result of direct environmental impact (40 Code of Federal Regulations [C.F.R.] § 125.122). Applicable federal standards and guidelines specific to each stressor are detailed in Section 3.1.3 (Environmental Consequences). Proposed training and testing activities also occur beyond 200 nm, but U.S. legal and regulatory authority does not extend beyond 200 nm. In such cases, impacts will be judged against federal standards and guidelines.

The International Convention for the Prevention of Pollution from Ships addresses pollution generated by normal vessel operations. The convention is incorporated into U.S. law as 33 U.S.C. §§ 1901-1915. The convention includes six annexes: Annex I, oil discharge; Annex II, hazardous liquid control; Annex III, hazardous material transport; Annex IV, sewage discharge; Annex V, plastic and garbage disposal; and Annex VI, air pollution. The Navy is required to comply with the convention; however, the United States is not a party to Annex IV, sewage discharge. The convention contains handling requirements and specifies where materials can be discharged at sea, but it does not contain standards and guidelines related to sediment and water quality.

3.1.1.2.1 Intensity and Duration of Impact

The intensity or severity of impact is defined as follows (increasing order of negative impacts):

- Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses.
- Chemical, physical, or biological changes to sediment or water quality would be measurable but below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses.
- Chemical, physical, or biological changes to sediment or water quality would be measurable and readily apparent but within applicable standards, regulations, and guidelines. Sediment or water quality would be altered compared to historical baseline, desired conditions, or designated uses. Mitigation would be necessary and would likely be successful.
- Chemical, physical, or biological changes to sediment or water quality would be readily measurable, and some standards, regulations, and guidelines would be periodically approached, equaled, or exceeded. Sediment or water quality would be frequently altered from the historical baseline or desired conditions or designated uses. Mitigation would be necessary, but success would not be assured.

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.

3.1.1.2.2 Measurement and Prediction

Because many of the conditions described above often influence each other, measuring and characterizing various substances in the marine environment is often difficult (Byrne 1996; Ho et al. 2007). For instance, sediment contaminants may also change over time. Valette-Silver (1993) reviewed several studies that demonstrated the gradual increase in a variety of contaminants in coastal sediment that began as early as the 1800s, continued into the 1900s, peaked between the 1940s and 1970s, and declined thereafter (e.g., lead, dioxin, PCBs). After initial deposition, normal physical, chemical, and biological processes can resuspend, transport, and redeposit sediment and associated substances in areas far removed from the original source (Hameedi et al. 2002; U.S. Environmental Protection Agency 2008e).

The conditions noted above further complicate predictions of the impact of various substances in the marine environment and on marine organisms; that is, the degree to which they are bioavailable, transfer between trophic levels, and bioaccumulate.

- "Bioavailability" refers to the degree to which a substance is available to be taken in by an organism with the potential for distribution, metabolism, and elimination.

- "Trophic transfer" is the movement of substances up the food chain as predator eats prey. Trophic levels represent different positions in the food chain.
- "Bioaccumulation" is the increase in the concentration of a substance in an organism from a lower trophic level to a higher trophic level (McGeer et al. 2004).

3.1.1.2.3 Sources of Information

A systematic review of relevant literature was conducted to complete this analysis of sediments and water quality, including journals, technical reports published by government agencies, work conducted by private businesses and consulting firms, and U.S. Department of Defense (DoD) reports, operational manuals, natural resource management plans, and current and prior environmental documents for facilities and activities in the Study Area. The literature and other information sources cited are identified at the end of Section 3.1 (Sediments and Water Quality).

Other informative sources for this sediments and water quality analysis include the recent Navy water range assessments developed pursuant to the Navy's Water Range Sustainability Environmental Program Assessment Policy (Chief of Naval Operations 2008). Pursuant to this policy, U.S. Fleet Forces conducted water range assessments for ranges located within state waters with particular emphasis (i.e., operational range site modeling and fate and transport analysis) on those water ranges with specific and distinct operational aim or use points. Four water range assessments were completed:

- Virginia Capes Range Complex Water Range Assessment (U.S. Department of the Navy 2010b),
- Jacksonville Range Complex Water Range Assessment (U.S. Department of the Navy 2010a),
- Key West Range Complex Water Range Assessment (U.S. Department of the Navy 2011), and
- Gulf of Mexico Range Complex Water Range Assessment (U.S. Department of the Navy 2012).

The Water Range Sustainability Environmental Program Assessment Policy establishes procedures to:

- ensure the long-term sustainability of water ranges and operating areas;
- determine whether there has been a release or a substantial threat of a release of munitions constituents of potential concern or military expended material constituents from an operational range to an off-range area;
- determine whether the release or substantial threat of a release of munitions constituents of potential concern or military expended material constituents from an operational range to an off-range area poses an unacceptable risk to human health or the environment;
- assess the potential environmental impacts of the use of military munitions on operational ranges; and
- implement, where appropriate, protective measures for Navy operational ranges that are primarily in water.

Each of the four water range assessments conducted within the AFTT Study Area concluded that no complete exposure pathways to receptors on- or off-range are anticipated. With the projected non-detectable concentrations of munitions constituents and military expended material constituents attenuated in surface waters, using conservative assumptions, it is unlikely that an introduction or accumulation of trace training-related munitions constituents and military expended material constituents pose a risk to human health or the environment. Based on the analysis in each assessment, no further steps are needed to ensure the sustainability of the water ranges.

Because of its importance and proximity to humans, information is readily available regarding the condition of inshore and nearshore sediment and water quality. However, much less is known about deep ocean sediment and open ocean water quality. Because inshore and nearshore sediment and water quality are negatively affected mostly by various human social and economic activities, two general assumptions are used in this discussion: (1) the greater the distance from shore, the higher the quality of sediment and waters; and (2) deeper waters are generally of higher quality than surface waters.

3.1.1.2.4 Areas of Analysis

The locations where specific military expended materials would be used are discussed under each stressor in Section 3.1.3 (Environmental Consequences). Activities at the South Florida Ocean Measurement Facility Testing Range and at pierside locations are not analyzed for impacts on sediment or water quality because no military expended materials are proposed for use at those locations.

3.1.2 Affected Environment

The affected environment includes sediment and water quality within the Study Area, from nearshore areas to the open ocean and deep sea bottom. Existing sediment conditions are discussed first and water quality thereafter. Figures 3.0-1 to 3.0-9 depict the regions and areas discussed below. Figure 3.0-5 provides a general diagram of the continental margin and abyssal (deep ocean) zone.

3.1.2.1 Sediment

The following subsections discuss sediment for each region in the Study Area. Table 3.1-2 provides the sediment quality criteria and index for the U.S. east coast and Gulf of Mexico (U.S. Environmental Protection Agency 2008d).

3.1.2.1.1 Sediment in the North Atlantic

The North Atlantic area consists of the West Greenland Shelf, the Newfoundland-Labrador Shelf, and the Scotian Shelf Large Marine Ecosystems, as well as the Labrador Current Open Ocean Area. The area includes the coasts and offshore marine areas southwest of Greenland, east and northeast of Newfoundland and Labrador, and surrounding Nova Scotia. Note: Although there are no designated range complexes in this region, the area may be used for Navy training and testing activities. See Table 3.0-2 for a list of range complexes within each large marine ecosystem, and Figure 3.0-2 for their locations.

Because of the low population densities and low levels of development, pollution from land-based sources is limited in the North Atlantic area (Aquarone and Adams 2008a, b; Aquarone et al. 2008). However, pollution is increasing from oil and gas development activities (Aquarone and Adams 2008a, b), and metal pollution exists from prior mineral development activity (Larsen et al. 2001) and atmospheric deposition (Bindler 2001). Natural hydrocarbon seeps are located near Baffin Island to the north (Kvenvolden and Cooper 2003).

Table 3.1-2: Sediment Quality Criteria and Index, U.S. East Coast and Gulf of Mexico

Criterion	Site Criteria			Regional Rating		
	Good	Fair	Poor	Good	Fair	Poor
Sediment Toxicity	Amphipod survival rate ≥ 80%	N/A	Amphipod survival rate < 80%	< 5% of coastal area in poor condition	N/A	≥ 5% of coastal area in poor condition
Sediment Contaminants	No ERM concentration exceeded, and < 5 ERL concentration exceeded	No ERM concentration exceeded and ≥ 5 ERL concentration exceeded	An ERM concentration exceeded for one or more contaminants	< 5% of coastal area in poor condition	5-15% of coastal area in poor condition	> 15% of coastal area in poor condition
Excess Sediment TOC	TOC concentration < 2%	TOC concentration 2% to 5%	TOC concentration > 5%	< 20% of coastal area in poor condition	20-30% of coastal area in poor condition	> 30% of coastal area in poor condition
Sediment Quality Index	No individual criteria rated poor, and sediment contaminants criteria is rated good	No individual criteria rated poor, and sediment contaminants criteria is rated fair	One or more individual criteria rated poor	< 5% of coastal area in poor condition, and > 50% in good condition	5-15% of coastal area in poor condition, and > 50% in combined fair and poor condition	> 15% of coastal area in poor condition

ERM (effects range–median) is the level measured in the sediment below which adverse biological effects were measured 50% of the time.
ERL (effects range–low) is the level measured in the sediment below which adverse biological effects were measured 10% of the time (Long et al. 1995).
N/A: Not Applicable; TOC: (total organic carbon) refers to the amount of carbon contained in organic compounds; %: percent; "≥: equal to or greater than; "<": less than; and ">": greater than.

3.1.2.1.2 Sediment in the Northeast U.S. Large Marine Ecosystem

Almost the entire continental shelf along the eastern United States is covered by medium-sized sand (0.013 to 0.02 in. [0.35 to 0.50 mm]). Sediment north of Cape Hatteras is dominated by quartz and feldspar from Precambrian and Paleozoic rocks that were mechanically weathered and deposited by glaciers and rivers. Silicon- and phosphorus-based sediment is locally abundant (Milliman et al. 1972). Sediment in deep areas beyond the continental break is often dominated by calcium carbonate shells of marine plankton. Nearshore areas of capes and at the mouths of bays, such as Chesapeake Bay and Delaware Bay, are influenced by longshore and cross-shelf currents as well as tidal fluctuations (McBride and Moslow 1991; Murray and Thieler 2004). Extensive estuaries on the east coast tend to trap much of the sediment delivered by rivers. Fine-grained sediment that reaches the ocean is usually transported shoreward by tides or deposited on the continental slope and beyond. Fine sediment occurs in the Gulf of Maine and off the coast of Martha's Vineyard in an area known as the "Mud Patch" (Chang et al. 2001).

Overall, sediment in northeast coastal areas—Maine through Virginia—rates poor in an evaluation of coastal conditions by the USEPA (U.S. Environmental Protection Agency 2008e). Criteria used in the agency's sediment quality index include sediment toxicity, sediment contaminants, and excess sediment carbon contained in organic compounds (total organic carbon).

The poor rating for the northeast coastal areas was due mostly to the areal extent of poor sediment and the degree of contamination adjacent to urbanized areas and areas of past industrial activity, such as Cape Cod Bay, western Long Island Sound, New York-New Jersey Harbor, and tidal freshwater parts of Delaware Bay. However, 76 percent of coastal sediment had low levels of chemical contamination, an absence of acute toxicity, and moderate-to-low levels of sediment total organic carbon (U.S. Environmental Protection Agency 2008e). In a study of sediment in Long Island Sound, Greig et al. (1977) found that concentrations of several metals varied greatly among the 159 sites sampled. Table 3.1-3 compares the range of values found by Greig et al. (1977) with sediment guidelines developed by the National Oceanic and Atmospheric Administration (1999). Greig et al. (1977) commented that the most likely source for these metals was onshore industrial activity.

Table 3.1-3: Comparison of Select Metals in Sediments by Greig et al., with Sediment Guidelines by the National Oceanic and Atmospheric Administration

Metal	Sediment Study by Greig et al. 1977 (ppm)	National Oceanic and Atmospheric Administration	
		Effects Range-Low* (ppm)	Effects Range-Median* (ppm)
Cadmium	2–4	1.2	9.6
Chromium	200-350	81	370
Copper	200-350	34	270
Lead	200-350	46.7	218
Mercury	2–4	0.15	0.71
Nickel	42	20.9	51.6
Silver	2–4	1.0	3.7
Zinc	200–350	150	410

ppm: parts per million, dry weight
* See Table 3.1-2 above for definitions.

Table 3.1-4 provides a range of values for polycyclic aromatic hydrocarbons and PCBs found by various authors in sediments in the northwest Atlantic. The table compares those values with guidelines developed by the National Oceanic and Atmospheric Administration (1999).

Table 3.1-4: Comparison of Polycyclic Aromatic Hydrocarbons and Polychlorinated Biphenyls in Sediment Samples with Sediment Guidelines Developed by the National Oceanic and Atmospheric Administration

Sediment Contaminant	Studies within Northeast Atlantic Region			National Oceanic and Atmospheric Administration	
	Boehm and Gequejo (1986)	Farrington and Trip (1977)	Lamoreaux and Brownawell (1999)	Effects Range-Low*	Effects Range-Median*
PAHs (ppb)	2,000 to 20,000	0.5-3.0	5,600 to 6,100	4,022	44,792
PCBs (ppb)			415 to 500	22.7	180
Location(s)	"Mud Patch," Martha's Vineyard; Gulf of Maine	New York Bight	Governors Island, New York		

ppb: parts per billion, µg/g; PAH refers to polycyclic aromatic hydrocarbons; PCBs refers to polychlorinated biphenyls
* See Table 3.1-2 for definitions.

Boehm and Gequejo (1986) and Farrington and Trip (1977) noted that the source of polycyclic aromatic hydrocarbons was artificial.

Existing Sediment Quality Ratings in the Northeast U.S. Continental Shelf Large Marine Ecosystem

States bordering the Northeast U.S. Continental Shelf Large Marine Ecosystem include Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and northeast North Carolina. See Table 3.0-2 for a list of range complexes within each large marine ecosystem, and Figure 3.0-2 for their locations. Information regarding the current quality of sediment in nearshore areas of these states is provided below. Figure 3.1-1 depicts those conditions. Except where otherwise indicated, information provided below was drawn from the National Estuary Program Coastal Condition Report (U.S. Environmental Protection Agency 2008c).

Maine. Sediment along the Maine coast was rated 44 percent good, 39 percent fair, and 3 percent poor; 14 percent was missing data. Concerns related to sediment in Maine include PCBs, mercury, and dioxin. As a result, seafood consumption advisories were issued. These concerns involve all the state's estuarine and marine habitats. In much smaller areas, bacteria, low oxygen, copper, and polycyclic aromatic hydrocarbons were also identified (Maine Department of Environmental Protection 2010). Wade and Sweet (2005) reported that sediment from the interior of Casco Bay (Portland, Maine) contains elevated levels of trace metals, PCBs, DDT, and the pesticide chlordane.

New Hampshire. Sediment along the New Hampshire coast were rated 56 percent good, 27 percent fair, and 7 percent poor; 10 percent was missing data. Issues included metals, polycyclic aromatic hydrocarbons, and DDT. These concerns involve all the state's estuarine and marine waters. Marine sediment samples were analyzed for heavy metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc) and organic compounds (PCBs and polycyclic aromatic hydrocarbons). Results indicate that, with few exceptions, the levels of contaminants detected in shellfish and sediment were within the range of contaminants found elsewhere in New England, other regions of the United States, and the world. Two estuarine areas were impaired due to pesticides. Ocean waters are listed as impaired due to dioxin, mercury, and PCBs. As noted above, concerns are related to seafood consumption (New Hampshire Department of Environmental Services 2008).

Massachusetts. Sediment in the Massachusetts Bay area (from Cape Cod north) was rated 78 percent good, 1 percent fair, and 16 percent poor, with 5 percent missing data. Most poor sediment was concentrated in the Boston Harbor area. No specific issues were indicated. For Buzzards Bay, sediment was rated 85 percent good and 11 percent poor, with 4 percent missing data. No specific issues were indicated.

Rhode Island. Sediment in Narragansett Bay was rated 45 percent good, 37 percent fair, and 15 percent poor; 3 percent was missing data. Issues included high concentrations of metals, DDT, and PCBs. Contaminated sediments were listed as a concern for 1 square mile ($mi.^2$) (2.59 square kilometers [km^2]) of estuarine habitat in Rhode Island. The issue involved "legacy/historical pollutants," such as PCBs in Narragansett Bay (Rhode Island Department of Environmental Management 2008).

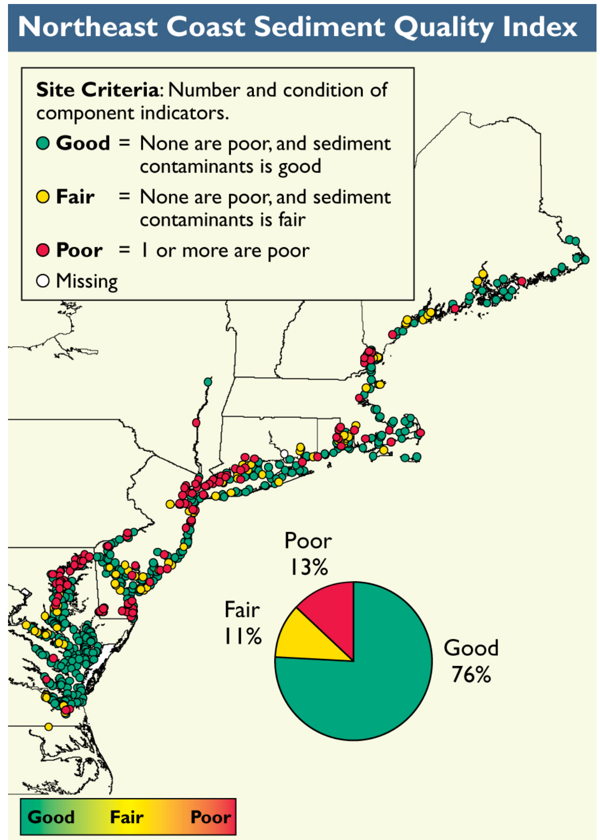

Figure 3.1-1: Sediment Quality Index for the Northeast U.S. Coast

Source: U.S. Environmental Protection Agency (2008b)

Connecticut. Long Island Sound comprises most of the estuarine habitat for Connecticut. In a 2007 study, 45 percent of sediment in the sound was rated good and 32 percent poor. Sampling indicated a trend of decreasing impacts from runoff moving east from New York City. Mecray et al. (2000) found that sediment was enriched two to five times above background levels for silver, calcium, chromium, copper, manganese, lead, and zinc. Compared to a 1977 study, overall trends for silver, cadmium, chromium, copper, and mercury were decreasing, while trends for manganese, nickel, lead, and zinc were increasing.

New York/New Jersey. Sediment in the New York-New Jersey Harbor estuary were rated 30 percent good, 5 percent fair, and 65 percent poor. Issues included elevated concentrations of metals and PCBs. Information for Long Island Sound sediment is presented under Connecticut above. Sediment in Barnegat Bay on the Atlantic coast was rated 81 percent good, 8 percent fair, and 6 percent poor; 5 percent was missing data. No sediment information was collected for Peconic Bay. Information for Delaware Bay is provided below.

Delaware. Sediment in Delaware Bay was rated 65 percent good, 18 percent fair, and 6 percent poor; 11 percent was missing data. The highest levels of sediment contaminants were near Philadelphia and the Maurice River. There may be some point sources for metals, but organic contaminants appear to be primarily from nonpoint sources. Sediment in the inland bays area on the Atlantic coast was rated as 85 percent good and 15 percent poor, mostly due to high levels of total organic carbon. Metals and organic contaminants in sediment tend to decrease from upper to lower Delaware Bay. Sediment in coastal zones has trace amounts of metals and organic contaminants (Hartwell and Hameedi 2006).

Maryland. Sediment in Maryland's coastal bay area on the Atlantic coast was rated 95 percent good, 4 percent fair, and 1 percent poor. According to the Coastal Bays Report Card (2009), sediment along the Atlantic coast received a grade of C+. Issues of concern are biologically oriented, such as excess nutrients and low dissolved oxygen.

Virginia. Nearly four percent of Virginia's estuaries (87 $mi.^2$ [225 km^2]) are rated as impaired because of contaminated sediment. Several fish consumption advisories were issued because of concerns for mercury and PCBs (Virginia Department of Environmental Quality 2010).

North Carolina. Sediment in the Albemarle-Pamlico Estuarine Complex was rated 93 percent good and 7 percent poor. According to Hackney et al. (1998) "between 37.5 and 75.8 percent of surface sediments in North Carolina's sounds and estuaries were contaminated, and between 19.0 and 36.0 percent were highly contaminated." Contaminants in declining order of frequency were nickel, arsenic, DDT, chromium, PCBs, and mercury. The most contaminated areas were the Neuse and Pamlico Rivers. In general, areas with limited tidal flushing and high river discharge were most contaminated. According to Hyland et al. (2000), 38 percent of the total area of North Carolina estuaries had at least one chemical contaminant present at a concentration in excess of levels at which biological effects can be expected. The most common contaminants in their study were arsenic, mercury, chromium, nickel, pesticides, and PCBs. There were relatively few degraded sites in the open portions of Pamlico Sound and smaller estuaries south of Cape Lookout.

Chesapeake Bay. Major sources of sediment contaminants in Chesapeake Bay are point sources, urban runoff, atmospheric deposition, and spills. The northern portion of the bay, including Baltimore Harbor, Susquehanna Flats, and the Patapsco and Chester Rivers, contain higher levels of contaminants than other areas of the bay farther from development. Sediment samples indicate a decrease in certain polycyclic aromatic hydrocarbons over the past decades, but concentrations are still one to two orders of magnitude above pristine conditions. Sediment in most of the main stem of the bay is relatively uncontaminated; concentrations of PCBs, pesticides, and polycyclic aromatic hydrocarbons are one-tenth lower than sediment in the tributaries. One exception is the Elizabeth River at the southern end of the bay in the more developed areas between Norfolk and Portsmouth (Hartwell and Hameedi 2007).

Note: The Chesapeake Bay watershed includes portions of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia. In order to simplify the discussion and reduce repetition, sediment issues in Chesapeake Bay are not reviewed on a state-by-state basis because: (1) many of the sediment issues are common to most or all of these bordering states; and (2) Navy training and testing activities are limited to the extreme southeast portion of the bay and do not appreciably impact sediment issues in the bay.

3.1.2.1.3 Sediments in the Southeast U.S. Large Marine Ecosystem

Moving south from Cape Hatteras, coastal sediment changes from largely land-based sources to largely marine-based sources. Weathering of sediment in the piedmont and coastal plain provinces in the southeast is mostly chemical; deposition of sediment is mostly by rivers. Sediment farther north was more heavily influenced by mechanical (glacial) processes and glacial deposition. Off the coast of the Carolinas, the calcium carbonate content of sediment is between 5 and 50 percent; this increases to 100 percent on the East Florida Shelf. Sources of calcium carbonate include the shells of molluscs, echinoderms, barnacles, coralline algae, foraminifera, and ooids, small (0.01 to 0.08 in. [0.25 to 2 mm]) spherical deposits of calcium carbonate (Milliman et al. 1972). Some areas of the continental shelf along the southeast coast have been swept clean of sediment by the Gulf Stream, exposing the underlying bedrock (Riggs et al. 1996). Sediment on the continental shelf off Florida is primarily silt and clay (Milliman et al. 1972).

Hyland et al. (2006) examined the presence of a wide variety of trace metals and persistent organic pollutants in the water and sediment between 1.24 and 47.8 mi. (2 and 77 km) off the Georgia coast. The maximum values found were well below levels of biological effect. Windom et al. (1989) noted that it is not unusual for natural trace metal concentrations in coastal sediment to range over two orders of magnitude, particularly in the southeastern United States. Boehm and Gequejo (1986) noted that sediment hydrocarbons along the southeast coast were less than 10 parts per million in all cases. In a discussion of sediment quality guidelines, MacDonald et al. (1996) noted that Biscayne Bay is contaminated with trace metals, PCBs, polycyclic aromatic hydrocarbons, and pesticides, and that sediment from the St. Johns River had elevated levels of PCBs. Windom et al. (1989) found lead and zinc-contaminated sediment from Biscayne Bay, apparently influenced by discharge from the Miami River.

Existing Sediment Quality Ratings in the Southeast U.S. Continental Shelf Large Marine Ecosystem

States bordering the Southeast U.S. Continental Shelf Large Marine Ecosystem include North Carolina (southeast), South Carolina, Georgia, and Florida (Atlantic coast). See Table 3.0-2 for a list of range complexes within each large marine ecosystem, and Figure 3.0-2 for their locations. The current quality of sediment in nearshore areas of these states is described below. Figure 3.1-2 depicts those conditions. Overall sediment quality for the coastal areas from North Carolina through the southern tip of Florida rated good. Sediment for 80 percent of this coastal area rated good, 2 percent of coastal areas rated fair, and 12 percent of the area rated poor. No issues related to specific contaminants were noted (U.S. Environmental Protection Agency 2008e). Except where otherwise indicated, information provided below was drawn from the National Estuary Program Coastal Condition Report (U.S. Environmental Protection Agency 2008c).

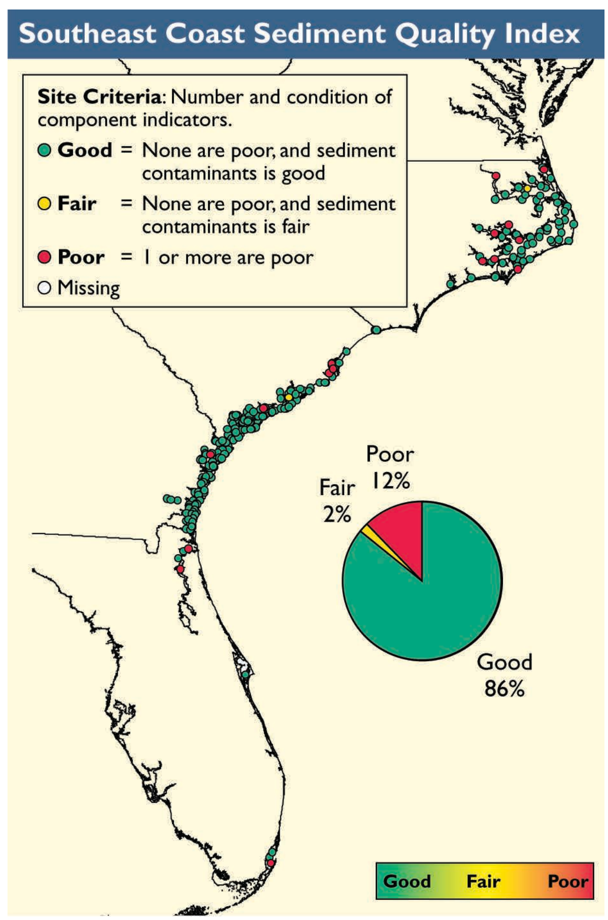

Figure 3.1-2: Sediment Quality Index for the Southeast U.S. Coast
Source: U.S. Environmental Protection Agency (2008b)

North Carolina. Information regarding sediment along the North Carolina coast is provided in Section 3.1.2.1.2 (Sediment in the Northeast United States Large Marine Ecosystem).

South Carolina. Just over four percent of the state's estuarine area (17.3 mi.^{2} [44.8 km^2]) is impaired by metals, mostly by copper, but also nickel and zinc (South Carolina Department of Health and Environmental Control 2008). A recent study found that 33 monitoring points (12 open water, 21 tidal creeks) had at least one contaminant that exceeded concentrations shown to have negative biological effects in 10 percent of published studies. Contaminants included polycylic aromatic hydrocarbons, DDT, and five metals: arsenic, cadmium, copper, lead, and zinc (Van Dolah et al. 2006).

Georgia. Overall, estuarine sediment assessed along the Georgia coast rates 71 percent good, 22 percent fair, and 7 percent poor (Georgia Department of Natural Resources 2010). In terms of toxicity, 97 percent of Georgia's sediment rated good and 2 percent rated poor; 1 percent was missing data. In terms of sediment likely to have negative biological effects, 72 percent rated good, 24 percent rated fair, and 4 percent rated poor. No specific contaminants were indicated. Four mi. (6.4 km) of coastal streams are impaired by mercury and 2 mi. (3.2 km) are impaired by cadmium. Pesticides (in fish tissue) impaired 8 mi. of coastal streams (13 km), and PCBs (in fish tissue) impaired 26 mi. (42 km) of coastal streams (Georgia Department of Natural Resources 2010).

Florida. Sediment in the Indian River Lagoon rated good based on total organic carbon content. Information concerning sediment contaminants and toxicity was not collected. According to the Florida Department of Environmental Protection (2010), estuarine sediment metal concentrations reported above background levels were most often for cadmium, mercury, lead, and zinc. Seventy percent of samples tested for organic chemicals indicated the presence of polycyclic aromatic hydrocarbons. The following metals have impaired estuarine habitat: copper (100 mi.^{2} [259 km^2]), iron (98 mi.^{2} [254 km^2]), nickel (40 mi.^{2} [106.3 km^2]), arsenic (8 mi.^{2} [20.7 km^2]), and lead (7 mi.^{2} [18.1 km^2]). Copper has also impaired 83 mi.^{2} (241 km^2) of coastal waters. A study of sediment in South Florida estuaries by Macauley et al. (2002) also found that elevated concentrations of pesticides were fairly common, but that elevated levels of metals were not.

3.1.2.1.4 Sediment in the Caribbean Sea Large Marine Ecosystem

The Caribbean Sea Large Marine Ecosystem includes offshore marine areas south and southeast of the Florida Keys. Within the Study Area, the majority of the Key West Range Complex is located within this ecosystem. See Table 3.0-2 for a list of range complexes within each large marine ecosystem, and Figure 3.0-2 for their locations. Sediment in the Straits of Florida consists of 50 to 95 percent carbonate sand, mud, and silt (Cronin 1983). Sediment distribution in shallower areas (less than 1,600 ft. [488 m]) is influenced by tides and the Gulf of Mexico Loop Current; those at intermediate depths are influenced by the eastward-flowing Florida Current; and low-energy, westward-flowing currents dominate in deeper areas (greater than 2,600 ft. [792 m]) (Brooks and Holmes 1990). Western portions of the Straits of Florida are 7,200 ft. [2,190 m] deep. Specific information regarding sediment quality in the Key West Range Complex could not be located. However, contamination of sediment and shellfish by organic and inorganic compounds was low in nearshore areas of Key West (Cantillo et al. 1997).

3.1.2.1.5 Sediment in Gulf of Mexico Large Marine Ecosystem

States bordering the Gulf of Mexico Large Marine Ecosystem include Florida (west coast), Alabama, Mississippi, Louisiana, and Texas. Please see Table 3.0-2 for a list of range complexes within each large marine ecosystem, and Figure 3.0-2 for their locations.

The western and central portions of the Gulf of Mexico are dominated by sediment deposition from the Rio Grande and Mississippi River systems, mostly in the form of sandstone and shale (Galloway et al. 2000). DeSoto Canyon, a submarine feature southwest of Pensacola, Florida, marks the transition between the Mississippi River-influenced sediment to the west (Alabama, Mississippi, Louisiana, and Texas) and the carbonate-dominated sediment to the east and south along western Florida (Gearing et al. 1976). The Naval Surface Warfare Center, Panama City Division Testing Range straddles this transition area. Sediment is predominantly carbonate-sand mixture. Carbonate sources include corals, molluscs, and marine microbes. The amount of organic material mixed with the sand generally increases with the distance from shore. Like other deep ocean areas, the central portions of the Gulf of Mexico are dominated by clay-sized particles (less than 0.002 mm).

According to Summers et al. (1996), of the sites in the Gulf of Mexico enriched by three or more metals, 44 percent occur near populated areas and 56 percent occur in agricultural watersheds or the Mississippi River. Many contaminated sites are in watersheds with Superfund sites or are identified by the USEPA National Sediment Inventory as "areas of probable concern" (U.S. Environmental Protection Agency 2008e).

Sediment samples from Pensacola Bay near port facilities were contaminated by lead and zinc (Windom et al. 1989). Lewis et al. (2001) noted that sediment in three bayous of Pensacola Bay contained, on average, as much as 10 times more total heavy metals (e.g., cadmium, copper, and zinc) than sediment collected in Pensacola Bay near the entrance to the bayous. Pesticide concentrations were as much as 45 times greater in the bayou sediment than in those from Pensacola Bay. The authors noted that the bayous were acting as sinks or reservoirs for many contaminants, reducing their transport and availability in Pensacola Bay. The probable source of the contamination was storm water runoff from urbanized watersheds. The authors also indicated that metals and persistent organic pollutant levels in three bayous of Pensacola Bay decreased in a seaward direction.

MacDonald et al. (1996) noted that sediment from Tampa and Pensacola Bays is contaminated with trace metals, PCBs, polycyclic aromatic hydrocarbons, and pesticides; sediment from Choctawhatchee and St. Andrew Bays is contaminated by metals, aromatic hydrocarbons, and pesticides; and sediment from St. Andrew, Apalachicola, Naples, Rookery Bays, and Charlotte Harbor had elevated levels of PCBs. Wade et al. (1988) evaluated coastal sediment at 51 sites in the Gulf of Mexico chosen for their distance from known point sources of polycyclic aromatic hydrocarbons, PCBs, and chlorinated pesticides. The concentrations of the 18 polycyclic aromatic hydrocarbons tested averaged 507 parts per billion (ppb) (range: less than 5 ppb to 36,701 ppb). Eleven percent of all samples had no detectable polycyclic aromatic hydrocarbons. PCB concentrations ranged from less than 5 to 50 ppb, and chlorinated pesticides ranged from less than 0.02 to 5 ppb, with most samples below the limits of detection.

The Gulf of Mexico has several natural hydrocarbon seeps (Kvenvolden and Cooper 2003). In the eastern Gulf of Mexico, Boehm and Gequejo (1986) found that sediment hydrocarbons are mainly marine in origin, although the Gulf Loop Current carries hydrocarbon-laden sediment from the Mississippi River into the area (concentration: 0.4 to 0.5 ppm). West of the Mississippi River, the concentration of hydrocarbons increases in shallow (less than 30 ft. [10 m]) nearshore areas (20 to 70 ppm) and are predominately from man-made sources. Along the Texas coast, sediment hydrocarbon concentrations ranged from 0.5 to 20 ppm; proximity to urban and riverine sources increased the contribution from man-made sources. Farther offshore, hydrocarbons carried on wind as a result of burning fuels were more common.

Existing Sediment Quality Ratings in the Gulf of Mexico Large Marine Ecosystem

Information regarding the current quality of sediment in nearshore areas of the states bordering the Gulf of Mexico Large Marine Ecosystem – Florida, Alabama, Mississippi, Louisiana, and Texas – is provided below. Figure 3.1-3 depicts those conditions. In the Gulf of Mexico – from the southern tip of Florida to the Texas-Mexico border – coastal sediment was generally rated good (79 percent), with 18 percent of the coastal area rated poor because of elevated levels of metals, pesticides, PCBs, and, occasionally, polycyclic aromatic hydrocarbons (U.S. Environmental Protection Agency 2008e). Except where otherwise indicated, information provided below was drawn from the National Estuary Program Coastal Condition Report (U.S. Environmental Protection Agency 2008c).

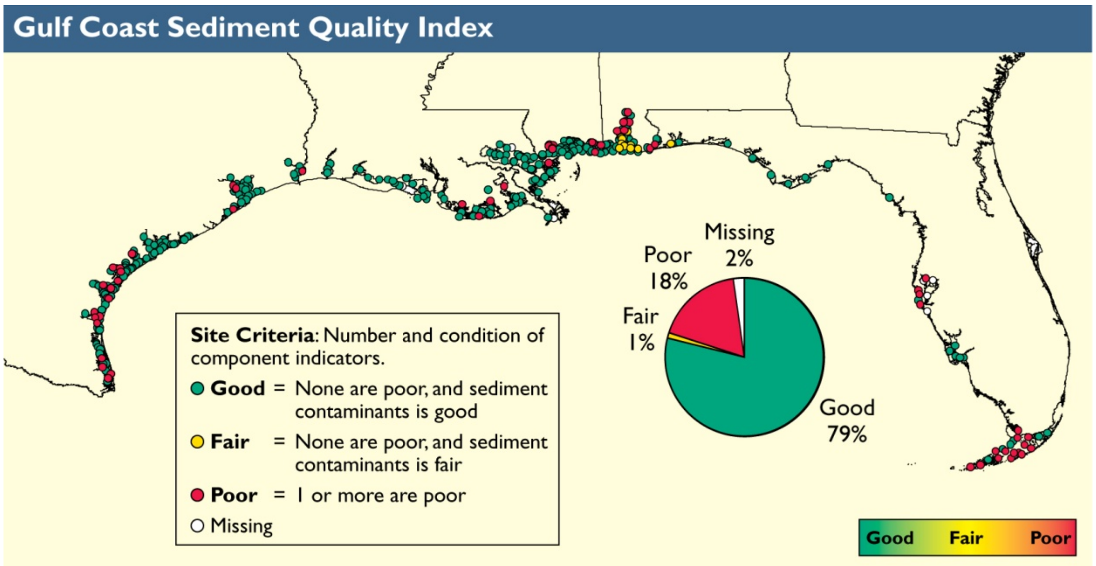

Figure 3.1-3: Sediment Quality Index for the U.S. Gulf Coast
Source: U.S. Environmental Protection Agency (2008b)

Florida. Within the Gulf of Mexico, the National Estuary Program evaluated sediment in Charlotte, Tampa, and Sarasota Bays. Based on low levels of total organic carbon, sediment in each bay rated good. Information concerning sediment contaminants and toxicity was not collected.

Alabama. Mobile Bay, in addition to the sources of polycyclic aromatic hydrocarbons common to a major port, also contains coal burning facilities, natural gas production facilities, and drilling platforms (Peachey 2003). Sediment in Mobile Bay rated 67 percent good, 24 percent fair, and 9 percent poor. No specific contaminants were indicated. Alabama has impaired ocean/estuary habitat due to mercury (201 mi.^{2} [502.6 km^2]) and thallium (94 mi.^{2} [243.5 km^2]) (Alabama Department of Environmental Management 2010). According to Peachey (2003), Mobile Bay and eight related bodies of water were designated as impaired due to high levels of pesticides, persistent organic pollutants, and metals. The Peachey study found that the level of polycyclic aromatic hydrocarbons in bay sediment decreased from the upper bay to the lower bay, and that the main source of the polycyclic aromatic hydrocarbons was burning of fossil fuels.

Mississippi. Most sites sampled along the Mississippi coast indicated good sediment quality. The most recent water quality report for Mississippi did not contain any information regarding marine sediment concerns (Mississippi Department of Environmental Quality 2010).

Louisiana. Sediment in the Terrebonne Estuarine Complex was rated 84 percent good and 12 percent poor; 4 percent was missing data. No specific contaminants were indicated. According to the Louisiana Department of Environmental Quality (2008), mercury impairs 1,657 mi.^{2} (4,291.6 km^2) of estuarine habitat in Louisiana.

Texas. Sediment in Galveston Bay rated 87 percent good and 13 percent poor. For the coastal bend bays areas, 54 percent rated good and 38 percent rated poor; 11 percent was missing data. No specific contaminants were indicated.

Deepwater Horizon Oil Spill

A recent report on the 2010 oil spill in the Gulf of Mexico indicated that 4.9 million barrels of oil were released from the *Deepwater Horizon* well between April and July, 2010 (Lubchenko et al. 2010). Of the oil released, the authors estimated that

- 25 percent was recovered directly at the wellhead or removed by burning and skimming;
- 23 percent naturally evaporated or dissolved;
- 13 percent naturally dispersed;
- 16 percent chemically dispersed; and
- 23 percent "is either on or just below the surface as light sheen and weathered tar balls, has washed ashore or been collected from the shore, or is buried in sand and sediments."

Oil is considered dispersed if it is in droplets less than 100 microns in diameter (about the width of a human hair). Federal agencies, along with academic and independent scientists, continue to monitor and evaluate the fate, transport, and impact of the oil (Lubchenko et al. 2010). Recent visits to deep water habitats indicate oil spill impacts on bottom-dwelling coral communities in the Gulf of Mexico (National Oceanic and Atmospheric Administration 2010).

3.1.2.1.6 Marine Debris, Military Expended Materials, and Sediment

None of the studies of marine debris reviewed for the Atlantic Ocean (i.e., Law et al. 2010; Sheavly 2007; Sheavly 2010) segregated the extent of military expended materials collected, and the studies reviewed reported marine debris, but not their origin. For comparison, Keller et al. (2010) conducted a survey of marine debris collected from the seafloor off the coasts of Washington, Oregon, and California during annual groundfish surveys in 2007 and 2008. This survey focused on marine debris and military expended materials on the ocean floor. Depth of trawling ranged from 180 to 4,200 ft. (55 to 1,280 m), and marine debris was recovered in 469 tows. Categories of marine debris collected included plastic, metal, glass, fabric and fiber, rubber, fishing, and other. Plastic and metallic debris occurred in the greatest number of hauls, followed by fabric and fiber, and glass. The area was within the Navy's west coast training complexes, in which activities occur similar to those in the Proposed Action. Data regarding military expended materials as a component of materials recovered are provided in Table 3.1-5.

Table 3.1-5: Military Expended Materials as Component of All Materials Recovered on the West Coast of the United States, 2007-2008

Category	Count	Percent of Total Count	Weight (kg)	Percent of Total Weight
Plastic	29	7.4	28.3	5.8
Metal	37	6.2	420.3	42.7
Fabric, Fiber	34	13.2	23.3	6.7
Rubber	3	4.7	14.9	6.8

kg: kilogram

Military expended materials with metals included rocket boosters and launchers, and cannon shells. The authors noted that "virtually all" materials identified as military were collected off the coast of Southern California in an area where naval maneuvers are conducted and where permitted military disposal sites are located. No similar study of ocean floor debris and military expended materials was found for the Study Area.

Because they are buoyant, many types of plastic float and may travel thousands of miles in the ocean (U.S. Commission on Ocean Policy 2004). Exceptions include heavy nets and ropes. Because many plastics remain in the water column, additional discussion of marine debris is provided in Section 3.0.5.3.5 (Ingestion Stressors). Although plastics are resistant to degradation, they do gradually break down into smaller particles due to sunlight (photolysis) and mechanical wear (Law et al. 2010). Thompson et al. (2004) found that microscopic particles were common in sediment at 18 beaches around the United Kingdom. They noted that such particles were ingested by small filter and deposit feeders, with unknown effects. The fate of plastics that sink beyond the continental shelf is largely unknown. However, analysis of debris in the center of an area near Bermuda with a high concentration of plastic debris on the surface showed no evidence of plastic as a substantial contributor to debris sinking at depths of 1,650 to 10,500 ft. (500 to 3,200 m) (Law et al. 2010). Marine microbes and fungi are known to degrade biologically produced polyesters, such as polyhydroxyalkanoates, a bacterial carbon and energy source (Doi et al. 1992). Marine microbes also degrade other synthetic polymers, although at slower rates (Shah et al. 2008).

3.1.2.1.7 Climate Change and Sediment

Aspects of climate change that influence sediment include increasing ocean acidity (pH), increasing sea surface water temperatures, and increasing storm activity. Breitbarth et al. (2010) referred to seawater temperature and pH as "master variables for chemical and biological processes," and noted that effects of changes on trace metal biogeochemistry "may be multifaceted and complex." Under more acidic conditions, metals tend to dissociate from particles to which they are bound in sediment, becoming more soluble and potentially more biologically available.

As noted in the beginning of this section, tropical storms can have significant impacts on the resuspension and distribution of bottom sediment (Wren and Leonard 2005). However, no consensus appears to exist on whether climate change will generate more tropical storms or whether those storms will be more intense. If storm frequency and intensity increase, the additional disturbance of sediment may negatively impact water quality in nearshore and coastal areas. A more detailed discussion of this issue is provided in Section 3.1.2.2 (Water Quality).

3.1.2.2 Water Quality

The current state of water quality in the Study Area is discussed below, from nearshore areas to the open ocean and deep sea bottom. Additional information on ocean currents in the Study Area is included in Section 3.0.3 (Ecological Characterization of the Study Area).

3.1.2.2.1 Water Quality in the North Atlantic

The North Atlantic area consists of the West Greenland Shelf, the Newfoundland-Labrador Shelf, and the Scotian Shelf Large Marine Ecosystems, as well as the Labrador Current Open Ocean Area. The area includes the coasts and offshore marine areas southwest of Greenland, east and northeast of Newfoundland and Labrador, and those surrounding Nova Scotia. Although there are no designated range complexes in this region, the area may be used for Navy training and testing activities.

Because of the low population densities and low levels of development, pollution from land-based sources is limited in the North Atlantic area (Aquarone and Adams 2008a, b; Aquarone et al. 2008). However, pollution is increasing from oil and gas development activities (Aquarone and Adams 2008a, b), and concern has been expressed regarding spills, discharges, and contaminants from marine vessels (Aquarone and Adams 2008b).

3.1.2.2.2 Water Quality in the Northeast United States Continental Shelf Large Marine Ecosystem

The Northeast U.S. Continental Shelf Large Marine Ecosystem includes the Northeast and VACAPES Range Complexes and the Naval Undersea Warfare Center Division, Newport Testing Range. The testing range includes waters of Narragansett Bay, Rhode Island Sound, Block Island Sound, Buzzards Bay, Vineyard Sound, and Long Island Sound. See Figure 3.0-2 for the locations of these areas.

Open Ocean Water Quality

Sauer et al. (1989) surveyed the micro-surface layer and subsurface water at five open ocean sites off the Delaware-New Jersey shore for the presence of PCBs and several chlorinated pesticides. Micro-surface layer samples collected contained PCB concentrations between less than 2 and 20 nanograms per liter (ng/L; 2 to 20 parts per trillion [ppt]), and pesticide concentrations between less than 7 and 80 ng/L (7 to 80 ppt). Subsurface water samples contained PCB concentrations between 0.007 and 0.17 ng/L (0.007 to 0.17 ppt), and pesticide concentrations between 0.01 and 0.09 ng/L (0.01 to 0.09 ppt). Wallace et al. (1977) tested surface waters in the northwest Atlantic between Massachusetts and Bermuda. The minimum and maximum ranges of metals found are provided in Table 3.1-6. Units are ng/L, plus or minus the error value.

Table 3.1-6: Particulate Trace Metals Surface Water Concentrations (ng/L) in the Northwest Atlantic Ocean

	Manganese	Iron	Nickel	Chromium	Copper	Zinc	Lead	Cadmium
Minimum	1.2	52	< 0.2	1.4	1.9	1.62	0.84	0.008
Maximum	330	6,800	9.1	21	8.9	75	22	6.0

"<": less than; ng/L: nanograms per liter

In all cases except cadmium, the maximum values were found closest to the shore southeast of Cape Cod. The authors noted that suspended clay minerals and biologically produced particles are important concentrators of trace metals in the marine environment, and that the influence of river-borne suspended sediment extends approximately 1 mi. offshore.

Nearshore Water Quality

States bordering the Northeast U.S. Continental Shelf Large Marine Ecosystem include Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Delaware, Maryland, Virginia, and northeast North Carolina. Information regarding the current quality of marine waters in nearshore areas of these states is provided below. Figure 3.1-4 depicts those conditions.

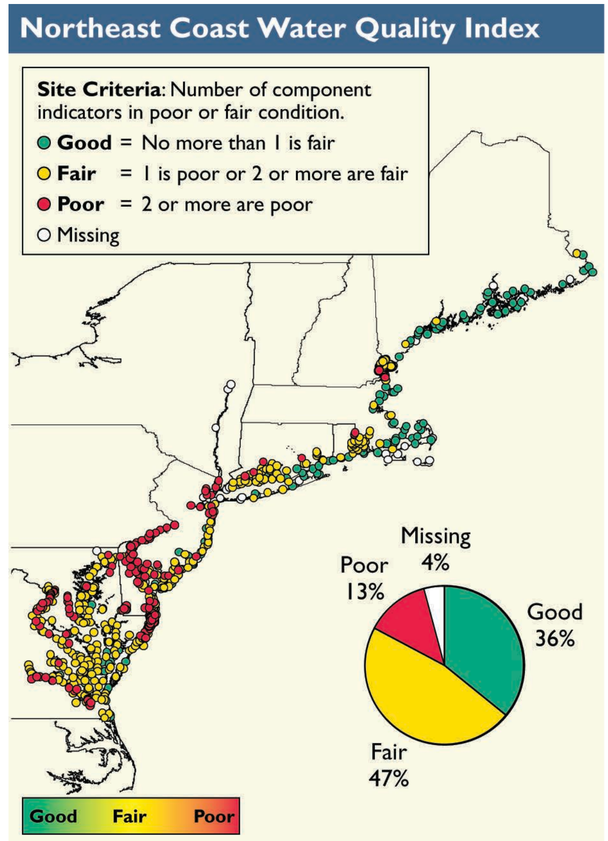

Figure 3.1-4: Water Quality Index for the Northeast United States Coast
Source: U.S. Environmental Protection Agency (2008b)

The USEPA report (2008e) rated the waters along the northeast U.S. coast as fair. Of the sites sampled, 13 percent were in poor condition. Most of these poor sites were concentrated in a few estuarine systems, such as the New York/New Jersey Harbor, Delaware Bay, and Chesapeake Bay. The poor ratings were based on chlorophyll *a* (a measure of turbidity) and low dissolved oxygen. Past and ongoing industrial activities also impact water quality (Aquarone and Adams 2008c). Except where indicated, the following discussion of water quality is drawn from the USEPA (2010).

Maine. Water quality for all the estuaries and bays assessed in Maine is considered impaired, mainly by pathogens (bacteria). All estuarine and marine waters in Maine have an advisory for the consumption of shellfish (lobster tomalley) due to the presence of PCBs and dioxins, presumed to be from atmospheric deposition or prior industrial activity (U.S. Environmental Protection Agency 2008b).

New Hampshire. Water quality for all the estuaries and bays assessed in New Hampshire is considered impaired. Main concerns included dioxin, PCBs, and mercury; nutrients, pathogens, and turbidity were also noted. The entire ocean and nearshore waters assessed were also considered impaired based on similar concerns.

Massachusetts. Water quality for 9.3 percent of estuaries and bays assessed in Massachusetts is considered good and 90.7 percent is considered impaired, mostly by pathogens. Other issues include toxic organics, nutrients, and low dissolved oxygen.

Rhode Island. Water quality for 64.5 percent of estuaries and bays assessed in Rhode Island is considered good and 35.5 percent is considered impaired. The main issues involve low dissolved oxygen, fecal coliform, and excess nutrients (nitrogen).

Connecticut. Water quality for 31.4 percent of estuaries and bays assessed in Connecticut is considered good and 68.6 percent is considered impaired. The main issues involve low dissolved oxygen, eutrophication, and excess nutrients (nitrogen).

New York. Water quality for 42.2 percent of estuaries and bays assessed in New York is considered good and 57.8 percent is considered impaired. The main issues involved PCBs; other issues included total coliform, low dissolved oxygen, cadmium, and excess nutrients (nitrogen).

New Jersey. Water quality for 11.6 percent of estuaries and bays assessed in New Jersey is considered good and 88.4 percent is considered impaired. The main issues involved pesticides, PCBs, low dissolved oxygen, and mercury. The report notes similar concerns for coastal and ocean waters.

Delaware. Water quality for all the estuaries and bays assessed in Delaware is considered impaired. Excess nitrogen, excess phosphorus, and pathogens were issues of almost equal concern.

Maryland. Water quality for 9.8 percent of the state's estuaries and bays is considered good and 90.2 percent is considered impaired. No specific issues were noted. However, (Wazniak et al. 2004) indicate that water quality conditions in Maryland's coastal bays range from generally degraded conditions within or close to tributaries, to better conditions in the bay regions. Most issues are related to excess nutrients. Tributaries generally show poor to very degraded water quality, primarily due to high nutrient inputs, while the open bays have good to excellent water quality. Also, the northern bays are generally in poorer condition than the southern bays due to the extent of development and, to a lesser degree, the extent of flushing that occurs. Areas within the tidal portion of the Potomac River have been placed on the state 303(d) "impaired waters" list because of contamination by PCBs (Interstate Commission on the Potomac River Basin 2008).

Virginia. Water quality for 5.3 percent of estuaries and bays in Virginia is considered good and 94.7 percent is considered impaired. The main issues involve PCBs, noxious aquatic plants, and low dissolved oxygen. Water quality parameters are measured at over 4,000 stations in Virginia's coastal zone. Monitoring data show that 316 coastal water bodies are impaired (Virginia Department of Environmental Quality 2001). Shellfish concerns are related to bacteria, and health advisories have been issued for fish consumption related to PCBs and mercury (Virginia Department of Environmental Quality 2010).

North Carolina. All 322 mi. (518 km) of the North Carolina coastal shoreline are considered impaired. The main issues reported are mercury in fish tissue, as well as selenium at limited locations. Bays and estuaries were not assessed. According to the USEPA (2008c), water quality in the Albemarle-Pamlico Estuarine Complex is rated good. Impairment is primarily the result of runoff from agricultural and urban areas that leads to excess nutrients and increased turbidity from algal blooms.

Chesapeake Bay. Bay water is listed as impaired under Section 303(d) of the federal Clean Water Act due to excess nutrients and sediment (U.S. Geological Society 2005). The most contaminated sites were concentrated at the northern end of the bay, where development is most intensive. Nutrient enrichment in the bay arises from agricultural and other nonpoint source runoff, and municipal and industrial wastewater treatment facilities (U.S. Army Corps of Engineers 2009).

Note: The Chesapeake Bay watershed includes portions of Delaware, Maryland, New York, Pennsylvania, Virginia, West Virginia, and the District of Columbia. In order to simplify the discussion and reduce repetition, water quality issues in the bay are not reviewed on a state-by-state basis because: (1) many of the water quality issues are common to most or all of these bordering states; and (2) Navy training and testing activities are limited to the extreme southeast portion of the bay and do not appreciably impact water quality issues in the bay.

3.1.2.2.3 Water Quality in the Southeast U.S. Continental Shelf Large Marine Ecosystem

The Southeast U.S. Continental Shelf Large Marine Ecosystem includes the Navy Cherry Point and JAX Range Complexes, and the South Florida Ocean Measurement Facility Testing Range. See Figure 3.0-3 for the locations of these areas.

Open Ocean Water Quality

Of the large marine ecosystems in the Study Area, the southeast is judged to be in the best ecological condition (Aquarone et al. 2008). Sauer et al. (1989) surveyed the micro-surface layer and subsurface water at five open ocean sites between Cape Hatteras, North Carolina and Florida for the presence of PCBs and several chlorinated pesticides. Micro-surface layer samples collected contained PCB concentrations between less than 0.5 and 1.5 ng/L, and pesticide concentrations between less than 0.5 and 1.0 ng/L. Subsurface water samples contained PCB concentrations between 0.003 and 0.424 ng/L and pesticide concentrations between 0.013 and 0.1 ng/L.

Nearshore Water Quality

States bordering the Southeast U.S. Continental Shelf Large Marine Ecosystem include southeast North Carolina, South Carolina, Georgia, and Florida (Atlantic coast only). Information regarding the current quality of marine waters in the nearshore areas of these states is provided below. Figure 3.1-5 depicts those conditions. The USEPA report (2008e) rated the waters along the southeast coast as fair; 6 percent of the sites sampled rated poor. Except where indicated, the following discussion of water quality is drawn from USEPA (2010).

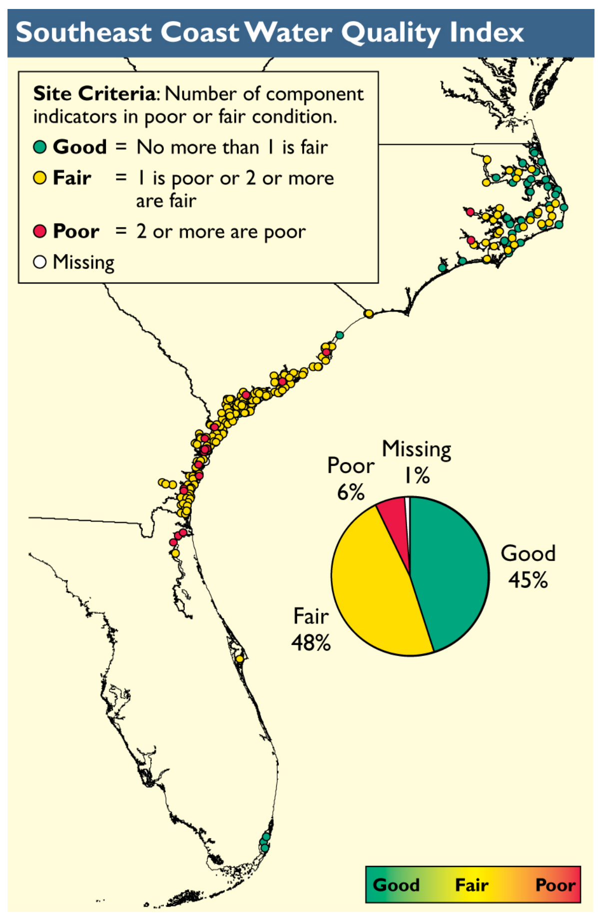

Figure 3.1-5: Water Quality Index for the Southeast U.S. Coast

Source: U.S. Environmental Protection Agency (2008b)

North Carolina. All 322 mi. (518 km) of the North Carolina coastal shoreline are considered impaired. The main issues involved mercury in fish tissue, as well as selenium at limited locations. Bays and estuaries were not assessed. According to Mallin (2000), most estuaries in North Carolina exhibit low-to-moderate eutrophication. However, conditions in three estuaries – the Pamlico River, Neuse River, and New River – were rated as highly eutrophic based on frequency and extent of algal blooms, bottom-water hypoxia and anoxia, fish kills, and loss of submerged aquatic vegetation. According to the USEPA (2008c), water quality in the Albemarle-Pamlico estuarine complex is rated good. Impairment is primarily the result of runoff from agricultural and urban areas that leads to excess nutrients and increased turbidity from algal blooms.

South Carolina. For South Carolina, water quality for 57.9 percent of estuaries and bays is considered good and 42.1 percent is considered impaired (U.S. Environmental Protection Agency 2008c). Estuaries in South Carolina exhibit low or moderate eutrophication (Mallin et al. 2000). Ocean and near-coastal waters were rated good.

Georgia. Water quality along Georgia's coast is rated fair based on five indicators: dissolved oxygen, dissolved inorganic nitrogen, dissolved inorganic phosphorus, turbidity as measured by chlorophyll *a*, and water clarity. Eighty percent of the state's estuaries rated fair, 18 percent rated poor, and 1 percent rated good. Increasing eutrophication and decreasing water clarity were noted as concerns (Georgia Department of Natural Resources 2005).

Florida. Most of the state's estuaries and all of its coastal waters are considered impaired because of mercury in fish tissue, low dissolved oxygen, turbidity as measured by chlorophyll *a*, fecal coliform, and bacteria in shellfish. Harmful algal blooms and nutrient enrichment are of increasing concern (Florida Department of Environmental Protection 2010). Because Florida is included in both the Southeast U.S. Continental Shelf and the Gulf of Mexico Large Marine Ecosystems, Florida's gulf coast is discussed below.

3.1.2.2.4 Water Quality in the Caribbean Sea Large Marine Ecosystem

The Caribbean Sea Large Marine Ecosystem includes offshore marine areas south and southeast of the Florida Keys. Within the Study Area, the majority of the Key West Range Complex is located within this ecosystem. See Table 3.0-2 for a list of range complexes within each large marine ecosystem, and Figure 3.0-2 for their locations. These marine waters are clear and poor in nutrients (Heileman and Mahon 2008). Specific information regarding water quality in the Key West Range Complex could not be located. As with other coastal areas, nearshore water quality is mostly influenced by onshore activities and development, plus the discharge of solid waste and wastewater from commercial and cruise vessels (Heileman and Mahon 2008; Lapointe et al. 1994).

3.1.2.2.5 Water Quality in the Gulf of Mexico Large Marine Ecosystem

The Gulf of Mexico Large Marine Ecosystem includes the GOMEX Range Complex, which consists of four OPAREAs: Panama City, Pensacola, New Orleans, and Corpus Christi. Also within the Gulf of Mexico Large Marine Ecosystem are the Naval Surface Warfare Center, Panama City Division Testing Range (Florida) and a portion of the Key West Range Complex. See Table 3.0-2 for a list of range complexes within each large marine ecosystem, and Figure 3.0-2 for their locations.

Open Ocean Water Quality

Unlike the other areas, no open ocean areas are specifically designated for the Gulf of Mexico. However, Sauer et al. (1989) surveyed the micro-surface layer and subsurface water at six sites in the west central part of the Gulf of Mexico for the presence of PCBs and several chlorinated pesticides. Micro-surface layer samples collected contained PCB concentrations between less than 0.2 and 1.0 ng/L and pesticide concentrations between less than 0.1 and 0.5 ng/L. Subsurface water samples contained PCB concentrations between 0.0006 and 0.0024 ng/L and pesticide concentrations between 0.0002 and 1.46 ng/L.

Nearshore Water Quality

States bordering the Gulf of Mexico Large Marine Ecosystem include Florida (gulf coast only), Alabama, Mississippi, Louisiana, and Texas. Information regarding the current quality of marine waters in the nearshore areas of these states is provided below. Figure 3.1-6 depicts those conditions. The USEPA (2008e) rated the gulf waters as fair. Of the sites sampled, 14 percent rated poor. Various combinations of all the water quality indicators were responsible for poor site conditions. Onshore development, oil and gas extraction, and excess nutrients are the main sources of stress on the Gulf of Mexico (Heileman and Rabalais 2008). Except where indicated, the following discussion of water quality is drawn from USEPA (2010).

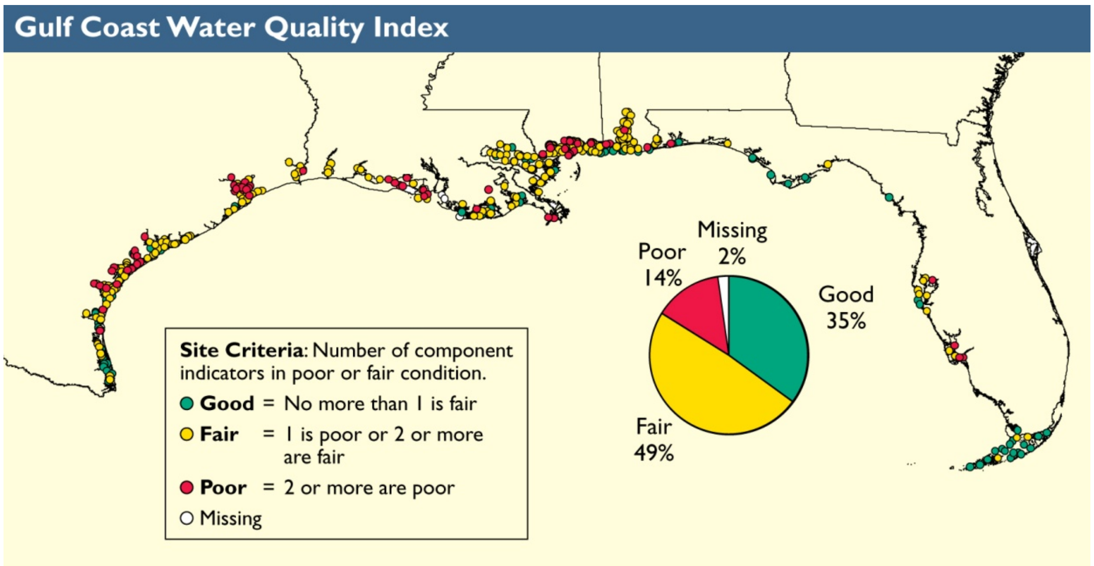

Figure 3.1-6: Water Quality Index for the U.S. Gulf Coast
Source: U.S. Environmental Protection Agency (2008b)

Florida. Most of the state's estuaries and all of its coastal waters are considered impaired because of mercury in fish tissue, bacteria in shellfish, low dissolved oxygen, turbidity as measured by chlorophyll *a*, and fecal coliform. Harmful algal blooms and nutrient enrichment are of increasing concern (Florida Department of Environmental Protection 2010).

Lewis et al. (2001) studied the impacts of urbanization on three areas in Pensacola Bay. Although total metal concentrations varied widely, copper and zinc were most commonly detected in surface waters. Average levels for copper exceeded both the chronic (3.1 µg/L) and acute (4.8 µg/L) exposure levels established to protect marine life. Cadmium, chromium, and nickel were detected in fewer samples but, where detected, concentrations exceeded chronic exposure levels. Concentrations of most chlorinated pesticides, polycyclic aromatic hydrocarbons, and all PCBs were below the limits of detection. The most commonly detected pesticides were diazinon (0.03 to 0.22 µg/L) and atrazine (0.03 to 0.30 µg/L). The authors noted that some pesticides occasionally exceeded the recommended maximum surface water concentration of 0.004 µg/L and that total polycylic aromatic hydrocarbons concentrations at some sites exceeded the recommended annual average of less than or equal to 0.031 µg/L, but these occasions were "uncommon." Petroleum hydrocarbons were detected in surface water collected from several sites, but most commonly in Bayou Grande, where the average concentrations ranged from 1.1 to 8.9 µg/L.

Alabama. Water quality for the estuaries and bays assessed for Alabama rated 15.6 percent as good and 84.4 percent as impaired, mainly by pathogens (fecal bacteria). Ocean and near coastal water quality was rated impaired. The main issue was mercury.

Mississippi. Of the 23 mi. (37 km) of coastal Mississippi shoreline assessed, 62.5 percent rated good and 37.5 percent rated impaired. The main issue was pathogens (fecal bacteria). No information was provided for bays and estuaries. Sampling along the coast indicated degraded water clarity and high phosphorus levels contributed to poor water quality (U.S. Environmental Protection Agency 2008c; 4% missing data).

Louisiana. Clark and Goolsby (2000) studied herbicide concentrations in the Mississippi River at Baton Rouge between 1991 and 1997. Peak herbicide concentrations generally followed peak discharges in late winter or early spring. Herbicides and their metabolites were detected in more than half of the samples (e.g., alachlor, atrazine, metolachlor, deethylatrazine, and cyanazine). No compound exceeded 5 µg/L, and the total herbicide concentration did not exceed 10 µg/L. None of the average annual concentrations of the herbicides examined in that study exceeded maximum contaminant levels or the health advisory levels established at that time.

Water quality for the estuaries and bays in Louisiana was rated as 51.8 percent good and 48.2 percent impaired. The main issues were mercury and fecal coliform.

Texas. Water quality for the estuaries and bays in Texas were rated as 69.2 percent good and 30.8 percent impaired. The main issues were bacteria (in oyster waters) and low dissolved oxygen. Of the coastal shoreline assessed, the issue was bacteria; for ocean and nearshore waters, the issue was mercury in fish.

***Deepwater Horizon* Oil Spill**

An overview of the 2010 oil spill in the Gulf of Mexico from the *Deepwater Horizon* well is provided in Section 3.1.2.1.5 (Sediment in Gulf of Mexico Large Marine Ecosystem).

3.1.2.2.6 Marine Debris and Water Quality

The National Marine Debris Monitoring Program developed three categories of marine debris for its study of the extent of man-made materials in the oceans: land-based, ocean-based, and general, i.e., origin unspecified (Sheavly 2007). Land-based debris may blow in on the wind, be washed in with storm water, arise from recreational use of coastal areas, and be generated by extreme weather such as hurricanes. Ocean-based sources of marine debris include commercial shipping and fishing, private boating, offshore mining and extraction, and legal and illegal dumping at sea. Ocean current patterns, weather and tides, and proximity to urban centers, industrial and recreational areas, shipping lanes, and fishing grounds influence the types and amount of debris found (Sheavly 2010). These materials are concentrated at the surface and in the water column.

According to Sheavly (2010), land-based sources account for about half of marine debris, and ocean/waterway-based sources contribute another 18 percent. Land-based debris included syringes, condoms, metal beverage cans, motor oil containers, balloons, six-pack rings, straws, tampon applicators, and cotton swabs. Ocean-based debris included gloves, plastic sheets, light bulbs and tubes, oil and gas containers, pipe-thread protectors, nets, traps and pots, fishing line, light sticks, rope, salt bags, fish baskets, cruise line logo items, and floats and buoys. General debris included plastic bags, strapping bands, and plastic bottles for beverages, food, cleaners, and other products (Sheavly 2007).

Microscopic plastic fragments enter the marine environment from use as scrubbers in hand cleaning products, abrasive beads for cleaning ships, and deterioration of macroscopic plastics (Teuten et al. 2007). Recent marine debris findings in the Study Area (Sheavly 2007) are provided in Table 3.1-7 below.

Table 3.1-7: Percent Marine Debris by Source in Atlantic Fleet Training and Testing Study Area

Sheavly Study Area	Locations within Study Area	Land-Based (%)	Ocean-Based (%)	General (%)
Region 1 (Provincetown, Massachusetts, to Canadian border)	Northeast Range Complexes	28	42	30
Region 2 (Cape Cod, Massachusetts, to Beaufort, North Carolina)	Northeast and Virginia Capes Range Complexes; Naval Undersea Warfare Center Division, Newport Testing Range	63	7	30
Region 3 (Morehead City, North Carolina, to Port Everglades, Florida)	Navy Cherry Point and Jacksonville Range Complexes; Undersea Warfare Training Range	41	14	44
Regions 4 & 5 (Port Everglades, Florida, to Mexican border)	Gulf of Mexico and Key West Range Complexes; Naval Surface Warfare Center, Panama City Division Testing Range	48	16	36

%: percent
Numbers may not sum due to rounding.

In a recent survey of marine debris in the North Atlantic, 62 percent of all net tows contained detectable amounts of plastic debris (Law et al. 2010). The highest concentrations were observed between 22° and 38°N latitude (roughly south of Florida to Maine). Tows closest to land, such as along the Florida coast and in the Gulf of Maine, found relatively small amounts of plastic.

Because of their buoyancy, many types of plastic float and may travel thousands of miles in the ocean (U.S. Commission on Ocean Policy 2004). Exceptions include heavy nets and ropes. Although plastics are resistant to degradation, they do gradually breakdown into smaller particles due to sunlight ("photolysis") and mechanical wear (Law et al. 2010). A study by Teuten et al. (2007) indicated that the water-borne phenanthrene (a type of polycyclic aromatic hydrocarbon) adhered preferentially to small pieces of plastic ingested by a bottom-dwelling marine lugworm and incorporated into its tissue. Marine microbes and fungi are known to degrade biologically produced polyesters, such as polyhydroxyalkanoates, a bacterial carbon and energy source (Doi et al. 1992). Marine microbes also degrade other synthetic polymers, although at slower rates (Shah et al. 2008).

Plastics may serve as vehicles for transport of various pollutants, whether by binding them from seawater or from the constituents of the plastics themselves. Mato et al. (2001) noted that polypropylene resin pellets (precursors to certain manufactured plastics) collected from sites in Japan contained PCBs, dichlorodiphenyldichloroethylene (a breakdown product of DDT), and the persistent organic pollutant nonylphenol (a precursor to certain detergents). PCBs and dichlorodiphenyldichloro-ethylene were adsorbed from seawater. The original source of nonylphenol was less clear; it may have originated from the pellets themselves or may have been adsorbed from the seawater.

3.1.2.2.7 Climate Change and Water Quality

Aspects of climate change that influence water quality include decreasing ocean pH (i.e., more acidic), increasing water temperatures, and increasing storm activity. Changes in pH outside the normal range can make it difficult for marine animals with shells to maintain those shells (Fabry et al. 2008). Since many creatures are at the base of the marine food chain, such as diatoms and phytoplankton, changes may reverberate through the ecosystem. Warming waters can be detrimental to coastal ecosystems. For example, in waters that are warmer than normal, coral colonies appear to turn white (bleaching) because they expel symbiotic microbes (zooxanthellae) that give them some of their colors. These microbes are important for coral survival because they provide the coral with food and oxygen, while the coral provides shelter, nutrients, and carbon dioxide. Especially when combined with acidification, warmer waters can be detrimental to corals (Anthony et al. 2008). Major coral bleaching events occurred during increased sea water temperatures in 2005–2006 that caused extensive bleaching of corals in Florida and the Caribbean. Water pollution and natural disturbances (e.g., hurricanes) often inflict additional stress on coral ecosystems (Hughes and Connell 1999).

According to the Intergovernmental Panel on Climate Change, there is no clear global trend in the annual numbers of tropical hurricanes (Intergovernmental Panel on Climate Change 2007). However, according to the Pew Center on Global Climate Change, there has been an increase in the frequency of tropical storms and major hurricanes in the North Atlantic. The intensity of tropical storms has also increased, with the strongest trends in the North Atlantic and Indian Oceans (Pew Center on Global Climate Change 2010). The Intergovernmental Panel on Climate Change (2007) and the U.S. Climate Change Science Program (2008) rate as “likely” that future storms will be more intense, with higher peak wind speeds and heavier precipitation. Others disagree with these conclusions. For example, Knutson (2010) contends that, although there is a recent trend of more tropical storms, there is a declining trend for land-falling hurricanes. From 1850 to 1990, the long-term average number of tropical storms per year in the North Atlantic and Gulf of Mexico was about 10, about half of which were hurricanes. For the period 1998–2007, the average is about 15 tropical storms per year (Blake et al. 2007). These authors noted that “this increase in frequency correlates strongly with the rise in North Atlantic sea surface temperature,” a rise that is linked to climate change. If storm frequency and intensity increase, there would be a resulting increase in marine sediment disturbance (Wren and Leonard 2005) resulting in a decline in nearshore and coastal area water quality.

3.1.3 ENVIRONMENTAL CONSEQUENCES

This section evaluates how and to what degree the training and testing activities described in Chapter 2 (Description of Proposed Action and Alternatives) potentially could impact sediment and water quality in the Study Area. Tables 2.8-1 through 2.8-3 present the baseline and proposed training and testing activity locations for each alternative (including number of events and ordnance expended). Each sediments and water quality stressor is introduced, analyzed by alternative, and analyzed for training and testing activities. Potential impacts could be associated with

- the release of materials into the water that subsequently disperse, react with seawater, or may dissolve over time;
- the deposition of materials on the ocean bottom and any subsequent interactions with sediment or the accumulation of such materials over time;
- the deposition of materials or substances on the ocean bottom and any subsequent interaction with the water column; and
- the deposition of materials on the ocean bottom and any subsequent disturbance of that sediment or the creation of turbidity.

These potential impacts are categorized into four stressors: (1) explosives and explosion byproducts; (2) metals; (3) chemicals other than explosives; and (4) a miscellaneous category of other materials. The term “stressor” is used because materials in these four categories may directly impact sediment and water quality by altering their physical and chemical characteristics.

The area of analysis for sediment and water quality includes the estuaries, nearshore areas, and the open ocean (including the sea bottom) in the western Atlantic Ocean and Gulf of Mexico. Sediment and marine waters within territorial and nonterritorial waters along the east coast and Gulf of Mexico would be similar in terms of their reactions to military expended materials. For instance, extremely small sediment size is a major determinant of how metals behave in sediment, and sediment size would be similar at a given distance from shore. Thus, potential impacts on sediment and water quality from military expended materials that come to rest in sediment at a given distance from shore are assumed to be similar whether off the east coast or the Gulf of Mexico.

3.1.3.1 Explosives and Explosion Byproducts

3.1.3.1.1 Introduction

Explosives are complex chemical mixtures that may negatively impact sediment and water quality through the byproducts of their detonation in water and the distribution of unconsumed explosives in sediment and the water column. The use of explosives may also disturb sediment, increasing turbidity. Underwater explosions resuspend sediment into the water column, creating a turbidity plume. However, these turbidity impacts are not considered substantial because, depending on specific site conditions of wind and tidal currents, the turbidity plume eventually dissipates as particles return to the bottom or are dispersed. Therefore, this issue is not considered further.

The proposed alternatives involve the use of three main categories of explosives:

- Nitroaromatics such as trinitrotoluene (TNT), ammonium picrate, and tetryl (methyl-2,4,6-trinitrophenyl-nitramine);
- Nitramines such as royal demolition explosive (RDX or hexahydro-1,3,5-trinitro-1,3,5-triazine) and high melting explosive (HMX or octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine); and
- Nitrate esters, such as pentaerythritol tetranitrate.

The explosives TNT, royal demolition explosive, and high melting explosive are components of bombs, missile and rocket fuels, warheads, torpedoes, sonobuoys, medium- and large-caliber munitions, and charges used in a variety of activities, such as mine countermeasure and mine neutralization activities (Clausen et al. 2007). Pentaerythritol tetranitrate (PETN) is most commonly used in blasting caps, detonation cord, and other initiators of explosions. Chemical stressors other than explosives are discussed in Section 3.1.3.3 (Chemicals Other than Explosives).

During their detonation, energetic compounds may undergo high-order detonation, low-order detonation, or may fail to detonate. High-order (complete) detonations consume 98 to 99 percent of the explosive, with the remainder released into the environment as discrete particles. Low-order (incomplete) detonations consume a lower percentage of the explosive and release larger amounts of explosives into the environment. If the ordnance fails to detonate, the energetic compound may be released to the environment over time if corrosion of the shell occurs. For the remainder of this discussion, the term “explosives” is used to refer to unconsumed explosives remaining after low-order detonations and detonation failures. The term “explosion byproducts” is used to refer to the liquids and gases that remain after detonation of explosives. The remainder of Section 3.1.3.1 discusses explosives and explosion byproducts.

- Sections 3.1.3.1.2 and 3.1.3.1.3 provide more detail concerning explosives and explosion byproducts as well as the estimated rates at which munitions do not perform as expected;
- Section 3.1.3.1.4 describes how explosives and explosion byproducts will be evaluated under each alternative;
- Section 3.1.3.1.5 reviews information regarding the behavior and potential negative impacts of explosives and explosion byproducts on sediment and water quality; and
- Section 3.1.3.1.6 evaluates each alternative in terms of the information provided in Sections 3.1.3.1.4 and 3.1.3.1.5.

Explosions that occur above or at the surface are assumed to distribute nearly all explosion byproducts into the air, rather than into the water. These impacts are discussed in Section 3.2 (Air Quality). This analysis concerns only those explosions that occur underwater. It should also be noted that military expended materials that explode in the air or at the water surface may deposit particles of unconsumed explosives in the marine environment. These materials are addressed in Section 3.1.3.3.5 (Other Chemicals Associated with Ordnance) which deals with unconsumed explosives.

3.1.3.1.2 Background

Under the Proposed Action, explosions would occur: (1) above the surface of the water, at the water surface, or just beneath the water surface in those warfare areas that use bombs, medium- and large-caliber projectiles, missiles, and rockets; and (2) underwater during mine countermeasure and mine neutralization activities, ship shock trials, explosives testing, and use of torpedoes, explosive sonobuoys and percussion grenades. Mine countermeasure and neutralization activities occur beneath the surface and on or near the bottom, typically in fairly shallow areas. Charges range in size from 2 to 60 lb. (0.9 to 27.2 kg) net explosive weight. Ship shock trials occur in deeper waters (at least 600 ft. [183 m]) and involve charges ranging from 1,000 to 58,000 lb. (454 to 26,310 kg) net explosive weight. Detonations occur about 200 ft. (61 m) below the surface and at varying distances from the vessel (U.S. Department of the Navy 2008a).

Mine countermeasure and mine neutralization activities most often involve the explosive composition 4 (C-4). C-4 is composed of about 95 percent royal demolition explosive mixed with polyisobutylene, a plastic binding material. When functioning properly (i.e., complete detonation), 99.997 percent of the explosive is converted to inorganic compounds (Renner and Short 1980; U.S. Army Corps of Engineers 2003). Table 3.1-8 below details the byproducts of underwater detonation of C-4 (95 percent RDX).

Table 3.1-8: Byproducts of Underwater Detonation of C-4

Byproduct	Percent of Total, by Weight	Byproducts	Percent of Total, by Weight
Nitrogen	37.0	Propane	0.2
Carbon dioxide	24.9	Methane	0.2
Water	16.4	Hydrogen cyanide	< 0.01
Carbon monoxide	18.4	Methyl alcohol	< 0.01
Ethane	1.6	Formaldehyde	< 0.01
Ammonia	0.9	Other compounds	< 0.01
Hydrogen	0.3		

"<": less than.

From Table 3.1-8, nitrogen, carbon dioxide, water, carbon monoxide, ammonia, and hydrogen are natural components of seawater and represent 98 percent of all byproducts produced from the detonation of royal demolition explosive.

Ship shock trial charges use high blast explosive (HBX-1), which consists of the following components (by weight): cyclotrimethylene trinitramine (39.3 percent), TNT (37.8 percent), aluminum powder (17.1 percent), wax (4.6 percent), and miscellaneous fillers (1.3 percent). Table 3.1-9 below details the byproducts of underwater detonation of a high blast explosive (U.S. Department of the Navy 2008a). No explosion byproducts exceeded permissible concentrations (U.S. Environmental Protection Agency 1986).

Table 3.1-9: Byproducts of Underwater Detonation of High Blast Explosive

Byproduct	Predicted Concentration (mg/L)	Permissible Concentration (mg/L)
Aluminum oxide	0.434	N/A
Carbon	0.143	N/A
Carbon monoxide	0.0293	0.552
Ethane	0.00469	120
Carbon dioxide	0.00262	1.0
Ammonia	0.00230	0.092
Propane	0.00135	120
Hydrogen cyanide	0.000298	0.001
Methane	0.000126	120
Other compounds*	< 0.0001	–

Source: U.S. Environmental Protection Agency 1986
* Other compounds include methyl alcohol, formaldehyde, acetylene, and phosphine.
Predicted concentrations were well below permissible concentrations.
"<": less than; mg/L: milligrams per liter.

3.1.3.1.3 Ordnance Failure and Low-Order Detonations

Table 3.1-10 provides information about the rates of failure and low-order detonations for high-explosives and other munitions (Rand Corporation 2005; U.S. Army Corps of Engineers 2007).

Table 3.1-10: Failure Rates and Low-Order Detonation Rates of Military Ordnance

Ordnance	Failure Rate (Percent)	Low-Order Detonation Rate (Percent)
Guns/artillery	4.68	0.16
Hand grenades	1.78	–
High explosive ordnance	3.37	0.09
Rockets	3.84	–
Submunitions*	8.23	–

* Submunitions are munitions contained within and distributed by another device such as a rocket.

3.1.3.1.4 Approach to Analysis

Most activities involving explosives and explosion byproducts would be conducted more than 3 nm off shore in each range complex and testing range. Activities in these areas (3 nm to 200 nm) would be subject to federal sediment and water quality standards and guidelines. This includes mine countermeasure and mine neutralization activities conducted in Warning Area 50 (W-50) in the VACAPES Range Complex (Virginia). (Note: Proposed training and testing activities also occur beyond 200 nm, but U.S. legal and regulatory authority does not extend beyond 200 nm. In such cases, impacts will be judged against federal standards and guidelines.)

Explosives are also used in nearshore areas (low tide line to 3 nm) specifically designated for mine countermeasure and mine neutralization activities. Such activities are conducted in the following areas: Joint Expeditionary Base Little Creek-Fort Story, VACAPES (Virginia, North Carolina); Onslow Bay in the Navy Cherry Point Range Complex (North Carolina); the Charleston OPAREA in the JAX Range Complex (North and South Carolina); and the Naval Surface Warfare Center, Panama City Division Testing Range (Florida). These activities would be subject to state sediment and water quality standards and guidelines.

For explosion byproducts, “local” refers to the water column in the vicinity of the underwater detonation. For unconsumed explosives, “local” refers to the area of potential impact from explosives in a zone of sediment about 66 inches (2 m) in diameter around the unconsumed explosive where it comes to rest on the sea floor.

State standards and guidelines. Table 3.1-11 below summarizes existing state standards and guidelines for sediment and water quality related to explosives and explosion byproducts.

Table 3.1-11: State Water Quality Criteria for Explosives and Explosion Byproducts

State	Explosives, Explosion Byproducts	Criteria (µg/L)	Source
Florida	Cyanide	≤ 1.0	Florida 1994, 2010b
Georgia	Cyanide	1.0	Georgia 2010
	2,4-dinitrotoluene	3.4	
North Carolina	Cyanide	1.0	North Carolina 2007
Virginia*	Cyanide	1.0 (chronic/acute)	Virginia 2011
	2,4-dinitrotoluene	≤ 9.1 annual average	

* “Acute” criteria reflect a one-hour average concentration not to be exceeded more than once every three years on average. “Chronic” criteria reflect a four-day average concentration not to be exceeded more than once every three years on average. “≤” means less than or equal to. µg/L: micrograms per liter.

Federal standards and guidelines. Table 3.1-12 summarizes the USEPA (U.S. Environmental Protection Agency 2009) criteria for explosives and explosion byproducts in saltwater.

Table 3.1-12: Federal Criteria for Explosives and Explosion Byproducts in Saltwater

Explosives, Explosion Byproducts	Criterion Maximum Concentration (µg/L)	Criterion Continuous Concentration (µg/L)
Cyanide	1	1

“Criteria maximum concentration” is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. “Criterion continuous concentration” is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. µg/L: micrograms per liter.

3.1.3.1.5 Impacts from Explosives and Explosion Byproducts

As recently as 2004, Zhao et al. (2004) reported that little data are available on the fate and degradation of unconsumed explosives in sediment. In 2007, Cruz-Uribe et al. (2007) noted that "contamination of the marine environment by munitions constituents is not well documented," and Montgomery et al. (2008) noted that there is "little published information on TNT degradation in seawater or sediments aside from the work of Carr and Nipper (2003)." Still, Zhao et al. (2004) noted that leaching of unconsumed explosives is considered a major source of sediment contamination in seas and waterways, and that contaminants can subsequently move from the sediment and accumulate in aquatic organisms. According to Nipper et al. (2002), their studies of Puget Sound sediment demonstrate "that the studied ordnance compounds were not a cause for environmental concern in the levels previously measured in sediments." The studied compounds included 2,6-dinitrotoluene, tetryl, and picric acid. They remarked that the "levels of ordnance compounds that would be of concern in sediments have not yet been identified."

The behavior of explosives and explosion byproducts in marine environments—and the extent to which those constituents have negative impacts—is influenced by various processes, including the ease with which the explosive dissolves in water (solubility), the degree to which explosives are attracted to other materials in the water (e.g., clay-sized particles and organic matter; sorption), and the tendency of the explosives to evaporate (volatilization). These characteristics, in turn, influence the extent to which the material is subject to biotic (biological) and abiotic (physical and chemical) transformation, degradation, and bioaccumulation (Pennington and Brannon 2002). The solubility of various explosives is provided in Table 3.1-13. In the table, higher numbers mean that the substance is more soluble in water. For instance, high melting explosive is virtually insoluble in water. Table salt, which dissolves easily in water, is provided for comparison.

Table 3.1-13: Water Solubility of Common Explosives and Explosive Degradation Products

Compound[1]	Water Solubility[2]
Table salt (sodium chloride)	357,000
Ammonium perchlorate (D)	249,000
Picric acid (E)	12,820
Nitrobenzene (D)	1,900
Dinitrobenzene (E)	500
Trinitrobenzene (E)	335
Dinitrotoluene (D)	160–161
TNT (E)	130
Tetryl (E)	51
Pentaerythritol tetranitrate (E)	43
Royal demolition explosive (E)	38
High melting explosive (E)	7

Source: U.S. Department of the Navy (2008a)
[1] "E" refers to explosive; "D" refers to explosive degradation product.
[2] Units are milligrams per liter (mg/L) at 20°C.
TNT: trinitrotoluene

Solubility rates were not affected by pH, but they increase as temperature increases (Lynch et al. 2002). Explosives proposed for use under the alternatives have low solubilities as shown in Table 3.1-13 and would dissolve slowly over time. Thus they are not very mobile within marine environments (Juhasz and Naidu 2007). Nitroaromatics such as TNT do not bind to metal hydroxides but may bind to clays, depending on the type (more so with potassium or ammonia ions but "negligibly small" for clays with ions of sodium, calcium, magnesium, and aluminum). Sorption by nitroamines such as royal demolition explosive is "very low" (Haderlein et al. 1996).

According to Walker et al. (2006), TNT, royal demolition explosive, and high melting explosive experience rapid biological and photochemical degradation in marine systems. The authors noted that productivity in marine and estuarine systems is largely controlled by the limited availability of nitrogen. Because nitrogen is a key component of explosives, explosives are attractive as substrates for marine bacteria that metabolize other naturally occurring organic matter, such as polycyclic aromatic hydrocarbons. Juhasz and Naidu (2007) also noted that microbes use explosives as sources of carbon and energy.

Carr and Nipper (2003) indicated that conversion of TNT to carbon dioxide, methane, and nitrates in coastal sediment (a process referred to as "mineralization") occurred at rates typical for naturally occurring compounds such as phenanthrene, fluoranthene, toluene, and naphthalene. They noted that transformation of 2,6-dinitrotoluene and picric acid by organisms in sediment is dependent on temperature and type of sediment (i.e., finer-grained). Pavlostathis and Jackson (2002) reported the uptake and metabolism of TNT by the marine microalgae *Anabaena* sp. Nipper et al. (2002) noted that enhanced degradation of 2,6-dinitrotoluene, tetryl, and picric acid occurred in fine-grained sediment high in organic carbon. Cruz-Uribe et al. (2007) noted that three species of marine macroalgae metabolize TNT to 2-amino-4,6-dinitrotoluene and 4-amino-2,6-dinitrotoluene, and they speculate that "the ability of marine macroalgae to metabolize…TNT is widespread, if not generic."

Singh et al. (2009) indicated that biodegradation of royal demolition explosive and high melting explosive occurs with oxygen (aerobic) and without (anoxic or anaerobic), but that they more easily degraded under the latter conditions. Crocker et al. (2006) indicated that the mechanism of high melting explosive and royal demolition explosive biodegradation are similar, but degradation of high melting explosive occurs more slowly. Singh et al. (2009) noted that royal demolition explosive and high melting explosive are biodegraded under a variety of anaerobic conditions by specific microbial species and by mixtures ("consortia") of such species. Work by Zhao et al. (2004) indicated that biodegradation of royal demolition explosive and high melting explosive occurs in cold marine sediment.

According to Singh et al. (2009), typical end products of royal demolition explosive degradation include nitrite , nitrous oxide, nitrogen, ammonia, formaldehyde, formic acid , and carbon dioxide. Crocker et al. (2006) stated that many of the primary and secondary intermediate compounds from biodegradation of royal demolition explosive and high melting explosive are unstable in water and spontaneously decompose. Thus, these explosives are degraded by a combination of biotic and abiotic reactions. Formaldehyde is subsequently metabolized to formic acid, methanol, carbon dioxide, or methane by various microorganisms (Crocker et al. 2006).

According to Juhasz and Naidu (2007), TNT, royal demolition explosive, and high melting explosive also degrade from photolysis (exposure to light) and hydrolysis (exposure to water). The byproducts of TNT photolysis include nitrobenzenes, benzaldehydes, azoxydicarboxylic acids, and nitrophenols. The byproducts of royal demolition explosive and high melting explosive photolysis include azoxy compounds, ammonia, formaldehyde, nitrate, nitrite, nitrous oxide, and *N*-nitroso-methylenediamine (Juhasz and Naidu 2007). Walker et al. (2006) speculated that degradation of TNT "below the photic (light) zone in coastal waters and sediments may be largely controlled by metabolism by heterotrophic bacteria." According to Monteil-Rivera et al. (2008), at the pH common in marine environments (i.e., 8), there should be a "slow but significant removal" of royal demolition explosive and high melting explosive due to alkaline hydrolysis. Under such conditions, and absent biodegradation, royal demolition explosive would take over 100 years to hydrolyze, while high melting explosive would require more than 2,100 years (Monteil-Rivera et al. 2008).

Detection and Fate of Unexploded Ordnance in Marine Environments

Most studies of unexploded ordnance in marine environments have not detected explosives or have detected them in the range of parts per billion. Studies examining the impact of ordnance on marine organisms have produced mixed results. More information regarding these studies is provided below. The amount and concentration of ordnance deposited in the areas studied were far in excess of those that would occur under the Proposed Action.

Several authors studied the impact of unexploded ordnance in Halifax Harbor, Nova Scotia, Canada. Rodacy et al. (2000) noted that munitions explosions in 1917 and 1946 scattered ordnance across an area known as the Bedford Basin. Resulting ordnance was both fully exposed on and partially buried in the sea floor. They reported that 34 of 59 water samples (58 percent) "produced detectable signatures" of ordnance, as did 26 of 27 sediment samples (96 percent). They also noted that marine growth was observed on most of the exposed ordnance, and that TNT metabolites were present and suspected as the result of biological decomposition. In a prior study (Durrach et al. 1998), sediment collected near unexploded, but broken, ordnance did not indicate the presence of TNT, but samples near ordnance targets that appeared intact showed trace explosives in the range of low parts per billion or high parts per trillion. The sampling distance was 6 to 12 inches (0.15 to 0.3 m) from the munitions. The authors expressed the opinion that, after 50 years, the contents of broken munitions had dissolved, reacted, biodegraded, or photodegraded, and that intact munitions appear to be slowly releasing their contents through corrosion pinholes or screw threads.

A study was conducted on chemical and conventional munitions disposed on the ocean floor approximately 5 mi. (8 km) south of Pearl Harbor, Hawaii (Hawaii Undersea Military Munitions Assessment 2010). Documents indicate that, following World War II (October-November 1944), sixteen thousand 100 lb. (45 kg), mustard-filled bombs may have been disposed in this area. The state of deterioration of the munitions ranged from "nearly intact to almost completely disintegrated." The authors collected 94 sediment samples and 30 water samples from 27 stations at five locations. These were analyzed for chemical agents, explosives, metals (arsenic, copper, lead, and zinc), polycyclic aromatic hydrocarbons, pesticides, PCBs, phenols, and organic tin. There were no confirmed detections of chemical agents or explosives, and comparisons between the disposal site and reference sites showed no statistically significant differences in levels of munitions constituents, chemical agents, and metals. However, the sampling distance for this project was 3 to 6 ft. (1 to 2 m). The authors compared their sampling distance to that used by Durrach et al. (1998), that is, 6 to 12 inches (0.15 to 0.3 m). Regarding that difference, they indicated the project sampling distance may be too far to detect any chemical agents or explosives and that sampling distance may be a significant factor determining whether munitions constituents can be detected near discarded munitions. Samples with elevated metals relative to typical deep-sea sediment were "most likely" the result of dumping sediment dredged from Oahu harbors.

Hoffsommer et al. (1972) analyzed seawater and ocean floor sediment and fauna at known ocean dumping sites for military ordnance. The sites were 85 mi. (137 km) west of Cape Flattery, Washington, and 172 mi. (277 km) south-southeast of Charleston, South Carolina. Samples were tested for TNT, royal demolition explosive, tetryl, and ammonium perchlorate. None of these materials were detected in any of the samples. Detection limits were in parts per trillion. Walker et al. (2006) sampled seawater and sediment at two offshore sites where underwater demolition had been performed using 10-lb. (4.5-kg) charges of TNT and royal demolition explosive. Both explosives were below the detection limit in seawater, including samples collected in the detonation plume within five minutes of detonation.

According to Fisheries Research Services Report (1996), over one million tons of chemical and conventional munitions were disposed of at Beaufort's Dyke, a trench in the North Channel between Scotland and Ireland. The trench is more than 30 mi. (50 km) long and 2 mi. (3.5 km) wide. The average density of munitions is about 2,225 tons per mi.^{2} (5,700 tons per km^2). Seabed sediment samples were obtained from 105 sites. Sampling distance from the munitions was not noted. Sediment sampling results did not find detectable concentrations of the explosives nitroglycerine, TNT, royal demolition explosive, or tetryl, and analysis of metals indicated that levels within the survey area were within the ranges reported from other Scottish coastal areas.

Nipper et al. (2002) studied the impact of the explosives 2,6-dinitrotoluene, tetryl, and picric acid in sediment in Puget Sound. They noted that the levels measured did not account for the sediment's toxicity. Test subjects and processes included small marine crustaceans (amphipods), marine segmented worms (polychaetes), macro-algae germination and growth, and sea urchin embryo development. The authors suggested that the degradation products of the explosives rather than the explosives themselves may be responsible. They acknowledged that the "persistence of such degradation compounds in marine environments is not known."

An underwater explosion deposits a fraction of the chemical products of the reaction in the water in a roughly circular surface pool that moves with the current (Young and Willey 1977). In a land-based study, Pennington et al. (2006) noted that data demonstrate that high explosives in the main charge of howitzer rounds, mortar rounds, and hand grenades are efficiently consumed (on average 99.997 percent or more) during live-fire operations that result in high-order detonations. The explosives not consumed during these detonations are spread over an area that would, on average, contribute 10 µg/kg per detonation or less to the ground surface. However, the applicability of the study by Pennington et al. (2006) to underwater marine systems remains uncertain.

Table 3.1-14 provides: (1) the amount of explosive remaining after underwater detonation of 5-lb. (2.26-kg) and 20-lb. (9-kg) charges of C-4; and (2) the volume of water required to meet the Department of Defense Range and Munitions Use working group marine screening value for the amount of C-4 remaining after detonation. A 5-lb. block of C-4 contains 4.6 lb. (2.06 kg) of royal demolition explosive; a 20-lb. block contains 18.2 lb. (8.24 kg) of royal demolition explosive (U.S. Department of the Navy 2010b).

Pennington et al. (2006) assumed that 0.02 percent of royal demolition explosive residue remained after detonation. The failure rate is zero for C-4 because, during mine countermeasure and mine neutralization activities, personnel do not leave any undetonated C-4 on range at the end of training.

Table 3.1-14: Volume of Water Needed to Meet Marine Screening Value for Royal Demolition Explosive

Screening Value for Ecological Marine Surface Water	5-Pound (2.26 kg) Charge		20-Pound (9 kg) Charge	
	Amount of Royal Demolition Explosive Remaining after Detonation	Attenuation Needed to Meet Screening Value	Amount of Royal Demolition Explosive Remaining after Detonation	Attenuation Needed to Meet Screening Value
5,000 µg/L	0.01 ounce (0.41 gram)	22 gallons (82.6 liters)	0.06 ounce (1.65 grams)	87 gallons (330 liters)

kg: kilogram; µg/L: micrograms per liter

The amount of pentaerythritol tetranitrate in detonation cord associated with any underwater detonation event is low (approximately 13.4 ounces [381 grams]). Assuming five percent is not consumed in the detonation, 0.7 ounce (19 grams) of pentaerythritol tetranitrate would be present. This amount would attenuate to a level below the Department of Defense Range and Munitions Use working group benchmark risk screening value for marine surface water in 60 gallons (227 liters) of water (U.S. Department of the Navy 2010b).

3.1.3.1.6 Evaluation of Alternatives

Table 3.1-15 summarizes the types and amounts of high-explosive military expended materials proposed under all alternatives. Numbers represent amounts expended annually, except for ship shock trials. Explosives used for ship shock trials reflect use over a five-year period. The types and amounts of expended materials in the table were drawn from the tables in Chapter 2 (Description of Proposed Action and Alternatives).

In most instances, explosive bombs, projectiles, missiles, and rockets detonate above the surface of the water, at the water surface, or just beneath the surface. Underwater detonations always occur during ship shock trials, mine countermeasure and mine neutralization training and testing, explosives testing, and during the use of explosive torpedoes, percussion grenades, and explosive sonobuoys.

The following sections evaluate each alternative in terms of the information provided in Sections 3.1.3.1.4 (Approach to Analysis) and 3.1.3.1.5 (Impacts from Explosives and Explosion Byproducts). Potential impacts on sediment and water quality from explosives and explosion byproducts should be viewed in the following context: (1) nearshore sediment and water quality in many areas are negatively impacted, both by historical and ongoing activities; and (2) the majority of those impacts are from human-generated, land-based activities.

3.1.3.1.6.1 No Action Alternative

Under the No Action Alternative, training and testing with explosives would involve 1,691 events. Numerically, large-caliber explosive projectiles and explosive sonobuoys represent 84 percent of the high-explosive items expended during those events. Charge sizes for these projectiles range from 0.6 to 10 lb. (0.3 to 4.5 kg). For comparison, charges in sonobuoys range from 2.6 to 5 lb. (1.2 to 2.3 kg), charges in missiles proposed for use range from 2.5 to 488 lb. (1.1 to 221 kg), charges in mine neutralization range from 0.25 to 20 lb. (0.1 to 9 kg) and may include the use of an explosive mine (650 lb., 295 kg), and charges in bombs range from 250 to 1,000 lb. (113 to 454 kg).

Table 3.1-15: High-Explosive Military Expended Materials – All Alternatives Annually

Type of Military Expended Material	No Action Alternative	Alternative 1	Alternative 2
Torpedoes			
Training	1	1	1
Testing	8	8	8
Total	9	9	9
Sonobuoys			
Training	1,770	1,978	1,978
Testing	956	2,988	3,996
Total	2,726	4,966	5,974
Neutralizers			
Training	30	92	92
Testing	130	323	362
Total	160	415	454
Anti-Swimmer Grenades			
Training	100	206	206
Testing	0	0	0
Total	100	206	206
Bombs			
Training	25	133	133
Testing	0	0	0
Total	25	133	133
Rockets			
Training	0	7,980	7,980
Testing	0	368	404
Total	0	8,348	8,384
Missiles			
Training	321	490	490
Testing	10	141	148
Total	331	631	638
Large-Caliber Projectiles			
Training	2,026	13,038	13,038
Testing	0	6,435	7,425
Total	2,026	19,473	20,463
Medium-Caliber Projectiles			
Training	0	123,954	123,954
Testing	0	23,400	26,100
Total	0	147,354	150,054

Table 3.1-15: High-Explosive Military Expended Materials – All Alternatives Annually (Continued)

Type of Military Expended Material	No Action Alternative	Alternative 1	Alternative 2
Shock Trial Charges			
Training	0	0	0
Testing	0	16	16
Total	0	16	16
Surface and Underwater Detonations[1]			
Training	86	2,190	2,190
Testing	215	397	439
Total	301	2,587	2,629

[1] Mine neutralization, mine countermeasures, and ordnance testing activities

Training Activities. Under the No Action Alternative, numerically, training activities represent 80 percent of activities that use explosives (1,347 events); sonobuoys and large-caliber projectiles would comprise 84 percent of activities that use explosives. The majority of that activity (52 percent) would occur in two range complexes: VACAPES (32 percent) and JAX (20 percent), with another 18 percent occurring in Other AFTT Areas. Training activities are further described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Table 2.8-1.

Comparison of Training Materials by Net Explosive Weight. A review of training materials based on net explosive weight provides a different perspective on the relative contribution of various items under the No Action Alternative. Table 3.1-16 depicts those categories of training materials that contribute nearly all (97 percent) of the total net explosive weight under the No Action Alternative. The estimated total net explosive weight for these categories used during training under the No Action Alternative is 61,876 lb. (28,092 kg). For purposes of estimating explosive weight, within each type of military expended material, ordnance near the median value was chosen to represent that category.

Table 3.1-16: High-Explosive Training and Testing Materials under the No Action Alternative – Comparison of Number of Items versus Net Explosive Weight

Type of Military Expended Material (ordnance used for estimating)	Percent of Total HE by Number	Percent of Total HE by Net Explosive Weight
Training		
Missiles	7.4	52
Large-Caliber Projectiles	46.5	31
Bombs	0.6	8
Sonobuoys	40.6	8
Underwater Detonations	2.0	1
Testing		
Sonobuoys	72.5	14
Underwater Detonations	16.3	86

HE: high explosive

Under the No Action Alternative, the distribution of the training materials based on net explosive weight would be as follows:

- Missiles – VACAPES (55 percent), JAX (27 percent), Cherry Point (14 percent) Range Complexes, and Other AFTT Areas (3 percent).
- Large-Caliber Projectiles – VACAPES (42 percent), JAX (19 percent), and Cherry Point (4 percent) Range Complexes, and Other AFTT Areas (35 percent).
- Bombs –VACAPES (80 percent) and GOMEX (16 percent) Range Complexes, and Other AFTT Areas (4 percent).
- Sonobuoys –VACAPES, JAX, Cherry Point, and GOMEX Range Complexes (20 percent each); and Northeast Range Complexes (19 percent).
- Underwater Detonations – VACAPES (72 percent) and Cherry Point (17 percent) Range Complexes.

Testing Activities. Under the No Action Alternative, numerically, testing activities represent 20 percent of activities that use explosives (344 events). Most of that activity (72.5 percent) would involve sonobuoys (Table 3.1-16). Use of sonobuoys is split fairly evenly between the Northeast Range Complexes, VACAPES Range Complex, Navy Cherry Point Range Complex, JAX Range Complex, GOMEX Range Complex, and Other AFTT Areas. Testing activities are further described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Tables 2.8-2 and 2.8-3.

Comparison of Testing Materials by Net Explosive Weight. The total net explosive weight used during testing (Table 3.1-16) under the No Action Alternative is 19,951 lb. (9,951 kg). The number of underwater detonations at the Naval Surface Warfare Center, Panama City Division Testing Range account for 58 percent of the total number of underwater detonations for testing and 42 percent occur in the VACAPES Range Complex. The underwater detonations account for 86 percent of the net explosive weight under the No Action Alternative.

Subsurface high-order explosions and their byproducts. Under the No Action Alternative, training and testing activities would involve 3,108 subsurface detonations. Numerically, 88 percent of those detonations involve explosive sonobuoys. Mine neutralization and countermeasure activities would represent 12 percent of subsurface detonations. See the previous paragraphs for the net explosive weight and distribution of explosive sonobuoy and underwater detonations used during training and testing. Most of the mine countermeasure and neutralization activities would occur in two locations: the Naval Surface Warfare Center, Panama City Division Testing Range and the VACAPES Range Complex.

Unconsumed explosives. Under the No Action Alternative, there would be 1,691 training and testing events involving high explosives. Based on estimates of unconsumed explosive, low-order detonations, and ordnance failure, a total of 2,907 lb. (1,320 kg) of unconsumed explosives would be released into sediment and the surrounding water column.

Summary of Impacts from Explosives and Explosion Byproducts

Under the No Action Alternative, the impacts on sediment and water quality from explosives and explosion byproducts associated with training and testing activities would be short- and long-term and local. Short-term impacts could arise from explosion byproducts; long-term impacts could arise from unconsumed explosives. The majority of high-order explosions occur at or above the surface of the ocean and would have minimal impacts on sediment and water quality. Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Reasons for this level of impact include: (1) the number of explosives used is small relative to the area across which they would be distributed; (2) most explosion byproducts are benign or are natural constituents of seawater; and (3) explosion byproducts would dissipate, evaporate, or be quickly diluted to undetectable levels. Neither state nor federal standards or guidelines would be exceeded.

The impacts of unconsumed explosives associated with training and testing activities would be long-term and local. Chemical, physical, or biological changes to sediment or water quality would be measurable but below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses. This level of impact is based on the following: (1) the majority of explosives are consumed during detonation; (2) the frequency of low-order detonations is low, and therefore the frequency of unconsumed explosives is low; (3) the number of explosives used is small relative to the area across which they would be distributed; and (4) the constituents of unconsumed explosives are subject to several physical, chemical, and biological processes that render the materials harmless or would otherwise dissipate them to undetectable levels. Neither state nor federal standards or guidelines would be exceeded.

3.1.3.1.6.2 Alternative 1

Under Alternative 1, training and testing with explosives would increase from 1,691 to 8,054 events compared to the No Action Alternative. Numerically, medium- and large-caliber explosive projectiles are accounted for in 41 percent of events involving explosives, but represent 91 percent of the explosive items expended under Alternative 1.

Training Activities. Under Alternative 1, training activities that use explosives would increase from 1,347 to 5,891 events compared to the No Action Alternative. Numerically, training activities would represent 73 percent of activities that use explosives under Alternative 1 (80 percent under the No Action Alternative), with medium- and large-caliber explosive projectiles representing 91 percent of those explosives events (47 percent under the No Action Alternative). Most such training would occur in three range complexes: VACAPES (41 percent; 42 percent under the No Action Alternative), JAX (37 percent; 19 percent under the No Action Alternative), and Navy Cherry Point (16 percent; 4 percent under the No Action Alternative).

Comparison of Training Materials by Net Explosive Weight. Like the No Action Alternative, a review of training materials based on net explosive weight under Alternative 1 provides a different perspective on the relative contribution of various items. Table 3.1-17 depicts those categories of training materials that contribute nearly all (99 percent) of the total net explosive weight under Alternative 1. Total net explosive weight used during training would increase from an estimated 61,876 to an estimated 441,959 lb. (28,092 to 200,650 kg) compared to the No Action Alternative. Most (98 percent) of the explosions would occur at or above the surface of the water.

Table 3.1-17: High-Explosive Training Materials under Alternative 1 – Comparison of Number of Items versus Net Explosive Weight

Type of Military Expended Material (ordnance used for estimating)	Percent of Total HE by Number	Percent of Total HE by Net Explosive Weight
Training		
Missiles	0.33	11
Large- and Medium-Caliber Projectiles	91.3	70
Bombs	0.1	6
Sonobuoys	1.3	1
Underwater Detonations	1.5	3
Rockets	5.3	9
Testing		
Missiles	0.41	10
Large- and Medium-Caliber Projectiles	87.6	70
Bombs	0.0	0
Sonobuoys	8.8	6
Underwater Detonations	1.2	12
Rockets	1.1	1

HE: high explosives

Under Alternative 1, the distribution of the training materials based on net explosive weight would be as follows:

- Missiles – VACAPES (39 percent; 55 percent under the No Action Alternative), JAX (36 percent; 27 percent under the No Action Alternative), and Navy Cherry Point (19 percent; 14 percent under the No Action Alternative) Range Complexes.
- Large- and medium-caliber projectiles – VACAPES (45 percent; 42 percent under the No Action Alternative), JAX (36 percent; 19 percent under the No Action Alternative), and Navy Cherry Point (13 percent; 4 percent under the No Action Alternative) Range Complexes.
- Bombs – VACAPES (48 percent; 80 percent under the No Action Alternative), JAX (24 percent; 0 percent under the No Action Alternative), and Navy Cherry Point (24 percent; 0 percent under the No Action Alternative) Range Complexes.
- Sonobuoys – VACAPES (22 percent; 20 percent under the No Action Alternative), JAX (56 percent; 20 percent under the No Action Alternative), and Navy Cherry Point (9 percent; 20 percent under the No Action Alternative) Range Complexes.
- Underwater Detonations – VACAPES (97 percent; 72 percent under the No Action Alternative).
- Rockets – VACAPES (48 percent; 0 percent under the No Action Alternative) and JAX (48 percent; 0 percent under the No Action Alternative) Range Complexes.

Testing Activities. Under Alternative 1, testing activities that use explosives would increase from 344 to 2,163 events compared to the No Action Alternative. Numerically, these testing activities represent 27 percent of activities that use explosives under Alternative 1 (20 percent under the No Action Alternative). Medium- and large-caliber explosive projectiles represent 89 percent of all testing-related explosions under Alternative 1. Most testing with explosives (92 percent) would occur in two range complexes: VACAPES (43 percent) and JAX (35 percent), and the AFTT Study Area (14 percent).

Comparison of Testing Materials by Net Explosive Weight. The total net explosive weight used during testing (Table 3.1-17) would increase from an estimated 19,951 to 136,681 lb. (9,058 to 62,053 kg) compared to the No Action Alternative. Large- and medium-caliber projectiles would account for 70 percent of the total net explosive weight, underwater detonations would account for 12 percent, and explosive sonobuoys would account for 6 percent. Under Alternative 1, the distribution of the majority of testing materials based on net explosive weight would be as follows:

- Large- and medium-caliber projectiles – VACAPES Range Complex (33 percent), JAX (19 percent) Range Complex, and AFTT Study Area (39 percent); 0 percent under the No Action Alternative.
- Sonobuoys – Northeast (11 percent; 23 percent under the No Action Alternative), VACAPES (27 percent; 18 percent under the No Action Alternative), JAX (5 percent; 16 percent under the No Action Alternative), and Key West (44 percent; 0 percent under the No Action Alternative) Range Complexes, and Other AFTT Areas (6 percent; 19 percent under the No Action Alternative).
- Underwater Detonations – VACAPES Range Complex (34 percent; 42 under the No Action Alternative) and Naval Surface Warfare Center, Panama City Division Testing Range (44 percent; 58 under the No Action Alternative).

Direct comparisons with explosives testing between Alternative 1 and the No Action Alternative are difficult. Under the No Action Alternative, the majority of expended explosives are sonobuoys or large-caliber projectiles (80 percent of explosive items, 40 events). Under Alternative 1, the majority of expended explosives are medium- and large-caliber explosive projectiles (91 percent of explosive items, 812 events). Last, although the alternatives would have two range complexes in common (VACAPES and JAX), most explosives testing under the No Action Alternative would occur below the surface, while most would occur at or above the surface of the water under Alternative 1.

Subsurface High-order Explosions and Their Byproducts. Under Alternative 1, subsurface detonations associated with training and testing activities would increase from 3,108 to 7,490 compared to the No Action Alternative. Numerically, 94 percent of the detonations involve explosive sonobuoys (3 percent of the net explosive weight) and mine countermeasure and neutralization activities (5 percent of the net explosive weight). This compares to 88 percent involving sonobuoys and 12 percent involving mine neutralization and mine countermeasures activities under the No Action Alternative. See the previous paragraphs for the net explosive weight and distribution of training and testing.

Unconsumed Explosives. Under Alternative 1, training and testing activities involving explosives would increase from 1,691 to 8,054 events compared to the No Action Alternative. Based on estimates of unconsumed explosive, low-order detonations, and ordnance failure, a total of 25,322 lb. (11,496 kg) of unconsumed explosives would be released into sediment and into the surrounding water column.

Summary of Impacts from Explosives and Explosion Byproducts

Although the amount of explosive material under Alternative 1 represents an increase over the No Action Alternative, impacts would be similar to the No Action Alternative, i.e., no impacts on sediments and minimal impacts on water quality. Impacts on sediment and water quality from explosion byproducts under Alternative 1 would be short-term and local. The majority of high-order explosions occur at or above the surface of the ocean and would have no impacts on sediments and minimal impacts on water quality. The impacts of unconsumed explosives associated with training and testing activities under Alternative 1 would be long-term and local. Although the number of activities that use explosives increases over the No Action Alternative, the level of impact is similar to the No Action Alternative based on the following: (1) the majority of explosives are consumed during detonation; (2) the frequency of low-order detonations is low, and therefore the frequency of unconsumed explosives is low; (3) the number of explosives used is small relative to the area across which they would be distributed; and (4) the constituents of unconsumed explosives are subject to several physical, chemical, and biological processes that render the materials harmless or would otherwise dissipate them to undetectable levels. Neither state nor federal standards or guidelines would be exceeded. Some unconsumed explosives would be expected in sediment, but they are not anticipated to accumulate. Chemical, physical, or biological changes to sediment or water quality would be measurable, but below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses.

3.1.3.1.6.3 Alternative 2 (Preferred Alternative)

Under Alternative 2, training and testing activities involving explosives would increase from 1,691 to 8,269 events compared to the No Action Alternative. Numerically, medium- and large-caliber explosive projectiles are accounted for in 41 percent of events involving explosives, but represent 91 percent of the explosive items expended under Alternative 2.

Training Activities. Under Alternative 2, the use of explosives for training would increase from 1,347 to 5,903 events compared to the No Action Alternative. Numerically, training activities represent 71 percent of activities that use explosives under Alternative 2 (80 percent under the No Action Alternative). Medium- and large-caliber explosive projectiles represent 91 percent of all explosives items expended under Alternative 2 (37 percent under the No Action Alternative). The distribution of activities that use explosives would be the same as Alternative 1.

Comparison of Training Materials by Net Explosive Weight. Similar to Alternative 1, a review of training materials based on net explosive weight under Alternative 2 provides a different perspective on the relative contribution of various items. Table 3.1-18 depicts those categories of training materials that contribute nearly all (99 percent) the total net explosive weight under Alternative 2. Total net explosive weight used during training would increase from an estimated 61,876 to an estimated 441,959 lb. (28,092 to 200,650 kg) compared to the No Action Alternative.

Table 3.1-18: High-Explosive Training Materials under Alternative 2 – Comparison of Number of Items versus Net Explosive Weight

Type of Military Expended Material (ordnance used for estimating)	Percent of Total HE by Number	Percent of Total HE by Net Explosive Weight
Training		
Missiles	0.3	11
Large- and Medium-Caliber Projectiles	91.3	70
Bombs	0.1	6
Sonobuoy	1.3	1
Underwater Detonations	1.5	3
Rockets	5.3	9
Testing		
Missiles	0.4	10
Large- and Medium-Caliber Projectiles	86.2	70
Bombs	0.0	0
Sonobuoy	10.3	8
Underwater Detonations	1.1	11
Rockets	1.0	1

HE: high explosive

Under Alternative 2, the distribution of the training materials based on net explosive weight would be the same as described under Alternative 1.

Testing Activities. Under Alternative 2, the use of explosives for testing would increase from 344 to 2,366 events compared to the No Action Alternative. Numerically, explosive testing activities represent 29 percent of explosive use under Alternative 2. Medium- and large-caliber explosive projectiles represent 86 percent of all explosive testing under Alternative 2 (Table 3.1-18). Explosive sonobuoys would be involved in 10 percent of events and 1 percent would involve mine neutralization and mine countermeasures activities. Distribution of explosive testing materials would be the same as under Alternative 1. Direct comparisons with testing between Alternative 2 and the No Action Alternative are difficult for the reasons discussed under Alternative 1.

Subsurface High-Order Explosions and Their Byproducts. Under Alternative 2, subsurface detonations associated with training and testing activities would increase from 3,108 to 8,540 compared to the No Action Alternative. Numerically, 90 percent of the detonations involve explosive sonobuoys (3 percent of the net explosive weight) and mine countermeasure and neutralization activities (5 percent of the net explosive weight). This compares to 88 percent under the No Action Alternative. The relative contribution and distribution of subsurface detonations would be the same as under Alternative 1. Impacts on sediment and water quality from explosion byproducts associated with training and testing activities under Alternative 2 would be short-term and local. Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Although use of explosives increases over the No Action Alternative, the reasons for a level of impact similar to the No Action Alternative are the same as those enumerated under the No Action Alternative. Specifically, this level of impact is based on the following: (1) the majority of explosives are consumed during detonation; (2) the frequency of low-order detonations is low, and therefore the frequency of unconsumed explosives is low; (3) the number of explosives used is small relative to the area across which they would be distributed; and (4) the constituents of unconsumed explosives are subject to several physical, chemical, and biological processes that render the materials harmless or would otherwise dissipate them to undetectable levels. Neither state nor federal standards or guidelines would be exceeded.

Charge sizes in ship shock trials range from 2,000 to 58,000 lb. (908 to 26,310 kg) net explosive weight. The percent of the total net explosive weight used for ship shock trials under Alternative 2 would be approximately 5 percent, the same as under Alternative 1.

Unconsumed Explosives. Under Alternative 2, training and testing activities associated with explosives would increase from 1,691 to 8,269 events compared to the No Action Alternative. Based on estimates of unconsumed explosives, low-order detonations, and ordnance failure, a total of 26,168 lb. (11,880 kg) of unconsumed explosives would be released into sediment and into the surrounding water column.

Summary of Impacts from Explosives and Explosion Byproducts

Although the amount of explosive material under Alternative 2 represents an increase over the No Action Alternative, impacts would be similar to the No Action Alternative, i.e., no impacts on sediments and minimal impacts on water quality. Impacts on sediment and water quality from explosion byproducts under Alternative 2 would be short-term and local. The majority of high-order explosions occur at or above the surface of the ocean and would have no impacts on sediments and minimal impacts on water quality. The impacts of unconsumed explosives associated with training and testing activities under Alternative 2 would be long-term and local. Although the number of activities that use explosives increases over the No Action Alternative, the level of impact similar to the No Action Alternative based on the following: (1) the majority of explosives are consumed during detonation; (2) the frequency of low-order detonations is low, and therefore the frequency of unconsumed explosives is low; (3) the number of explosives used is small relative to the area across which they would be distributed; and (4) the constituents of unconsumed explosives are subject to several physical, chemical, and biological processes that render the materials harmless or would otherwise dissipate them to undetectable levels. Neither state nor federal standards or guidelines would be exceeded. Some unconsumed explosives would be expected in sediment, but they are not anticipated to accumulate. Chemical, physical, or biological changes to sediment or water quality would be measurable, but below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses.

3.1.3.2 Metals

3.1.3.2.1 Introduction

Many metals occur naturally in seawater, and several are necessary for marine organisms and ecosystems to function properly, such as iron, zinc, copper, and manganese. Zinc, copper, and manganese may also be harmful to plants and animals at high concentrations. Other metals have negative impacts on sediment and water quality (e.g., cadmium, chromium, lead, and mercury).

Metals are introduced into sediment and seawater through training and testing activities. Metals represent parts or the whole of vessels, manned and unmanned aircraft, ordnance (bombs, projectiles, missiles, and torpedoes), sonobuoys, chaff cartridges, batteries, electronic components, and as anti-corrosion compounds coating exterior surfaces of some munitions. In most instances, because of the physical and chemical reactions that occur with metals in marine systems (e.g., precipitation), metals often concentrate in sediment. Thus, metal contaminants in sediment are more of an issue than metals in the water column.

Military expended materials such as steel bomb bodies or fins, missile casings, small arms projectiles, and naval gun projectiles may contain small percentages (less than 1 percent by weight) of lead, manganese, phosphorus, sulfur, copper, nickel, tungsten, chromium, molybdenum, vanadium, boron, selenium, columbium, or titanium. Smaller caliber rounds are composed of steel with small amounts of aluminum and copper, and brass casings that are 70 percent copper and 30 percent zinc. Naval gun shells are composed of steel, brass, copper, tungsten, and other metals. The 20-mm cannon shells used in close-in weapons systems are composed mostly of tungsten alloy. Some projectiles have lead cores (U.S. Department of the Navy 2008b). Torpedo guidance wire is composed of copper and cadmium coated with plastic (U.S. Department of the Navy 2008a). Sonobuoy components include metal housing, batteries and battery electrodes, lead solder, copper wire, and lead used for ballast. Thermal batteries in sonobuoys are contained in a hermetically sealed and welded stainless steel case that is 0.03 to 0.1 in. (0.1 to 0.25 cm) thick and resistant to the battery electrolytes (Naval Facilities Engineering Command 1993). Rockets are usually composed of steel and steel alloys, although composite cases made of glass, carbon, or Kevlar® fiber are also used (Missile Technology Control Regime 1996).

Non-explosive practice munitions refers to ammunition and components that contain no explosive material and may include: (1) ammunition and components that have had all explosive material removed and replaced with inert material; (2) empty ammunition or components; and (3) ammunition or components manufactured with inert material in place of all explosive material. These practice munitions vary in size from 25 lb. (11 kg) to 500 lb. (227 kg) and can be built to simulate different explosive capabilities. Some non-explosive practice munitions may also contain unburned propellant (e.g., rockets) and may contain spotting charges or signal cartridges for locating the point of impact (e.g., smoke charges for daylight spotting or flash charges for night spotting) (U.S. Department of the Navy 2010b). Non-explosive practice munitions are composed mainly of iron and steel casings that are filled with sand, concrete, or vermiculite. These materials are similar to those used to construct artificial reefs. Non-explosive practice munitions are configured to have the same weight, size, center of gravity, and ballistics as live bombs (U.S. Department of the Navy 2006). Practice bombs entering the water do not contain combustion chemicals found in the warheads of live bombs.

Decommissioned vessels used as targets during vessel-sinking exercises are selected from a list of U.S. Navy-approved vessels that have been cleaned or remediated in accordance with USEPA guidelines. By rule, vessel-sinking exercises must be conducted at least 50 nm offshore and in water at least 6,000 ft. (1,830 m) deep (40 C.F.R. § 229.2). The USEPA considers the contaminant levels released during the sinking of a target to be within the standards of the Marine Protection, Research, and Sanctuaries Act (33 U.S.C. §§ 1401-1445).

The next sections provide the following overview:

- Section 3.1.3.2.2 discusses how metals will be evaluated under each alternative;
- Section 3.1.3.2.3 reviews information regarding the behavior and potential negative impacts of metals on sediment and water quality; and
- Section 3.1.3.2.4 evaluates each alternative in terms of the information provided in Sections 3.1.3.2.2 and 3.1.3.2.3.

3.1.3.2.2 Approach to Analysis

Most activities involving military expended materials with metal components would be conducted more than 3 nm offshore in each range complex or test range. Activities in these areas would be subject to federal sediment and water quality standards and guidelines. Military expended materials with metal components are also used in nearshore areas specifically designated for mine countermeasure and mine neutralization activities in the Navy Cherry Point (Onslow Bay) and JAX (Charleston OPAREA) Range Complexes and in the Naval Surface Warfare Center, Panama City Division Testing Range. These activities would be subject to state sediment and water quality standards and guidelines. Standard operating procedures require that materials be removed after training is complete, including metal fragments on the bottom. Therefore, potential impacts from metals are assumed to be negligible in these areas. For metals, "local" refers to the zone of sediment about 0.4 in. (1 cm) surrounding the metal where it comes to rest.

State standards and guidelines. Table 3.1-19 summarizes the state standards and guidelines for metals in sediment in Florida, the only state for which sediment criteria could be located.

Table 3.1-19: Florida – Sediment Screening Guidelines for Metals

Metal	**Threshold Effects Level** (µg/L)	**Probable Effects Level** (µg/L)
Chromium	52.3	160
Lead	30.2	112
Mercury	0.13	0.696

µg/L: micrograms per liter. The threshold effects level is the concentration of a contaminant above which adverse biological effects are expected to rarely occur. The probable effects level is the concentration of a contaminant above which adverse biological effects are expected to occur frequently (MacDonald et al. 1996).

Table 3.1-20 summarizes the state standards and guidelines for water quality related to metals for Virginia, North Carolina, South Carolina, Georgia, and Florida.

Table 3.1-20: Water Quality Criteria for Metals – Virginia, North Carolina, South Carolina, Georgia, and Florida (µg/L)

	Virginia[1]		North Carolina[2]	South Carolina[3]		Georgia[4]		Florida[5]
Metal	**Acute**	**Chronic**	**Criteria**	**CMC**	**CCC**	**Acute**	**Chronic**	**Criteria**
Chromium VI	1,100	50	20	1,100	50	1,100	50	≤ 50
Lead	240	9.3	25	220	8.5	210	8.1	≤ 8.5
Mercury	1.8	0.94	0.025	1.1	1.1	1.8	0.025	0.025

[1] "Acute" criteria reflect a one-hour average concentration not to be exceeded more than once every three years on average. "Chronic" criteria reflect a four-day average concentration not to be exceeded more than once every three years on average. Source: (Table 3.1-8; Virginia Department of Environmental Quality 2011).
[2] Source: North Carolina Department of Environment and Natural Resources (2007).
[3] "CMC" refers to criterion maximum concentration, the highest in-stream concentration of a substance to which the organisms can be exposed for a brief period of time without causing an acute effect (analogous to "acute"). "CCC" refers to criterion continuous concentration, the highest in-stream concentration of a substance to which the organisms can be exposed to protect against long-term effects (analogous to "chronic"). Source: South Carolina Department of Health and Environmental Control (2008).
[4] Source: Georgia Department of Natural Resources (2010).
[5] (Table 3.1-10 and Table 3.1-11; Florida Department of Environmental Protection 2010)).
"≤": less than or equal to; µg/L: micrograms per liter.

Federal standards and guidelines. Table 3.1-21 summarizes the USEPA “threshold values” for metals in marine waters (U.S. Environmental Protection Agency 2009).

Table 3.1-21: U.S. Environmental Protection Agency Threshold Values for Exposure to Select Metals in Saltwater

Metal	Criteria (µg/L)	
	Acute Toxicity (1-hour exposure)	Chronic Toxicity (4-day average exposure)
Cadmium	40	8.8
Chromium	1,000	50
Copper	4.8	3.1
Lead	210	8.1
Lithium*	6,000	n/a
Mercury	1.8	0.94
Nickel	74	8.2
Silver	1.9	n/a
Zinc	90	81

*No threshold value established by USEPA. Value shown is from Kszos et al.(2003).
n/a: no chronic value is available; µg/L: micrograms per liter

“Acute toxicity” means a negative response to a substance observed in 96 hours or less (e.g., mortality, disorientation, or immobilization). “Chronic toxicity” means the lowest concentration of a substance that causes an observable effect (e.g., reduced growth, lower reproduction, or mortality). This effect occurs over a relatively long period of time, such as one-tenth of the life span of the species. A 28-day test period is used for small fish test species (U.S. Environmental Protection Agency 1991).

3.1.3.2.3 Impacts from Metals

The discussion below summarizes studies that investigated the impacts of sampled metal in military expended materials introduced into the marine environment.

In general, three things happen to military expended materials that come to rest on the ocean floor: (1) they lodge in sediment where there is little or no oxygen, usually below 4 in. (10 cm); (2) they remain on the ocean floor and begin to react with seawater; or (3) they remain on the ocean floor and become encrusted by marine organisms. As a result, rates of deterioration depend on the metal or metal alloy and the conditions in the immediate marine and benthic environment. If buried deep in ocean sediments, materials tend to decompose at much lower rates than when exposed to seawater (Ankley 1996). With the exception of torpedo guidance wires and sonobuoy parts, sediment burial appears to be the fate of most ordnance used in marine warfare (Canadian Forces Maritime Experimental and Test Ranges 2005).

In those situations where metals are exposed to seawater, they begin to slowly corrode, a process that creates a layer of corroded material between the seawater and uncorroded metal. This layer of corrosion removes the metal from direct exposure to the corrosiveness of seawater, a process that further slows movement of the metals into the adjacent sediment and water column. This is particularly true of aluminum. Any elevated levels of metals in sediment would be restricted to a small zone around the metal, and any release to the overlying water column would be diluted. In a similar fashion, as materials become covered by marine life, the direct exposure of the material to seawater decreases and the rate of corrosion decreases. Dispersal of these materials in the water column is controlled by physical mixing and diffusion, both of which tend to vary with time and location. The analysis of metals in marine systems begins with a review of studies involving metals used in proposed activities that may be introduced into the marine environment.

In one study, water quality sampling for lead, manganese, nickel, vanadium, and zinc was conducted at a shallow bombing range in Pamlico Sound (state waters of North Carolina) immediately following a bomb training event with non-explosive practice munitions. All water quality parameters tested, except nickel, were within the state limits. The nickel concentration was significantly higher than the state criterion, although the concentration did not differ significantly from the control site located outside the bombing range. This suggests that bombing activities were not responsible for the elevated nickel concentrations (U.S. Department of the Navy 2010b). A recent study conducted by the U.S. Marine Corps sampled sediment and water quality for 26 different constituents related to munitions at several U.S. Marine Corps water-based training ranges. Metals included lead and magnesium. This area was also used for bombing practice. No levels were detected above screening values used at the U.S. Marine Corps water ranges (U.S. Department of the Navy 2010b).

A study by Pait et al. (2010) of previous Navy training areas at Vieques, Puerto Rico, found generally low concentrations of metals in sediment. Areas in which live ammunition were used (live-fire areas) were included in the analysis. Table 3.1-22 compares the sediment concentrations of several metals from those naval training areas with sediment screening levels established by the National Oceanic and Atmospheric Administration (Buchman 2008).

Table 3.1-22: Concentrations and National Oceanic and Atmospheric Administration Screening Levels for Select Metals in Sediments, Vieques, Puerto Rico

Metal	Sediment Concentration (µg/g)			Sediment Guidelines – National Oceanic and Atmospheric Administration (µg/g)	
	Minimum	Maximum	Average	Threshold Effect Level	Probable Effect Level
Cadmium	0	1.92	0.15	0.68	4.21
Chromium	0	178	22.58	52.3	160
Copper	0	103	25.9	18.7	390
Lead	0	17.6	5.42	30.24	112
Mercury	N/R	0.112	0.019	130	700
Nickel	N/R	38.3	7.80	15.9	42.8
Zinc	N/R	130	34.4	124	271

N/R: not reported; µg/g: micrograms per gram

The "threshold effect level" is the concentration of a contaminant above which adverse biological effects are expected to rarely occur. The "probable effect level" is the concentration of a contaminant above which adverse biological effects are expected to occur frequently (MacDonald et al. 1996).

As reflected in Table 3.1-22, with the exception of copper, average sediment concentrations of the metals evaluated were below both the threshold and probable effects levels. Copper's average concentration (25.9 µg/g) was above the threshold effect level but below the probable effect level.

For other elements, (1) the average sediment concentration of arsenic at Vieques was 4.37 µg/g, and the highest concentration was 15.4 µg/g—both values were below the sediment quality guidelines examined; and (2) the average sediment concentration of manganese in sediment was 301 µg/g, and the highest concentration was 967 µg/g (Pait et al. 2010). The National Oceanic and Atmospheric Administration did not report threshold or probable effects levels for manganese.

A study of the impacts of lead and lithium was conducted at the Canadian Forces Maritime Experimental and Test Ranges near Nanoose Bay, British Columbia, Canada (Canadian Forces Maritime Experimental and Test Ranges 2005). These materials are common to expendable mobile anti-submarine warfare training targets, acoustic device countermeasures, sonobuoys, and torpedoes. The study noted that lead is a naturally occurring metal in the environment and that typical concentrations of lead in the test range were between 0.01 and 0.06 ppm in seawater, and from 4 to 16 ppm in sediment. Cores taken of sediment in the test range show a steady increase in lead concentration from the bottom of the core to a depth of approximately 8 in. (20 cm). This depth corresponds to the late 1970s and early 1980s and was attributed to atmospheric deposition from lead as a gasoline additive. The sediment cores showed a general reduction in concentration to the present time, coincident with the phasing out of lead in gasoline by the mid-1980s. The study also noted that other training ranges show minimal impacts of lead ballasts because they are usually buried deep in sediment, where they are not biologically available. The study concluded there would be no negative impacts on marine organisms from the lead ballasts due to the low probability of mobilization of lead.

A study by the U.S. Department of the Navy examined the impact of materials from activated seawater batteries in sonobuoys that freely dissolve in the water column (e.g., lead, silver, and copper ions), as well as nickel-plated steel housing, lead solder, copper wire, and lead shot used for sonobuoy ballast (Naval Facilities Engineering Command 1993). The study concluded that constituents released from saltwater batteries as well as the decomposition of other sonobuoy components did not exceed state or federal standards and that the reaction products are short-lived in seawater.

Lead. Lead is used as ballast in torpedoes, in batteries in torpedoes and sonobuoys, and various munitions. Lead is nearly insoluble in water, particularly at the near-neutral pH levels of seawater. While it is reasonable to assume some dissolution of lead could occur, such releases into the water column would be small and would be diluted (U.S. Department of the Navy 2006).

Several studies have evaluated the potential impacts of batteries expended in seawater (Borener and Maugham 1998; Canadian Forces Maritime Experimental and Test Ranges 2005; Naval Facilities Engineering Command 1993; U.S. Coast Guard 1994). Sediment samples were taken adjacent to and near fixed navigation sites where these batteries are used and analyzed for all metal constituents in the batteries. Results indicated that metals were either below or consistent with background levels or were below National Oceanic and Atmospheric Administration sediment screening levels (Buchman 2008), “reportable quantities” under the Comprehensive Environmental Response, Compensation, and Liability Act §103(a), or USEPA toxicity criteria (U.S. Environmental Protection Agency 2008f).

A sonobuoy battery experiment employed lead (II) chloride batteries in a 17-gallon (64-liter) seawater bath for eight hours (Naval Facilities Engineering Command 1993). Under these conditions, the dilution assumptions are conservative relative to normal ocean bottom conditions. The concentration released from the battery was diluted to 200 µg/L (200 ppb) in two seconds, which is less than the acute criteria of 210 µg/L (210 ppb). Considering each milliliter as a discrete parcel, dilution by a current traveling at two inches per second (5 cm per second) would dilute the lead released from the battery to 200 µg/L (200 ppb) in two seconds, which is less than the acute criteria of 210 µg/L (210 ppb). Assuming the exponential factor of two dilutions, the concentration is less than the chronic limit of 8.1 µg/L (8.1 ppb) in seven seconds. The calculated rate of leaching will decrease as the concentration of lead within the battery decreases.

Since lead (II) chloride tends to dissolve more readily than either silver chloride or copper thiocyanate, this assures that the potential impacts from batteries employing silver chloride or copper thiocyanate are substantially lower than those for the lead (II) chloride battery. The copper thiocyanate battery also has the potential to release cyanide, a material often toxic to the marine environment. However, thiocyanate is tightly bound and can form a salt or bind to bottom sediment. Therefore, the risk associated with thiocyanate is low (U.S. Department of the Navy 2008a). The peak concentration of copper released from a copper thiocyanate seawater battery was calculated to be 0.015 μg/L (0.015 ppb) (Naval Facilities Engineering Command 1993), which is substantially lower than USEPA acute and chronic toxicity criteria.

Tungsten and tungsten alloys. Because of environmental concerns related to lead in munitions, tungsten has been used as a replacement (Defense Science Board 2003). Tungsten was initially chosen because it was considered nonreactive in the environment under normal circumstances. However, concerns have risen lately regarding that assessment. Adverse health consequences arise with inhalation, and movement of tungsten into groundwater is an issue (Agency for Toxic Substances and Disease Registry 2005). However, no drinking water standard exists for tungsten, and it is not listed as a carcinogen (U.S. Environmental Protection Agency 2008f), and neither inhalation nor groundwater is an issue relative to sediment and water quality in the AFTT Study Area.

The natural concentration of tungsten reported in seawater is about 0.1 μg/L (0.1 ppb) (Agency for Toxic Substances and Disease Registry 2005). It arises naturally from weathering of tungsten-rich deposits and from underwater hydrothermal vents; elevated levels in sediment from natural sources have been reported. Industrial processes also contribute tungsten to the environment (Koutsospyros et al. 2006). In water, tungsten can exist in several different forms depending on pH, and it has a strong tendency to form complexes with various oxides and with organic matter. The rate at which tungsten dissolves or dissociates increases as pH decreases below 7.0. (The pH of seawater is normally between 7.5 and 8.4.) The speed of the process also depends on the metal with which tungsten is alloyed. For instance, iron tends to enhance the dissolution of tungsten, while cobalt slows the process (Agency for Toxic Substances and Disease Registry 2005). Tungsten is a component of metabolic enzymes in various microbes (Kletzin and Adams 1996). Although much is known about the physical and chemical properties of tungsten, less is known about the behavior of the various complexes that tungsten forms, making predictions about its behavior in the environment difficult. For instance, it is not known whether the organic complexes that tungsten forms affect its bioavailability (Koutsospyros et al. 2006).

Lithium. Silver chloride, lithium, or lithium iron disulfide thermal batteries are used to power subsurface units of sonobuoys. The lithium-sulfur batteries used typically contain lithium sulfur dioxide and lithium bromide, but may also contain lithium carbon monofluoroxide, lithium manganese dioxide, sulfur dioxide, and acenitrile (a cyanide compound). During battery operation, the lithium reacts with the sulfur dioxide to form lithium dithionite. Thermal batteries are contained in a hermetically sealed and welded stainless steel case that is 0.03 to 0.1 in. (0.1 to 0.25 cm) thick and resistant to the battery electrolytes.

Lithium always occurs as a stable mineral or salt, such as lithium chloride or lithium bromide (Kszos et al. 2003). Lithium is naturally present in seawater at 180 μg/L (180 ppb). Its incorporation into clay minerals is a major process in its removal from solution (Stoffyn-Egli and Machenzie 1984).

Kszos et al. (2003) demonstrated that sodium ions in saltwater mitigate the toxicity of lithium to sensitive aquatic species. Fathead minnows (*Pimephales promelas*) and the water flea (*Ceriodaphnia dubia*) were unaffected by lithium concentrations as high as 6 mg/L (6 ppm) in the presence of tolerated concentrations of sodium. Therefore, it is expected that in the marine environment, where sodium concentrations are at least an order of magnitude higher than tolerance limits for the tested freshwater species, lithium would be essentially nontoxic.

Canadian Forces Maritime Experimental and Test Ranges (2005) reported that 99 percent of the lithium in a sonobuoy battery would be released to the environment over 55 years. The release will result in a dissolved lithium concentration of 83 mg/L (83 parts ppm) in the immediate area of the breach in the sonobuoy housing. At a distance of 0.2 in. (5.5 mm) from the breach, the concentration of lithium will be about 15 mg/L (15 ppm), or 10 percent of typical seawater lithium values (150 ppm). Thus, it would be difficult to discern the additional concentration due to the lithium leakage from the background concentration (Canadian Forces Maritime Experimental and Test Ranges 2005). Cores taken of sediment in the Canadian Forces Maritime Experimental and Test Ranges near Nanoose Bay, British Columbia, Canada, showed fairly consistent lithium concentrations with depth, indicating little change in lithium deposition with time. Given ambient lithium concentrations taken outside the range, the report concluded that “it is difficult to demonstrate an environmental impact of lithium caused by (test range activities)” (Canadian Forces Maritime Experimental and Test Ranges 2005).

3.1.3.2.3.1 Metals in Non-Explosive Practice Munitions

On the bottom, non-explosive practice munitions and fragments are exposed to seawater or lodge in sediment. Once settled, metal components slowly corrode in seawater. Over time, natural encrustation of exposed surfaces occurs and reduces the rate of corrosion. Elemental aluminum in seawater tends to be converted by hydrolysis to aluminum hydroxide, which is relatively insoluble, and scavenged by particulates and transported to the bottom sediment (Monterey Bay Research Institute 2010). Practice bombs are made of materials similar to those used to construct artificial reefs. The steel and iron, though durable, corrode over time, with no noticeable environmental impacts (U.S. Department of the Navy 2006).

3.1.3.2.4 Evaluation of Alternatives

Table 3.1-23 summarizes the types and amounts of military expended materials with metal components for all alternatives. The numbers represent amounts expended annually for each type of material under each alternative. The types and amounts of expended materials in the table were drawn from the tables in Section 3.0 (Introduction to the Affected Environment and Environmental Consequences).

The following sections evaluate each alternative in terms of the information provided in Sections 3.1.3.2.3 (Impacts from Metals) and 3.1.3.2.4 (Evaluation of Alternatives). Potential impacts on sediment and water quality from military expended materials with metal components should be viewed in the following context: (1) nearshore sediment and water quality in many areas have been negatively impacted by metals from other sources, especially those near major river systems and industrial facilities; and (2) the majority of those impacts are from human-generated, land-based activities. The numbers of military expended materials discussed below reflect amounts expended annually for each type of material under each alternative.

3.1.3.2.4.1 No Action Alternative

Under the No Action Alternative, approximately 2.6 million military expended materials with metal components would be distributed throughout the Study Area during training and testing. Numerically, small-, medium-, and large-caliber projectiles comprise 96 percent of the total.

Table 3.1-23: Military Expended Materials with Metal Components – All Alternatives Annually

Type of Military Expended Material	No Action Alternative	Alternative 1	Alternative 2
Small-Caliber Projectiles			
Training	2,040,880	6,264,040	6,264,040
Testing	8,800	45,000	51,800
Total	2,049,680	6,309,040	6,315,840
Medium-Caliber Projectiles[1]			
Training	405,530	1,676,596	1,676,596
Testing	63,482	293,500	310,508
Total	469,012	1,970,096	1,987,104
Large-Caliber Projectiles[1]			
Training	10,874	19,421	19,421
Testing	596	19,760	21,390
Total	11,470	39,181	40,811
Bombs[1]			
Training	2,379	3,502	3,502
Testing	655	1,063	1,145
Total	3,034	4,565	4,647
Missiles[1]			
Training	456	494	494
Testing	151	800	881
Total	607	1,294	1,375
Rockets[1]			
Training	3,700	7,980	7,980
Testing	377	2,761	3,037
Total	4,077	10,741	11,017
Expendable Subsurface Targets[2]			
Training	1,621	2,306	2,306
Testing	133	766	862
Total	1,754	3,072	3,168
Vessels as Targets			
Training	6	1	1
Testing	0	0	0
Total	6	1	1
Other Surface Targets[3]			
Training	1,440	3,116	3,116
Testing	406	1,140	1,242
Total	1,846	4,256	4,358

Table 3.1-23: Military Expended Materials with Metal Components – All Alternatives Annually (Continued)

Type of Military Expended Material	No Action Alternative	Alternative 1	Alternative 2
Airborne Targets			
Training	0	0	0
Testing	110	110	121
Total	110	110	121
Chaff Cartridges			
Training	64,590	45,612	45,612
Testing	2,984	10,660	11,650
Total	67,574	56,272	57,262
Sonobuoys			
Training	30,151	30,945	30,945
Testing	4,068	16,246	19,791
Total	34,219	47,191	50,736
Mines, Mine Shapes			
Training	0	84	84
Testing	204	607	674
Total	204	691	758
Torpedoes			
Training	1	1	1
Testing	12	42	45
Total	13	43	46
Torpedo Accessories[4]			
Training	127	116	116
Testing	127	1,009	1,112
Total	254	1,125	1,228
Grenades			
Training	100	206	206
Testing	0	0	0
Total	100	206	206

[1] Includes non-explosive practice munitions.
[2] Includes expendable torpedo targets.
[3] High-speed jet skis and motorboats.
[4] Includes guidance wires, flex hoses, ballast, protective nose covers, suspension bands, air stabilizers, and propeller baffles used with air-launched torpedoes.

Training Activities. Under the No Action Alternative, numerically, training activities represent 97 percent of all materials with metal components, of which 96 percent are small- and medium-caliber projectiles. Most of those projectiles (85 percent) would be used in two range complexes: VACAPES (62 percent) and JAX (23 percent).

Comparison of Training Materials by Weight. A review of training materials based on metal weight provides a different perspective on the relative contribution of various items under the No Action Alternative. For instance, although small-caliber projectiles comprise 77 percent of the total number of items, by weight they represent less than 6 percent of the total. The total metal weight of training materials under the No Action Alternative would be an estimated 1,747 tons (1.58 million kg). Table 3.1-24 depicts those categories of materials that contribute most (89 percent) of the total metal weight of training items under the No Action Alternative.

Table 3.1-24: Training Materials with Metal Components under the No Action Alternative – Comparison of Number of Items versus Weight

Type of Military Expended Material	Percent of Total by Number	Percent of Total by Weight
Bombs	0.09	33.9
Large- and Medium-Caliber Projectiles	16.25	26.8
Sonobuoys	1.18	17.0
Missiles	0.02	11.0

"<": less than.
Percent of Total by Weight shows the contribution of metal weight

Under the No Action Alternative, the distribution of the training materials based on weight would be as follows:

- Bombs – Cherry Point (34 percent), JAX (29 percent), and VACAPES (24 percent) Range Complexes.
- Large- and medium-caliber projectiles – JAX (16 percent), Navy Cherry Point (9 percent), and VACAPES (50 percent) Range Complexes.
- Sonobuoys – JAX (68 percent), VACAPES (16 percent), and Navy Cherry Point (6 percent) Range Complexes.
- Missiles – VACAPES (63 percent), JAX (23 percent), and Navy Cherry Point (11 percent) Range Complexes.

Note: Because the contribution of testing materials to the total amount of materials with metal components is relatively small – by number and by weight, only training materials were used for the comparisons in Table 3.1-24. Surface vessels used as targets also contribute a large amount of metal weight. Under the No Action Alternative, six surface vessels are proposed for vessel sinking exercises. However, the types of vessels used as targets depend on their availability and, therefore, cannot be specified. For comparison, the total weight of training materials with metal components under the No Action Alternative is estimated to be 1,747 tons (1.58 million kg). A Navy vessel used as a target would weigh between 5,000 and 10,000 tons (4.5 to 9.1 million kg).

Testing Activities. Under the No Action Alternative, testing activities represent 3 percent of all materials with metal components. Of those materials, 89 percent are small-, medium-, and large-caliber projectiles, all of which (100 percent) would be used in four range complexes or testing ranges: VACAPES (59 percent), JAX (22 percent); Naval Surface Warfare Center, Panama City Division Testing Range (16 percent); and GOMEX (3 percent). Testing activities are described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Tables 2.8-2 and 2.8-3.

Summary of Impacts from Metals

Under the No Action Alternative, potential impacts on sediment and water quality from training and testing activities involving materials with metal components would be long-term and local. Metal components would come to rest on the sea floor exposed to seawater when resting on the bottom or, more likely, buried in sea floor sediment. These metals would slowly corrode over years or decades and release small amounts of metals and metal compounds to adjacent sediment and waters. Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. This conclusion is based on the following: (1) most of the metals are benign, and those of potential concern make up a small percentage of munitions; (2) metals released through corrosion would be diluted by currents or bound up and sequestered in adjacent sediment; (3) impacts would be limited to the immediate area around the expended material; and (4) the areas across which metal components would be distributed are large. Neither state nor federal standards or guidelines would be exceeded.

3.1.3.2.4.2 Alternative 1

Under Alternative 1, use of training and testing materials with metal components would increase 324 percent compared to the No Action Alternative. Numerically, small- and medium-caliber projectiles would comprise 98 percent of the total (96 percent under the No Action Alternative). Materials expended at the Undersea Warfare Training Range will include torpedo accessories (e.g., guidance wires, air launch accessories, and ballast), sonobuoys, acoustic countermeasures, and expendable mobile anti-submarine warfare training targets. Because of the concentration of this training, these items are expected to increase on the sea floor within the training range. Items used in the training range are included in the tally of materials in Table 3.1-25.

Training Activities. Under Alternative 1, training activities would represent 95 percent of all materials with metal components, similar to the No Action Alternative. Those training materials would increase 314 percent compared to the No Action Alternative. Numerically, 99 percent are small-, medium and large-caliber projectiles (96 percent under the No Action Alternative), most of which (84 percent) would be used in two range complexes: VACAPES (59 percent; 62 percent under the No Action Alternative) and JAX (25 percent; 23 percent under the No Action Alternative).

Table 3.1-25: Training Materials with Metal Components under Alternative 1 – Comparison of Number of Items versus Weight

Type of Military Expended Material	Percent of Total by Number	Percent of Total by Weight
Large- and Medium-Caliber Projectiles	21.0	35.9
Bombs	< 0.1	30.6
Small-Caliber Projectiles	77.6	11.0
Sonobuoys	0.4	10.9

"<": less than.

Comparison of Training Materials by Weight. As with the No Action Alternative, a review of training materials based on weight provides a different perspective on the relative contribution of various items under Alternative 1. Under Alternative 1, the total weight of training materials with metal components would be an estimated 2,844 tons (2.58M kg), compared to an estimated 1,747 tons (1.58M kg) under the No Action Alternative, an increase of 163 percent. Table 3.1-25 depicts those categories of materials that contribute most (88 percent) of the total weight of training items with metal components under Alternative 1.

Under Alternative 1, the distribution of the training materials based on weight would be as follows:

- Large- and medium-caliber projectiles – JAX (28 percent; 17 percent under the No Action Alternative), Navy Cherry Point (14 percent; 10 percent under the No Action Alternative), and VACAPES (51 percent; 56 percent under the No Action Alternative) Range Complexes.
- Bombs – Navy Cherry Point (34 percent; same under the No Action Alternative), JAX (37 percent; 29 percent under the No Action Alternative), and VACAPES (19 percent; 24 percent under the No Action Alternative) Range Complexes.
- Small-caliber projectiles – JAX (24 percent; 25 percent under the No Action Alternative), Navy Cherry Point (9 percent; 10 percent under the No Action Alternative), and VACAPES (62 percent; 64 percent under the No Action Alternative) Range Complexes.
- Sonobuoys – JAX (70 percent; 68 percent under the No Action Alternative), VACAPES (16 percent; same under the No Action Alternative), and Navy Cherry Point (5 percent; 6 percent under the No Action Alternative) Range Complexes.

Note: Because the contribution of testing materials to the total amount of materials with metal components is relatively small – by number and to some degree by weight, only training materials were used for the comparisons in Table 3.1-25. Surface vessels used as targets also contribute a large amount of metal weight. Under Alternative 1, one surface vessel is proposed for vessel sinking exercises (six under the No Action Alternative). However, the types of vessels used as targets depend on their availability and, therefore, cannot be specified. For comparison, the total weight of materials with metal components under Alternative 1 is estimated to be 4,167 tons (3.78 million kg). A Navy vessel used as a target would weigh between 5,000 and 10,000 tons (4.5 to 9.1 million kg).

Testing Activities. Testing activities would represent 5 percent of all materials with metal components under Alternative 1 (3 percent under the No Action Alternative). Testing materials with metal components would increase 479 percent compared to the No Action Alternative. Of those materials, 91 percent are medium- and large-caliber projectiles, most of which (87 percent; 91 percent under the No Action Alternative) would be used in two range complexes: VACAPES (60 percent; 66 percent under the No Action Alternative), and JAX (27 percent; 25 percent under the No Action Alternative). Testing activities are described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Tables 2.8-2 and 2.8-3.

Summary of Impacts from Metals

Although the amount of expended materials associated with training and testing under Alternative 1 would represent an increase over the No Action Alternative, impacts would be similar to the No Action Alternative. Even though the total weight of metals increases under Alternative 1 over the No Action Alternative, the conclusions regarding potential impacts do not change for the following reasons: (1) most of the metals are benign, and those of potential concern make up a small percentage of munitions; (2) metals released through corrosion would be diluted by currents or bound up and sequestered in adjacent sediment; (3) impacts would be limited to the immediate area around the expended material; and (4) the areas across which metal components would be distributed are large. Metal components would come to rest on the sea floor exposed to seawater when resting on the bottom or, more likely, buried in sea floor sediment. These metals would slowly corrode over years or decades and release small amounts of metals and metal compounds to adjacent sediment and waters. Potential impacts on sediment and water quality would be long-term and local. Chemical, physical, or biological changes to sediment or water quality would be measurable, but below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses. Neither state nor federal standards or guidelines would be exceeded.

3.1.3.2.4.3 Alternative 2 (Preferred Alternative)

Under Alternative 2, training and testing activities involving materials with metal components would increase 324 percent compared to the No Action Alternative. Numerically, small-, medium-, and large-caliber projectiles make up 98 percent of the total (96 percent under the No Action Alternative). Materials expended at the Undersea Warfare Training Range will include torpedo accessories (e.g., guidance wires, air launch accessories, and ballast), sonobuoys, acoustic countermeasures, and expendable mobile anti-submarine warfare training targets. Because of the concentration of this training, these items are expected to increase on the sea floor within the training range. Items used in the training range are included in the tally of materials in Table 3.1-26.

Training Activities. Under Alternative 2, training activities involving materials with metal components would increase 314 percent compared to the No Action Alternative. Such activities would represent 95 percent of materials with metal components, similar to the No Action Alternative. Numerically, 99 percent are small-, medium-, and large-caliber projectiles (95 percent under the No Action Alternative), most of which (84 percent) would be used in two range complexes: VACAPES (59 percent; 62 percent under the No Action Alternative) and JAX (25 percent; 23 percent under the No Action Alternative).

Comparison of Training Materials by Weight. Similar to Alternative 1, a review of training materials based on weight provides a different perspective on the relative contribution of various items under Alternative 2. Under Alternative 2, the total weight of training materials with metal components would be an estimated 2,844 tons (2.58 million kg), compared to an estimated 1,747 tons (1.58 million kg) under the No Action Alternative, an increase of 63 percent. Table 3.1-26 depicts those categories of materials that contribute most (88 percent) of the total weight of training items with metal components under Alternative 2.

Table 3.1-26: Training Materials with Metal Components under Alternative 2 – Comparison of Number of Items versus Weight

Type of Military Expended Material	Percent of Total by Number	Percent of Total by Weight
Large- and Medium-Caliber Projectiles	21.0	35.9
Bombs	< 0.1	30.6
Small-Caliber Projectiles	77.6	11.0
Sonobuoys	0.4	10.9

"<": less than.

Under Alternative 2, the distribution of the training materials based on weight would be the same as described under Alternative 1.

Note: Because the contribution of testing materials to the total amount of materials with metal components is relatively small by number and to some degree by weight, only training materials were used for the comparisons in Table 3.1-26. Surface vessels used as targets also contribute a large amount of metal weight. Under Alternative 2, one surface vessel is proposed for vessel sinking exercises (six under the No Action Alternative). However, the types of vessels used as targets depend on their availability and, therefore, cannot be specified. For comparison, the total weight of military expended materials with metal components under Alternative 2 is estimated to be 4,405 tons. A Navy vessel used as a target would weigh between 5,000 and 10,000 tons.

Testing Activities. Under Alternative 2, testing activities would represent 5 percent of all materials with metal components, the same as the No Action Alternative. Use of these materials would increase 517 percent compared to the No Action Alternative. Of those materials, 90 percent are small-, medium-, and large-caliber projectiles, most of which (87 percent; 91 percent under the No Action Alternative) would be used in two range complexes: VACAPES (60 percent; 66 percent under the No Action Alternative), and JAX (27 percent; 25 percent under the No Action Alternative). Testing activities are described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Tables 2.8-2 and 2.8-3.

Summary of Impacts from Metals

Although the amount of materials with metal components associated with training and testing activities under Alternative 2 would represent an increase, similar to Alternative 1 and the impacts would be similar to the No Action Alternative. Even though the total weight of metals increases under Alternative 2 over the No Action Alternative, the conclusions regarding potential impacts do not change for the following reasons: (1) most of the metals are benign, and those of potential concern make up a small percentage of munitions; (2) metals released through corrosion would be diluted by currents or bound up and sequestered in adjacent sediment; (3) impacts would be limited to the immediate area around the expended material; and (4) the areas across which metal components would be distributed are large. Metal components would come to rest on the sea floor exposed to seawater when resting on the bottom or, more likely, buried in sea floor sediment. These metals would slowly corrode over years or decades and release small amounts of metals and metal compounds to adjacent sediment and waters. Potential impacts on sediment and water quality would be long-term and local. Chemical, physical, or biological changes to sediment or water quality would be measurable but below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses. Neither state nor federal standards or guidelines would be exceeded.

3.1.3.3 Chemicals Other than Explosives

3.1.3.3.1 Introduction

Under the Proposed Action, chemicals other than explosives are associated with the following military expended materials: (1) solid-fuel propellants in missiles, rockets, and unmanned aerial vehicles (targets); (2) Otto Fuel II torpedo propellant and combustion byproducts; (3) PCBs in target vessels used during sinking exercises; (4) other chemicals associated with ordnance; and (5) chemicals and biological materials that simulate chemical and biological warfare agents, referred to as “chemical simulants” and “biological simulants.”

The next sections provide the following overview:

- Sections 3.1.3.3.2, 3.1.3.3.3, and 3.1.3.3.4 provide more detail concerning the solid-fuel propellants, Otto Fuel II, and PCBs;
- Sections 3.1.3.3.5 and 3.1.3.3.6 provide a summary of other chemicals associated with ordnance and additional detail related to chemical and biological simulants;

- Section 3.1.3.3.7 discusses how chemicals other than explosives will be evaluated under each alternative;
- Section 3.1.3.3.8 reviews information about the behavior and potential impacts of chemicals other than explosives on sediment and water quality; and
- Section 3.1.3.3.9 evaluates each alternative in terms of the information provided in Sections 3.1.3.3.7 and 3.1.3.3.8.

Hazardous air pollutants associated with explosives and explosion byproducts are discussed in Section 3.2.3.2 (Hazardous Air Pollutants). Fuels onboard manned aircraft and vessels are not reviewed, nor are fuel-loading activities or onboard operations and maintenance activities.

3.1.3.3.2 Missile and Rocket Propellant – Solid Fuel

The largest chemical constituent of missiles is solid propellant. Solid propellant contains both the fuel and the oxidizer (a source of oxygen needed for combustion). A Standard Missile-1 typically contains 150 lb. (68 kg) of solid propellant (U.S. Department of the Navy 2008b). Ammonium perchlorate is an oxidizing agent used in most modern solid-propellant formulas. It normally accounts for 50 to 85 percent of the propellant by weight. Ammonium dinitramide may also be used as an oxidizing agent. Aluminum powder as a fuel additive makes up 5 to 21 percent by weight of solid propellant; it is added to increase missile range and payload capacity. Two high explosives—high melting explosive (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine, also known as HMX) and royal demolition explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine, also known as RDX)—may be added, although they usually compose less than 30 percent of the propellant weight (Missile Technology Control Regime 1996).

The most common substance used as binding material for solid propellants is hydroxyl-terminated polybutadiene. Other binding materials include carboxyl-terminated polybutadiene and polybutadiene-acrylic acid-acrylonitrile. These materials also burn as fuels and contribute to missile thrust. Other materials found in solid-fuel propellants include curing agents and catalysts such as triphenyl bismuth; nitrate esters and nitrated plasticizers are liquid explosives added to increase the engine burn rate, and n-hexyl carborane and carboranylmethyl propionate are also used to increase propellant performance.

Double-base propellant is a solid fuel that is a mixture of fuels and small particulate oxidizers. Like other solid propellants, the most commonly used fuel component of these propellants is ammonium perchlorate. High melting explosive and royal demolition explosive may be added to improve performance, and the most common binder is hydroxyl-terminated polybutadiene. In addition to the binders listed in the preceding paragraph, polybutadiene-acrylic acid polymer, elastomeric polyesters, polyethers, and nitrocellulose plasticized with nitroglycerine or other nitrate esters may be used. To reduce decomposition of propellant, 2-nitrodiphenylamine and N-methyl-4-nitroaniline may be added (Missile Technology Control Regime 1996).

3.1.3.3.3 Torpedo Propellant – Otto Fuel II and Combustion Byproducts

The MK 48 torpedo weighs roughly 3,700 lb. (1,680 kg) and uses Otto Fuel II as a liquid propellant. Otto Fuel II is composed of propylene glycol dinitrate and nitro-diphenylamine (76 percent), dibutyl sebacate (23 percent and 2-nitrodiphenylamine as a stabilizer (2 percent). Combustion byproducts of Otto Fuel II include nitrous oxides, carbon monoxide, carbon dioxide, hydrogen, nitrogen, methane, ammonia, and hydrogen cyanide. During normal venting of excess pressure or upon failure of the torpedo's buoyancy bag, the following are discharged: carbon dioxide, water, hydrogen, nitrogen, carbon monoxide, methane, ammonia, hydrochloric acid, hydrogen cyanide, formaldehyde, potassium chloride, ferrous oxide, potassium hydroxide, and potassium carbonate (U.S. Department of the Navy 1996a, b).

3.1.3.3.4 Polychlorinated Biphenyls in Target Vessels Used During Sinking Exercises

In the past, PCBs were raised as an issue because they were found in certain solid materials on vessels used as targets during vessel-sinking exercises (e.g., insulation, wires, felts, and rubber gaskets). Currently, vessels used for sinking exercises are selected from a list of U.S. Navy-approved vessels that have been cleaned in accordance with USEPA guidelines. By rule, a sinking exercise must be conducted at least 50 nm offshore and in water at least 6,000 ft. (1,830 m) deep (40 C.F.R. § 229.2). Six sinking exercises per year are proposed under the No Action Alternative. Under Alternatives 1 and 2, one sinking exercise is planned per year. In the Study Area, these exercises occur in an area that straddles the Gulf Stream and North Atlantic Gyre Open Ocean Areas.

The USEPA estimates that as much as 100 lb. (45 kg) of PCBs remain onboard sunken vessels. The agency considers the contaminant levels released during the sinking of a target to be within the standards of the Marine Protection, Research, and Sanctuaries Act (33 U.S.C. §§ 1401-1445) (U.S. Environmental Protection Agency 1999). Based on the foregoing considerations, PCBs will not be considered further.

3.1.3.3.5 Other Chemicals Associated with Ordnance

Table 3.1-27 provides a list of ordnance constituents remaining after low-order detonations and with unconsumed explosives. These constituents are in addition to the high explosives contained in the ordnance.

Lead azide, titanium compounds, perchlorates, barium chromate, and fulminate of mercury are not natural constituents of seawater. Lead oxide is a rare, naturally occurring mineral. It is one of several lead compounds that form films on lead objects in the marine environment (Agency for Toxic Substances and Disease Registry 2007). Metals are discussed in more detail in Section 3.1.3.2.

Table 3.1-27: Constituents Remaining after Low-Order Detonations and from Unconsumed Explosives

Ordnance Component	Constituent
Pyrotechnics Tracers Spotting Charges	Barium chromate ($BaCrO_4$) Potassium perchlorate Chlorides Phosphorus Titanium compounds
Oxidizers	Lead (II) oxide (PbO)
Delay Elements	Barium chromate ($BaCrO_4$) Potassium perchlorate Lead chromate
Fuses	Potassium perchlorate
Detonators	Fulminate of mercury [$Hg(CNO)_2$] Potassium perchlorate
Primers	Lead azide [$Pb(N_3)_2$]

3.1.3.3.6 Chemical and Biological Simulants

Chemical and biological agent detectors are used to monitor the presence of chemical and biological warfare agents and to protect military personnel and civilians from the threat of exposure to these agents. The exposure of military personnel or the public to even small amounts of real warfare agents, such as nerve or blistering agents, or harmful biological organisms, such as anthrax, is potentially harmful and not legal in most countries in the world, including the United States. Furthermore, their use, including the testing of detection equipment, is banned by international agreement. The 1993 Chemical Weapons Convention banned the use of chemical weapons, their development, production, stockpiling, and transfer. It also required that all existing stocks of chemical weapons be destroyed within 10 years, with the exception of trace amounts of live agents used for lab testing. The United States signed the Chemical Weapons Convention on 13 January 1993 and ratified it on 25 April 1997. Nevertheless, because chemical and biological warfare agents remain a security threat, the DoD searches for and utilizes relatively harmless compounds (simulants) as substitutes for chemical and biological warfare agents to test equipment intended to detect their presence. The simulants trigger a physical or chemical interaction by the detection equipment without irritating or injuring personnel involved in testing detectors and without harming the environment.

Simulants must have one or more characteristics – size, density, or aerosol behavior – similar to those of real chemical or biological agents so they can effectively mimic them. Simulants are selected using the following criteria: (1) safety to humans and the environment and (2) the ability to trigger a response by the infrared sensors used in the detection equipment.

Safety to humans and the environment. Simulants must be relatively benign (e.g., low toxicity or effects potential) from a human health, safety, and environmental perspective. Exposure levels during testing activities should be well below concentrations associated with any adverse human health or environmental effects. The degradation products of simulants must also be harmless.

Infrared absorbance. The spectral absorbance peaks for simulant vapors should be within a certain range of the spectral absorbance peaks of the warfare agents they are intended to mimic in order to assess the capacity of detection equipment to see the vapors of simulants or agents.

Both chemical and biological simulants may be used for testing purposes. Under Alternatives 1 and 2, chemical and biological simulant testing could occur anywhere within the Northeast, VACAPES, Cherry Point, and JAX Range Complexes. Under the No Action Alternative this testing would only occur in the VACAPES Range Complex. Vapor releases would take place in these areas allowing vapor clouds to disperse as predicted by modeling and by monitoring weather conditions just prior to the test. Because of the need for early detection of chemical and biological agents, testing is designed to detect simulants at very low levels – levels well below quantities that could present risks to human health and the environment.

The types of chemical simulants proposed for use in testing exercises include Navy Chemical Agent Simulant 82 (NCAS-82), glacial acetic acid, triethyl phosphate, sulfur hexaflouride, 1,1,1,2-tetraflouroethane (refrigerant – 134 or “R-134”) and 1,1-difluoroethane (refrigerant -152a or “R-152a”). Sulfur hexafluoride and the proposed refrigerant simulants (refrigerant-134 and refrigerant-152a) are also referred to as gaseous simulants and can be released in smaller quantities in conjunction with glacial acetic acid or triethyl phosphate releases. The types of biological simulants that may be used include spore-forming bacteria, non-spore-forming bacteria, ovalbumin, bacteriophage MS2, and *Aspergillus niger*.

3.1.3.3.6.1 Chemical Simulants

Navy Chemical Agent Simulant 82. NCAS-82 is a mixture of 90 percent polyethylene glycol and 10 percent methyl salicylate. This simulant is used to test the detection of liquid agents deposited on ship surfaces or aerosolized agents carried into ship spaces. In addition, ships’ decontamination, filtration, and collective protection systems and procedures can be evaluated for their ability to remove this simulant. NCAS-82 is dispersed by aircraft or watercraft to deliver relatively coarse droplets from above to targeted ships and can also be dispersed by hand sprayer. Up to 20 gallons of simulant is released per aircraft pass with most of the liquid intended to reach the surface of the target area on the ship. Tests are typically planned for the possibility of up to three releases — in the event a release does not sufficiently coat the target area due to wind conditions or other targeting complications. This simulant is also used in hand-held sprayers in quantities less than 5 gallons per sprayer, and up to 20 gallons would be applied per day by hand sprayer. This simulant is delivered essentially undiluted to ship surfaces (Neil 2013).

Polyethylene glycol. Polyethylene glycol occurs as a clear liquid or as a white semi-solid to solid with a slightly sweet (mild) odor, depending on its molecular weight and the ambient temperature. The form used for NCAS-82 is referred to as PEG-200 and occurs as a liquid. It can be used as one of the components of a chemical simulant for a G-agent (nerve agent) or H-agent (blistering agent) due to its physicochemical properties (U.S. Patent Office 2003).

Methyl salicylate. Methyl salicylate is a colorless or pale yellow liquid with a strong characteristic wintergreen odor. It is used as a simulant for blistering agents such as sulfur mustard agents (Seitzinger et al. 1990). It occurs naturally in plants, where it probably developed as an anti-herbivore defense. Methyl salicylate has a half-life of about 1.4 days due to its reaction with photochemically produced hydroxyl radicals (Meylan and Howard 1993). It is slightly soluble in water, with lowest solubility of 0.11 percent at an acid concentration of 62 percent acid and increasing in solubility at concentrations both above and below this value (Rubel 1989).

Glacial Acetic Acid. Glacial acetic acid is used to simulate airborne chemical agents because its appearance to infrared standoff detectors is similar to that of blister agent vapor. It is used as a simulant for persistent nerve agents, the V-agents. Glacial acetic acid is dispersed by spraying a fine mist into a high speed airflow so the simulant forms a vapor cloud approximately 100 feet above the sea surface. Up to 10 gallons is released per aircraft or vessel pass to produce a cloud of vapor. Glacial acetic acid could be released up to 20 times per day.

Glacial acetic acid is a concentrated form of acetic acid, which is a colorless liquid that gives vinegar its sour taste and pungent smell. Acetic acid is highly soluble in water and has many industrial and household uses. Acetic acid-producing bacteria are ubiquitous throughout the world and have been widely used for fermentation processes throughout history. Acetic acid occurs throughout the environment and is a normal metabolite in animals, hence people are continually exposed to low concentrations of it through the ingestion of food and the inhalation of air (Hazardous Substances Data Bank 2008b). Although acetic acid commonly occurs in the environment in dilute form, in concentrated form such as glacial acetic acid, it is harmful to the skin, eyes, and respiratory system.

Triethyl phosphate. Triethyl phosphate is a colorless liquid with a slight pleasant or sweetish odor (Lewis et al. 2001) that is soluble in most organic solvents, alcohol, and ether, and is capable of being fully mixed into water (Lewis 1999). For testing purposes triethyl phosphate is applied in a manner similar to glacial acetic acid, dispersed by spraying a fine mist into a high speed airflow so the simulant forms a vapor cloud approximately 100 feet above the sea surface. Up to 10 gallons is released per aircraft or vessel pass to produce a cloud of vapor. Triethyl phosphate could be released up to 20 times per day.

Triethyl phosphate is used primarily in industry, but is also used as a flame retardant. Consumer exposure to triethyl phosphate via inhalation during its use as a flame retardant in plastic materials was calculated to be approximately 0.001 mg/m^3 (National Institute for Occupational Safety and Health 1983). Triethyl phosphate is considered for use as a G-agent (e.g., sarin) simulant due to its physicochemical properties (Bartelt-Hunt et al. 2008). In aquatic systems, lethal doses (LD50, single doses required to kill 50 percent of a test population) ranged from more than 100 to 2,140 mg/kg for fish and from more than 100 to 2,705 mg/L for invertebrates in tests ranging from 48 to 96 hours (United Nations Environmental Program 1998). In a subchronic 21-day test, the concentration at which half the test individuals showed effects, known as the Effective Concentration 50 or EC50, for the water flea Daphnia magna was 729 mg/L (Verschueren 2001). The bioconcentration potential of triethyl phosphate in aquatic organisms is considered to be low (Hazardous Substances Data Bank 2008c). Triethyl phosphate is considered to be moderately toxic, with a probable oral lethal dose to humans of between 500 to 5,000 mg/kg, which equates to between 1 ounce (oz.) and 16 oz. for a 150-lb. (68-kg) individual (Gosselin et al. 1984).

3.1.3.3.6.1.1 Gaseous Simulants

For testing purposes the three gaseous simulants (sulfur hexafluoride, refrigerant-134, and refrigerant-152a) discussed below are released in small quantities in conjunction with releases of glacial acetic acid or triethyl phosphate because they are detectible by standoff infrared detectors (Neil 2013).

Sulfur hexafluoride. Sulfur hexafluoride is a colorless, odorless gas. It is soluble in potassium hydroxide and alcohol, but has a low solubility in water. It is primarily used in industry as a gaseous electrical insulating material and for the production of semiconductors (dry/plasma etching).

As with other gases, direct exposure to large concentrations could cause asphyxiation as a result of the displacement of oxygen (American Conference of Governmental Industrial Hygienists 1994-1995). However, ordinarily sulfur hexafluoride does not exist in a pure state (Sittig 2002). The degeneration products of sulfur hexafluoride (e.g., sulfur tetrafluoride) can be toxic, causing nose and ear irritation, nausea and vomiting, coughing, shortening of breath, tightness in the chest, and pulmonary edema. Because sulfur hexafluoride is on the USEPA's Greenhouse Gas Action List, its use is being phased out and its future use is unlikely in testing exercises.

Refrigerant -134 (R-134). Refrigerant-134 is an inert colorless, odorless gas used primarily as a high temperature refrigerant for refrigeration and automobile air conditioners. It began to be used in the 1990s to replace dichlorodifluorometane (Freon-12), which was banned in the United States and other countries in 1994 because of its ozone-depleting properties. Refrigerant-134 exhibits relatively low toxicity in animals with a four-hour (acute toxicity) lethal concentration of 567,000 ppm (2,360 g/m^3) reported for rats and no effects observed at 81,000 ppm (338 g/m^3). At concentrations in excess of 200,000 ppm (834 g/m^3), exposure to 1,1,1,2-tetrafluoroethane depressed the central nervous system of rats (World Health Organization/International Program on Chemical Safety 1998). In aquatic systems, refrigerant-134 shows low toxicity for the few organisms upon which it has been tested. It also has a low estimated half-life of 3 hours for volatilization in a river (Hazardous Substances Data Bank 2008a). The low toxicity and high volatility indicate negligible risk to aquatic organisms (World Health Organization/International Program on Chemical Safety 1998). In addition, low estimated bioconcentration indicates that 1,1,1,2-tetrafluoroethane would not bioconcentrate in fish and aquatic organisms (Lyman et al. 1982).

Refrigerant -152a (R-152a). Refrigerant-152a is an inert colorless, odorless gas used primarily as a high temperature refrigerant for refrigeration and air conditioners and as an aerosol propellant. It is also known as Freon 152a, Genetron 152, and HCFC-152a. Refrigerant-152a is recommended as an alternative refrigerant to refrigerant-134, as it has a lower global warming potential (U.S. Environmental Protection Agency 2008a).

A two-year inhalation study on rats was used to evaluate the toxicity of refrigerant-152a, where rats were exposed to 0, 2,000, 10,000, or 25,000 ppm 1,1-difluoroethane (equal to 0, 5,399, 26,994, or 67,485 mg/m^3, respectively) (McAlack and Schneider 2009). The 25,000 ppm concentration was designated as a chronic "no adverse effect level," as no significant respiratory, mortality, metabolic, or other effects were observed. Exposure to higher concentrations of refrigerant-152a in an acute study indicates it is practically nontoxic.

3.1.3.3.6.2 Chemical Simulant Safety

Naval Surface Warfare Center, Dahlgren Division uses an air dispersion/deposition model to estimate the amount of each simulant that would be deposited on the water's surface prior to testing. The analysis uses the DoD-approved Vapor, Liquid, and Solid Tracking Model (VLSTRACK: Version 3.1.1) to calculate the concentration and deposition levels resulting from testing under various release scenarios.

In addition to modeling, field test results were evaluated to understand airborne dispersal and surface deposition behavior for simulants. Field tests performed by Naval Surface Warfare Center, Dahlgren Division indicate that less than 1 percent of unvaporized liquid falls out on water surfaces. Testing conducted at the Potomac River Test Range showed surface deposition rates of 0.08 percent for glacial acetic acid and 0.35 percent for triethyl phosphate (Driscoll et al. 2004). Maximum water concentrations calculated were 7 parts per billion for glacial acetic acid, and 76 parts per billion for triethyl phosphate using a 0.1 meter mixing depth (Neil 2013).

Additional modeling and testing performed in 2003, 2005, and 2009 showed no impacts from the testing of chemical simulants. There were no observable environmental effects during or after testing (Organization for Economic Cooperation and Development 2005; U.S. Department of the Navy 2009). Based on all these findings, chemical simulants would not have measurable environmental impacts and will not be considered further.

3.1.3.3.6.3 Biological Simulants

Biological simulants are microorganisms that exhibit qualities similar to actual biological threat agents but do not present threats to human health. Biosafety Level 1 organisms are proposed for use as simulants. Because they rarely cause reactions or diseases, Biosafety Level 1 organisms are commonly used in high school and introductory college teaching laboratories. Examples of Biosafety Level 1 organisms are *Lactobacillus acidophilus,* which is used to turn milk into yogurt, and *Neurospora crassa*, a bread mold, which is used for genetic studies because its simple genome has been completely sequenced. All tests would be conducted in accordance with local, state, and federal regulations. Testing activities would use the following Biosafety Level 1 organisms, or something comparable, as simulants:

- Spore-forming bacteria: *Bacillus atrophaeus* (formerly known as *Bacillus globigii), Bacillus subtilis*, and *Bacillus thuringiensis*
- Non-spore-forming bacteria*: Pantoea agglomerans (*formerly known as *Erwinia herbicola)* and *Deinococcus radiodurans*
- The protein ovalbumin
- MS2 bacteriophages
- The fungus *Aspergillus niger*

These biological simulants are described below. Biological simulants would be applied as an aerosol and the amount of simulant used would be the minimum amount necessary to obtain the desired results, up to approximately 11 lb. (5 kg) dry weight per simulant per day.

Spore-Forming Bacteria: Bacillus atrophaeus, Bacillus subtilis, and Bacillus thuringiensis. *Bacillus* species produce an endospore, which is a dormant, tough, non-reproductive structure that allows the bacteria to survive through periods of environmental stress such as extreme heat and desiccation (U.S. Environmental Protection Agency 1997). Under most conditions *Bacillus* are not biologically active but exist in endospore form. The endospores are ubiquitous in soil and rocks and are easily dispersed by wind and water (Moeller et al. 2004). *Bacillus* species are also commonly found in dust, air, water, and on wet surfaces throughout the world (Center for Research Information Inc. 2004). They generally occur at population levels of 10 to 100 per gram of soil (Alexander 1977). However, concentrations of *Bacillus* occurring naturally in the desert have been measured at 100,000 spores per gram of surface soil (United States Army 2003). Benign species of *Bacillus* are used to simulate the toxic spore-forming bacterium, *Bacillus anthracis*, commonly known as anthrax. *Bacillus subtilis* and similar *Bacillus* species are common in the environment and are uncommon causes of disease to healthy individuals (Department of Defense 2003).

Bacillus atrophaeus produces its own toxins and can sicken people whose immune systems have been compromised. Human infection by *Bacillus atrophaeus* primarily results from deep incisions in the skin, such as penetrating injuries, surgical procedures, catheters and intravenous lines, or a debilitated health state. Infections are usually treated with antibiotics (Blue et al. 1995). Cases of long-term persistence or recurrence of extended latency have not been found. However, based on a recent reevaluation of *Bacillus atrophaeus*, it is now considered a pathogen for humans (Center for Research Information Inc. 2004).

Bacillus thuringiensis is a naturally occurring bacterial disease of insects and is used as an active ingredient in some insecticides. Several strains of *Bacillus thuringiensis* can infect and kill lepidopterans (moths, butterflies, and caterpillars) by producing proteins that react with the cells of the gut lining of susceptible insects and paralyze the digestive system. Infected insects generally die from starvation, which can take several days. The most commonly used strain of *Bacillus thuringiensis* (*kurstaki* strain) kills only leaf- and needle-feeding caterpillars. Among the various strains, insecticidal activity is specific to the target insect group, and *Bacillus thuringiensis* is considered safe to people and nontarget species. Some formulations are considered safe to be used on food crops (Cranshaw 2006).

Because the *Bacillus* species proposed for use are ubiquitous in the environment, the releases expected from activities would not increase *Bacillus* populations in the environment.

Non-Spore-Forming Bacteria: Pantoea agglomerans and Deinococcus radiodurans. *Pantoea agglomerans* is a gram-negative, rod-shaped bacterium associated with plants. No adverse human health effects associated with *Pantoea agglomerans* have been observed through data reports submitted to USEPA or public literature. Based on available data and its low toxicological significance, USEPA classifies *Pantoea agglomerans* (strain E325) as having the lowest toxicity level, toxicity category IV (U.S. Environmental Protection Agency 2006). Toxicity categories for pesticide products range from toxicity category I, for products that are considered highly toxic or severely irritating, to toxicity category IV, for products that are practically non-toxic and non-irritating.

Deinococcus radiodurans is a gram-positive extremophilic bacterium – an organism that thrives in physically or geochemically extreme conditions. It is one of the most radioresistant (resistant to radiation) organisms known and can survive conditions that include cold, dehydration, vacuum, and acid (DeWeerdt 2002). While *Deinococcus radiodurans* is quite hardy, it is a relatively weak competitor. It is not considered a human pathogen and a *Deinococcus*-related bacterium has been found living inside the human stomach (Bik et al. 2006).

Ovalbumin. Ovalbumin is a glycoprotein (a conjugated protein having a carbohydrate as the nonprotein component). It is the main protein found in egg white and is used as a key reference protein for immunization and *biochemical* studies. It can also be used to simulate protein toxins such as ricin – a protein extracted from the castor bean (*Ricinus communis*) – and botulinum toxin – a potent neurotoxic protein produced by the bacterium *Clostridium botulinum* (O'Connell et al. 2002). Ovalbumin is commonly consumed in food products and used as a medium to grow vaccines.

Bacteriophage MS2. Bacteriophage MS2 (family *Leviviridae*) is a small, icosahedral, bacteriophage of *Escherichia coli,* a bacterium commonly found in the intestine of warm-blooded animals, including humans. A bacteriophage is a virus that infects bacteria. MS2 are ubiquitous and are found in places populated by their bacterial hosts such as soil or the intestines of animals. The small size of MS2, its simple structure, its ribonucleic acid genome, and harmlessness to humans, animals, plants, and other higher organisms, make it a useful simulant for deadly small ribonucleic acid viruses such as Ebola virus (*Ebolavirus*), Marburg virus (*Marburgvirus*), and smallpox (*Variola major* and *Variola minor*). MS2 is used in place of pathogenic viruses in a wide variety of studies that range from the testing of compounds for disinfecting surfaces to studying the environmental fate and transport of pathogenic viruses in groundwater (O'Connell et al. 2006).

***Aspergillus niger*.** The fungus *Aspergillus niger* is one of the most common species of the genus *Aspergillus*. It causes a disease called black mold on certain fruits and vegetables such as grapes, onions, and peanuts, and is a common contaminant of food. It is ubiquitous in soil and is commonly reported in indoor environments. It is widely used in biotechnology and has been in use for many decades to produce extracellular (food) enzymes and citric acid (Schuster E. et al. 2002).

Aspergillus niger is less likely to cause human disease than some other *Aspergillus* species but, if large amounts of spores are inhaled, a serious lung disease, aspergillosis, can occur. Since *Aspergillus* is so common in the environment, most people breathe in *Aspergillus* spores every day (Centers for Disease Control and Prevention 2008). The spores do not harm people with healthy immune systems, but individuals with compromised immune systems breathing in many spores (such as in a very dusty environment) may become infected. Schuster et al. concluded that with appropriate safety precautions, *Aspergillus niger* is a safe production organism.

3.1.3.3.6.4 Biological Simulant Safety

All the proposed biological simulants that would potentially be used are considered Biosafety Level 1 organisms and would be dispersed in the air, with the potential for subsequent deposition of some smaller portion of the simulant onto the water surface. Biosafety Level 1 represents the basic level of protection and is appropriate for working with microorganisms that are not known to cause disease in normal healthy humans (Centers for Disease Control and Prevention and National Institutes of Health 2007). Based on these findings, biological simulants would not have environmental impacts and will not be considered further.

3.1.3.3.7 Approach to Analysis

Most testing activities related to the chemical and biological simulants discussed above would be conducted more than 3 nm offshore in each range complex. These activities would be subject to federal sediment and water quality standards and guidelines. The areas within each complex represent the region across which the chemicals discussed would be distributed. For properly functioning expended materials, the term “local” refers to the volume of water that each self-propelled subsurface training and testing material passes through. In these situations, impacts would be to water quality from combustion byproducts. For lost and malfunctioning expended material, the term “local” refers to a small zone around noncombusted propellant in sediment, perhaps a centimeter or two, and a smaller area if directly exposed to seawater.

State and federal standards and guidelines. No state or federal sediment and water quality standards or guidelines exist that are specific to the chemical and biological simulants discussed above.

3.1.3.3.8 Impacts from Chemicals Other than Explosives

The following sections discuss the potential impact on sediment and water quality from solid-fuel propellants for missiles and rockets, Otto Fuel II torpedo propellant, and combustion byproducts.

3.1.3.3.8.1 Solid-Fuel Propellants

The failure rate of rockets is 3.8 percent (Rand Corporation 2005; U.S. Army Corps of Engineers 2007). The remaining solid propellant fragments (i.e., one percent or less of the initial propellant weight) sink to the ocean floor and undergo physical and chemical changes in contact with sediment and seawater. Tests show that water penetrates about 0.06 in. (0.14 cm) into the propellant during the first 24 hours of immersion, and that fragments slowly release ammonium and perchlorate ions (Fournier and Brady 2005). These ions would disperse into the surrounding seawater, so local concentrations would be low. For example, a standard missile with 150 lb. (68 kg) of solid propellant would generate less than 1.5 lb. (0.7 kg) of propellant residue after completing its flight. If all the propellant deposited on the ocean floor were in the form of 4-in. (10-cm) cubes, about 0.42 percent of the propellant would be wetted during the first 24 hours of immersion. If all the ammonium perchlorate leached out of the wetted propellant, then approximately 0.01 lb. (0.005 kg) would enter the surrounding seawater (U.S. Department of the Navy 2008b). This leach rate would decrease over time as the concentration of perchlorate in the propellant declined. The aluminum in the binder would be converted to aluminum oxide by seawater.

Perchlorate. Ammonium perchlorate accounts for 50 to 85 percent of solid propellant by weight (Missile Technology Control Regime 1996). Perchlorates are highly soluble and stable in water. According to the Agency for Toxic Substances and Disease Registry (2008), perchlorate “does not readily bind to soil particles or to organic matter, and does not readily form ionic complexes with other materials in solution.” Because of these characteristics, perchlorate is highly mobile in soil and does not readily leave solution through chemical precipitation. Thus, perchlorate has the potential to affect sediment and water quality because of its persistence in the environment.

Natural sources of perchlorate include Chilean caliche ore (U.S. Environmental Protection Agency 2008d) and ozone oxidation of atmospheric chlorine (Petrisor and Wells 2008). Martinelango (2006) stated that perchlorate was present in seawater at levels ranging from less than 0.07 µg/L to 0.34 µg/L (0.07 to 0.34 ppb). Studies indicate that it may accumulate in living organisms, such as fish and plants (Agency for Toxic Substances and Disease Registry 2008). Toxicity in plants and microbes is thought to be due to negative impacts on metabolic enzymes (van Wijk and Hutchinson 1995). Research by Martinelango

(2006) found that perchlorate can concentrate in marine algae from 200 to 5,000 times, depending on the species. Chaudhuri et al. (2002) noted that several species of microbes are capable of metabolizing chlorate and perchlorate. The end product is chloride. Logan et al. (2001) used sediment samples from a variety of marine and saline environments to demonstrate that microbial perchlorate reduction can occur in saline solutions greater than 3 percent. Seawater salinity is about 3.5 percent. The organism responsible for the perchlorate reduction was not identified in the study. However, Okeke et al. (2002) identified three species of halophilic ("salt-loving") bacteria that biodegrade perchlorate. The USEPA has established a drinking water standard for perchlorate, but no standards or guidelines have been established for perchlorate in marine systems.

Polyesters. Regarding other solid-fuel components, marine microbes and fungi are known to degrade biologically produced polyesters, such as polyhydroxyalkanoates, a bacterial carbon and energy source (Doi et al. 1992). These organisms are also capable of biodegrading other synthetic polymers, although at slower rates (Shah et al. 2008). The chemical structure of natural rubber is similar to that of polybutadiene (Tsuchii and Tokiwa 2006). Thus, although no specific studies were found that documented biodegradation of polybutadiene in marine ecosystems, the prospects seem likely based on the findings of researchers such as Tsuchii and Tokiwa (2006).

Nitriles. Nitriles are cyanide-containing organic compounds that are both natural and man-made. Several species of marine bacteria are capable of metabolizing acrylonitrile (Brandao and Bull 2003). Given that productivity of marine ecosystems is most often limited by available nitrogen (Vitousek and Howarth 1991), biodegradation of nitrate esters and nitrated plasticizers in the marine environment seems likely.

3.1.3.3.8.2 Otto Fuel II and Combustion Byproducts

Microbial degradation of the main components of Otto Fuel II (propylene glycol dinitrate and nitro-diphenylamine) has been demonstrated (Sun et al. 1996; Walker and Kaplan 1992). Although these studies did not involve marine microbes, other studies demonstrated that marine bacteria in anaerobic sediment were able to degrade 2-nitrodiphenylamine (Drzyzga and Blotevogel 1997; Powell et al. 1998). According to the Agency for Toxic Substances and Disease Registry (1995), 2-nitrodiphenyl-amine tends to bind to sediment and does not bioaccumulate in aquatic organisms and is not likely to biomagnify in the environment. The agency indicated that dibutyl sebacate "is readily degraded by environmental bacteria and fungi" (Agency for Toxic Substances and Disease Registry 1995).

Combustion byproducts from Otto Fuel II released into the ocean will dissolve, dissociate, or be dispersed and diluted in the water column. Except for hydrogen cyanide, combustion byproducts are not a concern (U.S. Department of the Navy 1996a, b) for the reasons detailed below:

- Most Otto Fuel II combustion products such as carbon dioxide, nitrogen, methane, and ammonia occur naturally in seawater;
- Several of the combustion products are bioactive. Nitrogen is converted into nitrogen compounds through nitrogen fixation by certain cyanobacteria, providing nitrogen sources and essential micronutrients for marine phytoplankton. Carbon dioxide and methane are integral parts of the carbon cycle in the oceans, and are taken up by many marine organisms;
- Carbon monoxide and hydrogen have low solubility in seawater and excess gases bubble to the surface;

- Trace amounts of oxides of nitrogen may be present, but they are usually below detectable limits. Oxides of nitrogen in low concentrations are not harmful to marine organisms and are a micronutrient source of nitrogen for aquatic plant life; and
- Ammonia can be toxic to marine organisms in high concentrations, but releases from the combustion of Otto Fuel II are quickly diluted to insignificant concentrations.

Hydrogen cyanide does not normally occur in seawater. Major releases of cyanide to water are from metal-finishing industries, iron and steel mills, and organic chemical industries (U.S. Environmental Protection Agency 1981). At high concentrations, cyanide can pose a risk to both humans and marine biota. Compared to recommendations of the USEPA of 1.0 µg/L (1.0 ppb) (U.S. Environmental Protection Agency 2010), hydrogen cyanide released from MK 48 torpedoes would result in ambient concentrations ranging from 140 to 150 µg/L (140 to 150 ppb) (U.S. Department of the Navy 1996b), well above the recommended levels. However, because hydrogen cyanide is soluble in seawater, it would be diluted to less than 1 µg/L (1.0 ppb) within a distance of 18 ft. (5.4 m) from the center of the torpedo's path when first discharged. Additional dilution would occur thereafter.

Approximately 30,000 exercise tests of the MK 48 torpedo have been conducted over the last 25 years. Most of these launches have been on Navy test ranges, where there have been no reports of harmful impacts on water quality from Otto Fuel II or its combustion products. Furthermore, U.S. Navy studies conducted at torpedo test ranges that have lower flushing rates than the open ocean did not detect residual Otto Fuel II in the marine environment (U.S. Department of the Navy 1996a, b).

3.1.3.3.8.3 Operational Failure – Torpedoes, Missiles, and Rockets

Some materials are recovered after use, such as torpedoes. However, sometimes these recoverable items are lost or they fail to perform correctly. For instance, the failure rate of rockets is 3.8 percent (Rand Corporation 2005; U.S. Army Corps of Engineers 2007). Corrosion of munitions in the marine environment is discussed in more detail in Section 3.1.3.2 (Metals).

3.1.3.3.9 Evaluation of Alternatives

Table 3.1-28 summarizes the types and numbers of military expended materials that contain chemicals other than explosives for all alternatives. The numbers represent amounts expended annually for each type of material under each alternative. The types and amounts of military expended materials in the table were drawn from the tables in Chapter 2 (Description of Proposed Action and Alternatives).

Table 3.1-28: Numbers of Military Expended Materials that Contain Chemicals Other than Explosives – All Alternatives Annually

Type of Military Expended Material	Chemical Component	No Action Alternative	Alternative 1	Alternative 2
Missiles	Solid fuel propellants			
Training		456	494	494
Testing		151	800	881
Total		607	1,294	1,375
Rockets	Solid fuel propellants			
Training		3,700	7,980	7,980
Testing		377	2,761	3,037
Total		4,077	10,741	11,017
Torpedoes	Otto Fuel II			
Training		1	1	1
Testing		12	42	45
Total		13	43	46
Expendable Subsurface Targets	Otto Fuel II			
Training		1,621	2,306	2,306
Testing		133	766	862
Total		1,754	3,072	3,168

The following sections evaluate each alternative in terms of the information provided in Sections 3.1.3.3.7 (Approach to Analysis) and 3.1.3.3.8 (Impacts from Chemicals Other than Explosives). Potential impacts on sediment and water quality from chemicals other than explosives should be viewed in the following context: (1) nearshore sediment and water quality in many areas have been negatively impacted; in particular, a wide variety of chemicals are delivered to the ocean by major river systems; and (2) the majority of those impacts are from human-generated and land-based activities. The numbers of military expended materials discussed below reflect amounts expended annually for each type of material under each alternative.

3.1.3.3.9.1 No Action Alternative

Under the No Action Alternative, 6,451 pieces of military expended materials that contain chemicals other than explosives. Of these materials, 63 percent are rockets and 27 percent are expendable subsurface targets.

Training Activities. Under the No Action Alternative, numerically, training activities would represent 90 percent of military expended materials that contain chemicals other than explosives. Of these training materials, rockets would comprise 64 percent, all of which would be used in the VACAPES Range Complex. Expendable subsurface targets comprise 28 percent of training materials. Half of such targets would be used in the JAX Range Complex, and another 47 percent would be used in three locations: the Northeast Range Complex, VACAPES Range Complex, and the Navy Cherry Point Range Complex.

Testing Activities. Under the No Action Alternative, numerically, testing activities would represent 10 percent of materials using chemicals other than explosives. Rockets would comprise 56 percent of these materials and would be tested in two range complexes: VACAPES (70 percent) and JAX (30 percent). Expendable subsurface targets would comprise 20 percent of testing materials, of which 85 percent would be tested in three range complexes or testing ranges: VACAPES (53 percent), JAX (20 percent), and the Naval Undersea Warfare Center Division, Newport Testing Range (12 percent). Testing activities are described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Table 2.8-2 and Table 2.8-3.

Summary of Impacts from Chemicals Other than Explosives

Under the No Action Alternative, impacts on sediment and water quality associated with training and testing activities involving chemical other than explosives would be short-term and local with properly functioning materials, and long-term and local with lost or malfunctioning materials.

For properly functioning materials, chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Impacts would be minimal for the following reasons: (1) the size of the area in which expended materials would be distributed is large; (2) the majority of propellant combustion byproducts are benign, while those of concern would be diluted to below detectable levels within a short time; (3) most propellants are consumed during normal operations; (4) the failure rate is low for such expended materials; and (5) most of the constituents of concern are biodegradable by various marine organisms or by physical and chemical processes common in marine ecosystems.

For lost or malfunctioning expended materials, chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Impacts would be minimal for the following reasons: (1) the size of the area in which expended materials would be distributed is large; (2) the majority of propellants (99 percent) are consumed during normal operations and the failure rate is low, so quantities of unused propellants would be low; and (3) studies indicate that most of the constituents of concern are biodegradable by various marine organisms or by physical and chemical processes common in marine ecosystems. Neither state nor federal standards or guidelines would be exceeded.

3.1.3.3.9.2 Alternative 1

Under Alternative 1, military expended materials that contain chemicals other than explosives would increase from 6,451 to 15,150 (235 percent). Of these materials, 71 percent would be rockets (63 percent under the No Action Alternative) and 20 percent would be expendable subsurface targets (27 percent under the No Action Alternative).

Training Activities. Under Alternative 1, numerically, training materials would represent 71 percent of the military expended materials that contain chemicals other than explosives (89 percent under the No Action Alternative). These training materials would increase from 5,778 to 10,781 (71 percent compared to 90 percent for the No Action Alternative). Rockets would comprise 74 percent of these training materials (64 percent under the No Action Alternative), of which nearly half (48 percent) would be used in the VACAPES Range Complex (100 percent under the No Action Alternative) and nearly half (48 percent) in the JAX Range Complex (0 percent under the No Action Alternative). Expendable subsurface targets comprise 21 percent of these training materials (28 percent under the No Action Alternative), most of which would be used in the JAX Range Complex (63 percent; 50 percent under the No Action Alternative).

Testing Activities. Under Alternative 1, numerically, testing activities would represent 28 percent of all materials using chemicals other than explosives (10 percent under the No Action Alternative).

Testing of these materials would increase from 673 to 4,369 (649 percent increase) compared to the No Action Alternative. Specifically,

- Missile testing would increase from 151 to 800 events. Nearly all of this activity (98 percent) would occur in two range complexes: VACAPES (86 percent; 88 percent under the No Action Alternative) and JAX (12 percent; 7 percent under the No Action Alternative).
- Rocket testing would increase from 377 to 2,761 events. All of that activity would occur in two range complexes: VACAPES (75 percent; 70 percent under the No Action Alternative) and JAX (25 percent; 30 percent under the No Action Alternative).
- Torpedo testing would increase from 12 to 42 events. Much of this activity (81 percent) would occur in two locations: the VACAPES Range Complex (67 percent; 17 percent under the No Action Alternative); and the JAX Range Complex (14 percent; 17 percent under the No Action Alternative).
- Testing of expendable subsurface targets would increase from 133 to 766 events. Most of this activity (94 percent) would occur in three locations: the VACAPES Range Complex (56 percent; 53 percent under the No Action Alternative), Naval Undersea Warfare Center Division, Newport Testing Range (14 percent; 12 percent under the No Action Alternative), and the JAX Range Complex (24 percent; 20 percent under the No Action Alternative).

Testing activities are described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Tables 2.8-2 and 2.8-3.

Summary of Impacts from Chemicals Other than Explosives

Under Alternative 1, although training and testing with materials using chemicals other than explosives would increase compared to the No Action Alternative, the impacts are judged to be similar to the No Action Alternative for the reasons enumerated under the No Action Alternative. Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Neither state nor federal standards or guidelines would be exceeded.

3.1.3.3.9.3 Alternative 2 (Preferred Alternative)

Under Alternative 2, military expended materials that contain chemicals other than explosives would increase for training and testing from 6,451 to 15,606 (242 percent) over the No Action Alternative. Of these materials, 71 percent would be rockets (63 percent under the No Action Alternative) and 20 percent would be expendable subsurface targets (27 percent under the No Action Alternative).

Training Activities. Under Alternative 2, numerically, military expended materials from training would represent 71 percent of military expended materials that contain chemicals other than explosives (90 percent under the No Action Alternative). These training materials would increase from 5,778 to 10,781 (187 percent increase over the No Action Alternative). Rockets would comprise 74 percent of training materials (64 percent under the No Action Alternative, of which nearly half (48 percent) would be used in the VACAPES Range Complex (100 percent under the No Action Alternative) and nearly half (48 percent) in the JAX Range Complex (0 percent under the No Action Alternative). Expendable subsurface targets comprise 21 percent of these training materials (28 percent under the No Action

Alternative), most of which would be used in the JAX Range Complex (65 percent; 51 percent under the No Action Alternative).

Testing Activities. Under Alternative 2, military expended materials from testing activities represent 31 percent of all military expended materials that contain chemicals other than explosives (10 percent under the No Action Alternative). Testing of these materials would increase from 673 to 4,825 items (717 percent increase) compared to the No Action Alternative. Changes relative to the No Action Alternative are similar to those noted under Alternative 1. Specifically,

- Missile testing would increase from 151 to 881 events. Nearly all of this activity (97 percent) would occur in two range complexes: VACAPES (86 percent) and JAX (11 percent).
- Rocket testing would increase from 377 to 3,037 events. All of that activity would occur in two range complexes: VACAPES (75 percent) and JAX (25 percent).
- Torpedo testing would increase from 12 to 45 events. A majority of this activity (83 percent) would occur in two locations: the VACAPES Range Complex (67 percent); and the JAX Range Complex (16 percent).
- Testing of expendable subsurface targets would increase from 133 to 862 events. Most of this activity (93 percent) would occur in three locations: the VACAPES Range Complex (55 percent), Naval Undersea Warfare Center Division, Newport Testing Range (15 percent), and the JAX Range Complex (23 percent).

Testing activities are described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Tables 2.8-2 and 2.8-3.

Summary of Impacts from Chemicals Other than Explosives

Under Alternative 2, although military expended materials that contain chemicals other than explosives would increase for training and testing activities compared to the No Action Alternative, the impacts are judged to be similar to the No Action Alternative for the reasons enumerated under the No Action Alternative. Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Neither state nor federal standards or guidelines would be exceeded.

3.1.3.4 Other Materials

3.1.3.4.1 Introduction

In the Proposed Action, other materials include marine markers and flares, chaff, towed and stationary targets, and miscellaneous components of other materials. These materials and components are made mainly of nonreactive or slowly reactive materials (e.g., glass, carbon fibers, and plastics) or they break down or decompose into benign byproducts (e.g., rubber, steel, iron, and concrete). Most of these objects would settle to the sea floor where they would: (1) be exposed to seawater; (2) become lodged in or covered by sea floor sediment; (3) become encrusted by chemical processes such as rust; (4) slowly dissolve; or (5) be covered by marine organisms such as coral. Plastics may float or descend to the bottom, depending on their buoyancy. Markers and flares are largely consumed during use.

Steel in ordnance normally contains a variety of metals, some of potential concern. However, these other metals are present in low quantities (1 to 5 percent of content) such that steel is not generally considered a potential source of metal contamination. Metals are discussed in more detail in Section 3.1.3.2. Various chemicals and explosives are present in small amounts (mostly as components of flares and markers), but are not considered likely to cause negative impacts. Chemicals other than explosives are discussed in more detail in Section 3.1.3.3, and explosives and explosion byproducts are discussed in more detail in Section 3.1.3.1.

The next sections provide the following overview:

- Sections 3.1.3.4.2, 3.1.3.4.3, and 3.1.3.4.4 provide more detail concerning marine markers, flares, and chaff;
- Section 3.1.3.4.5 discusses how these other materials described above are evaluated under each alternative;
- Section 3.1.3.4.6 reviews information regarding the behavior and potential negative impacts of those materials on sediment and water quality; and
- Section 3.1.3.4.7 evaluates each alternative in terms of the information in Sections 3.1.3.4.5 and 3.1.3.4.6.

Note: Towed and stationary targets include floating steel drums, towed aerial targets, the trimaran, and inflatable, floating targets. Potential impacts from floating steel drums are considered as part of the analysis of non-explosive practice munitions. The trimaran is a three-hulled boat with a four-foot-square sail that is towed as a moving target. Large, inflatable, plastic targets can be towed or left stationary. Towed aerial targets are either: (1) rectangular pieces of nylon fabric 7.5 ft. by 40 ft. (2.3 m by 12.2 m) that reflects radar or lasers; or (2) aluminum cylinders with a fiberglass nose cone, aluminum corner reflectors (fins), and a short plastic tail section. This second target is about 10 ft. long (3 m) and weighs about 75 lb. (34 kg). These four targets are recovered after use and will not be considered further.

3.1.3.4.2 Marine Markers and Flares

Marine markers are pyrotechnic devices dropped on the water's surface during training exercises to mark a position on the ocean surface for search and rescue activities, or as bomb targets. The MK-58 marker is a tin tube that weighs about 12 lb. (5.4 kg). Markers release smoke at the water surface for 40 to 60 minutes. After the pyrotechnics are consumed, the marine marker fills with seawater and sinks. Iron and aluminum constitute 35 percent of the marker weight. To produce the lengthy smoke effect, approximately 40 percent of the marker weight is made up of pyrotechnic materials. The propellant, explosive, and pyrotechnic constituents of the MK-58 include red phosphorus 2.19 lb. (1 kg) and manganese (IV) dioxide 1.40 lb. (0.6 kg). Other constituents include magnesium powder (0.29 lb. [0.1 kg]), zinc oxide (0.12 lb. [0.05 kg]), nitrocellulose (0.000017 lb. [0.008 g]), nitroglycerin (0.000014 lb. [0.006 g]), and potassium nitrate (0.2 lb. [0.09 kg]). The failure rate of marine markers is five percent (U.S. Department of the Navy 2010b).

Flares are used for signaling, nighttime illumination of surface areas in search and attack operations, and to assist with search and rescue activities. They range in weight from 12 to 30 lb. (5.4 to 14 kg). The major constituents of flares include magnesium granules and sodium nitrate. Containers are constructed of aluminum, and the entire assembly is usually consumed during flight. Flares may also contain a primer such as TNT, propellant (ammonium perchlorate), and other explosives. These materials are present in small quantities (e.g., 1.0×10^{-4} ounces of ammonium perchlorate and 1.0×10^{-7} ounces of explosives). Small amounts of metals are used to give flares and other pyrotechnic materials bright and distinctive colors. Combustion products from flares include magnesium oxide, sodium carbonate, carbon dioxide, and water. Illuminating flares and marine markers are usually entirely consumed during use; neither is intended to be recovered. Table 3.1-29 summarizes the components of markers and flares (U.S. Department of the Navy 2010b).

Table 3.1-29: Summary of Components of Marine Markers and Flares

Flare or Marker	Constituents
LUU-2 Paraflare	Magnesium granules, sodium nitrate, aluminum, iron, TNT, royal demolition explosive, ammonium perchlorate, potassium nitrate, lead, chromium, magnesium, manganese, nickel
MK 45 Paraflare	Aluminum, sodium nitrate, magnesium powder, nitrocellulose, TNT, copper, lead, zinc, chromium, manganese, potassium nitrate, pentaerythritol tetranitrate, nickel, potassium perchlorate
MK-58 Marine Marker	Aluminum, chromium, copper, lead, lead dioxide, manganese dioxide, manganese, nitroglycerin, red phosphorus, potassium nitrate, silver, zinc, zinc oxide

3.1.3.4.3 Chaff

Chaff consists of small, thin glass fibers coated in aluminum that are light enough to remain in the air anywhere from 10 minutes to 10 hours. Chaff is an electronic countermeasure designed to confuse enemy radar by deflecting radar waves and thereby obscuring aircraft, ships, and other equipment from radar tracking sources. Chaff is typically packaged in cylinders approximately 6 in. x 1.5 in. (15 cm x 4 cm) that weigh about 5 ounces (140 g) and contain a few million fibers. Chaff may be deployed from an aircraft or may be launched from a surface vessel.

The chaff fibers are approximately the thickness of a human hair (generally 25.4 microns in diameter), and range in length from 0.3 to 2 in. (0.75 to 5 cm). The major components of the chaff glass fibers and the aluminum coating are provided in Table 3.1-30 (U.S. Air Force 1994).

Table 3.1-30: Major Components of Chaff

Component	Percent by Weight
Glass Fiber	
Silicon dioxide	52–56
Alumina	12–16
Calcium oxide, magnesium oxide	16–25
Boron oxide	8–13
Sodium oxide, potassium oxide	1–4
Iron oxide	≤ 1
Aluminum Coating	
Aluminum	99.45 (min.)
Silicon and Iron	0.55 (max.)
Copper	0.05
Manganese	0.05
Zinc	0.05
Vanadium	0.05
Titanium	0.05
Others	0.05

"≤" means less than or equal to
min.: minimum; max.: maximum

3.1.3.4.4 Additional Examples of Other Materials

Miscellaneous components of other materials include small parachutes used with sonobuoys and flares; nylon cord, plastic casing, and antenna float used with sonobuoys; natural and synthetic rubber, carbon, or Kevlar® fibers used in missiles; and plastic end-caps and pistons used in chaff cartridges.

3.1.3.4.5 Approach to Analysis

Most activities involving military expended materials composed of the other materials discussed above would be conducted more than 3 nm offshore in each range complex. Most of the components of other materials are benign. In the analysis of alternatives, "local" refers to the area in which the material comes to rest.

State and federal standards and guidelines. No state or federal sediment and water quality standards or guidelines exist that are specific to major components of other materials discussed above.

3.1.3.4.6 Impacts from Other Materials

The rate at which other materials deteriorate in marine environments depends on the material and conditions in the immediate marine and benthic environment. Usually when buried deep in ocean sediment, materials tend to decompose at lower rates than when exposed to seawater (Ankley 1996). With the exception of plastic parts, sediment burial appears to be the fate of most ordnance used in marine warfare (Canadian Forces Maritime Experimental and Test Ranges 2005). The behavior of these other materials in marine systems is discussed in more detail below.

3.1.3.4.6.1 Marine Markers and Flares

Most of the pyrotechnic components of marine markers are consumed and released as smoke in the air. Thereafter, the aluminum and steel cartridge sink to the bottom. Combustion of red phosphorus produces phosphorus oxides, which have a low toxicity to aquatic organisms. The amount of flare residue is insignificant. Phosphorus contained in the marker settles to the sea floor, where it reacts with the water to produce phosphoric acid until all phosphorus is consumed by the reaction. Phosphoric acid is a variable, but normal, component of seawater (U.S. Department of the Navy 2006). The aluminum and iron cartridges are expected to be covered by sand and sediment over time, become encrusted by chemical corrosion, or covered by marine plants and animals. Elemental aluminum in seawater tends to be converted by hydrolysis to aluminum hydroxide, which is relatively insoluble, and adheres to particulates and transported to the bottom sediment (Monterey Bay Research Institute 2010).

Red phosphorus, the primary pyrotechnic ingredient, constitutes 18 percent of the marine marker weight. Toxicological studies of red phosphorus revealed an aquatic toxicity in the range of 10 to 100 mg/L (10 to 100 ppm) for fish, *Daphnia* (a small aquatic crustacean), and algae (European Flame Retardants Association 2002). Red phosphorus slowly degrades by chemical reactions to phosphine and phosphorus acids. Phosphine is very reactive and usually undergoes rapid oxidation (California Environmental Protection Agency 2003). The final products, phosphates, are harmless (U.S. Department of the Navy 2010b). A study by the U.S. Air Force (1997) found that, in salt water, the degradation products of flares that do not function properly include magnesium and barium.

3.1.3.4.6.2 Chaff

Chaff can remain suspended in air from 10 minutes to 10 hours and can travel considerable distances from its release point (Arfsten et al. 2002; U.S. Air Force 1997). Factors influencing chaff dispersion include the altitude and location where it is released, prevailing winds, and meteorological conditions (Hullar et al. 1999). Doppler radar has tracked chaff plumes containing approximately 31.8 ounces (900 grams) of chaff drifting 200 mi. (322 km) from the point of release with the plume covering a volume of greater than 400 $mi.^3$ (1,666 km^3) (Arfsten et al. 2002). Based on the dispersion characteristics of chaff, large areas of open water would be exposed to chaff, but the chaff concentrations would be low. For example, Hullar et al. (1999) calculated that an area 4.97 mi. by 7.46 mi. (37.1 $mi.^2$ or 28 nm^2) would be affected by deployment of a single cartridge containing 5.3 ounces (150 grams) of chaff. The resulting chaff concentration would be about 5.4 g/nm^2. This concentration corresponds to less than 179,000 $fibers/nm^2$ or less than 5 fibers per 1,000 $ft.^2$ (52.2 $fibers/m^2$), assuming that each cartridge contains five million fibers.

Chaff is generally resistant to chemical weathering and likely remains in the environment for long periods. However, all components of chaff’s aluminum coating are present in seawater in trace amounts except magnesium, which is present at 0.1 percent (Nozaki 1997). Aluminum and silicon are the most common minerals in the earth’s crust as aluminum oxide (Al_2O_3) and silicon dioxide (SiO_2), respectively. Aluminum itself is the most common metal in the earth’s crust and is a trace element in natural waters. Since ocean waters are constantly exposed to crustal materials, there is little reason to believe that the addition of small amounts of chaff from a release would have any impact on either water or sediment composition (Hullar et al. 1999).

The dissolved concentration of aluminum in seawater ranges from 1 to 10 µg/L (1 to 10 ppb). For comparison, the concentration in rivers is 50 µg/L (50 ppb). In the ocean, concentrations tend to be higher on the surface, low at middle depths, and higher again at the bottom (Li et al. 2008). Aluminum is a very reactive element and is seldom found as the free metal in nature except under highly acidic (low pH) or alkaline (high pH) conditions. It is found combined with other elements, most commonly with oxygen, silicon, and fluorine. These chemical compounds are commonly found in soil, minerals, rocks, and clays (Agency for Toxic Substances and Disease Registry 2008; U.S. Air Force 1994). Elemental aluminum in seawater tends to be converted by hydrolysis to aluminum hydroxide, which is relatively insoluble, and is scavenged by particulates and transported to bottom sediment (Monterey Bay Research Institute 2010).

Because of their light weight, chaff fibers tend to float on the water surface for a time. The fibers are quickly dispersed by waves and currents. They may be accidentally or intentionally ingested by marine life, but the fibers are nontoxic. Chemicals leached from the chaff will be diluted by the surrounding seawater, reducing the potential for chemical concentrations reaching levels that can affect sediment quality and benthic habitats.

In a report by Systems Consultants, Inc. (1977), chaff samples were placed in Chesapeake Bay water for 13 days. No increases greater than 1 ppm of aluminum, cadmium, copper, iron, and zinc were detected. Given that no ongoing mixing was occurring in this experiment, accumulation and concentration of chaff constituents is not likely under natural conditions. In a U.S. Air Force study of chaff, nine elements were analyzed under various pH conditions: silicon, aluminum, magnesium, boron, copper, manganese, zinc, vanadium, and titanium. Only four were detected above the 0.02 mg/L (0.02 ppm) detection limit: magnesium, aluminum, zinc, and boron (U.S. Air Force 1994). In tests of marine organisms, no negative impacts from chaff exposure were found at levels in excess of those likely to be encountered in the Study Area (Farrell and Siciliano 2007; Systems Consultants 1977).

3.1.3.4.6.3 Additional Components of Other Materials

The majority of components of other materials are plastics. Although plastics are resistant to degradation, they do gradually breakdown into smaller particles due to sunlight and mechanical wear (Law et al. 2010). The fate of plastics that sink beyond the continental shelf is largely unknown, although marine microbes and fungi are known to degrade biologically produced polyesters (Doi et al. 1992) as well as other synthetic polymers, although the latter occurs more slowly (Shah et al. 2008). A more detailed discussion of plastics in the marine environment is provided in Section 3.1.2.2.6 (Marine Debris and Water Quality).

3.1.3.4.7 Evaluation of Alternatives

Table 3.1-31 summarizes the number of marine markers, flares, and chaff for all alternatives. The numbers represent amounts expended annually for each type of material under each alternative. The types and amounts of expended materials in the table were drawn from the tables in Chapter 2 (Description of Proposed Action and Alternatives).

Table 3.1-31: Summary of Military Expended Materials Involving Other Materials – All Alternatives Annually

Type of Military Expended Material	No Action Alternative	Alternative 1	Alternative 2
Marine Markers			
Training	1,349	1,682	1,682
Testing	190	193	240
Total	1,539	1,875	1,922
Flares			
Training	8,108	10,628	10,628
Testing	2,810	7,400	8,140
Total	10,918	18,028	18,768
Chaff Cartridges			
Training	64,590	45,612	45,612
Testing	2,984	10,660	11,650
Total	67,574	56,272	57,262

The following sections evaluate each alternative in terms of the information provided in Sections 3.1.3.4.5 (Approach to Analysis) and 3.1.3.4.6 (Impacts from Other Materials). Potential impacts on sediment and water quality from other materials should be viewed in the following context: (1) nearshore sediment and water quality in many areas have been negatively impacted; and (2) the majority of those impacts are from human-generated and land-based activities, especially plastics and other ocean debris. The numbers of military expended materials discussed below reflect amounts expended annually for each type of material under each alternative.

3.1.3.4.7.1 No Action Alternative

Under the No Action Alternative, a total of 80,031 military expended materials involving other materials would be used during training and testing. Chaff cartridges represent 84 percent of these materials, flares represent 14 percent, and marine markers represent 2 percent.

Training Activities. Under the No Action Alternative, numerically, training activities would represent 92.5 percent of other materials used under the No Action Alternative. Of those materials, 87 percent would be composed of chaff cartridges, 11 percent would be composed of flares, and 2 percent would be composed of marine markers. Most chaff used during training (77 percent) would occur in two range complexes: Key West (46 percent) and VACAPES (31 percent); most flare use would occur in the Key West Range Complex (42 percent).

Testing Activities. Under the No Action Alternative, numerically, testing activities would represent 7.5 percent of other materials used. Of those materials, 50 percent would be composed of chaff cartridges, 47 percent would be composed of flares, and 3 percent would be composed of marine markers. Most chaff testing would occur in the VACAPES Range Complex (67 percent), and most flare testing would also occur in the VACAPES Range Complex (66 percent). Testing activities are described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Tables 2.8-2 and 2.8-3.

Summary of Impacts from Other Materials

Under the No Action Alternative, potential impacts on sediment and water quality from training and testing involving other materials would be short- and long-term and local. Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Regarding chaff, its composition is much like clay minerals, common in ocean sediment (aluminosilicates). Study results indicate that adverse impacts are not anticipated even at concentrations many times the level realistically encountered during proposed training and testing activities. Regarding the remaining training and testing materials, the majority of pyrotechnics in marine markers and flares is consumed during use and expended in the air. The failure rate is low (5 percent), and the remaining amounts are small and subject to additional chemical reactions and subsequent dilution in the ocean. Plastics and other floating expended materials would either degrade over time or wash ashore. Materials would be widely scattered on the sea floor in areas used for training and testing. Neither state nor federal standards or guidelines would be exceeded.

3.1.3.4.7.2 Alternative 1

Under Alternative 1, military expended materials involving other materials would decrease compared to the No Action Alternative (from 80,031 to 76,175 items). The relative contribution of the materials would also change. Chaff cartridges would represent 74 percent of these materials (84 percent under the No Action Alternative), flares would represent 24 percent (14 percent under the No Action Alternative), and marine markers would represent 2.5 percent (2 percent under the No Action Alternative).

Training Activities. Under Alternative 1, numerically, training activities would represent 76 percent of other materials (92.5 percent under the No Action Alternative). Of those materials, 79 percent would be composed of chaff cartridges (87 percent under the No Action Alternative), flares (18 percent; 11 percent under the No Action Alternative), and marine markers (3 percent; 2 percent under the No Action Alternative). In terms of location, under Alternative 1, most chaff use during training would occur in the Key West Range Complex (66 percent; 46 percent under the No Action Alternative). Most flare use would continue to occur in the Key West Range Complex (42 percent; 42 percent under the No Action Alternative). Flare use would also increase in two other range complexes: Navy Cherry Point (18 percent; 7 percent under the No Action Alternative) and JAX (16 percent; 6 percent under the No Action Alternative).

Testing Activities. Under Alternative 1, numerically, testing activities represent 24 percent of other materials (7.5 percent under the No Action Alternative). Of those materials, 58 percent would be composed of chaff cartridges (50 percent under the No Action Alternative), flares (41 percent; 47 percent under the No Action Alternative), and marine markers (1 percent; 3 percent under the No Action Alternative). Most chaff use during testing would occur in two areas: VACAPES Range Complex (34 percent; 67 percent under the No Action Alternative) and the GOMEX Range Complex (40 percent; 22 percent under the No Action Alternative). Most flare testing would occur in two areas: VACAPES Range Complex (41 percent; 66 percent under No Action Alternative) and the GOMEX Range Complex (38 percent; 32 percent under the No Action Alternative). Testing activities are described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Tables 2.8-2 and 2.8-3.

Summary of Impacts from Other Materials

Under Alternative 1, potential impacts on sediment and water quality from other materials associated with training and testing activities would be short- and long-term and local. The small increase in other materials, coupled with the nature of those materials, indicate that potential impacts would be similar to the No Action Alternative. Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Neither state nor federal standards or guidelines would be exceeded.

3.1.3.4.7.3 Alternative 2 (Preferred Alternative)

Under Alternative 2, training and testing materials involving other materials would decrease compared to the No Action Alternative (from 80,031 to 77,952 items). The relative contribution of the materials would also change in a similar manner to Alternative 1. Chaff cartridges would comprise 73 percent of these materials (84 percent under the No Action Alternative), flares would comprise 24 percent (14 percent under the No Action Alternative), and marine markers would comprise 2.5 percent (2 percent under the No Action Alternative).

Training Activities. Under Alternative 2, numerically, training activities represent 74.3 percent of other materials (92.5 percent under the No Action Alternative). Of those materials, 79 percent would be composed of chaff cartridges (87 percent under the No Action Alternative), flares (18 percent; 11 percent under the No Action Alternative), and marine markers (3 percent; 2 percent under the No Action Alternative). In terms of location, under Alternative 2, most chaff use during training would occur in the Key West Range Complex (66 percent; 46 percent under the No Action Alternative). Most flare use would continue to occur in the Key West Range Complex (42 percent; 42 percent under the No Action Alternative). Flare use would also increase in two other range complexes: Navy Cherry Point (18 percent; 7 percent under the No Action Alternative) and JAX (16 percent; 6 percent under the No Action Alternative).

Testing Activities. Under Alternative 2, numerically, testing activities represent 25.7 percent of other materials (7.5 percent under the No Action Alternative). Of those materials, 58 percent would be composed of chaff cartridges (50 percent under the No Action Alternative), flares (41 percent; 47 percent under the No Action Alternative), and marine markers (1 percent; 3 percent under the No Action Alternative). Most chaff testing (95 percent) would occur in two areas: the VACAPES Range Complex (33 percent; 67 percent under the No Action Alternative) and the GOMEX Range Complex (40 percent; 22 percent under the No Action Alternative). Most flare testing would occur in two areas: the VACAPES Range Complex (41 percent; 66 percent under the No Action Alternative) and the GOMEX Range Complex (54 percent; 32 percent under the No Action Alternative). Testing activities are described in Chapter 2 (Description of Proposed Action and Alternatives) and listed in Tables 2.8-2 and 2.8-3.

Summary of Impacts from Other Materials

Under Alternative 2, potential impacts on sediment and water quality from other materials associated with training and testing activities would be short- and long-term and local. The small increase in other materials, coupled with the nature of those materials, indicate that potential impacts would be similar to the No Action Alternative. Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. Neither state nor federal standards or guidelines would be exceeded.

3.1.4 Summary of Potential Impacts on Water Quality

The stressors that may impact sediment and water quality include explosives and explosion byproducts, metals, chemicals other than explosives, and other military expended materials.

3.1.4.1 No Action Alternative

Under the No Action Alternative, chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated uses. When considered together, the impact of the four stressors would be additive. However, chemical, physical, or biological changes to sediment or water quality would not be detectable and would remain below or within existing conditions or designated uses. This conclusion is based on the following:

- Although individual training and testing activities may occur within a fairly small area, overall military expended materials and activities are widely dispersed in space and time;
- Many components of expended materials are inert or corrode slowly;
- Numerically, most of the metals expended are small- and medium-caliber projectiles, metals of concern comprise a small portion of the alloys used in expended materials, and metal corrosion is a slow process that allows for dilution;
- Most of the components are subject to a variety of physical, chemical, and biological processes that render them benign;
- Potential areas of negative impacts would be limited to small zones immediately adjacent to the explosive, metals, or chemicals other than explosives; and
- The failure rate is low for explosives and materials with propellant systems, limiting the potential impacts from the chemicals other than explosives involved.

3.1.4.2 Alternative 1

Under Alternative 1, when considered separately, the effects of the four stressors would not be additive:

- The impact of chemicals other than explosives and other materials on sediment and water quality would be similar to the No Action Alternative, that is, short- and long-term and local. Chemical, physical, or biological changes to sediment or water quality would not be detectable and would be below or within existing conditions or designated use; and
- The impact of explosives, explosion byproducts, and metals on sediment and water quality would also be short- and long-term and local. However, chemical, physical, or biological changes to sediment or water quality would be measurable but below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses.

When considered together, the impact of the four stressors would be additive. Chemical, physical, or biological changes to sediment or water quality would be measurable, but they would still be below applicable standards, regulations, and guidelines, and would be within existing conditions or designated uses. Although most types of expended materials would increase over the No Action Alternative, this conclusion is based on the reasons provided under the No Action Alternative as follows:

- Although individual training and testing activities may occur within a fairly small area, overall military expended materials and activities are widely dispersed in space and time;
- Many components of expended materials are inert or corrode slowly;
- Numerically, most of the metals expended are small- and medium-caliber projectiles, metals of concern comprise a small portion of the alloys used in expended materials, and metal corrosion is a slow process that allows for dilution;
- Most of the components are subject to a variety of physical, chemical, and biological processes that render them benign;
- Potential areas of negative impacts would be limited to small zones immediately adjacent to the explosive, metals, or chemicals other than explosives; and
- The failure rate is low for explosives and materials with propellant systems, limiting the potential impacts from the chemicals other than explosives involved.

3.1.4.3 Alternative 2 (Preferred Alternative)

Under Alternative 2, when considered separately, the impact on sediment and water quality of the four stressors would be the same as discussed under Alternative 1. This is because the types and amounts of military expended materials are relatively similar between the two alternatives.

When considered together, the impact of the four stressors would be additive, and changes to sediment or water quality would be measurable, but they would still be below applicable standards, regulations, and guidelines, and within existing conditions or designated uses. Because the types and amounts of military expended materials are similar between Alternatives 1 and 2, the reasons for this conclusion are the same as those discussed under the No Action Alternative as follows:

- Although individual training and testing activities may occur within a fairly small area, overall military expended materials and activities are widely dispersed in space and time;
- Many components of expended materials are inert or corrode slowly;
- Numerically, most of the metals expended are small- and medium-caliber projectiles, metals of concern comprise a small portion of the alloys used in expended materials, and metal corrosion is a slow process that allows for dilution;
- Most of the components are subject to a variety of physical, chemical, and biological processes that render them benign;
- Potential areas of negative impacts would be limited to small zones immediately adjacent to the explosive, metals, or chemicals other than explosives; and
- The failure rate is low for explosives and materials with propellant systems, limiting the potential impacts from the chemicals other than explosives involved.

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3.2 AIR QUALITY

AIR QUALITY SYNOPSIS

The Navy evaluated all potential stressors and the following have been analyzed for air quality:

- Criteria air pollutants
- Hazardous air pollutants

Preferred Alternative (Alternative 2)

- All reasonably foreseeable direct and indirect emissions in nonattainment and maintenance areas do not equal or exceed applicable *de minimis* levels.*

*Note: The emissions thresholds for conformity requirements are referred to as *de minimis* levels.

3.2.1 INTRODUCTION AND METHODS

3.2.1.1 Introduction

Air pollution is a threat to human health and also damages the environment (U.S. Environmental Protection Agency 2007b). Air pollution damages trees, crops, other plants, lakes, and animals. In addition to damaging the natural environment, air pollution damages the exteriors of buildings, monuments, and statues. It creates haze or smog that reduces visibility in national parks and cities and interferes with aviation. To improve air quality and reduce air pollution, Congress passed the Clean Air Act and its amendments, which set regulatory limits on air pollutants and helps to ensure basic health and environmental protection from air pollution.

Air quality is defined by ambient concentrations of specific air pollutants – pollutants the U.S. Environmental Protection Agency (USEPA) determined may affect the health or welfare of the public. The six major pollutants of concern are called “criteria pollutants”: carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), suspended particulate matter (dust particles less than or equal to 10 microns in diameter [particulate matter {PM_{10}}] and fine particulate matter less than or equal to 2.5 microns in diameter [$PM_{2.5}$]), and lead (Pb). The USEPA established National Ambient Air Quality Standards for these criteria pollutants.

In addition to the six criteria pollutants, the USEPA currently designates 188 substances as hazardous air pollutants under the federal Clean Air Act. Hazardous air pollutants are air pollutants known to cause or suspected of causing cancer or other serious health effects, or adverse environmental effects (U.S. Environmental Protection Agency 2010). National Ambient Air Quality Standards are not established for these pollutants; however, the USEPA developed rules that limit emissions from specific industrial sources. These emissions control standards are known as “maximum achievable control technologies” and “generally achievable control technologies.” They are intended to achieve the maximum degree of reduction in emissions of the hazardous air pollutants, taking into consideration the cost of emissions control, non-air quality health and environmental impacts, and energy requirements. Examples of hazardous air pollutants include benzene, which is found in gasoline; perchloroethene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper in some industries. Hazardous air pollutants are regulated under the Clean Air Act’s National Emission

Standards for Hazardous Air Pollutants, which apply to specific sources of hazardous air pollutants; and under the Urban Air Toxics Strategy, which applies to area sources.

Air pollutants are classified as either primary or secondary pollutants based on how they originate in the atmosphere. Primary air pollutants are emitted directly into the atmosphere from the source of the pollutant and retain their chemical form. Examples of primary pollutants are the ash produced by burning solid waste and volatile organic compounds emitted from a dry cleaner (U.S. Environmental Protection Agency 2010). Secondary air pollutants are those formed through atmospheric chemical reactions – reactions that usually involve primary air pollutants (or pollutant precursors) and normal constituents of the atmosphere (U.S. Environmental Protection Agency 2010). Ozone (O_3), a major component of photochemical smog, is a secondary air pollutant. O_3 precursors fall into two broad groups of chemicals: nitrogen oxides (NO_X) and organic compounds. NO_X consists of nitric oxide (NO) and nitrogen dioxide (NO_2). Organic compound precursors of O_3 are routinely described by various terms, including volatile organic compounds, reactive organic compounds, and reactive organic gases. Finally, some air pollutants are a combination of primary and secondary pollutants. PM_{10} and $PM_{2.5}$ are generated both as primary pollutants by various mechanical processes (e.g., abrasion, erosion, mixing, or atomization) or combustion processes. They are generated as secondary pollutants through chemical reactions or through the condensation of gaseous pollutants into fine aerosols.

Air pollutant emissions are reported as the amount (by weight or volume) of one or more specific compounds emitted into the atmosphere by a source. Most air pollutant emissions are expressed as a rate (e.g., pounds per hour, pounds per day, or tons per year). Typical units for emission rates from a source or source activity are pounds per thousand gallons of fuel burned, pounds per ton of material processed, and grams per vehicle-mile of travel.

Ambient air quality is reported as the atmospheric concentrations of specific air pollutants at a particular time and location. The units of measurement are expressed as a mass per unit volume (e.g., micrograms per cubic meter [$\mu g/m^3$] of air) or as a volume fraction (e.g., parts per million [ppm] by volume).The ambient air pollutant concentrations measured at a particular location are determined by the pollutant emissions rate, local meteorology, and atmospheric chemistry. Wind speed and direction and precipitation patterns affect the dispersal, dilution, and removal of air pollutant emissions from the atmosphere.

3.2.1.2 Methods

Section 176(c)(1) of the Clean Air Act, commonly known as the General Conformity Rule, requires federal agencies to ensure their actions conform to applicable implementation plans for achieving and maintaining the National Ambient Air Quality Standards for criteria pollutants.

3.2.1.2.1 Application of Regulatory Framework

3.2.1.2.1.1 National Ambient Air Quality Standards

The National Ambient Air Quality Standards for criteria pollutants are set forth in Table 3.2-1. Areas that exceed a standard are designated as “nonattainment” for that pollutant, while areas in compliance with a standard are in “attainment” for that pollutant. An area may be nonattainment for some pollutants and attainment for others simultaneously.

Table 3.2-1: National Ambient Air Quality Standards

Pollutant [final rule cite]		Primary / Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO) [76 FR 54294, Aug 31, 2011]		Primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead (Pb) [73 FR 66964, Nov 12, 2008]		Primary and Secondary	Rolling 3-month average	$0.15\ \mu g/m^3$ (1)	Not to be exceeded
Nitrogen Dioxide (NO_2) [75 FR 6474, Feb 9, 2010] [61 FR 52852, Oct 8, 1996]		Primary	1-hour	100 ppb	98^{th} percentile, averaged over 3 years
		Primary and Secondary	Annual	53 ppb(2)	Annual mean
Ozone (O_3) [73 FR 16436, Mar 27, 2008]		Primary and Secondary	8-hour	0.075 ppm(3)	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particle Pollution [71 FR 61144, Oct 17, 2006]	$PM_{2.5}$	Primary and Secondary	Annual	$15\ \mu g/m^3$	Annual mean, averaged over 3 years
			24-hour	$35\ \mu g/m^3$	98^{th} percentile, averaged over 3 years
	PM_{10}	Primary and Secondary	24-hour	$150\ \mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2) [75 FR 35520, Jun 22, 2010] [38 FR 25678, Sept 14, 1973]		Primary	1-hour[1]	75 ppb(4)	99^{th} percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Source: (U.S. Environmental Protection Agency 2012a), last updated October 2011.

Notes:

1 Final Rule signed October 15, 2008. The 1978 lead standard ($1.5\ \mu g/m^3$ as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard. Areas designated nonattainment under the 1978 standard remain in effect until implementation plans are approved to attain or maintain the 2008 standard.

2 The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

3 Final Rule signed March 12, 2008. The 1997 ozone standard (0.08 ppm, annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years) and related implementation rules remain in place. In 1997, EPA revoked the 1-hour ozone standard (0.12 ppm, not to be exceeded more than once per year) in all areas, although some areas have continued obligations under that standard (“anti-backsliding”). The 1-hour ozone standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is less than or equal to 1.

4 Final Rule signed June 2, 2010. The 1971 annual and 24-hour SO_2 standards were revoked in that same rulemaking. However, these standards remain in effect until one year after an area is designated for the 2010 standard, except in areas designated nonattainment for the 1971 standards, where the 1971 standards remain in effect until implementation plans to attain or maintain the 2010 standard are approved.

Other Acronyms: PM – particulate matter; ppb – parts per billion; ppm – parts per million.

States, through their air quality management agencies, are required to prepare and implement State Implementation Plans for nonattainment areas, which demonstrate how the area will meet the National Ambient Air Quality Standards. Areas that achieved attainment may be designated as “maintenance areas,” subject to maintenance plans showing how the area will continue to meet federal air quality standards. Nonattainment areas for some criteria pollutants are further classified, depending on the severity of their air quality problem, to facilitate their management:

- Ozone – marginal, moderate, serious, severe, and extreme
- Carbon monoxide – moderate and serious
- Particulate matter – moderate and serious

The USEPA delegates the regulation of air quality to the state once the state has an approved State Implementation Plan. The Clean Air Act also allows states to establish air quality standards more stringent than the National Ambient Air Quality Standards.

The Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area) is offshore of several states, and some elements of the Proposed Action occur within or over state waters. Most of the Study Area is substantially offshore, beyond state boundaries where attainment status is unclassified and Clean Air Act National Ambient Air Quality Standards do not apply. However, given fluctuations in wind direction, air quality in adjacent onshore areas may be affected by releases of air pollutants from Study Area sources. Therefore, National Ambient Air Quality Standards attainment status of adjacent onshore areas is considered in determining whether appropriate controls on air pollution sources in the adjacent offshore state waters is warranted.

3.2.1.2.1.2 General Conformity Evaluation

Federal actions are required to conform with the approved State Implementation Plan for those areas of the United States designated as nonattainment or maintenance air quality areas for any criteria air pollutant under the Clean Air Act (40 Code of Federal Regulations [C.F.R.] §§ 51 and 93). The purpose of the General Conformity Rule is to demonstrate that the Proposed Action would not cause or contribute to a violation of an air quality standard and that the Proposed Action would not adversely affect the attainment and maintenance of federal ambient air quality standards. A federal action would not conform if it increased the frequency or severity of any existing violations of an air quality standard or delayed the attainment of a standard, required interim emissions reductions, or any other air quality milestone. To ensure that federal activities do not impede local efforts to control air pollution, Section 176(c) of the Clean Air Act (42 United States Code [U.S.C.] § 7506(c)) prohibits federal agencies from engaging in or approving actions that do not conform to an approved State Implementation Plan. The emissions thresholds that trigger the conformity requirements are called *de minimis* levels.

Federal agency compliance with the General Conformity Rule is demonstrated in several ways. The review can be satisfied by (1) a determination that the action is not subject to the General Conformity Rule, (2) a record of nonapplicability, or (3) a conformity determination.

Compliance is presumed if the net increase in emissions from a federal action would be less than the relevant *de minimis* threshold. If net emissions increases exceed the *de minimis* thresholds, then a formal conformity determination must be prepared. *De minimis* levels are shown in Table 3.2-2. Note that *de minimis* levels are lower in the ozone transport region[1]. The states within the established ozone transport region include Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, and the Washington, D.C. Metropolitan Statistical Area, including the northern Virginia suburbs (Connecticut Department of Environmental Protection 2008).

[1] The ozone transport region in the northeastern United States experiences an ozone problem that is generated by local emissions as well as emissions released upwind of the area [from coal fired power plants and other sources in the Midwest] and transported over time to this area of concern (New Jersey Department of Environmental Protection 2007).

Table 3.2-2: *de Minimis* Thresholds for Conformity Determinations

Pollutant	Nonattainment or Maintenance Area Type	*de Minimis* Threshold (TPY)
Ozone (VOC 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 (VOC)	Marginal and moderate nonattainment inside an ozone transport region	50
	Maintenance within an ozone transport region	50
	Maintenance outside an ozone transport region	100
CO, SO_2 and NO_2	All nonattainment and maintenance	100
PM_{10}	Serious nonattainment	70
	Moderate nonattainment and maintenance	100
$PM_{2.5}$	All nonattainment and maintenance	100
Lead (Pb)	All nonattainment and maintenance	25

Source: (U.S. Environmental Protection Agency 2012b)

CO: carbon monoxide; NO_X: nitrogen oxides; Pb: lead; PM_{10}: particulate matter under 10 microns; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

3.2.1.2.2 Conformity Analyses in Nonattainment and Maintenance Areas

Certain Navy training and testing activities take place within specific nonattainment and maintenance areas. These nonattainment and maintenance areas are identified by their air quality control region (an area designated by the federal government where communities share a common air pollution problem). Four such air quality control regions were identified as relevant to co-located AFTT Environmental Impact Statement (EIS)/Overseas Environmental Impact Statement (OEIS) training or testing activities. Coastal waters within 3 nautical miles (nm) of a shoreline are part of the same air quality jurisdiction area as the contiguous land area.

3.2.1.2.2.1 Metropolitan Portland Intrastate Air Quality Control Region

The Proposed Action includes testing activities in the Metropolitan Portland Intrastate Air Quality Control Region (40 C.F.R. § 81.78). The region consists of the territorial area encompassed by the boundaries of the following jurisdictions or described area (including the territorial area of all municipalities [as defined in Section 302(f) of the Clean Air Act, 42 U.S.C. § 1857(h)(f)]) geographically located within the outermost boundaries of the area so delimited: in the State of Maine, the counties of Cumberland, Sagadahoc, and York and the towns of Brownfield, Denmark, Fryeburg, Hiram, and Porter. The Portsmouth Naval Shipyard lies within York County, Maine, and the Bath shipyard lies within Sagadahoc County.

The Metropolitan Portland Intrastate Air Quality Control Region is designated as a maintenance area for the federal 8-hour O_3 standard. The Metropolitan Portland Intrastate Air Quality Control Region is classified as an attainment area for the National Ambient Air Quality Standards for SO_x, NO_x, Pb, PM_{10}, and $PM_{2.5}$, and CO (40 C.F.R. § 81.320 and (U.S. Environmental Protection Agency 2011d)). The Portland

8-hour O_3 Maintenance Area includes the Maine counties of York, Cumberland, Androscoggin, and Sagadahoc (Maine Department of Transportation 2011).

The General Conformity Rule states that a federal action is exempt from the requirements of a full conformity demonstration for those criteria air pollutants for which emissions increases are below specific *de minimis* emissions levels. The Proposed Action is required to demonstrate conformity with the approved State Implementation Plan. In accordance with the General Conformity Rule, the *de minimis* levels for nonattainment and maintenance pollutants in the Metropolitan Portland Intrastate Air Quality Control Region are 50 tons per year for O_3 precursors (volatile organic compounds) and 100 tons per year for NO_x. Because this area lies within an ozone transport region, the *de minimis* threshold for volatile organic compounds is 50 tons per year instead of 100 tons per year.

The Metropolitan Portland Intrastate Air Quality Control Region included air pollutant emissions from shipyard activities in its State Implementation Plan inventory of O_3 emissions. These estimated emissions were accounted for in the state's management plan for the air basin and are deemed consistent with the State Implementation Plan emissions budget for the Metropolitan Portland Intrastate Air Quality Control Region. This EIS/OEIS includes emissions estimates for testing activities conducted at the Portsmouth Naval Shipyard in Kittery, Maine, and the shipyard in Bath, Maine, to evaluate whether a conformity determination is required.

Air emissions were calculated for relevant tests at Portsmouth Naval Shipyard and Bath shipyard. For air quality analysis, impacts of activities at the Portsmouth Naval Shipyard and Bath shipyard were evaluated concurrently because they are in the same air quality control region. No emissions are associated with testing activities at the Portsmouth Naval Shipyard or the Bath shipyard (i.e., pierside sound navigation and ranging [sonar] tests and electronic warfare systems testing). Therefore, a conformity determination is not required and testing activities at the Portsmouth Naval Shipyard or the Bath shipyard are not further analyzed in this EIS/OEIS.

3.2.1.2.2.2 Metropolitan Providence Air Quality Control Region

The Proposed Action includes activities in the Metropolitan Providence Interstate Air Quality Control Region (40 C.F.R. § 81.31). This Region, consisting of the five Rhode Island counties, is classified as an attainment area for the federal 8-hour O_3 (2008 standard) (Figure 3.2-1 for a map of the 8-hour ozone nonattainment areas within the USEPA Region 1). The Metropolitan Providence Air Quality Control Region is classified as an attainment area for the National Ambient Air Quality Standards for SO_x, NO_x, Pb, $PM_{10,}$ $PM_{2.5}$, CO and 8-hour O_3 (2008 standard) effective July 20, 2012. It was previously classified as a "moderate" nonattainment area of the 8-hour (1997 standard) for O_3 (40 C.F.R. § 81.340 and USEPA (2011a)).

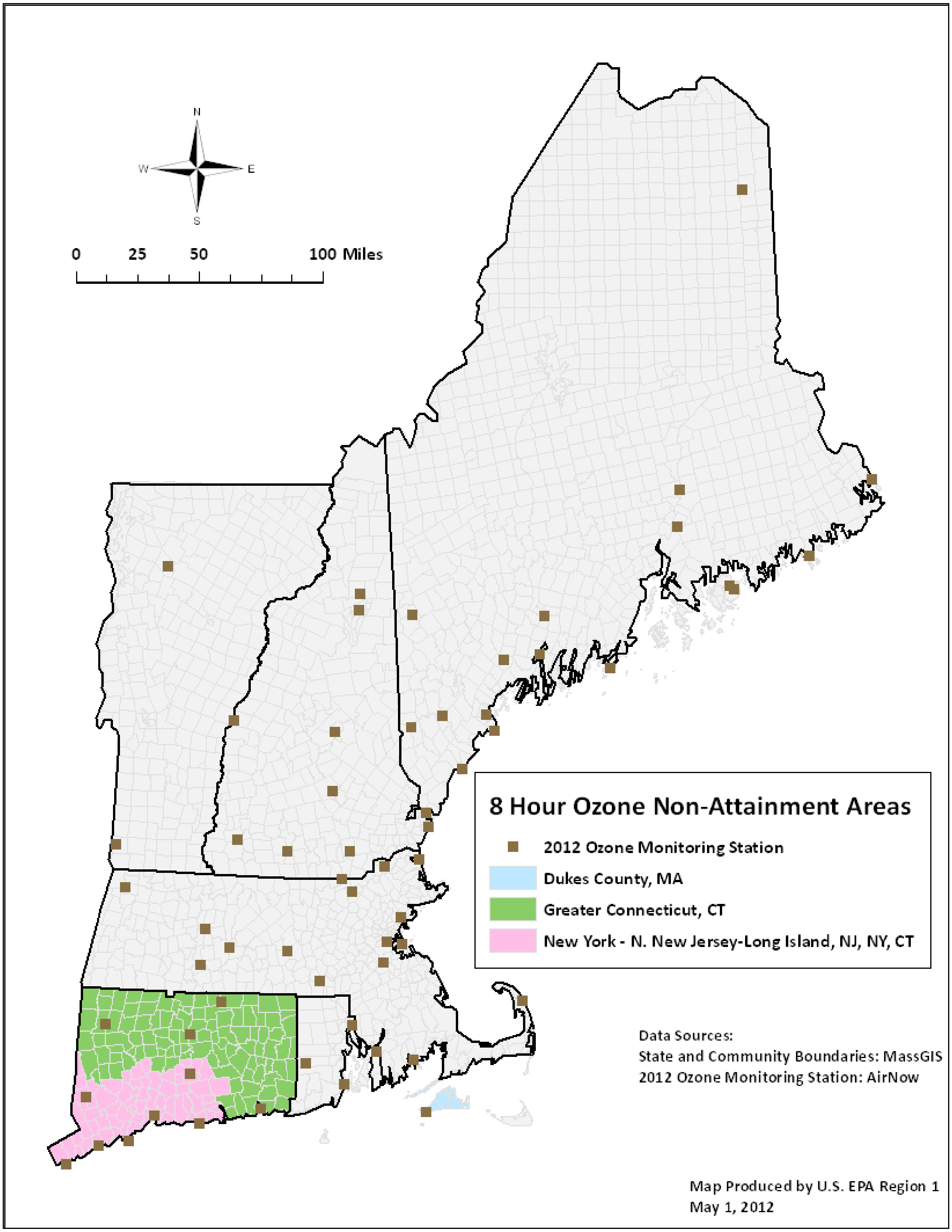

Figure 3.2-1: 8-Hour Ozone Nonattainment Areas in U.S. Environmental Protection Agency Region 1

Source: (U.S. Environmental Protection Agency 2007a)

CT: Connecticut; EPA: Environmental Protection Agency; MA: Massachusetts; NJ: New Jersey; NY: New York

The Proposed Action is required to demonstrate conformity with the approved State Implementation Plan. In accordance with the General Conformity Rule, the *de minimis* levels for nonattainment and maintenance pollutants in the Metropolitan Providence Air Quality Control Region are: 50 tons per year for O_3 precursors (volatile organic compounds or reactive organic gases) and 100 tons per year for CO and NO_2. Because this area lies within an ozone transport region, the *de minimis* threshold for volatile organic compounds is 50 tons per year instead of 100 tons per year.

The Metropolitan Providence Air Quality Control Region included air pollutant emissions from Naval Undersea Warfare Center Division, Newport, and Naval Station Newport military activities in its State Implementation Plan inventory of O_3 emissions. These estimated emissions were accounted for in the management plan for the air basin and are deemed consistent with the State Implementation Plan emissions budget for the Metropolitan Providence Air Quality Control Region. This EIS/OEIS includes emissions estimates for testing activities conducted at the Naval Undersea Warfare Center Division, Newport, Rhode Island, to evaluate whether a conformity determination is required (see Table 2.8-3 for torpedoes, launchers, towed equipment, and unmanned vehicle testing).

3.2.1.2.2.3 Greater Connecticut Air Quality Control Region

The Proposed Action includes activities in the Greater Connecticut Air Quality Control Region. This Region is classified as a marginal nonattainment area for the federal 8-hour O_3 standard (Figure 3.2-1 for a map of the 8-hour ozone nonattainment areas located within the USEPA Region 1). This Region is classified as an attainment area for the National Ambient Air Quality Standards for SO_x, NO_x, Pb, $PM_{10,}$ $PM_{2.5}$, and CO, but is classified as a marginal nonattainment area of the 8-hour standard for O_3 (U.S. Environmental Protection Agency 2011a).

The Proposed Action is required to demonstrate conformity with the currently approved State Implementation Plan. In accordance with the General Conformity Rule, the *de minimis* levels for nonattainment and maintenance pollutants in the Greater Connecticut Air Quality Control Region are 50 tons per year for O_3 precursors (volatile organic compounds) and 100 tons per year for CO and NO_2. Because this area lies within an ozone transport region, the *de minimis* threshold for volatile organic compounds is 50 tons per year instead of 100 tons per year.

The Greater Connecticut Air Quality Control Region included air pollutant emissions from military testing and maintenance activities at the Naval Submarine Base New London and the Groton shipyard in its State Implementation Plan inventory of O_3 emissions. These estimated emissions were accounted for in the management plan for the air basin and are deemed consistent with the State Implementation Plan emissions budget for the Greater Connecticut Air Quality Control Region. No emissions are associated with testing activities at the Naval Submarine Base New London and the Groton shipyard (i.e., pierside sound navigation and ranging [sonar] tests and electronic warfare systems testing). Therefore, a conformity determination is not required and testing activities at the Naval Submarine Base New London and the Groton shipyard are not further analyzed in this EIS/OEIS.

3.2.1.2.2.4 Hampton Roads Intrastate Air Quality Control Region

The Proposed Action includes training and testing activities in the Hampton Roads Intrastate Air Quality Control Region (40 C.F.R. § 81.93). The Hampton Roads area is located in southeastern Virginia within USEPA Region 3 (Figure 3.2-2 for a map that illustrates the attainment, nonattainment, and maintenance areas within the region [*Note: Figure 3.2-2 was drawn prior to the U.S. Environmental Protection Agency issuance of the 2008 Ozone Standard Designations Final Rule on May 21, 2012*]). The Hampton Roads Intrastate Air Quality Control Region is in attainment (maintenance) of the 1997 8-hour

O_3 national ambient air quality standard (U.S. Environmental Protection Agency 2011a) and is classified as an attainment area for the National Ambient Air Quality Standards for SO_x, NO_x, Pb, PM_{10}, $PM_{2.5}$, and CO (40 C.F.R. § 81.347). The Hampton Roads Intrastate Air Quality Control Region is also in attainment (maintenance) of the 2008 8-hour O_3 national ambient air quality standard, which became effective July 20, 2012 (40 C.F.R. Part 81).

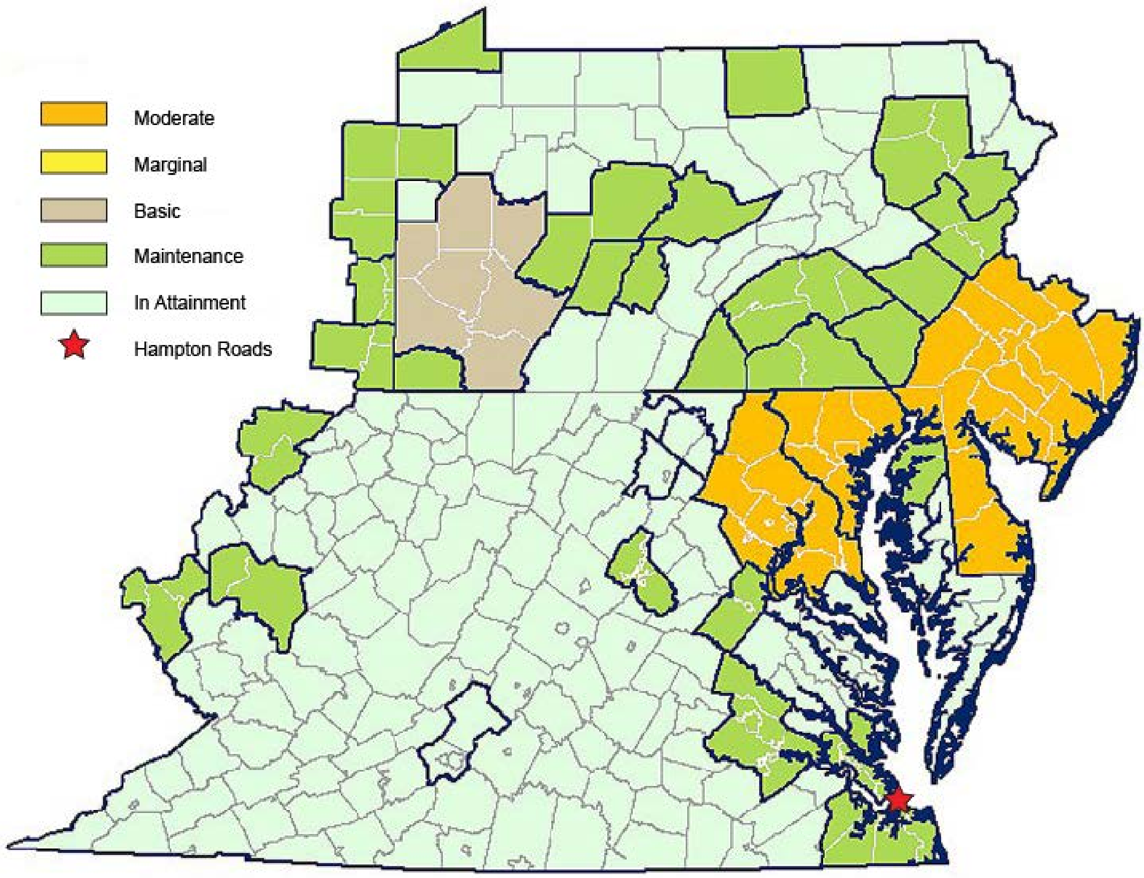

Figure 3.2-2: 8-Hour Ozone Nonattainment and Maintenance Areas in U.S. Environmental Protection Agency Region 3
Source: (U.S. Environmental Protection Agency 2011c)
Note: Figure does not reflect the 2008 8-hour O_3 Final Rule Designations (effective 20 July 2012).

In accordance with the General Conformity Rule, the *de minimis* levels (rates in tons per year) applicable to maintenance areas outside the ozone transport region, such as the Hampton Roads Intrastate Air Quality Control Region, are 100 tons per year for ozone precursors (NO_x and volatile organic compounds). This EIS/OEIS includes emissions estimates for mine warfare training activities conducted in the state waters of the lower Chesapeake Bay north of Norfolk Naval Station, and in the state waters adjacent to Virginia Beach. The emissions estimates (Section 3.2.1.4) for these nearshore training and testing activities are evaluated to determine whether a conformity determination is required.

3.2.1.2.2.5 Other Air Basins Adjacent to the Study Area

As mentioned, the conformity review is satisfied by a determination that the action is not subject to the General Conformity Rule, a record of nonapplicability, or a conformity determination. Actions not subject to the Rule include actions that occur in attainment areas, and that do not generate emissions in nonattainment areas. If National Environmental Policy Act (NEPA) documentation is prepared for an action, the determination that the Proposed Action is not subject to the General Conformity Rule is described in that documentation. Otherwise, no documentation is required. This EIS/OEIS includes the determination that actions in the attainment areas that do not generate emissions in nonattainment areas are not subject to the General Conformity Rule.

With the exception of activities within the Metropolitan Portland, Metropolitan Providence, Greater Connecticut, and Hampton Roads Air Quality Control Regions mentioned in the preceding sections, training and testing in the Study Area take place either within an attainment area or they take place beyond 3 nm from shore in unclassified portions of the Study Area. Although the Operating Areas and special use airspace of the Northeast Range Complexes are adjacent to air quality control regions classified as maintenance or nonattainment areas for O_3, training or testing conducted within these offshore sea and air spaces is conducted beyond state waters (at least 3 nm offshore and typically more than 12 nm offshore) within areas whose attainment status is unclassified. There is no provision for any classification in the Clean Air Act for waters outside the boundaries of state waters.

Nearshore counties in the southeastern United States are in attainment of the 8-hour ozone standard (see Figure 3.2-3 [range complexes are shown in relation to these areas in Figure 3.2-4] [*Note: Figure 3.2-3 was drawn prior to the U.S. Environmental Protection Agency issuance of the 2008 Ozone Standard Designations Final Rule on May 21, 2012*]). Therefore, training and testing conducted over or upon state waters of the southeastern United States do not generate emissions in nonattainment areas. The Navy Cherry Point, Jacksonville (JAX), Key West, and Gulf of Mexico (GOMEX) Range Complexes lie adjacent to nearshore counties of the southeastern United States in attainment of the National Ambient Air Quality Standards. A substantial portion (over 70 percent) of all AFTT EIS/OEIS training and testing activities occur within these range complexes adjacent to coastal attainment areas. For example, a portion of Maritime Security Operations training in the Corpus Christi Operating Area (GOMEX Range Complex) takes place within Corpus Christi–Victoria Intrastate Air Quality Control Region, an attainment area. As a second example, Naval Surface Warfare Center, Panama City Division testing activities occur within or adjacent to the Mobile (Alabama)–Pensacola–Panama City (Florida)–Southern Mississippi Interstate Air Quality Control Region, an attainment area. Thirdly, portions of anti-submarine warfare testing conducted within the Key West Range Complex occur within the Southeast Florida Intrastate Air Quality Control Region, an attainment area. Furthermore, search and rescue training in Jacksonville, Florida, takes place within the Jacksonville (Florida)–Brunswick (Georgia) Interstate Air Quality Control Region, an attainment area. Finally, amphibious assaults and amphibious raids conducted within the Navy Cherry Point Range Complex occur within the Northern Coastal Plain and Southern Coastal Plain Air Quality Control Regions, areas in attainment for all criteria pollutants.

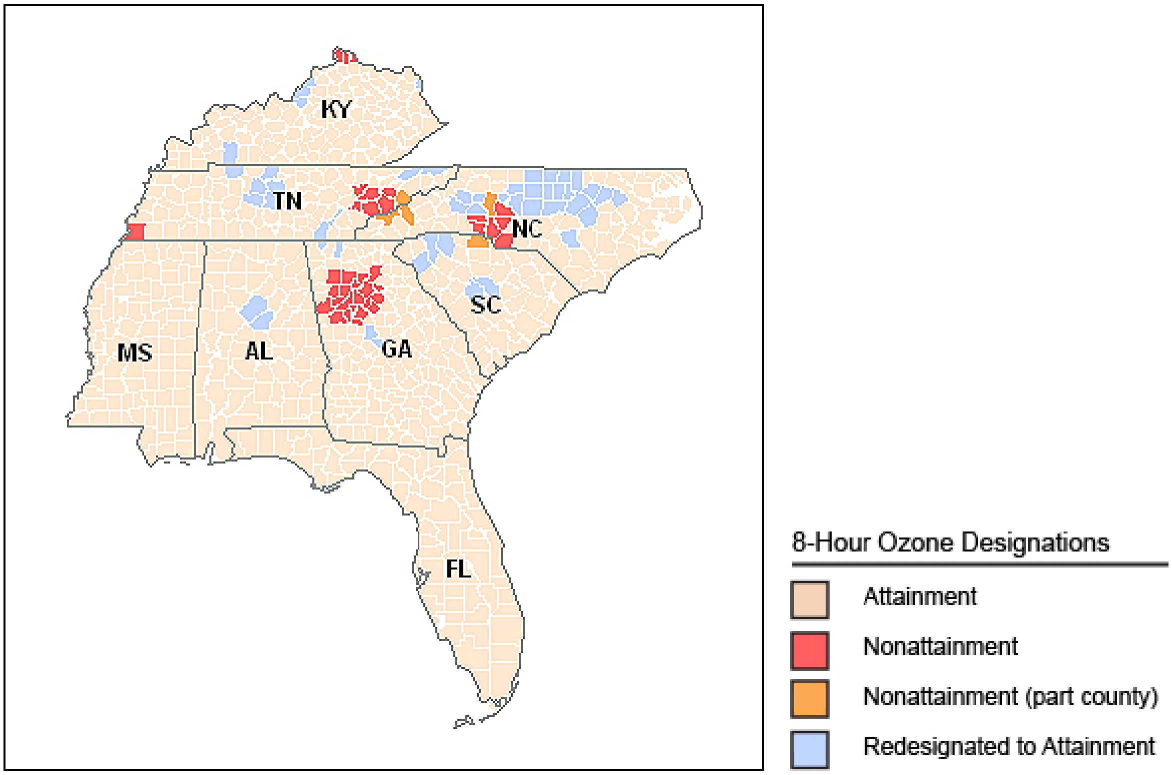

Figure 3.2-3: 8-Hour Ozone Nonattainment Areas in U.S. Environmental Protection Agency Region 4
Source: (U.S. Environmental Protection Agency 2009e)
Note: Figure does not reflect the 2008 8-hour O_3 Final Rule Designations (effective 20 July 2012).
AL: Alabama; FL: Florida; GA: Georgia; KY: Kentucky; MS: Mississippi;
NC: North Carolina; SC: South Carolina; TN: Tennessee

3.2.1.3 Approach to Analysis

The air quality impact evaluation requires two separate analyses: (1) impacts of air pollutants emitted by Navy training and testing in the Atlantic Ocean and Gulf of Mexico in U.S. territorial seas (i.e., within 12 nm of the coast) are assessed under NEPA, and (2) impacts of air pollutants emitted by Navy training and testing activities outside U.S. territorial seas are evaluated as required under Executive Order (EO) 12114. State waters are within the jurisdiction of the respective state and, because each state has a distinct State Implementation Plan, the air quality analysis separately addresses those activities that emit air pollutants within each state's jurisdiction. Portions of the Study Area that lie within 3 nm of the east coastline of states from Maine to Georgia, and the southern coasts of Alabama, Mississippi, and Louisiana, are within those state air quality jurisdictions. Portions of the Study Area that lie within 9 nm of the Gulf of Mexico coastlines of Texas and Florida are within the air quality jurisdictions of those states.

Air pollutants emitted more than 3,000 ft. (914 m) above ground level are considered to be above the atmospheric inversion layer and, therefore, do not affect ground-level air quality (U.S. Environmental Protection Agency 1992). These emissions thus do not affect the concentrations of air pollutants in the lower atmosphere, measured at ground-level monitoring stations, upon which federal, state, and local regulatory decisions are based. For the analysis of the effects on global climate change, however, all emissions of greenhouse gases from aircraft and vessels participating in training and testing activities, as well as targets and ordnance expended, are included regardless of altitude (Chapter 4, Cumulative

Impacts). Analysis of health-based air quality impacts under NEPA includes estimates of criteria air pollutants for all training and testing activities where aircraft, missiles, or targets operate at or below the aforementioned inversion layer or that involve vessels in U.S. territorial seas. The analysis of health-based air quality impacts under EO 12114 includes emissions estimates of only those training and testing activities in which aircraft, missiles, or targets operate at or below the aforementioned inversion layer, or that involve vessels outside of U.S. territorial seas.

Criteria air pollutants are generated by the combustion of fuel by surface vessels and by fixed-wing and rotary-wing aircraft. They also are generated by the combustion of explosives and propellants in various types of munitions. Propellants used to fire small-, medium-, and large-caliber projectiles generate criteria pollutants when detonated. Nonexplosive practice munitions contain spotting charges and propellants that generate criteria air pollutants when they function. Powered targets require fuel, generating criteria air pollutants during their operation, and towed targets generate criteria air pollutants secondarily because another aircraft or vessel is required to provide power. Stationary targets may generate criteria air pollutants if all or portions of the item burn in a high-order detonation. Chaff cartridges used by ships and aircraft are launched by an explosive charge that generates small quantities of criteria air pollutants. Countermeasure flares, parachute flares, and smoke floats are designed to burn for a prescribed period, emitting criteria pollutants in the process.

The air quality analysis also estimates the amounts of hazardous air pollutants emitted by the proposed activities and assesses their potential impacts on air quality. Trace amounts of hazardous air pollutants would be emitted by combustion sources and use of ordnance. Hazardous air pollutants, such as rocket motor exhaust and unspent missile fuel vapors, may be emitted during missile and target use. Hazardous air pollutants are generated, in addition to criteria air pollutants, by combustion of fuels, explosives, propellants, and the materials of which targets, munitions, and other training and testing materials are constructed (e.g., plastic, paint, and wood). Fugitive volatile and semi-volatile petroleum compounds also may be emitted whenever mechanical devices are used. These emissions are typically one or more orders of magnitude smaller than concurrent emissions of criteria air pollutants, and only become a concern when large amounts of fuel, explosives, or other materials are consumed during a single activity or in one location.

Emissions of hazardous air pollutants are intermittent and dispersed over a vast ocean area. Because only small quantities of hazardous air pollutants are emitted into the lower atmosphere, which is well mixed over the ocean, the potential for exposure is very low and the risk presented by the emissions is similarly very low. The primary emissions from many munition types are CO_2, CO, and particulate matter; hazardous air pollutants are emitted at low levels (U.S. Environmental Protection Agency 2008). A quantitative evaluation of hazardous air pollutant emissions is thus not warranted and was not conducted.

Electronic warfare countermeasures generate emissions of chaff, a form of particulate not regulated under the federal Clean Air Act as a criteria air pollutant. Virtually all radio frequency chaff is 10 to 100 times larger than particulate matter under PM_{10} and $PM_{2.5}$ (Spargo et al. 1999). The types of training and testing that produce these other emissions may take place throughout the Study Area but occur primarily within special use airspace. Chaff emissions during training and testing primarily occur 3 nm or more from shore and at altitudes over 3,000 ft. (914 m) (above the mixing layer). Chaff released over the ocean would disperse in the atmosphere and then settle onto the ocean surface. The air quality impacts of chaff were evaluated by the Air Force in *Environmental Effects of Self-Protection Chaff and Flares* (U.S. Air Force 1997). The study concluded that most chaff fibers maintain their integrity after ejection.

Although some fibers are likely to fracture during ejection, it appears this fracturing does not release particulate matter. Tests indicate that the explosive charge in the impulse cartridge results in minimal releases of particulate matter. A later study at Naval Air Station Fallon found that the release of 50,000 cartridges of chaff per year over 10,000 square miles would result in an annual average PM_{10} or $PM_{2.5}$ concentration of 0.018 $\mu g/m^3$. This is far below the then National Ambient Air Quality Standard of 50 $\mu g/m^3$ for PM_{10} and 15 $\mu g/m^3$ for $PM_{2.5}$ (Agency for Toxic Substances and Disease Registry 2003).[2] Similar predictions were made for St. Mary's County, Maryland (on the Chesapeake Bay), where chaff releases contribute no more than 0.008 percent of total particulate matter emissions (Arfsten et al. 2001). Therefore, chaff is not further evaluated as an air quality stressor in this EIS/OEIS.

As discussed in Section 3.1.3.3.6 (Chemical and Biological Simulants), chemical and biological simulant testing is performed against surface ships to verify the integrity of the ship's defense system, including installed detection, protection, and decontamination systems. Methods of simulant delivery include aerial dispersal and hand-held spray. The chemical and biological simulants are neither hazardous air pollutants nor criteria pollutants under the Clean Air Act. Depending on the particular simulant, up to 20 gallons of chemical simulant or 5 kg (dry weight) of biological simulant may be released into the air for the tests. Analysis of simulant testing on the Potomac River Test Range is informative to the AFTT EIS/OEIS analysis in that the type and quantity of a simulant employed during a test at the Potomac River Test Range is comparable to the type and quantity of simulant proposed for testing within the AFTT Study Area. Furthermore, the Potomac River Test Range analysis was conducted within a metropolitan region, a portion of which is designated as an ozone nonattainment area. In contrast, the majority of the AFTT Study Area is unclassified or designated in attainment of the National Ambient Air Quality Standards. Dispersion modeling conducted as a part of the Potomac River Test Range analysis showed that simulant concentrations decrease rapidly after release, with concentrations returning to undetectable levels within minutes (Driscoll and Neil 2009). Actual exposure concentrations of simulants are likely to be lower than predicted based on previous dispersion modeling and field tests conducted (Bossart 2006; Driscoll et al. 2004). Chemical and biological simulant testing may result in negligible, long-term, direct and indirect, negative air quality impacts. Therefore, chemical and biological simulants are not further evaluated as an air quality stressor in this EIS/OEIS.

The Proposed Action includes testing activities in select pierside nonattainment areas for O_3. The NEPA analysis includes a Clean Air Act General Conformity Analysis to support a determination pursuant to the General Conformity Rule (40 C.F.R. Part 93B). This analysis focuses on training and testing activities that could impact nonattainment or maintenance areas within the Region of Influence. As noted above, the Study Area lies partly within certain air basins of this classification (e.g., Hampton Roads Intrastate Air Quality Control Region, the Metropolitan Providence Interstate Air Quality Control Region, and the Metropolitan Portland Intrastate Air Quality Control Region). To evaluate the conformity of the Proposed Action with the State Implementation Plan elements of each air quality control region, air pollutant emissions within the applicable states are estimated, based on an assumed distribution of the proposed training and testing activities within these respective portions of the Study Area. The Clean Air Act Conformity Applicability Analysis addresses the applicability of the General Conformity Rule.

Air pollutant emissions outside U.S. territorial seas are estimated and their potential impacts on air quality are assessed through the EO 12114 compliance analysis. Emissions outside U.S. territorial seas are calculated in the same manner as emissions over territorial waters. The General Conformity Rule

[2] The current standard for PM_{10} is 150 $\mu g/m^3$ over a 24-hour average time (See Table 3.2-1).

does not apply to activities outside of U.S. territorial seas because the Clean Air Act does not apply to actions outside of the United States.

Data for the air quality analysis are based, wherever possible, on information from Navy subject matter experts and established training and testing requirements. These data were used to estimate the numbers and types of aircraft, surface ships and vessels, submarines, and munitions (i.e., potential sources of air emissions) that would be involved in training and testing activities under each alternative. Emissions sources and the approach used to estimate emissions under the No Action Alternative, Alternative 1, and Alternative 2 are presented herein.

3.2.1.4 Emissions Estimates

3.2.1.4.1 Aircraft Activities

To estimate aircraft emissions, the operating modes, number of hours of operation, and type of engine for each type of aircraft were evaluated. For estimating purposes, training and testing aircraft flights are assumed to originate offshore from aircraft carriers or other Navy vessels outfitted with flight decks. Emissions associated with airfield or air station operations ashore are analyzed within the home-basing environmental planning process (e.g., environmental impact statements or environmental assessments for (1) Introduction of F/A-18 E/F (Super Hornet) Aircraft to the East Coast of the United States (U.S. Department of the Navy 2003); (2) Introduction of the P-8A Multi-Mission Aircraft into the U.S. Navy Fleet (U.S. Department of the Navy 2008); and (3) Transition of E-2C Hawkeye to E-2D Advanced Hawkeye at Naval Station Norfolk, Virginia and Naval Base Ventura County Point Mugu, California (U.S. Department of the Navy 2009). All aircraft are assumed to travel to and from training and testing ranges at or above 3,000 ft. (914 m) above mean sea level and, therefore, their transits to and from the ranges do not affect surface air quality. Air combat maneuvers and air-to-air missile exercises are primarily conducted at altitudes well in excess of 3,000 ft. (914 m) above mean sea level and, therefore, are not included in the estimated emissions of criteria air pollutants. Activities or portions of those training or testing activities occurring below 3,000 ft. (914 m) are included in emissions estimates. Examples of activities typically occurring below 3,000 ft. (914 m) include those involving helicopter platforms such as mine warfare, anti-surface warfare, and anti-submarine warfare training and testing activities. The list of all training and testing activities and the estimated time spent above or below 3,000 ft. (914 m) for calculation purposes is included in the air quality emissions estimates presented in Appendix D (Air Quality Example Emissions Calculations and Example Record of Non-Applicability).

The types of aircraft used and the numbers of sorties flown under the No Action Alternative are derived from previously conducted environmental analysis. The types of aircraft identified include the typical aircraft platforms that conduct a particular training or testing exercise (or the closest surrogate when information is not available), including range support aircraft (e.g., non-Navy commercial air services). For Alternatives 1 and 2, estimates of future aircraft sorties are based on evolutionary changes in the Navy's force structure and mission assignments. Where there are no major changes in types of aircraft, future activity levels are estimated from the distribution of baseline activities. The types of aircraft used in each training or testing activity and numbers of sorties flown by such aircraft are presented in Appendix D (Air Quality Example Emissions Calculations and Example Record of Non-Applicability).

Time on range (activity duration) under the No Action Alternative was calculated from average times derived from range records and Navy subject matter experts. To estimate time on range for each aircraft activity in Alternatives 1 and 2, the average flight duration approximated in the baseline data was used in the calculations. Estimated altitudes of activities for all aircraft were obtained from aircrew members in operational squadrons. Several testing activities are similar to training activities, and therefore similar assumptions were made for such activities in terms of aircraft type, altitude, and flight duration. Table 2.4-2 lists Naval Air Systems Command testing activities similar to certain training activities. Where aircraft testing activities were dissimilar to training activities, assumptions for time on range were derived from Navy subject matter experts.

Air pollutant emissions were estimated based on the Navy's Aircraft Environmental Support Office Memorandum Reports for individual aircraft categories (Aircraft Emission Estimates: Mission Operations). When Aircraft Environmental Support Office emission factors were not available, emission factors were obtained from other published sources.

The emissions calculations performed for each alternative conservatively assume that each aircraft training and testing activity listed in Tables 2.8-1 to 2.8-3 is separately conducted. In practice, a testing activity may be conducted during a training flight. It is also probable that two or more training activities may be conducted during one flight (e.g., chaff or flare exercises may occur during electronic warfare activities; or air-to-surface gunnery and air-to-surface bombing activities may occur during a single flight operation). Conservative assumptions may produce elevated aircraft emissions calculations but accounts for the possibility, however remote, that each aircraft training and testing activity is separately conducted.

3.2.1.4.2 Surface Ship Activities

Marine vessel traffic in the Study Area includes military ship and boat traffic, unmanned surface vessels, and range support vessels providing services for military training and testing activities. Nonmilitary commercial vessels and recreational vessels are also regularly present. These commercial vessels are not evaluated in the air quality analysis because they are not part of the Proposed Action. The methods for estimating marine vessel emissions involve evaluating the type of activity, the number of hours of operation, the type of propulsion, and the type of onboard generator for each vessel type.

The types of surface ships and numbers of activities for the No Action Alternative are derived from range records and Navy subject matter experts regarding vessel participant data. For Alternatives 1 and 2, estimates of future ship activities are based on anticipated evolutionary changes in the Navy's force structure and mission assignments. Where there are no major changes in types of ships, estimates of future activities are based on the historical distribution of ship activities.

For surface ships, the durations of activities were estimated by taking an average over the total number of activities for each type of training and testing. Emissions for baseline activities and for future activities were estimated based on discussions with exercise participants. In addition, information provided by participants in surface ship activity was used to develop a breakdown of time spent at each operational mode (i.e., power level) used during activities in which marine vessels participated. Several testing activities are similar to training activities, and therefore similar assumptions were made for such activities in terms of vessel type, power level, and event duration.

Emission factors for marine vessels were obtained from the database developed for Naval Sea Systems Command by John J. McMullen Associates, Inc. (John J. McMullen Associates 2001). Emission factors were provided for each marine vessel type and power level. The resulting calculations provided information on the time spent at each power level in each part of the Study Area, emission factors for that power level (in pounds of pollutant per hour), and total emissions for each marine vessel for each operational type and mode.

The pollutants for which calculations are made include exhaust total hydrocarbons, CO, NO_x, PM, CO_2, and SO_2. For non-road engines, all particulate matter emissions are assumed to be smaller than PM_{10}, and 92 percent of the particulate matter from gasoline and diesel-fueled engines is assumed to be smaller than $PM_{2.5}$ (U.S. Environmental Protection Agency 2002). For gaseous-fueled engines (liquefied petroleum gas/compressed natural gas), 100 percent of the particulate matter emissions are assumed to be smaller than $PM_{2.5}$ (U.S. Environmental Protection Agency 2002).

The emissions calculations performed for each alternative conservatively assume that each vessel training and testing activity listed in Chapter 2 (Description of Proposed Action and Alternatives), Tables 2.8-1 to 2.8-3 is separately conducted and separately produces vessel emissions. In practice, one or more testing activities may take advantage of an opportunity to travel at sea and test aboard a vessel conducting a related or unrelated training activity. It is also probable that two or more training activities may be conducted during one training vessel movement (e.g., a ship may conduct large-, medium-, and small-caliber surface-to-surface gunnery exercises during one vessel movement). Furthermore, multiple unit level training activities may be conducted during a larger composite training unit exercise. Conservative assumptions may produce elevated vessel emissions calculations but accounts for the possibility, however remote, that each training and testing activity is separately conducted.

3.2.1.4.3 Submarine Activities

No U.S. submarines burn fossil fuel under normal operating conditions. Therefore, no air pollutants are emitted during submarine training or testing activities.

3.2.1.4.4 Naval Gunfire, Missiles, Bombs, Other Munitions, and Military Expended Material

Naval gunfire, missiles, bombs, and other types of munitions used in training and testing activities emit air pollutants. To estimate the amounts of air pollutants emitted by ordnance during its use, the numbers and types of munitions used during training or testing activities are first totaled. Then generally accepted emissions factors (AP-42, Compilation of Air Pollutant Emission Factors, Chapter 15: Ordnance Detonation ([U.S. Environmental Protection Agency 1995]) for criteria air pollutants are applied to the total amounts. Finally, the total amounts of air pollutants emitted by each munition type are summed to produce total amounts of each criteria air pollutant under each alternative.

Certain proposed Navy training and testing activities involve the expenditure of chaff bundles from both aircraft and vessels at sea. Such activities include air combat maneuvers, electronic warfare activities, chaff exercises, air-to-air weapons system tests, air-to-air missile tests, chaff tests, electronic system evaluations, vertical launch system tests, and combat system ship qualification trial–air defense tests. PM_{10} and $PM_{2.5}$ emissions are estimated, and their concentrations are monitored by the USEPA because they are inhalable and thus have a potential negative human health effect. Because virtually all chaff fibers retain a size greater than PM_{10} upon expenditure, impacts on air quality in terms of particulate matter in the Study Area are not separately evaluated in this EIS/OEIS.

3.2.1.5 Sensitive Receptors

Identification of sensitive receptors is part of describing the existing air quality environment. Sensitive receptors are residential areas, schools, parks, hospitals, or other sites for which there is a reasonable expectation of continuous human exposure during the timeframe coinciding with peak pollution concentrations. On the oceanic portions of the Study Area, crews of commercial vessels and recreational users of the northern Atlantic Ocean and Gulf of Mexico could encounter the air pollutants generated by the Proposed Action, but few such individuals are expected to be present and the duration of substantial exposure to these pollutants is limited because the areas are cleared of nonparticipants before event commencement. These potential receptors are not considered sensitive.

3.2.1.6 Climate Change

Greenhouse gases are compounds that contribute to the greenhouse effect—a natural phenomenon in which gases trap heat within the lowest portion of the earth's atmosphere (surface-troposphere system), causing heating (radiative forcing) at the surface of the earth. The primary long-lived greenhouse gases directly emitted by human activities are CO_2, methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride (SF_6). CO_2, CH_4, and N_2O occur naturally in the atmosphere. However, their concentrations increased from the preindustrial era (1750) to 2007–2008: CO_2 (38 percent), CH_4 (149 percent), and N_2O (23 percent) (U.S. Environmental Protection Agency 2009b). These gases influence the global climate by trapping heat in the atmosphere that would otherwise escape to space. The heating effect from these gases is considered the probable cause of the global warming observed over the last 50 years (U.S. Environmental Protection Agency 2009b). Global warming and climate change affect many aspects of the environment. Not all effects of greenhouse gases are related to climate. For example, elevated concentrations of CO_2 can lead to ocean acidification and stimulate terrestrial plant growth, and CH_4 emissions can contribute to higher ozone levels.

The administrator of the USEPA determined that six greenhouse gases taken in combination endanger both the public health and the public welfare of current and future generations. The USEPA specifically identified CO_2, CH_4, N_2O, hydrofluorocarbons, perfluorocarbons, and SF_6 as greenhouse gases ([U.S. Environmental Protection Agency 2009f); 74 Federal Register 66496, 15 December 2009].

To estimate global warming potential, the United States quantifies greenhouse gas emissions using the 100-year timeframe values established in the Intergovernmental Panel on Climate Change Second Assessment Report (Intergovernmental Panel on Climate Change 1995), in accordance with United Nations Framework Convention on Climate Change (United Nations Framework Convention on Climate Change 2004) reporting procedures. All global warming potentials are expressed relative to a reference gas, CO_2, which is assigned a global warming potential equal to 1. The five other greenhouse gases have global warming potentials of 21 for CH_4, 310 for N_2O, 140 to 6,300 for hydrofluorocarbons, 6,500 to 9,200 for perfluorocarbons, and up to 23,900 for SF_6. To estimate the CO_2 equivalency of a non-CO_2 greenhouse gas, the appropriate global warming potential of that gas is multiplied by the amount of the gas emitted. All six greenhouse gases are multiplied by their global warming potential and the results are added to calculate the total equivalent (Eq) emissions of CO_2 (CO_2 Eq). The dominant greenhouse gas emitted is CO_2, mostly from fossil fuel combustion (85.4 percent) (U.S. Environmental Protection Agency 2009d). Weighted by global warming potential, CH_4 is the second largest component of emissions, followed by N_2O. Global warming potential-weighted emissions are presented in terms of equivalent emissions of CO_2, using units of teragrams (1 million metric tons or 1 billion kilograms [Tg]) of carbon dioxide equivalents (Tg CO_2 Eq). The Proposed Action is anticipated to release greenhouse gases to the atmosphere. These emissions are quantified (using methods elaborated upon in the Federal Greenhouse Gas Accounting and Reporting Guidance Technical Support Document (Council on Environmental Quality 2010) for the proposed Navy training and testing in the Study Area, and estimates are presented in Chapter 4.

The potential effects of proposed greenhouse gas emissions are by nature global and may result in cumulative impacts because individual sources of greenhouse gas emissions are not large enough to have any noticeable effect on climate change. Therefore, the impact of proposed greenhouse gas emissions to climate change is discussed in the context of cumulative impacts in Chapter 4.

3.2.1.7 Other Compliance Considerations, Requirements, and Practices

3.2.1.7.1 Executive Order 12088

EO 12088, *Federal Compliance with Pollution Control Standards*, requires each federal agency to comply with applicable pollution control standards, defined as, "the same substantive, procedural, and other requirements that would apply to a private person." The EO further requires federal agencies to cooperate with USEPA, state, and local environmental regulatory officials.

3.2.1.7.2 Chief of Naval Operations Instruction 5090.1

The Navy developed Chief of Naval Operations Instruction 5090.1 series, which contains instruction for environmental evaluations. Chapter 7 and Appendix F of this series contain guidance for air quality analysis and general conformity determinations. The analysis in this EIS/OEIS was performed in compliance with this instruction.

3.2.1.7.3 Current Requirements and Practices

Equipment used by military units in the Study Area, including ships and other marine vessels, aircraft, and other equipment, are properly maintained and fueled in accordance with applicable Navy requirements. Operating equipment meets federal and state emission standards, where applicable. For example, in accordance with the Chief of Naval Operations Instruction 5090.1 series, Chapter 7, Navy commands shall comply with Navy and regulatory requirements for composition of fuels used in all motor vehicles, equipment, and vessels. To prevent misfueling, installations shall enforce appropriate controls to ensure that any fuel that does not meet low-sulfur requirements is not dispensed to commercial motor vehicles, equipment, or vessels not covered under a national security exemption.

3.2.2 AFFECTED ENVIRONMENT

3.2.2.1 Region of Influence

The region of influence for air quality is a function of the type of pollutant, emission rates of the pollutant source, proximity to other emission sources, and local and regional meteorology (Figure 3.2-4 for a map of the nonattainment areas in the vicinity of the Study Area). For inert pollutants (all pollutants other than O_3 and its precursors), the region of influence is generally limited to a few miles downwind from the source. For a photochemical pollutant such as O_3, however, the region of influence may extend much farther downwind. O_3 is a secondary pollutant formed in the atmosphere by photochemical reactions of previously emitted pollutants, or precursors (volatile organic compounds and NO_X). The maximum effects of precursors on O_3 levels tend to occur several hours after the time of emission during periods of high solar load, and may occur many miles from the source. O_3 and O_3 precursors transported from other regions can also combine with local emissions to produce high local O_3 concentrations. Therefore, the region of influence for air quality includes the Study Area as well as adjoining land areas several miles inland, which may from time to time be downwind from emission sources associated with the Proposed Action.

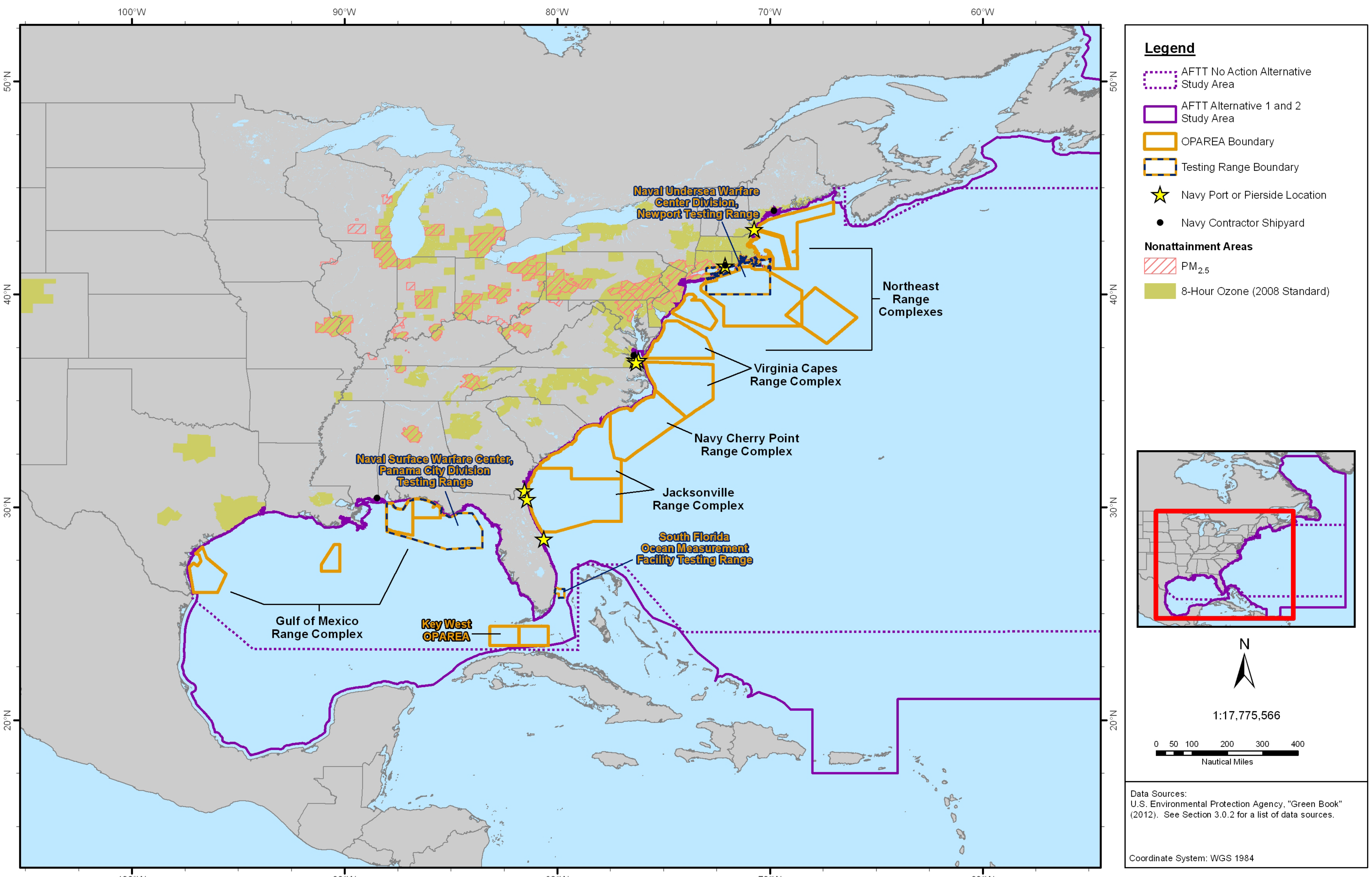

Figure 3.2-4: Nonattainment Areas in the Vicinity of the Study Area

Source: (U.S. Environmental Protection Agency 2009c). Notes: $PM_{2.5}$ = particulate matters ≤ 2.5 microns
AFTT: Atlantic Fleet Training and Testing; OPAREA: Operating Area

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3.2.2.2 Climate of the Study Area

The climatic conditions in the Study Area provide background on factors influencing air quality. Climate zones within the Study Area vary with latitude or region. For air quality, the Study Area can be divided into four areas: the North Atlantic Region (Arctic region to Nova Scotia), the Mid-Atlantic Region (Maine to Virginia), the Southeast Atlantic Region (North Carolina to southern Florida) and the Gulf of Mexico Region (southern Florida to Texas).

The climate is arctic near the 65-degree north latitude line and tropical at the 20-degree north latitude line, but most activities and their potential effects would occur in the northern temperate to subtropical climate zones between Maine, Florida, and the gulf coast.

The climate of the offshore Atlantic Ocean and adjacent land areas is influenced by the temperatures of the surface waters and water currents as well as by wind blowing across the water. Offshore climates are moderate and seldom have extreme seasonal variations because the ocean is slow to change temperature. Ocean currents of the Atlantic Ocean (i.e., Labrador, Gulf Stream, North Atlantic Drift, Canary, and North Equatorial) influence climate by moving warm and cold water between regions. Adjacent land areas are affected by wind that is cooled or warmed when blowing over these currents. In addition to its influence on temperature, the wind moves evaporated moisture from the ocean to adjacent land areas and is a major source of rainfall.

Atmospheric stability and mixing height provide a measure of the amount of vertical mixing of pollutants. Over water, the atmosphere tends to be neutral to slightly unstable because heat and moisture flow into the area. Over land, the atmospheric stability is more variable, being unstable during the daytime, especially in the summer due to rapid surface heating, and stable at night, especially under clear conditions in the cooler season. The mixing height over water typically ranges from 1,640 to 3,281 ft. (500 to 1,000 m), with a slight daily variation (Holzworth 1972). Mixing height over land can be 4,921 ft. (1,500 m) or greater during the afternoon in summer and near zero during clear, calm conditions at night in winter. For this EIS/OEIS, 3,000 ft. (914 m) is used as the typical maximum afternoon mixing height.

3.2.2.2.1 Newfoundland-Labrador Shelf and Scotian Shelf

In the North Atlantic (Newfoundland-Labrador Shelf and Scotian Shelf) winter begins (when daily temperatures average 32°F [0°C]) as early as mid-August in the Labrador Sea or as late as October 1 off the coast of the island of Newfoundland (Canadian Coast Guard 2010). Winter ends in this region in mid-June. Sea ice begins to grow shortly after the onset of winter as average sea temperatures reach 29°F to 35°F (-1.7°C to 1.7°C). Polar lows usually occur during the fall, winter, and early spring. Polar lows form near the ice edge or coast where very cold air flows from ice or land surfaces over open water, which is warm relative to the air temperature. Polar lows are often accompanied by strong winds (the winds generally blow from west to east) and areas of moderate to heavy precipitation. A polar low can form in as few as 12 hours and seldom lasts more than a day. However, under stagnant weather systems, polar lows or a family of polar lows can persist for several days. In the Labrador Sea, the main cause of vessel icing is freezing spray. Freezing spray is also responsible for the heaviest ice accretions. Arctic sea smoke can accompany spray icing if air temperatures are very cold. Vessel icing reports from east coast waters show that combined spray and fog icing conditions are more frequently experienced in the Labrador Sea. The potential for spray icing exists from October to May.

3.2.2.2.2 Northeast United States Continental Shelf

Along the coasts of Maine to New Jersey, the most frequent wind directions measured by buoys are from the west or west-northwest, but wind can come from any direction (Department of Commerce 2010). The average wind speeds are between 12.4 and 16.2 miles per hour (mph) (20 to 26 kilometers per hour [kph]). Wind speeds are typically lowest in July at 9.0 to 12.1 mph (15 to 20 kph), and highest in January at 15.7 to 20.0 mph (25 to 32 kph).

Annual average air temperature ranges from 47°F to 60°F (8.3°C to 15.6°C) along the coast of Maine to New Jersey (Department of Commerce 2010). Seasonal variations in temperature are greatest during the winter months. In January and February, the ambient temperature averages 28°F (-2.2°C) along the coast of Maine to New Jersey. During the warmer months, there is little daily variation in temperature. In August, the average temperature is 75°F (23.9°C) along the coast of this region.

Along the coasts of Maine to New Jersey, precipitation is frequent and abundant but occurs evenly throughout the year (Minerals Management Service 2007). Average annual rainfall along the Atlantic coast ranges from about 42 inches (in.) (107 centimeters [cm]) in Block Island, Rhode Island, to 58 in. (147 cm) in Miami, Florida. Rainfall in the warmer months is usually associated with cloud systems that produce showers and thunderstorms. Winter rains are associated with the passage of frontal systems through the eastern seaboard. Precipitation also falls as snow along the coasts of Maine to New Jersey. The highest snowfall among coastal U.S. areas within the Study Area occurs in Portland, Maine, with a maximum monthly average of 62.4 in. (158 cm).

3.2.2.2.3 Southeast United States Continental Shelf

Off the coast of North Carolina, the prevailing winds are from south to southwest, with average wind speeds between 13 to 16 mph (21 to 26 kph). Off the coasts of South Carolina and Georgia, the prevailing wind direction is from south to southwest, and from southeast to east-southeast off of Florida. Average wind speeds range from 12 to 14 mph (20 to 23 kph), and wind speeds exhibit smaller monthly variations than northern coastal states.

Annual average air temperatures range from 70°F to 75°F (21°C to 24°C) along the coast of the Southeast U.S. Continental Shelf (Department of Commerce 2010). In January and February, ambient temperatures average 55°F (13°C) along the coast of the Southeast U.S. Continental Shelf. During the warmer months, there is little daily variation in temperature. In August, average temperatures are 83°F (29°C) along the coast of this region. Air temperatures over the southern coast and offshore Atlantic Ocean have smaller daily and seasonal ranges than temperatures over inland areas because the ocean, which is slow to change temperature, has an important influence on ocean and coastal atmospheric temperatures.

At various locations along the Atlantic coast, fog occurs occasionally in the cooler months as a result of warm, moist air from the Gulf of Mexico blowing over cool land or water surfaces. The poorest visibility occurs from November through April. During periods of air stagnation, industrial pollution and agricultural burning also can affect visibility.

In the Southeast U.S. Continental Shelf coastal areas (generally from North Carolina to Florida), precipitation is frequent and abundant throughout the year, but tends to peak in the summer months.

Hurricanes develop in the southern part of the Atlantic Ocean. Hurricane season in the Atlantic Ocean runs from June to November, with a peak in mid-September. Most storms form in warm waters several hundred miles north of the equator. Once a tropical system forms, it usually travels west and slightly north while strengthening. Many storms curve to the northeast near the Florida peninsula. The Atlantic basin averages about 10 storms of tropical storm strength or greater per year; about half reach hurricane level (Department of Commerce 2005). Storms weaken as they encounter cooler water, land, or vertical wind shear, sometimes slowing to an extra-tropical storm, mostly affecting northern Atlantic coastal areas.

3.2.2.2.4 Gulf of Mexico

The climate of the Gulf of Mexico is influenced mainly by the clockwise circulation around the semi-permanent area of high barometric pressure commonly known as the Bermuda High (U.S. Department of the Interior 2002). The Gulf of Mexico is southwest of this center of circulation. This high-pressure system results in a predominantly southeasterly wind flow in the Gulf of Mexico. Two important classes of storms occasionally occur with this circulation pattern. During the winter months, cold fronts associated with cold air masses from land influence the northern coast of the Gulf of Mexico. Behind the fronts, strong north winds bring drier air into the region. Secondly, hurricanes may develop in or migrate into the Gulf of Mexico during the warmer months. These storms may affect any area of the Gulf of Mexico and substantially change the local wind circulation around them. In coastal areas, the sea breeze may become the primary circulation feature during the summer months. Conversely, land breezes (particularly at night) transport air pollutants from land to offshore areas. Locally, the land breeze diminishes as more heat is retained within large, growing coastal cities (National Science Foundation 2011). In general, however, the subtropical maritime climate is the dominant feature driving all aspects of the weather in this region. As a result, the climate shows very little daily or seasonal variation (U.S. Department of the Interior 2002).

Average air temperatures at Gulf of Mexico coastal locations (Texas to Florida) vary with latitude and exposure. Air temperatures range from highs in the summer of 88°F to 96°F (31°C to 6°C) to lows in the winter of 37°F to 59°F (3°C to 15°C) (U.S. Department of the Interior 2002). Temperatures depend on the frequency and intensity of polar air masses from the north. Air temperatures over the open waters of the Gulf of Mexico are more moderate and have smaller daily and seasonal temperature ranges than land temperatures because the Gulf of Mexico is slow to change temperature (Minerals Management Service 2006). The average temperature over the center of the Gulf of Mexico is about 84°F (29°C) in the summer and between 63°F to 73°F (17°C to 23°C) in the winter (Minerals Management Service 2006).

In the Gulf of Mexico portion of the Study Area, precipitation is frequent and abundant throughout the year (U.S. Department of the Interior 2002). Stations along the entire gulf coast record the highest precipitation values during the warmer months of the year. The warmer months usually have cloud systems that produce showers and thunderstorms; however, these thunderstorms rarely cause any damage or have hail (U.S. Department of the Interior 2002). The month of maximum rainfall for most locations in the Gulf of Mexico is July. Winter rains often come with frontal systems passing through the area. Rainfall is generally light, steady, and relatively continuous, often lasting several days. Snowfall is rare, and when snow or sleet does occur, it usually melts on contact with the ground. The chance for snow or sleet decreases with distance offshore, rapidly reaching zero.

Hurricanes affecting the Gulf of Mexico form near the equator in the Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico (U.S. Department of the Interior 2002). Data from 1886 to 1986 show that almost half (44.5 percent) of these hurricanes, or 3.7 storms per year, will affect the Gulf of Mexico (U.S. Department of the Interior 2002).

3.2.2.3 Regional Emissions

Few studies document pollutant emissions within the vast offshore expanse of the Study Area. However, one 2008 study of emissions within the Gulf of Mexico portion of the Study Area provides insight to the many emission sources within that region. The 2008 Gulfwide Emission Inventory indicates that outer continental shelf oil and gas production platform and nonplatform sources emit the majority of criteria pollutants and greenhouse gases in the Gulf of Mexico. PM, SO_2 (primarily emitted from commercial marine vessels) and N_2O (from biological sources) are exceptions (Wilson et al. 2010). The outer continental shelf oil and gas production platform and nonplatform sources account for 93 percent of the total CO emissions, 74 percent of NO_x emissions, 76 percent of volatile organic compound emissions, 99 percent of methane emissions, and 84 percent of CO_2 emissions. Natural gas engines on platforms were the largest CO emission sources, accounting for 60 percent of the estimated total. Support vessels were the largest emitters for NO_x accounting for 35 percent of the estimated total. Platform vents and fugitive sources accounted for the highest percentage of the volatile organic compounds and methane emissions. Support vessels (29 percent of total emissions), platform natural gas turbines (15 percent of total emissions), and drilling rigs (12 percent of total emissions) emitted the majority of the CO_2 emissions. The summary of this 2008 inventory is presented in Table 3.2-3.

The 2008 Gulfwide Emission Inventory noted that military vessels accounted for a small percentage of the total gulfwide criteria pollutant emissions. The percentage contribution from all military vessels (Navy and non-Navy) is shown in Table 3.2-4. The military vessel percentage contribution of criteria pollutant emissions to total emissions from all sources is less than 2.5 percent for each criteria pollutant.

Table 3.2-3: Total Platform and Nonplatform Emissions Estimates for Criteria Pollutants (Gulf of Mexico)

Equipment / Source Category	Emissions (TPY)					
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Total Platform	82,651	75,117	689	679	1,028	65,423
Drilling Rigs	5,343	58,288	971	971	7,772	971
Pipelaying Operations	2,186	10,535	398	398	1,789	398
Support Helicopters	13,636	1,114	217	217	275	2,693
Support Vessels	12,880	135,222	2,342	2,342	18,221	2,342
Survey Vessels	141	1,690	26	26	204	26
Total Outer Continental Shelf Oil/Gas Production	116,837	281,966	4,643	4,633	29,289	71,853
Total Non-Outer Continental Shelf Oil/Gas Production	8,432	100,880	7,004	6,481	52,022	22,442
Total	**125,269**	**382,846**	**11,647**	**11,114**	**81,311**	**94,295**

Source: (Wilson et al. 2010)

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns; PM_{10}: particulate matter ≤ 10 microns; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Totals may not sum due to rounding. Table includes criteria pollutant precursors (e.g., VOC).

Table 3.2-4: Estimated Gulfwide Criteria Pollutant Emissions Estimates (All Sources)

Equipment / Source Category	Emissions (TPY)					
	CO	NO_x	PM_{10}	$PM_{2.5}$	SO_x	VOC
Boilers/heaters/burners	716	1,482	26	17	9	46
Combustion Flares	1,315	257	2	2	2	22
Commercial Fishing Vessels	681	8,120	124	124	988	124
Commercial Marine Vessels	6,593	79,329	6,603	6,080	49,009	2,794
Diesel Engines	1,816	7,463	308	307	715	353
Drilling Equipment	549	2,072	37	36	262	52
Drilling Rigs	5,343	58,288	971	971	7,772	971
Louisiana Offshore Oil Platform	136	1,832	33	33	219	40
Military Vessels	702	8,539	158	158	1,409	130
Natural Gas Engines	75,408	52,736	250	250	15	1,312
Natural Gas Turbines	2,847	11,107	66	66	21	73
Pipelaying Operations	2,186	10,535	398	398	1,789	398
Support Helicopters	13,636	1,114	217	217	275	2,693
Support Vessels	12,880	135,222	2,342	2,342	18,221	2,342
Survey Vessels	141	1,690	26	26	204	26
Vessel Lightering	320	3,060	86	86	397	4,423
Total	**125,269**	**382,846**	**11,647**	**11,114**	**81,311**	**94,295**
Military Vessels as a Percentage of Total Gulfwide Criteria Pollutant Emissions	**0.56%**	**2.23%**	**1.36%**	**1.42%**	**1.73%**	**0.14%**

Source: (Wilson et al. 2010)

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns; PM_{10}: particulate matter ≤ 10 microns; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Note: In this table, not all VOC source categories are listed in order to display only like sources. The VOC sources were cold vents, fugitives, and biogenic and geogenic sources. Table includes criteria pollutant precursors (e.g., VOC).

Unknown quantities of air pollutants are emitted by commercial and recreational aircraft and vessels operating in the Study Area. The types of air pollutants emitted from vessels operating in the Study Area can include CO, NO_x, SO_x and PM from diesel fuel combustion (Markle and Brown 1995) and CO, NO_x, SO_x, polycyclic aromatic hydrocarbons, and formaldehyde from Jet Propellant-8 combustion (Ritchie et al. 2001). Other common fuels combusted by recreational aircraft and vessels include 100-Low-Lead (resulting in lead emissions in addition to those previously listed) and gasoline.

Given the prevailing wind directions in many parts of the Study Area, air pollutants generated in adjacent urban or industrial land areas can negatively affect air quality in the Study Area. In the northeastern United States, urban areas are large area sources of air pollutants, but these pollutants readily disperse during warm weather. In winter, when ground-based inversions are common, air pollutants from urban sources such as wood-burning stoves and automobiles become concentrated near the ground where their concentrations may exceed health-based air quality standards. In rural areas, mining, gas and coal extraction, and other extractive industries are major point sources of air pollutants, as are large wildfires in the southeastern United States.

3.2.2.4 Existing Air Quality

As a whole, the air quality of the Study Area is very good. As shown on Figure 3.2-4, most 8-hour ozone and $PM_{2.5}$ nonattainment areas in the eastern half of the continental United States are in the northeastern states or inland, urban, industrialized areas. This condition results from the relatively low number of air pollutant sources, size, and topography of the Study Area, and prevailing meteorological conditions. In general, air quality in the coastal counties of the lower-middle and southern Atlantic is in attainment of the National Ambient Air Quality Standards. Coastal counties near offshore training and testing areas in the Gulf of Mexico, and coastal counties near offshore training and testing areas along the southeastern United States are in attainment for all criteria pollutants (U.S. Environmental Protection Agency 2011b). None of the coastal counties in this region (lower-middle and southern Atlantic counties) are subject to the 8-hour O_3 standard, and all counties meet the National Ambient Air Quality Standards for SO_2, NO_2, and Pb.

In the Hampton Roads, Virginia area (in the vicinity of Naval Station Norfolk on Figure 3.2-4), concentrations of air pollutants, except O_3, are within the National Ambient Air Quality Standards. The Hampton Roads area is in attainment (maintenance) of the 1997 8-hour ozone National Ambient Air Quality Standards. The two Virginia counties on the Delmarva Peninsula, Accomack and Northampton Counties, are in attainment of the 8-hour O_3 standard.

Some other coastal counties in mid-Atlantic and northeastern states, however, are in nonattainment for O_3 or $PM_{2.5}$.

- New York County in New York is in nonattainment for PM_{10} and coastal counties in Connecticut, New Jersey, and New York are in nonattainment for both O_3 and $PM_{2.5}$. O_3 is a regional air pollutant issue. Emission controls are needed for local and regional sources to reduce ambient O_3 levels. Prevailing southwest to west winds carry air pollution from the Ohio River Valley, where major NO_x emission sources (e.g., power plants) are located, and from mid-Atlantic metropolitan areas, to the northeast, contributing to high-O_3 episodes.
- Some near-coastal areas between Delaware and Massachusetts are classified as marginal nonattainment areas for the 2008 8-hour O_3 Standard. Eight-hour O_3 nonattainment areas include Philadelphia-Wilmington-Trenton, Pennsylvania-Delaware-New Jersey-Maryland; New York-New York, New Jersey-Long Island, New York-New Jersey-Connecticut; Greater Connecticut, Connecticut; and Boston-Worcester-Manchester, Massachusetts-New Hampshire. Of these O_3 nonattainment areas, nonattainment areas for $PM_{2.5}$ are limited to Philadelphia-Wilmington-Trenton, Pennsylvania-Delaware-New Jersey-Maryland and New York-New York, New Jersey-Long Island, New York-New Jersey-Connecticut.

With the exception of the Houston-Galveston-Brazoria metropolitan region (an eight-county area in marginal nonattainment of the 2008 H-hour O_3 standard), Gulf of Mexico coastal counties are in attainment for all criteria pollutants. Coastal counties near offshore training and testing areas in the Gulf of Mexico, and coastal counties near offshore training and testing areas along the southeastern United States, are in attainment for all criteria pollutants.

Among the training and testing locations within the Study Area, several of the northeastern United States pierside surface ship and submarine sonar maintenance and testing locations are within nonattainment or maintenance areas. Table 3.2-5 lists Study Area pierside locations and the attainment status for each.

Table 3.2-5: Pierside Locations and Their Corresponding Air Quality Control Region's Attainment Status

Pierside Location	Air Quality Control Region	National Ambient Air Quality Standards (NAAQS) Attainment Status
Portsmouth Naval Shipyard, Kittery Maine Shipyard – Bath, Maine	Metropolitan Portland Intrastate	In attainment (maintenance) of the 8-hr ozone NAAQS Attainment of all other applicable NAAQS
Naval Submarine Base New London, Groton, Connecticut Shipyard – Groton, Connecticut	Greater Connecticut	Marginal nonattainment (8-hr ozone) Attainment of all other applicable NAAQS
Naval Undersea Warfare Center, Division, Newport, Newport, Rhode Island	Metropolitan Providence Interstate	In attainment (maintenance) of the 8-hr ozone NAAQS Attainment of all other applicable NAAQS
Naval Station Norfolk, Norfolk, Virginia Joint Expeditionary Base Little Creek-Fort Story, Virginia Beach, Virginia Norfolk Naval Shipyard, Portsmouth, Virginia Shipyard – Newport News, Virginia	Hampton Roads Intrastate	In attainment (maintenance) of the 8-hr ozone NAAQS Attainment of all other applicable NAAQS
Naval Submarine Base Kings Bay, Georgia Naval Station Mayport, Jacksonville, Florida	Jacksonville (Florida)-Brunswick (Georgia) Interstate	Attainment of all applicable NAAQS
Port Canaveral, Cape Canaveral, Florida	Central Florida Intrastate	Attainment of all applicable NAAQS
Shipyard – Pascagoula, Mississippi	Mobile (Alabama)-Pensacola-Panama City (Florida)-Southern Mississippi Interstate	Attainment of all applicable NAAQS

Source: 40 C.F.R. Part 81 and (U.S. Environmental Protection Agency 2011a)
NAAQS: National Ambient Air Quality Standards

3.2.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) potentially impact air quality within the Study Area. Tables 2.8-1 to 2.8-3 present the baseline and proposed training and testing activity locations for each alternative (including number of activities and ordnance expended). The air quality stressors vary in intensity, frequency, duration, and location within the Study Area. The stressors applicable to air quality in the Study Area are analyzed below and include the following:

- Criteria air pollutants
- Hazardous air pollutants

In this analysis, criteria air pollutant emissions estimates were calculated for vessels, aircraft, and ordnance. For each alternative, emissions estimates were developed by range complex and other training or testing locations and totaled for the Study Area. Details of the emission estimates are provided in Appendix D (Air Quality Example Emissions Calculations and Example Record of Non-Applicability). Hazardous air pollutants are analyzed qualitatively in relation to the prevalence of the sources emitting hazardous air pollutants during training and testing activities.

3.2.3.1 Criteria Air Pollutants

The potential impacts of criteria air pollutants are evaluated by first estimating the emissions from training and testing activities in the Study Area for each alternative. These estimates are then used to determine the potential impact of the emissions on the attainment status of the adjacent air quality control region. Emissions of criteria air pollutants may affect human health directly by degrading local or regional air quality or indirectly by their effects on the environment. Air pollutant emissions may also have a regulatory effect separate from their physical effect, if additional air pollutant emissions change the attainment status of an air quality control region.

The estimate of criteria air pollutant emissions for each alternative is organized by training emissions and testing emissions. These emissions are further categorized by region (e.g., by range complex or testing range) so that differences in background air quality, atmospheric circulation patterns, regulatory requirements, and sensitive receptors can be addressed. An overall estimate of air pollutant emissions for Navy training and testing activities in the Study Area under each alternative is also provided.

3.2.3.1.1 No Action Alternative

3.2.3.1.1.1 Training

Table 3.2-6 lists training-related criteria air pollutant and precursor emissions in the Study Area. Emissions are totaled for each major training region (i.e., range complex or Other AFTT Areas) of the Study Area. Total emissions for each major training region are then summed to arrive at the total emissions within the Study Area. Totals include aircraft and vessel emissions based on estimated numbers of vessels and aircraft involved in training activities. The air pollutants emitted in the greatest quantity are CO and NO_x.

Table 3.2-6: Annual Criteria Air Pollutant Emissions from Training under the No Action Alternative

Location	Air Pollutant Emissions (TPY)					
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$
Northeast Range Complexes						
Aircraft	1.66	7.67	0.37	0.36	1.81	1.81
Vessels	11.52	13.10	1.00	2.50	0.27	0.27
Ordnance	0.01	<0.01	<0.01	<0.01	0.08	0.01
Total	13.18	20.77	1.37	2.86	2.16	2.09
Virginia Capes Range Complex						
Aircraft	36.82	69.54	3.57	3.19	19.04	19.04
Vessels	287.50	176.63	27.71	72.00	6.21	6.21
Ordnance	7.63	0.19	<0.01	<0.01	0.97	0.64
Total	331.95	246.36	31.28	75.19	26.22	25.88
Navy Cherry Point Range Complex						
Aircraft	14.52	21.43	1.44	1.15	6.22	6.22
Vessels	602.26	381.20	54.09	176.10	14.56	14.56
Ordnance	0.88	0.02	<0.01	<0.01	0.09	0.02
Total	617.67	402.66	55.53	177.25	20.86	20.80
Jacksonville Range Complex						
Aircraft	20.84	37.60	2.26	1.88	10.26	10.26
Vessels	474.09	293.80	49.67	102.10	8.72	8.72
Ordnance	1.75	0.07	<0.01	<0.01	0.21	0.05
Total	496.69	331.47	51.92	103.98	19.20	19.04
Key West Range Complex						
Aircraft	10.07	10.37	0.89	0.65	3.40	3.40
Vessels	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ordnance	0.59	0.01	<0.01	<0.01	0.01	0.01
Total	10.66	10.38	0.89	0.65	3.41	3.40
Gulf of Mexico Range Complex						
Aircraft	4.54	8.52	0.45	0.40	2.34	2.34
Vessels	73.23	43.68	6.91	19.17	1.64	1.64
Ordnance	0.74	0.01	<0.01	<0.01	0.03	0.01
Total	78.51	52.21	7.36	19.57	4.01	3.99
Other AFTT Areas						
Aircraft	0.10	0.61	0.01	0.02	0.14	0.14
Vessels	25.14	11.65	1.97	4.45	0.30	0.30
Ordnance	0.04	0.06	<0.01	<0.01	<0.01	<0.01
Total	25.28	12.32	1.98	4.47	0.45	0.44
Study Area Total						
Aircraft	**88.54**	**155.75**	**8.99**	**7.65**	**43.20**	**43.20**
Vessels	**1,473.74**	**920.05**	**141.35**	**376.32**	**31.71**	**31.71**
Ordnance	**11.65**	**0.36**	**<0.01**	**<0.01**	**1.39**	**0.75**
Total	**1,573.94**	**1,076.16**	**150.33**	**383.97**	**76.30**	**75.66**

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Under the No Action Alternative, the annual numbers of Navy training activities in the Study Area would remain at baseline (existing) levels. The air pollutants emitted in the greatest quantities from aircraft are typically NO_x, followed by particulate matter (PM_{10} and $PM_{2.5}$) and CO. These emissions are associated with aircraft involvement in a variety of training activities: anti-air warfare, electronic warfare, and mine warfare. The air pollutants emitted in the greatest quantities from surface vessels are typically CO, NO_x, and SO_x. These emissions are associated with vessel involvement in a variety of training activities, including anti-submarine warfare, anti-surface warfare, and electronic warfare. The air pollutant emitted in the greatest quantity by munitions is CO, which is emitted under the No Action Alternative from a variety of munitions: bombs, rockets, missiles, smokes, flares, and gun rounds.

As shown in Table 3.2-6, certain regions (e.g., Virginia Capes [VACAPES], Navy Cherry Point, and JAX Range Complexes) account for the majority of the total Study Area emissions. These three regions account for 92 percent of the emissions but constitute only 5 percent of the total Study Area. The spatial distribution of emissions reflects the locations where Navy training most regularly occurs. The remaining 8 percent of emissions are spread across smaller geographical areas, including the Northeast, GOMEX, and Key West Range Complexes, and across the vast expanse of the Study Area outside of the range complexes.

While pollutants emitted in the Study Area may be carried ashore by prevailing winds, most training activities would occur more than 3 nm offshore, and natural mixing would substantially disperse pollutants before they reach the boundaries of the adjacent air quality control regions. Moreover, given the spatial distribution of emissions, only a fraction (approximately one quarter) of overall Study Area emissions are produced at latitudes consistent with nonattainment or maintenance areas, and of these, over 85 percent of training-related emissions are produced at least 3 nm from shore. The contributions of air pollutants generated in the Study Area to the air quality in the air quality control regions are insignificant and unlikely to measurably add to existing onshore pollutant concentrations because of the distances these offshore pollutants would be transported and their substantial dispersion during transport.

3.2.3.1.1.2 Testing

Table 3.2-7 lists testing-related criteria air pollutant and precursor emissions in the Study Area. Emissions are totaled for each major testing region (i.e., range complex, Other AFTT Areas, individual testing ranges, and pierside facilities) of the Study Area. Total emissions for each major testing region are then summed to arrive at the total testing emissions within the Study Area. Totals include aircraft and vessel emissions based on estimated numbers of vessels and aircraft involved in tests. The air pollutants emitted in the greatest quantity are CO and NO_x.

Under the No Action Alternative, the annual numbers of Navy testing activities in the Study Area would remain at baseline (existing) levels. Pollutants emitted in the Study Area may be transported ashore by periodic changes to prevailing winds, possibly affecting air basins along the U.S. coast. The air pollutants emitted in the greatest quantities from aircraft are typically NO_x, followed by particulate matter (PM_{10} and $PM_{2.5}$) and CO. These emissions are associated with aircraft involvement in a variety of testing activities, including anti-air warfare, electronic warfare, and mine warfare. The air pollutants emitted in the greatest quantities from surface vessels are typically CO, NO_x, and SO_x. These emissions are associated with vessel involvement in a variety of testing activities, including anti-submarine warfare, anti-surface warfare, and electronic warfare. The air pollutant emitted in the greatest quantity by munitions is CO, which is emitted under the No Action Alternative from a variety of munitions, including bombs, rockets, missiles, smokes, flares, and gun rounds.

Table 3.2-7: Annual Criteria Air Pollutant Emissions from Testing under the No Action Alternative

Location	Air Pollutant Emissions (TPY)					
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$
Northeast Range Complexes						
Aircraft	0.12	0.39	0.02	0.02	0.10	0.10
Vessels	4.45	2.73	0.38	0.86	0.07	0.07
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	4.57	3.13	0.40	0.87	0.17	0.17
Virginia Capes Range Complex						
Aircraft	3.84	5.54	0.36	0.28	1.58	1.58
Vessels	58.71	35.69	5.27	16.82	1.46	1.46
Ordnance	1.02	0.01	<0.01	<0.01	0.10	0.04
Total	63.57	41.24	5.63	17.10	3.15	3.09
Navy Cherry Point Range Complex						
Aircraft	0.39	0.57	0.04	0.03	0.17	0.17
Vessels	2.59	1.79	0.24	0.62	0.06	0.06
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	2.98	2.36	0.28	0.65	0.23	0.22
Jacksonville Range Complex						
Aircraft	0.65	0.95	0.07	0.05	0.28	0.28
Vessels	5.16	3.34	0.44	1.10	0.09	0.09
Ordnance	0.41	0.01	<0.01	<0.01	0.03	0.02
Total	6.23	4.30	0.51	1.16	0.41	0.40
Key West Range Complex						
Aircraft	0.02	0.07	<0.01	<0.01	0.02	0.02
Vessels	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	0.02	0.09	<0.01	0.01	0.02	0.02
Gulf of Mexico Range Complex						
Aircraft	1.63	1.85	0.15	0.11	0.59	0.59
Vessels	5.21	3.65	0.51	1.96	0.18	0.18
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	6.84	5.50	0.66	2.08	0.77	0.77
Other AFTT Areas						
Aircraft	0.10	0.29	0.02	0.02	0.08	0.08
Vessels	1.07	0.80	0.10	0.20	0.02	0.02
Ordnance	0.08	<0.01	<0.01	<0.01	<0.01	<0.01
Total	1.25	1.09	0.12	0.22	0.10	0.10

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Table 3.2–7: Annual Criteria Air Pollutant Emissions from Testing under the No Action Alternative (Continued)

Location	Air Pollutant Emissions (TPY)					
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$
Naval Undersea Warfare Center Division, Newport Testing Range						
Aircraft	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vessels	42.10	37.52	1.95	3.41	1.26	1.26
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	42.10	37.52	1.95	3.41	1.26	1.26
Naval Surface Warfare Center, Panama City Division Testing Range						
Aircraft	0.96	0.98	0.08	0.06	0.32	0.32
Vessels	39.82	47.32	2.42	4.05	1.81	1.81
Ordnance	0.10	<0.01	<0.01	<0.01	<0.01	<0.01
Total	40.87	48.30	2.51	4.11	2.14	2.13
Study Area Total (less pierside testing emissions separately quantified for conformity analyses)						
Aircraft	**7.70**	**10.65**	**0.75**	**0.58**	**3.14**	**3.14**
Vessels	**159.11**	**132.85**	**11.31**	**29.02**	**4.95**	**4.95**
Ordnance	**1.61**	**0.02**	**<0.01**	**<0.01**	**0.15**	**0.07**
Total	**168.42**	**143.52**	**12.06**	**29.60**	**8.24**	**8.16**

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

As shown in Table 3.2-7, certain regions (e.g., VACAPES Range Complex and the Naval Surface Warfare Center, Panama City Division Testing Range) account for the majority of the total Study Area testing-related emissions. These two regions account for over 60 percent of the testing-related emissions but constitute only 5 percent of the total Study Area. The spatial distribution of emissions reflects the locations where Navy testing most regularly occurs. Given the spatial distribution of emissions, only a fraction (approximately one quarter) of overall Study Area emissions are produced at latitudes consistent with nonattainment or maintenance areas, and of these, over 90 percent of testing emissions are produced at least 3 nm from shore.

The remaining 40 percent of emissions are spread across several smaller geographical areas, including the Northeast, GOMEX, and JAX Range Complexes; the Naval Undersea Warfare Center Division, Newport Testing Range, and pierside facilities. The contributions of testing-related air pollutants generated in the Study Area to the air quality in air quality control regions ashore are insignificant and unlikely to measurably add to existing onshore pollutant concentrations because of the distances these offshore pollutants would have to be transported and their substantial dispersion during transport.

Criteria Pollutant Emissions in Nonattainment or Maintenance Areas

Metropolitan Providence Air Quality Control Region

The U.S. Environmental Protection Agency Final Rule: Air Quality Designations for the 2008 Ozone National Ambient Air Quality Standards designated the Metropolitan Providence Air Quality Control Region (all Rhode Island counties) unclassifiable/attainment of the 2008 8-Hour Ozone National Ambient Air Quality Standards (U.S. Environmental Protection Agency 2012a). Nevertheless, given recent Rhode Island monitoring results, the region is likely to be redesignated nonattainment in the near future. Therefore, as a conservative measure, a conformity review is included herein. The amounts of criteria air pollutants emitted under the No Action Alternative by Navy testing activities in the Metropolitan

Providence Air Quality Control Region of the Study Area are presented in Table 3.2-8. The largest source of air pollutants associated with the proposed Navy testing activities in Narragansett Bay in the Rhode Island region is vessels. Various vessels support testing activities, including a 120-ft. long support vessel, the TWR-841, which also employs a diesel-powered electricity generator; the WB-30, a 36-ft. work boat; and smaller vessels ranging from 12-ft. to 22-ft. lengths. The two larger vessels are diesel powered, while the rest employ gasoline engines. The unmanned surface vehicles employ diesel engines. High-speed ferries may also be used to support Navy testing in Narragansett Bay.

The air pollutants expected to be emitted under the No Action Alternative would not have a measurable impact on air quality over Rhode Island coastal waters or adjacent land areas because of the distances from land at which the pollutants are emitted and the generally strong ventilation resulting from regional meteorological conditions. Air pollutant emissions under the No Action Alternative would not result in violations of state or federal air quality standards because they would not have a measurable impact on air quality in land areas.

Table 3.2-8: Estimated Annual Air Pollutant Emissions over Rhode Island State Waters (within 3 nm), No Action Alternative

	Emissions by Air Pollutant (TPY)					
	CO	NO_X	VOC	SO_x	PM_{10}	$PM_{2.5}$
Aircraft Emissions	0.09	0.43	0.02	0.02	0.10	0.10
Vessels Emissions	42.68	38.13	2.00	3.53	1.27	1.27
Total Emissions from all Sources	**42.78**	**38.56**	**2.02**	**3.55**	**1.37**	**1.37**

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Hampton Roads Intrastate Air Quality Control Region

The amounts of criteria air pollutants that would be emitted under the No Action Alternative by Navy testing activities over state waters with proximity to the Hampton Roads Intrastate Air Quality Control Region of the Study Area are presented in Table 3.2-9. The largest source of CO associated with the proposed Navy testing activities in the lower Chesapeake Bay and state waters of the Atlantic Ocean in Virginia is helicopters, while small boats emit primarily NO_x. Various helicopters are used in mine warfare, anti-submarine warfare, and anti-surface warfare activities, including: the SH-60H, CH-46D, CH-46E, CH-53E, H-3, SH-60R, and SH-60S.

The air pollutants expected to be emitted under the No Action Alternative would not have a measurable impact on air quality over Virginia coastal waters or adjacent land areas because of the distances from land at which the pollutants are emitted, and the generally strong ventilation resulting from regional meteorological conditions. Air pollutant emissions under the No Action Alternative would not result in violations of state or federal air quality standards because they would not have a measurable impact on air quality in land areas.

Table 3.2-9: Estimated Annual Air Pollutant Emissions over Virginia State Waters (within 3 nm), No Action Alternative

	Emissions by Air Pollutant (TPY)					
	CO	NO_X	VOC	SO_x	PM_{10}	$PM_{2.5}$
Aircraft Emissions	20.46	21.09	1.81	1.32	6.90	6.90
Vessels Emissions	1.22	3.49	0.59	0.50	0.04	0.04
Total Emissions over Virginia State Waters	**21.67**	**24.58**	**2.40**	**1.82**	**6.94**	**6.94**

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Summary – No Action Alternative

Total criteria air pollutant emissions under the No Action Alternative are summarized in Table 3.2-10. While criteria air pollutants emitted in the Study Area over territorial waters may be transported ashore, they would not affect the attainment status of the relevant air quality control regions. The amounts of air pollutants emitted in the Study Area and subsequently transported ashore would be insignificant because (1) emissions from Navy training and testing activities are small compared to the amounts of air pollutants emitted by sources ashore, (2) the distances the air pollutants would be transported are often large, and (3) the pollutants are substantially dispersed during transport. The criteria air pollutants emitted over non-territorial waters within the Study Area would be dispersed over vast areas of open ocean and thus would not have a measurable impact on environmental resources in those areas.

Estimates of air pollutant emissions under the No Action Alternative are a projection into the future of existing baseline emissions. Under the No Action Alternative, the annual numbers of Navy training and testing activities in the Study Area would remain at baseline levels. Emissions rates would remain constant for those pollutant sources not affected by other federal requirements to reduce air emissions. Any effects of the No Action Alternative on regional air quality are reflected in the current ambient criteria air pollutant concentrations in air quality control regions ashore. The No Action Alternative is exempt from the federal General Conformity Rule because training and testing activities under the No Action Alternative would not increase criteria air pollutant emissions above baseline levels.

Table 3.2-10: Estimated Annual Criteria Air Pollutant Emissions in the Study Area, No Action Alternative

Source	Emissions by Air Pollutant (TPY)					
	CO	NO_X	VOC	SO_x	PM_{10}	$PM_{2.5}$
Training-Related Emissions	1,573.94	1,076.16	150.33	383.97	76.30	75.66
Testing-Related Emissions	168.42	143.52	12.06	29.60	8.24	8.16
Total Study Area	**1,742.36**	**1,219.68**	**162.40**	**413.57**	**84.54**	**83.82**

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

3.2.3.1.2 Alternative 1

3.2.3.1.2.1 Training

Under Alternative 1, the annual number of Navy training activities in the Study Area would increase in comparison to the No Action Alternative (baseline) levels. Air pollutant emissions for CO, NO_x, volatile organic compounds, SO_x PM_{10}, and $PM_{2.5}$ would increase relative to emissions under the No Action Alternative. Emissions of most criteria pollutants would increase more than 100 percent over concentrations estimated under the No Action Alternative. Table 3.2-11 lists the estimated training-related criteria air pollutant and precursor emissions in the Study Area by region under Alternative 1.

As shown in Table 3.2-11, under Alternative 1, the air pollutant emitted in the greatest quantity by aircraft is NO_x, followed by PM_{10}, $PM_{2.5}$, and CO. These emissions are associated with aircraft involvement in a variety of training activities, including anti-air warfare, electronic warfare, and mine warfare. As shown in Table 3.2-11, the air pollutants emitted in the greatest quantities by surface vessels are CO, NO_x, and SO_x. These emissions are associated with vessel involvement in a variety of training activities, including anti-submarine warfare, anti-surface warfare, and electronic warfare. The air pollutant emitted in the greatest quantity by munitions is CO, which would be emitted under Alternative 1 by the same variety of munitions as under the No Action Alternative. Training activities involving the expenditure of ordnance primarily occur 3 nm or more from shore, thus reducing the likelihood that offshore emissions under the Proposed Action would affect regional air quality and receptors ashore.

Under Alternative 1, emissions are estimated to increase by 75 to 150 percent (depending on the pollutant) within the Study Area when compared to the No Action Alternative. Nevertheless, given the spatial distribution of emissions, only a fraction (approximately one quarter) of overall Study Area emissions are produced at latitudes consistent with nonattainment or maintenance areas, and of these, over 85 percent of training emissions are produced at least 3 nm from shore.

Table 3.2-11: Annual Criteria Air Pollutant Emissions from Training under Alternative 1

Location	Air Pollutant Emissions (TPY)					
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$
Northeast Range Complexes						
Aircraft	0.81	3.37	0.17	0.16	0.81	0.81
Vessels	6.60	7.26	0.90	1.45	0.16	0.16
Ordnance	0.04	<0.01	<0.01	<0.01	0.03	0.01
Total	7.46	10.63	1.07	1.61	1.00	0.98
Virginia Capes Range Complex						
Aircraft	49.22	80.10	5.04	3.90	22.31	22.31
Vessels	718.59	502.24	78.41	211.80	19.35	19.35
Ordnance	22.75	0.91	<0.01	<0.01	1.35	0.87
Total	790.56	583.25	83.45	215.70	43.00	42.53
Navy Cherry Point Range Complex						
Aircraft	26.32	194.15	3.18	5.97	45.00	45.00
Vessels	916.68	553.33	81.18	266.14	21.47	21.47
Ordnance	5.56	0.15	<0.01	<0.01	0.14	0.07
Total	948.56	747.62	84.36	272.11	66.61	66.54
Jacksonville Range Complex						
Aircraft	38.54	222.43	4.98	7.33	52.01	52.01
Vessels	832.32	490.85	82.32	198.38	16.44	16.44
Ordnance	12.42	0.54	<0.01	<0.01	1.28	0.75
Total	883.29	713.82	87.30	205.71	69.72	69.20
Key West Range Complex						
Aircraft	10.07	10.37	0.89	0.65	3.40	3.40
Vessels	0.01	0.34	<0.01	0.04	<0.01	<0.01
Ordnance	0.92	0.01	<0.01	<0.01	0.02	0.01
Total	11.00	10.72	0.89	0.68	3.42	3.41
Gulf of Mexico Range Complex						
Aircraft	7.95	11.47	0.73	0.60	3.38	3.38
Vessels	71.68	45.83	6.96	19.26	1.65	1.65
Ordnance	1.64	0.03	<0.01	<0.01	0.11	0.07
Total	81.27	57.33	7.69	19.85	5.15	5.11
Other AFTT Areas						
Aircraft	0.49	0.52	0.06	0.03	0.15	0.15
Vessels	32.44	24.41	3.44	9.14	0.86	0.86
Ordnance	0.87	0.08	<0.01	<0.01	0.02	0.02
Total	33.80	25.01	3.50	9.17	1.03	1.02
Study Area Total- Alternative 1	**2,755.94**	**2,148.39**	**268.26**	**724.83**	**189.92**	**188.78**
No Action Alternative	1,573.94	1,076.16	150.33	383.97	76.30	75.66
Net Increase (+) / Decrease (-) from No Action Alternative	+1,182.00	+1,072.23	+117.92	+340.86	+113.62	+113.13
Net Increase (+) / Decrease (-) (%) from No Action Alternative	+75.10%	+99.63%	+78.44%	+88.77%	+148.91%	+149.53%

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

3.2.3.1.2.2 Testing

Under Alternative 1, the annual number of Navy testing activities in the Study Area would increase in comparison to the No Action Alternative (baseline) levels. Air pollutant emissions for all criteria pollutants would increase relative to emissions under the No Action Alternative. Table 3.2-12 lists the estimated testing-related criteria air pollutant and precursor emissions in the Study Area by region under Alternative 1 when compared to the No Action Alternative.

Table 3.2-12: Annual Criteria Air Pollutant Emissions from Testing under Alternative 1

Location	Air Pollutant Emissions (TPY)					
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$
Northeast Range Complexes						
Aircraft	1.36	1.70	0.14	0.11	0.54	0.54
Vessels	61.05	42.73	5.59	18.53	1.69	1.69
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	62.42	44.44	5.73	18.63	2.24	2.23
Virginia Capes Range Complex						
Aircraft	13.81	18.35	1.29	0.97	5.43	5.43
Vessels	280.05	169.88	24.65	65.50	5.54	5.54
Ordnance	2.80	0.04	<0.01	<0.01	0.14	0.07
Total	296.67	188.27	25.94	66.48	11.12	11.05
Navy Cherry Point Range Complex						
Aircraft	3.65	3.90	0.33	0.24	1.26	1.26
Vessels	30.53	23.51	3.02	12.08	1.16	1.16
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	34.18	27.41	3.34	12.32	2.43	2.42
Jacksonville Range Complex						
Aircraft	5.44	6.44	0.50	0.37	2.01	2.01
Vessels	93.94	78.44	9.67	27.89	2.88	2.88
Ordnance	1.34	0.02	<0.01	<0.01	0.06	0.04
Total	100.72	84.89	10.18	28.27	4.96	4.94
Key West Range Complex						
Aircraft	0.44	0.51	0.04	0.03	0.16	0.16
Vessels	7.61	5.77	0.72	1.96	0.19	0.19
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	8.05	6.28	0.76	1.99	0.35	0.35
Gulf of Mexico Range Complex						
Aircraft	5.80	6.15	0.52	0.38	2.00	2.00
Vessels	25.62	24.13	2.78	14.90	1.46	1.46
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	31.42	30.28	3.30	15.28	3.46	3.46

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Table 3.2-12: Annual Criteria Air Pollutant Emissions from Testing under Alternative 1 (Continued)

Location	Air Pollutant Emissions (TPY)					
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$
Other AFTT Areas						
Aircraft	0.06	0.30	0.01	0.01	0.07	0.07
Vessels	4.53	4.06	0.48	1.37	0.15	0.15
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	4.59	4.36	0.50	1.39	0.22	0.22
South Florida Ocean Measurement Facility Testing Range						
Aircraft	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vessels	39.11	12.45	1.35	3.30	0.62	0.62
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	39.11	12.45	1.35	3.30	0.62	0.62
Naval Undersea Warfare Center Division, Newport Testing Range						
Aircraft	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vessels	57.58	50.87	2.64	4.63	1.71	1.71
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	57.58	50.87	2.64	4.63	1.71	1.71
Naval Surface Warfare Center, Panama City Division Testing Range						
Aircraft	0.96	0.98	0.08	0.06	0.32	0.32
Vessels	39.82	47.32	2.42	4.05	1.81	1.81
Ordnance	0.32	0.01	<0.01	<0.01	0.01	<0.01
Total	41.09	48.31	2.51	4.11	2.14	2.14
Study Area Total – Alternative 1 (less pierside testing emissions separately quantified for conformity analyses)	**675.83**	**497.56**	**56.25**	**156.40**	**29.24**	**29.14**
No Action Alternative	168.42	143.52	12.06	29.06	8.24	8.16
Net Increase (+) / Decrease (-) from No Action Alternative	**+507.40**	**+354.03**	**+44.19**	**+126.80**	**+21.00**	**+20.98**
Net Increase (+) / Decrease (-) (%) from No Action Alternative	**+301.27%**	**+246.67%**	**+366.34%**	**+428.41%**	**+254.89%**	**+257.13%**

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_X: sulfur oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

As shown in Table 3.2-12, under Alternative 1, the air pollutant emitted in the greatest quantity by aircraft is NO_x, followed by CO and particulate matter (PM_{10} and $PM_{2.5}$). These emissions are associated with aircraft involvement in a variety of testing activities, including anti-air warfare, electronic warfare, and mine warfare. The air pollutants emitted in the greatest quantities by surface vessels are CO, NO_x, and SO_x. These emissions are associated with vessel involvement in a variety of testing activities, including anti-submarine warfare, anti-surface warfare, and electronic warfare. The air pollutant emitted in the greatest quantity by munitions is CO, which would be emitted under Alternative 1 by the same variety of munitions as under the No Action Alternative. Testing activities involving the expenditure of ordnance primarily occur 3 nm or more from shore, thus reducing the likelihood that offshore emissions under the Proposed Action would affect regional air quality and receptors ashore.

Under Alternative 1, emissions from testing activities are estimated to increase by 247 to 428 percent (depending on the pollutant) within the Study Area. Nevertheless, given the spatial distribution of emissions, only a fraction (approximately one quarter) of overall Study Area emissions are produced at latitudes consistent with nonattainment or maintenance areas, and of these, over 90 percent of testing emissions are produced at least 3 nm from shore.

3.2.3.1.2.3 General Conformity Threshold Determinations

To address the requirements of the federal General Conformity Rule, the net change in criteria air pollutant emissions in air quality control regions of the Study Area under Alternative 1 were estimated, relative to their corresponding emissions under the No Action Alternative. As shown in Tables 3.2-13 through 3.2-14, the emissions increases for nonattainment and maintenance pollutants would be below the *de minimis* thresholds for a full conformity determination. The General Conformity Rule, therefore, does not apply under Alternative 1. Representative air pollutant emissions calculations are provided in Appendix D (Air Quality Example Emissions Calculations and Example Record of Non-Applicability).

Metropolitan Providence Air Quality Control Region

The U.S. Environmental Protection Agency Final Rule: Air Quality Designations for the 2008 Ozone National Ambient Air Quality Standards designated the Metropolitan Providence Air Quality Control Region (all Rhode Island counties) unclassifiable/attainment of the 2008 8-Hour Ozone National Ambient Air Quality Standards (U.S. Environmental Protection Agency 2012c). Nevertheless, given recent Rhode Island monitoring results, the region is likely to be redesignated nonattainment in the near future. Therefore, as a conservative measure, a conformity review is included herein. To address the requirements of the federal General Conformity Rule, the net change in criteria air pollutant emissions in the Metropolitan Providence Air Quality Control Region portion of the Study Area under Alternative 1 were estimated, relative to their corresponding emissions under the No Action Alternative. As shown in Table 3.2-13, the emissions increases for nonattainment pollutants would be below the *de minimis* thresholds for a full conformity determination. The General Conformity Rule, therefore, does not apply under Alternative 1. Representative air pollutant emissions calculations are provided in Appendix D (Air Quality Example Emissions Calculations and Example Record of Non-Applicability).

Table 3.2-13: Metropolitan Providence Air Quality Control Region Emissions Increases Compared to General Conformity *de Minimis* Thresholds, Alternative 1

Parameter	Emissions by Air Pollutant (TPY)		
	CO	NO_X	VOC
No Action Alternative, Metropolitan Providence Air Quality Control Region	42.78	38.56	2.02
Alternative 1, Metropolitan Providence Air Quality Control Region	**58.74**	**54.58**	**2.82**
Net Increase (+) / Decrease (-)	**+15.96**	**+16.02**	**+0.80**
de Minimis Threshold	100	100	50
Exceeds Threshold	No	No	No

CO: carbon monoxide; NO_X: nitrogen oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Hampton Roads Intrastate Air Quality Control Region

To address the requirements of the federal General Conformity Rule, the net change in criteria air pollutant emissions in the Hampton Roads Intrastate Air Quality Control District portion of the Study Area under Alternative 1 were estimated, relative to their corresponding emissions under the No Action

Alternative. As shown in Table 3.2-14, the emissions increases for nonattainment pollutants would be below the *de minimis* thresholds for a full conformity determination. The General Conformity Rule, therefore, does not apply under Alternative 1. Representative air pollutant emissions calculations are provided in Appendix D (Air Quality Example Emissions Calculations and Example Record of Non-Applicability).

Table 3.2-14: Hampton Roads Intrastate Air Quality Control Region Emissions Increases Compared to General Conformity *de Minimis* Thresholds, Alternative 1

Parameter	Emissions by Air Pollutant (TPY)		
	CO	NO_X	VOC
No Action Alternative, Hampton Roads Intrastate Air Quality Control Region	21.67	24.58	2.40
Alternative 1, Hampton Roads Intrastate Air Quality Control Region	**28.79**	**60.11**	**5.32**
Net Increase (+) / Decrease (-)	**+7.12**	**+35.54**	**+2.93**
de Minimis Threshold	100	100	100
Exceeds Threshold	No	No	No

CO: carbon monoxide; NO_X: nitrogen oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

3.2.3.1.3 Alternative 2 (Preferred Alternative)

3.2.3.1.3.1 Training

Under Alternative 2, the annual number of Navy training activities in the Study Area would increase in comparison to the No Action Alternative (baseline) levels. Air pollutant emissions for all criteria pollutants would increase relative to emissions under the No Action Alternative. Table 3.2-15 lists the estimated training-related criteria air pollutant and precursor emissions in the Study Area by region under Alternative 2.

As shown in Table 3.2-15, under Alternative 2, the air pollutant emitted in the greatest quantity by aircraft is NO_x, followed by particulate matter (PM_{10} and $PM_{2.5}$) and CO. These emissions are associated with aircraft involvement in a variety of training activities, including anti-air warfare, electronic warfare, and mine warfare. As shown in Table 3.2-15, the air pollutants emitted in the greatest quantities by surface vessels are CO, NO_x, and SO_x. These emissions are associated with vessel involvement in a variety of training activities, including anti-submarine warfare, anti-surface warfare, and electronic warfare. The air pollutant emitted in the greatest quantity by munitions is CO, which would be emitted under Alternative 2 by the same variety of munitions as the No Action Alternative. Training activities involving the expenditure of ordnance primarily occur 3 nm or more from shore, thus reducing the likelihood that offshore emissions under the Proposed Action would affect regional air quality and receptors ashore.

Under Alternative 2, training-related emissions are estimated to increase by 75 to 151 percent (depending on the pollutant) within the Study Area when compared to the No Action Alternative. Nevertheless, given the spatial distribution of emissions, only a fraction (approximately one quarter) of overall Study Area emissions are produced at latitudes consistent with nonattainment or maintenance areas, and of these, over 85 percent of training-related emissions are produced at least 3 nm from shore.

Table 3.2-15: Annual Criteria Air Pollutant Emissions from Training under Alternative 2

Location	Air Pollutant Emissions (TPY)					
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$
Northeast Range Complexes						
Aircraft	0.81	3.37	0.17	0.16	0.81	0.81
Vessels	6.60	7.26	0.90	1.45	0.16	0.16
Ordnance	0.04	<0.01	<0.01	<0.01	0.03	0.01
Total	7.46	10.63	1.07	1.61	1.00	0.98
Virginia Capes Range Complex						
Aircraft	49.22	80.10	5.04	3.90	22.31	22.31
Vessels	718.86	502.46	78.43	211.87	19.36	19.36
Ordnance	22.75	0.91	<0.01	<0.01	1.35	0.87
Total	790.82	583.47	83.48	215.77	42.84	42.54
Navy Cherry Point Range Complex						
Aircraft	26.32	194.15	3.18	5.97	45.00	45.00
Vessels	916.81	553.44	81.20	266.17	21.47	21.47
Ordnance	5.56	0.15	<0.01	<0.01	0.14	0.07
Total	948.69	747.73	84.37	272.14	66.61	66.54
Jacksonville Range Complex						
Aircraft	38.60	222.48	4.99	7.33	52.02	52.02
Vessels	836.93	499.81	82.72	208.44	17.33	17.33
Ordnance	12.42	0.54	<0.01	<0.01	1.28	0.75
Total	887.95	722.83	87.71	215.77	70.62	70.10
Key West Range Complex						
Aircraft	10.07	10.37	0.89	0.65	3.40	3.40
Vessels	0.01	0.34	<0.01	0.04	<0.01	<0.01
Ordnance	0.92	0.01	<0.01	<0.01	0.02	0.01
Total	11.00	10.72	0.89	0.68	3.42	3.41
Gulf of Mexico Range Complex						
Aircraft	7.95	11.47	0.73	0.60	3.38	3.38
Vessels	71.68	45.83	6.96	19.26	1.65	1.65
Ordnance	1.64	0.03	<0.01	<0.01	0.11	0.07
Total	81.27	57.33	7.69	19.85	5.15	5.11
Other AFTT Areas						
Aircraft	0.49	0.52	0.06	0.03	0.15	0.15
Vessels	32.57	24.51	3.45	9.18	0.86	0.86
Ordnance	0.87	0.08	<0.01	<0.01	0.02	0.02
Total	33.93	25.12	3.51	9.21	1.03	1.03
Study Area Total – Alternative 2	**2,761.13**	**2,157.83**	**268.72**	**735.04**	**190.84**	**189.70**
No Action Alternative	1,573.94	1,076.16	150.33	383.97	76.30	75.66
Net Increase (+) / Decrease (-) from No Action Alternative	**+1,187.19**	**+1,081.67**	**+118.39**	**+351.07**	**+114.54**	**+114.04**
Net Increase (+) / Decrease (-) (%) from No Action Alternative	**+75.43%**	**+100.51%**	**+78.75%**	**+91.43%**	**+150.11%**	**+150.73%**

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOCP: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

3.2.3.1.3.2 Testing

Under Alternative 2, the annual number of Navy testing activities in the Study Area would increase in comparison to the No Action Alternative (baseline) levels. Air pollutant emissions for all criteria pollutants would increase relative to emissions under the No Action Alternative. Table 3.2-16 lists the estimated testing-related criteria air pollutant and precursor emissions in the Study Area by region under Alternative 2.

Table 3.2-16: Annual Criteria Air Pollutant Emissions from Testing under Alternative 2

Location	Air Pollutant Emissions (TPY)					
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$
Northeast Range Complexes						
Aircraft	1.54	2.06	0.16	0.12	0.64	0.64
Vessels	66.86	47.02	6.12	20.19	1.85	1.85
Ordnance	0.02	<0.01	<0.01	<0.01	0.01	<0.01
Total	68.42	49.08	6.29	20.31	2.50	2.49
Virginia Capes Range Complex						
Aircraft	15.23	20.30	1.42	1.07	6.01	6.01
Vessels	309.96	188.84	27.34	72.51	6.16	6.16
Ordnance	4.06	0.19	<0.01	<0.01	0.58	0.39
Total	329.25	209.32	28.76	73.59	12.74	12.55
Navy Cherry Point Range Complex						
Aircraft	4.08	4.43	0.37	0.27	1.42	1.42
Vessels	34.12	26.36	3.37	13.35	1.29	1.29
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	38.20	30.80	3.74	13.62	2.72	2.71
Jacksonville Range Complex						
Aircraft	6.21	7.37	0.58	0.43	2.30	2.30
Vessels	104.09	86.49	10.67	30.75	3.17	3.17
Ordnance	1.69	0.05	<0.01	<0.01	0.18	0.13
Total	111.98	93.91	11.25	31.18	5.65	5.59
Key West Range Complex						
Aircraft	0.52	0.59	0.05	0.04	0.19	0.19
Vessels	9.02	6.85	0.86	2.22	0.21	0.21
Ordnance	0.12	0.03	<0.01	<0.01	<0.01	<0.01
Total	9.66	7.47	0.90	2.25	0.41	0.40
Gulf of Mexico Range Complex						
Aircraft	6.42	6.87	0.58	0.43	2.23	2.23
Vessels	29.30	27.60	3.18	16.96	1.67	1.67
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	35.72	34.47	3.76	17.39	3.89	3.89

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOCP: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Table 3.2-16: Annual Criteria Air Pollutant Emissions from Testing under Alternative 2 (Continued)

Location	Air Pollutant Emissions (TPY)					
	CO	NO_x	VOC	SO_x	PM_{10}	$PM_{2.5}$
Other AFTT Areas						
Aircraft	0.11	0.52	0.03	0.02	0.12	0.12
Vessels	5.53	5.05	0.59	1.56	0.17	0.17
Ordnance	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
Total	5.64	5.57	0.61	1.58	0.30	0.29
South Florida Ocean Measurement Facility Testing Range						
Aircraft	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vessels	41.12	13.16	1.43	3.49	0.65	0.65
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	41.12	13.16	1.43	3.49	0.65	0.65
Naval Undersea Warfare Center Division, Newport Testing Range						
Aircraft	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Vessels	63.25	56.79	2.93	5.10	1.90	1.90
Ordnance	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total	63.25	56.79	2.93	5.10	1.90	1.90
Naval Surface Warfare Center, Panama City Division Testing Range						
Aircraft	1.08	1.10	0.09	0.07	0.36	0.36
Vessels	46.23	56.20	2.83	4.67	2.12	2.12
Ordnance	0.35	0.01	<0.01	<0.01	0.01	0.01
Total	47.65	57.31	2.93	4.73	2.49	2.48
Study Area Total - Alternative 2 (less pierside testing emissions separately quantified for conformity analyses)	**750.90**	**557.89**	**62.61**	**173.25**	**33.23**	**32.96**
No Action Alternative	168.42	143.52	12.06	29.06	8.24	8.16
Net Increase (+) / Decrease (-) from No Action Alternative	**+582.48**	**+414.36**	**+50.55**	**+143.66**	**+24.99**	**+24.80**
Net Increase (+) / Decrease (-) (%) from No Action Alternative	**+345.84%**	**+288.71%**	**+419.05%**	**+485.37%**	**+303.31%**	**+304.02%**

CO: carbon monoxide; NO_X: nitrogen oxides; $PM_{2.5}$: particulate matter ≤ 2.5 microns in diameter; PM_{10}: particulate matter ≤ 10 microns in diameter; SO_x: sulfur oxides; TPY: tons per year; VOCP: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

As shown in Table 3.2-16, under Alternative 2, the air pollutant emitted in the greatest quantity by aircraft is NO_x, followed by particulate matter (PM_{10} and $PM_{2.5}$) and CO. These emissions are associated with aircraft involvement in a variety of testing activities, including anti-air warfare, electronic warfare, and mine warfare. As shown in Table 3.2-16, the air pollutants emitted in the greatest quantities from surface vessels are CO, NO_x, and SO_x, in decreasing order. These emissions are associated with vessel involvement in a variety of testing activities, including anti-submarine warfare, anti-surface warfare, and electronic warfare. The air pollutant emitted in the greatest quantity by munitions is CO, which would be emitted under Alternative 2 by the same variety of munitions as the No Action Alternative. Testing activities involving the expenditure of ordnance primarily occur 3 nm or more from shore, thus reducing the likelihood that offshore emissions under the Proposed Action would affect regional air quality and receptors ashore.

Under Alternative 2, testing-related emissions are estimated to increase by 289 to 485 percent (depending on the pollutant) within the Study Area when compared to the No Action Alternative. Nevertheless, given the spatial distribution of emissions, only a fraction (approximately one quarter) of overall Study Area emissions are produced at latitudes consistent with nonattainment or maintenance areas, and of these, over 90 percent of testing-related emissions are produced at least 3 nm from shore.

3.2.3.1.3.3 General Conformity Threshold Determinations

To address the requirements of the federal General Conformity Rule, the net change in criteria air pollutant emissions in air quality control regions of the Study Area under Alternative 2 were estimated, relative to their corresponding emissions under the No Action Alternative. As shown in Tables 3.2-17 through 3.2-18, the emissions increases for nonattainment and maintenance pollutants would be below the *de minimis* thresholds for a full conformity determination. The General Conformity Rule, therefore, does not apply under Alternative 2. Representative air pollutant emissions calculations are provided in Appendix D (Air Quality Example Emissions Calculations and Example Record of Non-Applicability).

Metropolitan Providence Air Quality Control Region

The U.S. Environmental Protection Agency Final Rule: Air Quality Designations for the 2008 Ozone National Ambient Air Quality Standards designated the Metropolitan Providence Air Quality Control Region (all Rhode Island counties) unclassifiable/attainment of the 2008 8-Hour Ozone National Ambient Air Quality Standards (U.S. Environmental Protection Agency 2012c). Nevertheless, given recent Rhode Island monitoring results, the region is likely to be redesignated nonattainment in the near future. Therefore, as a conservative measure, a conformity review is included herein. To address the requirements of the federal General Conformity Rule, the net change in criteria air pollutant emissions in the Metropolitan Providence Air Quality Control Region portion of the Study Area under Alternative 2 were estimated, relative to their corresponding emissions under the No Action Alternative. As shown in Table 3.2-17, the emissions increases for nonattainment pollutants would be below the *de minimis* thresholds for a full conformity determination. The General Conformity Rule, therefore, does not apply under Alternative 2. Representative air pollutant emissions calculations are provided in Appendix D (Air Quality Example Emissions Calculations and Example Record of Non-Applicability).

Table 3.2-17: Metropolitan Providence Air Quality Control Region Emissions Increases Compared to General Conformity *de Minimis* Thresholds, Alternative 2

Parameter	Emissions by Air Pollutant (TPY)		
	CO	NO_X	VOC
No Action Alternative, Metropolitan Providence Air Quality Control Region	42.78	38.56	2.02
Alternative 2, Metropolitan Providence Air Quality Control Region	**64.51**	**60.84**	**3.12**
Net Increase (+) / Decrease (-)	**+21.73**	**+22.28**	**+1.10**
de Minimis Threshold	100	100	50
Exceeds Threshold	No	No	No

CO: carbon monoxide; NO_X: nitrogen oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

Hampton Roads Intrastate Air Quality Control Region

To address the requirements of the federal General Conformity Rule, the net change in criteria air pollutant emissions in the Hampton Roads Intrastate Air Quality Control Region portion of the Study Area under Alternative 2 were estimated, relative to their corresponding emissions under the No Action Alternative. As shown in Table 3.2-18, the emissions increases for nonattainment pollutants would be below the *de minimis* thresholds for a full conformity determination. The General Conformity Rule, therefore, does not apply under Alternative 2. Representative air pollutant emissions calculations are provided in Appendix D (Air Quality Example Emissions Calculations and Example Record of Non-Applicability).

Table 3.2-18: Hampton Roads Intrastate Air Quality Control Region Emissions Increases Compared to General Conformity *de Minimis* Thresholds, Alternative 2

Parameter	Emissions by Air Pollutant (TPY)		
	CO	NO_X	VOC
No Action Alternative, Hampton Roads Intrastate Air Quality Control Region	21.67	24.58	2.27
Alternative 2, Hampton Roads Intrastate Air Quality Control Region	**29.53**	**60.78**	**5.39**
Net Increase (+) / Decrease (-)	**+7.86**	**+36.20**	**+2.99**
de Minimis Threshold	100	100	100
Exceeds Threshold	No	No	No

CO: carbon monoxide; NO_X: nitrogen oxides; TPY: tons per year; VOC: volatile organic compounds

Notes: Table includes criteria pollutant precursors (e.g., VOC). Individual values may not add exactly to total values due to rounding.

3.2.3.2 Hazardous Air Pollutants

3.2.3.2.1 No Action Alternative

The USEPA listed 188 hazardous air pollutants regulated under Title III (Hazardous Air Pollutants), Section 112(g) of the Clean Air Act. Hazardous air pollutants are emitted by several processes associated with Navy training and testing activities, including fuel combustion. Trace amounts of hazardous air pollutants are emitted by combustion sources participating in training and testing activities, including aircraft, vessels, targets, and munitions. The amounts of hazardous air pollutants emitted are small compared to the emissions of criteria pollutants; emission factors for most hazardous air pollutants from combustion sources are roughly three or more orders of magnitude lower than emission factors for criteria pollutants (California Air Resources Board 2007). For example, the fuel combustion product, benzene emission factor is 1.09×10^{-4} lb./gal. Emissions of hazardous air pollutants from munitions use are smaller still, with emission factors ranging from roughly 10^{-5} to 10^{-15} lb. of individual hazardous air pollutants per item for cartridges to 10^{-4} to 10^{-13} lb. of individual hazardous air pollutants per item for mines and smoke canisters (U.S. Environmental Protection Agency 2009a). As an example, 10^{-5} is equivalent to 0.0001 and 10^{-15} is equivalent to 0.00000000000001. In other words, to generate one pound of hazardous air pollutants would require the expenditure of ten thousand or ten trillion pounds of munitions, respectively.

3.2.3.2.1.1 Training and Testing

No health effects would result from training- or testing-related emissions of hazardous air pollutants in the Study Area under the No Action Alternative because (1) minute quantities of hazardous air pollutants are emitted during training and testing events in comparison to criteria air pollutants, (2) hazardous air pollutant emissions from training and testing activities would be released to the environment in a remote area (typically greater than 3 nm from shore) with few existing sources of air pollutants, (3) training- and testing-related hazardous air pollutant emissions would be distributed over the entire Study Area and rapidly dispersed over a large ocean area where few individuals would be exposed to them, and (4) hazardous air pollutant emissions would be diluted through mixing in the atmosphere to a much lower ambient concentration. Residual hazardous air pollutant impacts during respites between training and testing activities would not be detectable and would be below or within historical or desired air quality conditions. Therefore, hazardous air pollutant emissions from training and testing for the Proposed Action will not be quantitatively estimated in this EIS/OEIS.

3.2.3.2.2 Alternative 1

3.2.3.2.2.1 Training and Testing

Trace amounts of hazardous air pollutants would be emitted from sources participating in Alternative 1 training and testing activities, including aircraft, vessels, targets, and munitions. Hazardous air pollutant emissions under Alternative 1 would increase relative to the No Action Alternative emissions. As noted for the No Action Alternative in Section 3.2.3.2.1, hazardous air pollutant emissions are not quantitatively estimated, but the increase in hazardous air pollutant emissions under Alternative 1 would be roughly proportional to the increase in emissions of criteria air pollutants. Therefore, the amounts that would be emitted as a result of Alternative 1 activities would be somewhat greater than those emitted under the No Action Alternative, but would remain very small compared to the emissions of criteria air pollutants. The potential health effects of training- and testing-related hazardous air pollutant emissions under Alternative 1 would be the same as those discussed under the No Action Alternative.

3.2.3.2.3 Alternative 2 (Preferred Alternative)

3.2.3.2.3.1 Training and Testing

The amounts and distribution of training- and testing-related hazardous air pollutant emissions under Alternative 2 would be similar to but slightly greater than those described under Alternative 1. The potential health effects of training- and testing-related hazardous air pollutant emissions under Alternative 2 would be the same as those discussed under the No Action Alternative.

3.2.4 Summary of Impacts

3.2.4.1 No Action Alternative

As discussed in Sections 3.2.3.1 (Criteria Air Pollutants) and 3.2.3.2 (Hazardous Air Pollutants), emissions associated with Study Area training and testing primarily occur 3 nm or more from shore. For fixed-wing aircraft activities, emissions typically occur above the 3,000-ft. (914 m) mixing layer.

Even though these stressors co-occur in time and space, there would be sufficient dispersion so the impacts would be short term. Because changes in criteria pollutant emissions, hazardous air pollutant emissions, and chaff emissions are not expected to be detectable, air quality is expected to fully recover before experiencing a subsequent exposure. Given these characteristics, the impacts on air quality from the combination of these resource stressors are expected to be similar to the impacts on air quality for any of these stressors taken individually without any additive, synergistic, or antagonistic interaction.

3.2.4.2 Alternative 1

As discussed in Sections 3.2.3.1 (Criteria Air Pollutants) and 3.2.3.2 (Hazardous Air Pollutants) emissions associated with Study Area training and testing under Alternative 1 primarily occur at least 3 nm offshore. For fixed-wing aircraft activities, emissions typically occur above the 3,000-ft. (914 m) mixing layer. Even though these stressors co-occur in time and space, there would be sufficient dispersion so the impacts would be short term. Air quality is expected to fully recover before experiencing a subsequent exposure. Given these characteristics, the impacts on air quality from the combination of these resource stressors are expected to be similar to the impacts on air quality for any of these stressors taken individually without any additive, synergistic, or antagonistic interaction. Emissions of most criteria pollutants and hazardous air pollutants are expected to increase under Alternative 1 in comparison to the No Action Alternative.

3.2.4.3 Alternative 2

As discussed in Sections 3.2.3.1 (Criteria Air Pollutants) and 3.2.3.2 (Hazardous Air Pollutants) emissions associated with Study Area training and testing under Alternative 2 primarily occur at least 3 nm offshore. For fixed-wing aircraft activities, emissions typically occur above the 3,000-ft. (914 m) mixing layer. Even though these stressors co-occur in time and space, there would be sufficient dispersion so the impacts would be short term. Air quality is expected to fully recover before experiencing a subsequent exposure. Given these characteristics, the impacts on air quality from the combination of these resource stressors are expected to be similar to the impacts on air quality for any of these stressors taken individually without any additive, synergistic, or antagonistic interaction. Emissions of most criteria pollutants and hazardous air pollutants are expected to increase under Alternative 2 in comparison to the No Action Alternative.

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3.3 Marine Habitats

MARINE HABITATS SYNPOSIS

The Navy considered all potential stressors and analyzed the following for potential impacts on marine habitats as a non-living substrate for sedentary biological communities (marine vegetation and invertebrates):

- Acoustic (explosives on or near the bottom only)
- Physical disturbance and strikes (military expended materials and seafloor devices)

Alternative 2 (Preferred Alternative)

- Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of explosives on or near the bottom, military expended materials, and seafloor devices during training and testing activities may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of non-living substrates that constitute Essential Fish Habitat and Habitat Areas of Particular Concern. Essential Fish Habitat conclusions for associated marine vegetation and sedentary invertebrates are summarized in corresponding resource sections (e.g., marine vegetation, invertebrates). Impacts to the water column as Essential Fish Habitat are summarized in corresponding resource sections (e.g., invertebrates, fish) because they are impacts on the organisms themselves.

3.3.1 Introduction

This section analyzes potential impacts on marine nonliving (abiotic) substrates found in the Atlantic Fleet Training and Testing (AFTT) Study Area (Study Area). The Study Area covers a range of marine habitats that support communities of organisms that vary by season and area. The intent of this section is to cover abiotic habitats not covered in the individual living resource chapters. The substance and substrate of the water column and bottom provides the necessary habitat for sedentary biological communities and mobile organisms discussed in other sections of this chapter.

Table 3.3-1 lists the types of habitats discussed in this section in relation to the open ocean areas; large marine ecosystems; and bays, estuaries, and rivers in which they occur. For intertidal shore and subtidal bottom habitats, a modified version of the Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al. 1979) is used. The modified classification system starts at the subsystem level (e.g., intertidal shores/subtidal bottoms) and focuses analysis on a modified class level (e.g., soft shores/bottoms, hard shores/bottoms) differentiating non-living substrates from the living structures on the substrate. Living structures on the substrate are termed biogenic habitats, and include wetland shores, aquatic plant beds (floating or attached macroalgae, rooted vascular plants), sedentary invertebrate beds, and reefs. These habitats constitute Essential Fish Habitats and components of Habitat Areas of Particular Concern for one or more life-stages of managed species. The Essential Fish Habitat Assessment for AFTT is a supporting technical document, with concurrence from the National Marine Fisheries Service (NMFS)(U.S. Department of the Navy 2013).

Table 3.3-1: Habitat Types within the Atlantic Fleet Training and Testing Study Area

Habitat Types (sub-system/class level)	Open Ocean	Large Marine Ecosystems	Bays, Estuaries, and Rivers
Substrates			
Soft Shores (e.g., beaches, mudflats)	–	All	All
Hard Shores (e.g., rocky intertidal)	–	Northeast U.S. Continental Shelf	Bath, ME; Portsmouth Naval Shipyard; Kittery, ME; coastal southern New England waters; Naval Submarine Base New London; Groton, CT
Soft Bottoms	All	All	All
Hard Bottoms	All	All	All
Artificial Structures (e.g., shipwrecks, artificial reefs, oil/gas platforms)	All	All	All
Biogenic habitats			
Wetland Shores and Aquatic Plant Beds (e.g., attached macroalgae, seagrass, *Sargassum*)	Section 3.7 (Marine Vegetation)		
Sedentary Invertebrate Beds and Reefs	Section 3.8 (Marine Invertebrates)		

CT: Connecticut; ME: Maine

The fundamental habitat descriptors of unconsolidated (soft) or rocky (hard) substrate are key factors in structuring sedentary biological communities (Nybakken 1993). The difference between substrates represents a viable target for the best available mapping technology (e.g., multibeam sonar) and corresponds well to characterizations of Navy impacts (e.g., explosive charges on soft bottom). Other classification systems include levels of detail well beyond the basic substrate level (Allee et al. 2000; Valentine et al. 2005). Table 3.3-1 indicates habitat types discussed in subsequent sections in a comprehensive habitat classification scheme for the Study Area.

Description and distribution information is not provided for the water column itself because any impacts resulting from Navy training and testing activities would be minimal and short-lived (e.g., disruption of vertical mixing in a small spatial area). Impacts on federally managed species via the water column (e.g., noise, contaminants), are summarized in corresponding resource sections (e.g., marine vegetation, invertebrates, fish).

Rationale for evaluating the impact of stressors on marine substrate differs from the rationale applied to other biological resources. Unlike organisms, habitats are valued mainly for their function, which is largely based on their structural components. Accordingly, the assessment focuses on the ability of substrates to function as habitats. An impact on abiotic marine habitat is anticipated where training, testing, or associated transit activities could convert one substrate type into another (i.e., bedrock to unconsolidated soft bottom, or soft bottom to parachute canvas). Whereas the impacts to the biogenic growth are covered in their respective resource sections, the impacts to bottom substrate are considered here.

3.3.2 Affected Environment

The majority of the Study Area occurs outside of state waters in the open ocean greater than 12 nautical miles (nm) offshore. Relatively little of the Study Area includes intertidal and shallow subtidal areas in state waters where numerous habitats are exclusively present (i.e., salt/brackish marsh, mangrove, seagrass beds, kelp forests, oyster reefs). Intertidal nonliving (abiotic) habitats (i.e., beaches, tidal deltas, mudflats, rocky shores) are addressed only where intersections with naval training or testing activities are reasonably likely to occur. Distribution of abiotic marine habitats among the large marine ecosystems and open ocean areas is described in their respective sections.

Abiotic marine habitats vary according to underlying geology, hydrodynamics, atmospheric conditions, and suspended particle matter. Flow and sediment from creeks and rivers create channels, tidal deltas, intertidal/subtidal flats, and shoals of unconsolidated material along the shorelines and estuaries. The influence of land-based nutrients and sediment increases with proximity to nearshore and inland waters. In the open ocean, gyres and oceanic currents create dynamic microhabitats that influence the distribution of organisms. A patchwork of diverse habitats exists on the open-ocean floor where there is no sunlight, low nutrient levels, and minimum sediment movement (Levinton 2009). Major bathymetric features in offshore areas of large marine ecosystems include shelves, banks, breaks, slopes, canyons, plains, and seamounts (see Table 3.0-4). Geologic features such as these affect hydrodynamics of the ocean water column (i.e., currents, gyres, upwellings) as well as living resources present. Bathymetric features of the Study Area are described in Section 3.0.3.2 (Bathymetry).

3.3.2.1 General Threats

Estuarine and ocean environments worldwide are under increasing pressure from human development and expansion, accompanied by increased ship traffic, pervasive pollution, invasive species, destructive fishing practices, vertical shoreline stabilization, offshore energy infrastructure, and global climate change (Crain et al. 2009; Lotze et al. 2006; Pandolfi et al. 2003). Stressors associated with these activities are not distributed randomly across the patchwork of habitat types and ecosystems (Halpern et al. 2008). Areas where heavy concentrations of human activity co-occur with naval training or testing activities have the highest potential for cumulative stress on the marine ecosystem (see Chapter 4, Cumulative Impacts, for more information). Large areas of bottom waters lacking dissolved oxygen, or "dead zones," are documented in the Study Area off the Mississippi River outlet (Rabalais et al. 2002) and other large rivers flowing into coastal ocean waters (Diaz and Rosenberg 2008). Refer to individual resource sections (Section 3.1, Sediment and Water Quality; Section 3.7, Marine Vegetation; Section 3.8, Marine Invertebrates; and Section 3.9, Fish) for specific stressors and impacts on biological resources associated with marine substrates.

3.3.2.2 Biogenic Habitats

Biogenic habitats on intertidal shores are characterized by erect, rooted, wetland plants (Cowardin et al. 1979). Wetland plant habitat includes soft shores in all water regimes except subtidal and irregularly exposed. Wetland shores in the Study Area are formed by salt marsh (e.g., cordgrass) or mangrove plant species. Salt marsh and mangrove plants are living marine resources and biogenic habitat where they dominate the intertidal zone. Plant species forming wetland shores are covered in Section 3.7 (Marine Vegetation).

Biogenic habitats seaward of wetland shores include aquatic plant beds, sedentary invertebrate beds, and reefs. Aquatic plant beds are dominated by vascular or non-vascular plants that grow principally on or below the surface of the water for most of the growing season in most years (Cowardin et al. 1979). Water regimes include subtidal, irregularly exposed, regularly flooded, permanently flooded, intermittently exposed, semipermanently flooded, and seasonally flooded. Seagrasses, attached macroalgae (i.e., kelp), and floating macroalgae (i.e., *Sargassum* species) form submerged beds or floating mats where they dominate layers of the water column. Refer to Section 3.7 (Marine Vegetation) for the discussion of species forming aquatic plant beds.

Sedentary invertebrate beds are characterized by aggregations of unattached shellfish, soft corals, and other stationary invertebrates inhabiting soft or hard bottom substrate. Such aggregations do not form ridge-like or mound-like structures on hard bottom substrate; they form “meadows” or “beds” where they dominate shore or bottom areas. The Class Reef includes ridge-like or mound-like structures formed by the colonization and growth of sedentary invertebrates (Cowardin et al. 1979). Reefs are characterized by their three-dimensional structure, elevation above the surrounding substrate, and interference with normal wave flow; they are primarily subtidal, but parts of some reefs may be intertidal as well. Refer to Section 3.8 (Marine Invertebrates) for the discussion of species forming sedentary invertebrate beds and reefs.

3.3.2.3 Soft Shores

Soft shores include all wetland habitats having three characteristics: (1) unconsolidated substrates with less than 75 percent areal cover of stones, boulders, or bedrock; (2) less than 30 percent areal cover of vegetation other than pioneering plants; and (3) any of the following water regimes: irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, intermittently flooded, saturated, or artificially flooded (Cowardin et al. 1979). Soft shores include beaches, tidal flats/deltas, and streambeds of the tidal riverine and estuarine systems.

Intermittent or intertidal channels of the riverine system and intertidal channels of the estuarine system are classified as streambed. Intertidal flats, also known as tidal flats or mudflats, are unvegetated areas consisting of loose mud, silt, and fine sand, with organic-mineral mixtures, and are regularly exposed and flooded by the tides (Karleskint et al. 2006). Muddy fine sediment tends to be deposited where wave energy is low, such as in sheltered bays and estuaries (Holland and Elmore 2008). Mudflats are typically unvegetated but may be covered with mats of green algae and substrate diatoms (single-celled algae) or sparsely vegetated with low-growing aquatic species (New York Natural Heritage Program 2009). Muddy intertidal habitat occurs most often as part of a patchwork of intertidal habitats that may include rocky shores, tidal creeks, sandy beaches, salt marshes, and mangroves.

Beaches form through the interaction of waves and tides, as particles are sorted by size and are deposited along the shoreline (Acropora Biological Review Team 2005). Wide flat beaches occur where wave energy and tidal ranges are high and sands are fine-grained. Narrow steep beaches of coarser sand form where energy is limited (Speybroeck et al. 2008). Three zones characterize beach habitats: (1) dry areas above mean high water, (2) wrack lines at mean high water, and (3) high-energy intertidal zones. Refer to living resource sections for more information of species use of tidal deltas, intertidal flats, and beaches.

Distribution

Mudflats occur to some extent in virtually every large marine ecosystem within the Study Area. Muddy deposits accumulate in many wave-protected pockets on the Gulf of Maine coast along the northern part of the Northeast United States (U.S.) Continental Shelf Large Marine Ecosystem, especially at the heads of bays. Extensive mudflats occur in the upper reaches of the Bay of Fundy (Tyrrell 2004). In the Southeast U.S. Continental Shelf Large Marine Ecosystem, mudflats are most often associated with tidal creeks and estuaries. In the South Atlantic Bight area, salt marshes and tidal creeks feather the coastal margins. Mudflats associated with mangroves occur on the east coast of Florida, roughly from St. Augustine to the Florida Keys, and north to Cedar Key on the west coast (Mitsch et al. 2009) in the southern part of the Southeast U.S Continental Shelf Large Marine Ecosystem. Tidal deltas and intertidal flats are present along the coast of Puerto Rico and Vieques (National Ocean Service 2011). In the central portion of the Gulf of Mexico Large Marine Ecosystem, west of the Mississippi River, large expanses of unique muddy subtidal bottoms are stirred by storms and deposited at the shoreline (Draut et al. 2005).

Pure stands of sandy beaches are less abundant but do occur in the northern part of the Northeast U.S. Continental Shelf Large Marine Ecosystem, which are otherwise dominated by rocky coasts. Small pocket beaches occur within the northern Gulf of Maine, and sandy beaches are abundant on Cape Cod in the southern Gulf of Maine (Roman et al. 2000). Some sandy intertidal habitats occur in all the states and provinces on the Gulf of Maine coast (Tyrrell 2004).

The Mid- and South Atlantic coast region is protected by an almost continuous string of barrier islands, which provide sandy intertidal shores (National Ocean Service 2011). Sandy coasts and barrier islands are common from Long Island, New York to as far south as Florida. A long arc of barrier islands known as the Outer Banks protects the shore stretching from southeastern Virginia almost to South Carolina.

Sandy intertidal habitat predominates in the Southeast U.S. Continental Shelf Large Marine Ecosystem (Mitsch et al. 2009). The east and west coasts of Florida have long stretches of sandy beaches. The West Central Barrier Chain, a series of sandy barrier islands, stretches from Anclote Key (north of Tampa Bay) all the way south to Cape Romano and protects the west coast of Florida (Hine et al. 2003). Sandy beaches are present along the shoreline of Puerto Rico and Vieques.

The eastern portion of the Gulf of Mexico Large Marine Ecosystem is fringed by sandy intertidal habitat, including barrier islands off the coast of the Florida panhandle. Shorelines of the western portion of the Gulf of Mexico Large Marine Ecosystem are dominated by sand that forms broad straight beaches and barrier islands (Britton and Morton 1998). The longest undeveloped barrier island in the world is Padre Island National Seashore in Texas, which has 70 miles (mi.) (113 kilometers [km]) of sand beaches that provide nesting ground for sea turtles, foraging ground for shorebirds, and sandy intertidal habitat for numerous other species (National Park Service 2010). Other barrier islands continue in an arc, trending up the Texas coast (Mustang, San Jose, Matagorda, Follets, and Galveston Islands) (Britton and Morton 1998).

3.3.2.4 Hard Shores

Rocky shores include aquatic environments characterized by bedrock, stones, or boulders that singly or in combination cover 75 percent or more of an area that is covered less than 30 percent by vegetation (Cowardin et al. 1979). Water regimes are restricted to irregularly exposed, regularly flooded, irregularly flooded, seasonally flooded, temporarily flooded, and intermittently flooded. Rocky intertidal shores are areas of bedrock that alternate between marine and terrestrial habitats, depending on if the tide is high or low (Menge and Branch 2001). Extensive rocky shorelines can be interspersed with sandy areas, estuaries, or river mouths.

Environmental gradients between hard shorelines and subtidal habitats are determined by wave action, depth, and frequency of tidal inundation, and stability of substrate. Where wave energy is extreme, only rock outcrops may persist. In lower energy areas, a mixture of rock sizes will form the intertidal zone. Boulders scattered in the intertidal and subtidal areas provide substrate for attached macroalgae and sessile invertebrates. Refer to living resource sections for more information on species inhabiting hard shorelines.

Distribution

Most of the rocky coastline of the U.S. Atlantic coast occurs from Massachusetts northward into the Gulf of Maine, in the northern part of the Northeast U.S. Continental Shelf Large Marine Ecosystem (Roman et al. 2000). Glacial terrain made of bedrock, gravel, and sediment typical of the New England coast is unique on the east coast of the United States. On the U.S. Atlantic shore, rocky and gravelly areas do not occur south of New York (National Ocean Service 2011). Rocky coasts in the northern areas give way to sandy shores toward the south. In the Southeast U.S. Continental Shelf Large Marine Ecosystem, sandy beaches predominate. In the Caribbean Sea, rocky bedrock shorelines are mapped along the coast of Puerto Rico and Vieques (National Ocean Service 2011). Very little rock occurs anywhere in the northern Gulf of Mexico.

Rocky shorelines border transit or testing activities originating from the shipyard in Bath, Maine; Portsmouth Naval Shipyard (Kittery, Maine); coastal southern New England waters; and the shipyard and Naval Submarine Base New London (Groton, Connecticut) (National Ocean Service 2011; U.S. Fish and Wildlife Service 2011).

3.3.2.5 Soft Bottoms

Soft bottoms include all wetland and deepwater habitats with at least 25 percent cover of particles smaller than stones (rock fragments larger than 10 in. [25.4 cm]), and a vegetative cover less than 30 percent (Cowardin et al. 1979). Water regimes are restricted to subtidal, permanently flooded, intermittently exposed, and semipermanently flooded. Soft bottom forms the substrate of channels, shoals, subtidal flats, and other features of the bottom. Sandy channels emerge where strong currents connect estuarine and ocean water columns. Shoals or capes form where sand is deposited by sediment-laden currents. Subtidal flats occur between the soft shores and the channels or shoals. The continental shelf extends seaward of the shoals and inlet channels and includes an abundance of coarse-grained, soft bottom habitats. Finer-grained sediments collect off the shelf break, continental slope, and abyssal plain. These areas are inhabited by soft sediment communities of mobile invertebrates fueled by benthic algae production, chemosynthetic microorganisms, and detritus drifting through the water column. Refer to living resources Sections 3.7 and 3.8 (Marine Vegetation and Marine Invertebrates, respectively) for more information on sedentary organisms inhabiting soft bottom substrate.

Distribution

Soft bottoms occupy the largest habitat area in the Study Area and occur in all large marine ecosystems and the open ocean. However, the bottom types vary across the Study Area (Figures 3.3-1 to 3.3-4) and are depicted by at least six studies:

- United States Geological Survey (2000)
- Sheridan and Caldwell (2002)
- Gulf States Marine Fisheries Commission (2008)
- Detailed mapping from acoustic and video surveys in the southeast (U.S. Department of the Navy 2010) and Scotian Shelf Large Marine Ecosystem (Todd and Kostylev 2011)

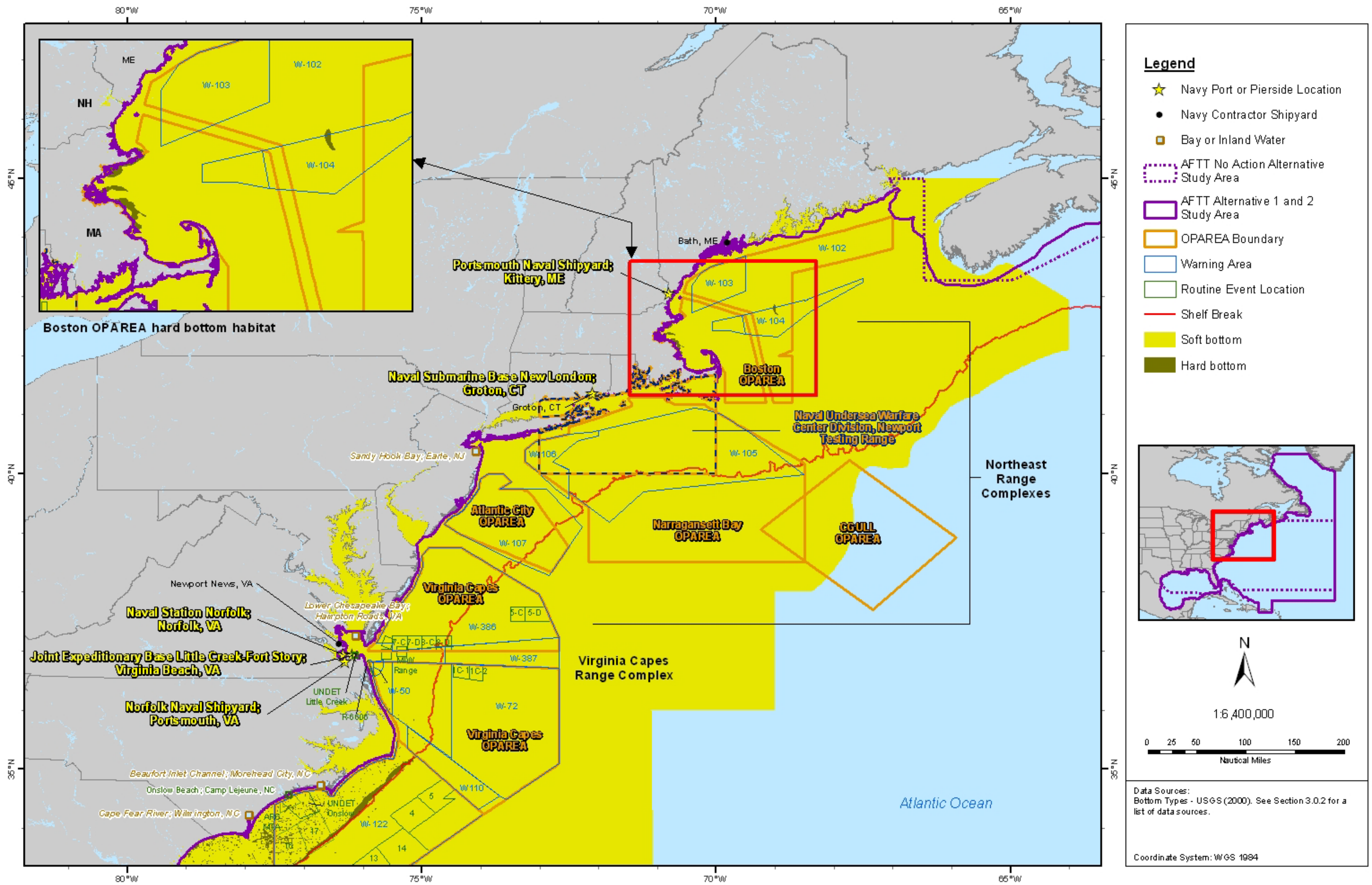

Figure 3.3-1: Bottom Types within the Northeast U.S. Continental Shelf Large Marine Ecosystem and Open Ocean Areas

AFTT: Atlantic Fleet Training and Testing; CT: Connecticut; MA: Massachusetts; ME: Maine; MIW: Mine Warfare; NH: New Hampshire; NJ: New Jersey; NC: North Carolina; OPAREA: Operating Area; UNDET: Underwater Detonation; USGS: U.S. Geological Survey; VA: Virginia

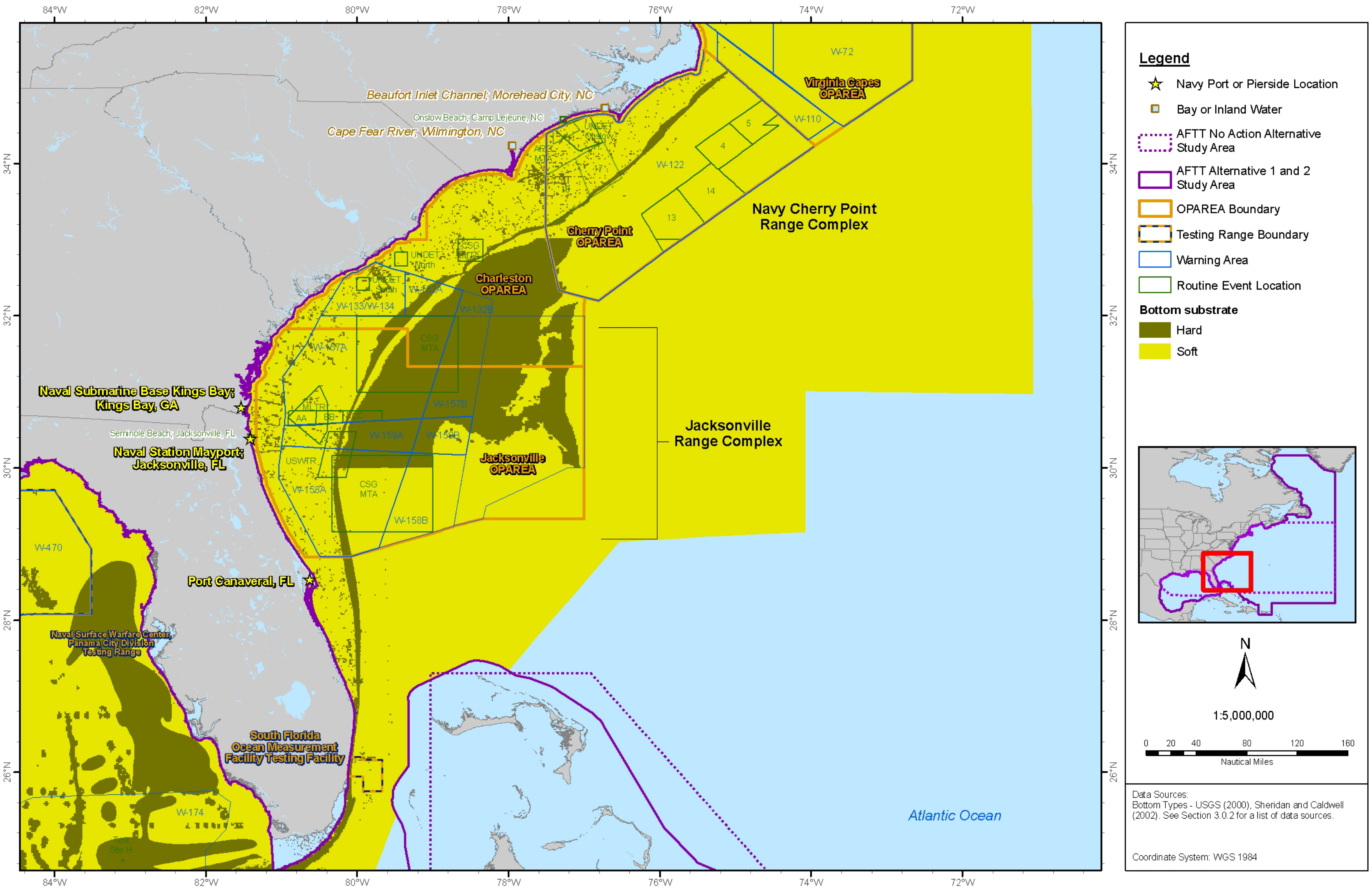

Figure 3.3-2: Bottom Types within the Southeast U.S. Continental Shelf Large Marine Ecosystem and Open Ocean Areas

AFTT: Atlantic Fleet Training and Testing; ARG MTA: Amphibious Readiness Group Mine Training Area; CSG MTA: Carrier Strike Group Mine Training Area; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; NC: North Carolina; OPAREA: Operating Area; UNDET: Underwater Detonation; USGS: U.S. Geological Survey; USWTR: Undersea Warfare Training Range

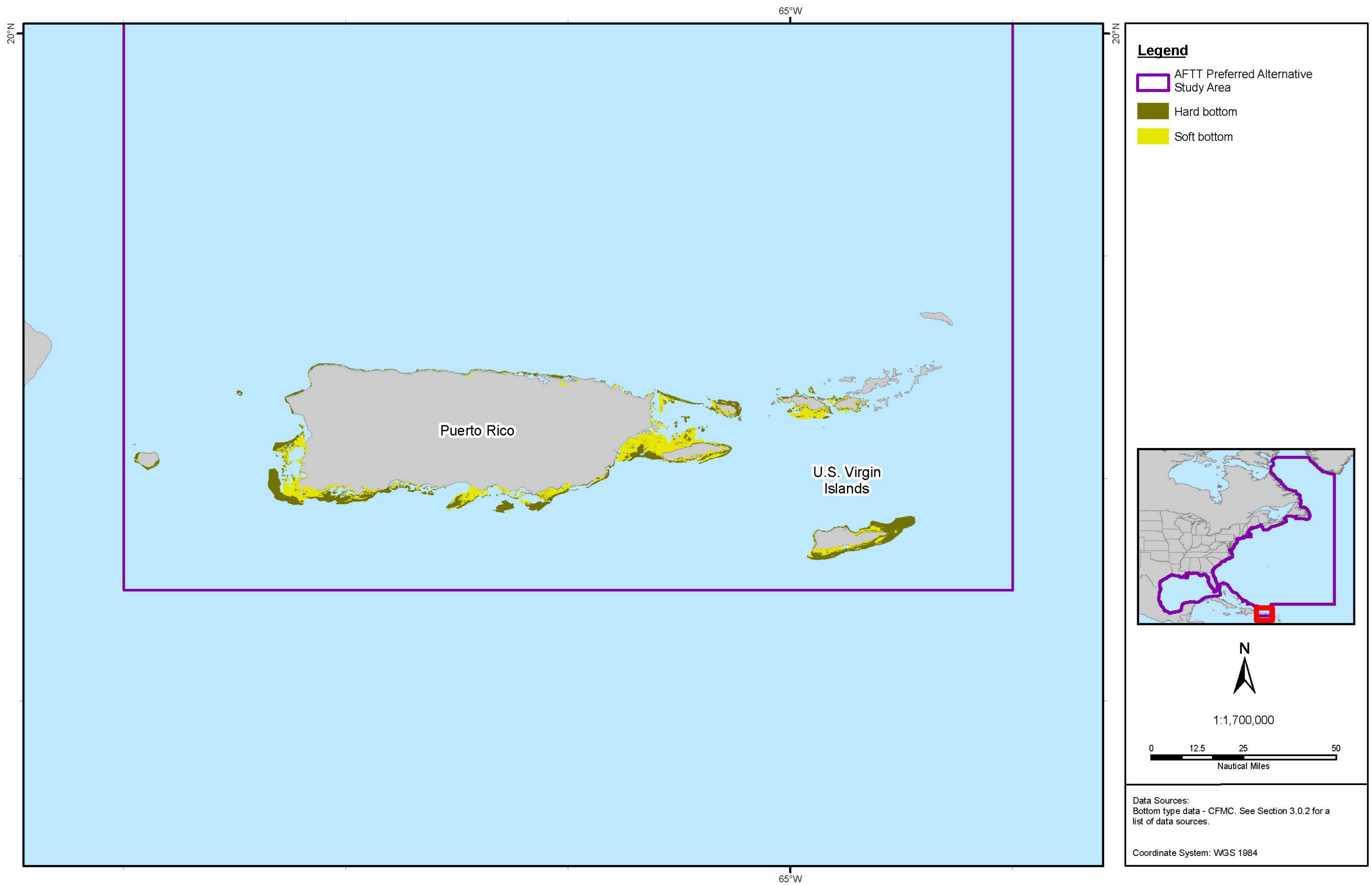

Figure 3.3-3: Bottom Types within the Caribbean Sea Large Marine Ecosystem

AFTT: Atlantic Fleet Training and Testing; CFMC: Caribbean Fishery Management Council; USGS: U.S. Geological Survey

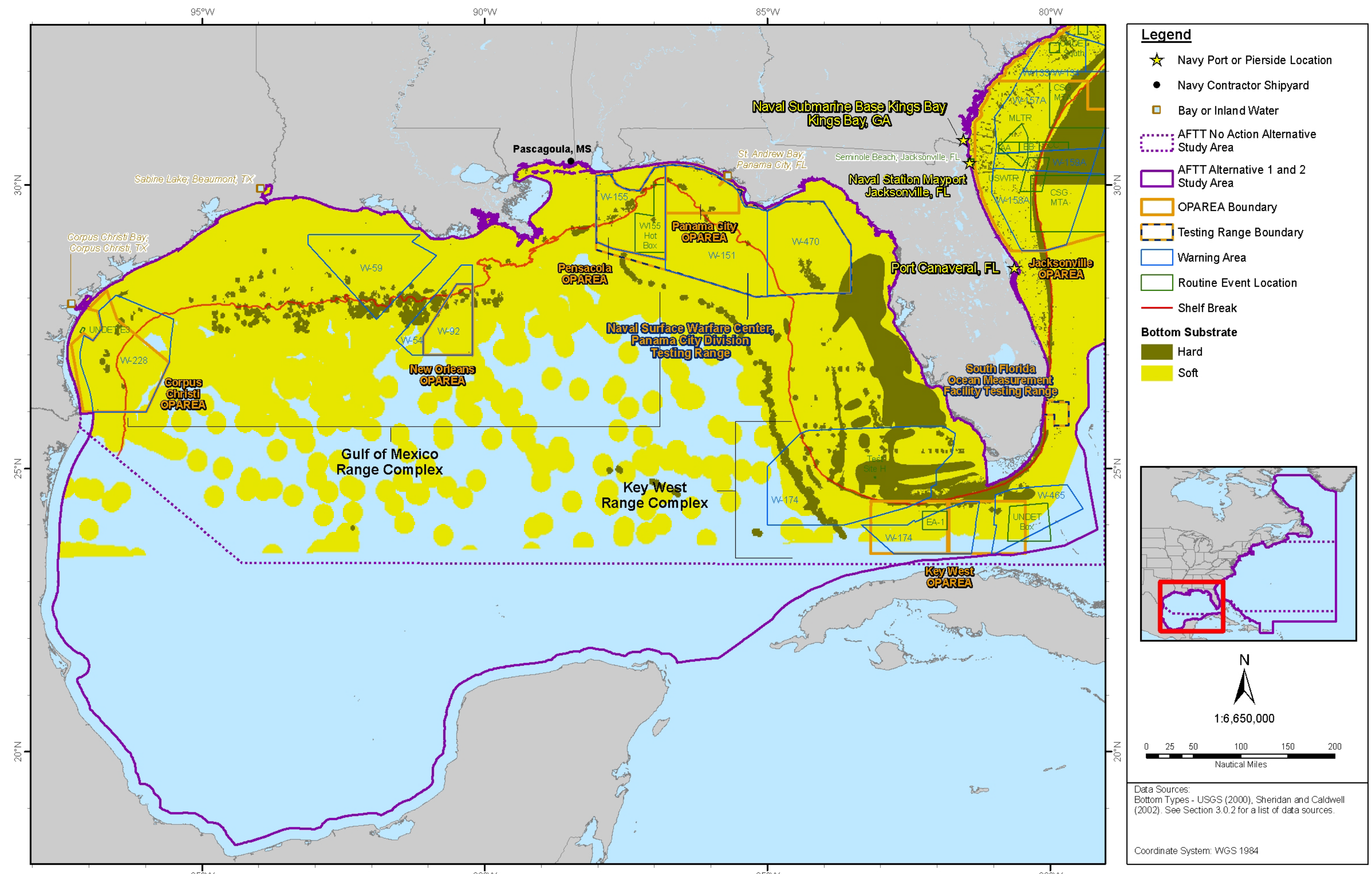

Figure 3.3-4: Bottom Types within the Gulf of Mexico Large Marine Ecosystem

AFTT: Atlantic Fleet Training and Testing; CSG MTA: Carrier Strike Group Mine Training Area; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; MS: Mississippi; OPAREA: Operating Area; TX: Texas; UNDET: Underwater Detonation; USWTR: Undersea Warfare Training Range; USGS: U.S. Geological Survey

These studies show a strikingly different distribution of bottom types in portions of shelf area they cover. There may be far less soft bottom in the Northeast U.S. Continental Shelf Large Marine Ecosystem than the U.S. Geological Survey indicates. The area mapped by Todd and Kostylev (2011) ranges from 30 to 250 m in depth, and is predominantly hard bottom (glacial till and bedrock). (U.S. Geological Survey 2000) classified the same area as predominately sand, sand/gravel, and gravel, suggesting a significant overestimation of soft bottom substrate. Conversely, there may be more soft bottom areas in the Southeast U.S. Continental Shelf Large Marine Ecosystem than the South Atlantic Fishery Management Council suggests. The U.S. Department of the Navy (2010) mapping suggests more soft bottom in the area than indicated on Southeast Area Monitoring and Assessment Program (SEAMAP) –South Atlantic (2001) maps (Figures 3.3-5 and 3.3-6); much of the area classified as "hard bottom" lacks hard substrate classifications (e.g., pavement, rock outcrops). Deepwater hard bottom areas, in particular, could be more accurately classified as mostly soft bottom, in the form of mounds composed of a mix of sediment and gravel to cobble-sized coral fragments.

Soft bottom around Puerto Rico was mapped in Kendell et al. (2001), whereas Gulf of Mexico soft bottom was mapped in geology surveys (Sheridan and Caldwell 2002) similar to United States Geological Survey (2000), and as a compilation of data sources (Gulf States Marine Fisheries Commission 2008).

Lack of detailed distribution information for marine substrate worldwide has prompted research to investigate other means of predicting their distribution. Watts et al. (2011) used slope of the bottom on 250 meter (m) resolution bathymetry data as an accurate indicator of hard bottom distribution of reefs off the southern coast of Australia, with greater slope meaning greater probability of reef occurrence. Conversely, lower slopes correspond to non-reef, soft bottom areas. The same concept applied to the western Atlantic and Gulf of Mexico suggests the dominance of soft bottom substrates landward of the shelf break and across the abyssal plain in open-ocean waters. Sediment types may also be implied from bathymetric contours in estuarine areas of the Study Area, where channels and subtidal beaches are generally coarse-grained, flood/ebb tidal deltas are finer-grained, and sheltered tidal creeks are very fine-grained.

3.3.2.6 Hard Bottoms

Hard, rocky bottom includes all subtidal habitats with substrates having an areal cover of stones, boulders, or bedrock 75 percent or greater and vegetative cover of less than 30 percent (Cowardin et al. 1979). Generic hard bottom could be any naturally occurring material on the bottom that is sufficiently solid and stationary (e.g., hard consolidated mud) to support sedentary, attached macroalgae or invertebrates (e.g., barnacles, anemones, hard corals). As such, hard bottom substrate forms the foundation of attached macroalgae beds (Section 3.7, Marine Vegetation), sedentary invertebrate beds and reefs (Section 3.8, Marine Invertebrates).

Hard bottoms occur as extensions of intertidal rocky shores and as isolated offshore outcrops. The shape and texture of the larger rock assemblage and the fine details of cracks and crevices are determined by the type of rock, the wave energy, and other local variables (Davis 2009). Maintenance of rocky reefs requires wave energy sufficient to sweep sediment away (Lalli 1993) or offshore areas lacking a significant sediment supply; therefore, rocky reefs are rare on broad coastal plains near sediment-laden rivers and are more common on high-energy shores and beneath strong bottom currents, where sediments cannot accumulate. The shape of the rocks determines, in part, the type of community that develops on a rocky bottom (Witman and Dayton 2001). Below a depth of about 20 m on rocky reefs, light is insufficient to support much plant life (Dawes 1998). Rocky reefs in this zone are

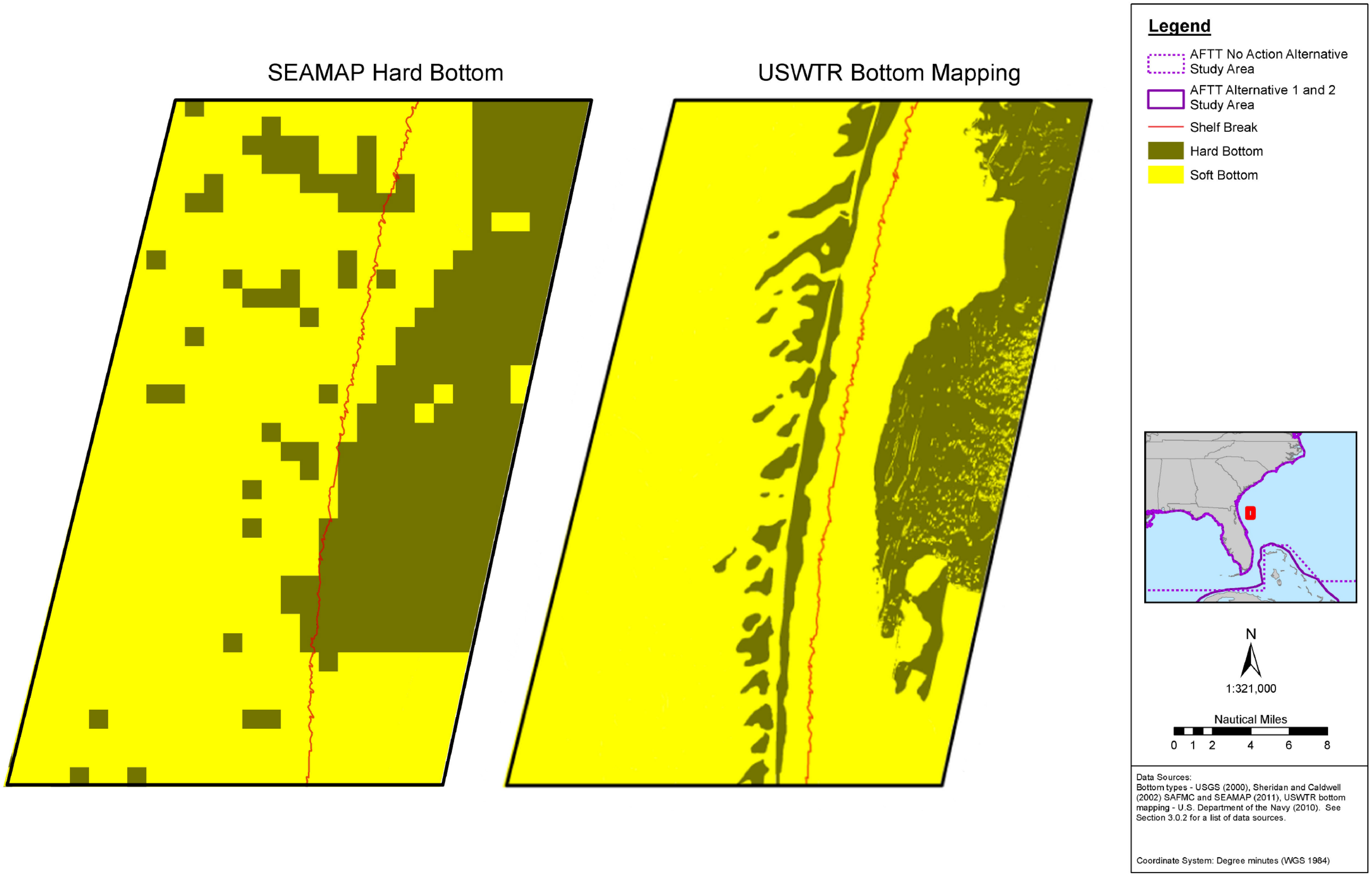

Figure 3.3-5: Comparison of Bottom Types within a Portion of the Southeast U.S. Continental Shelf Large Marine Ecosystem and Open Ocean Areas from Different Sources

AFTT: Atlantic Fleet Training and Testing; SAFMC: South Atlantic Fishery Management Council; USGS: U.S. Geological Survey; USWTR: Undersea Warfare Training Range; SEAMAP: Southeast Area Monitoring and Assessment Program

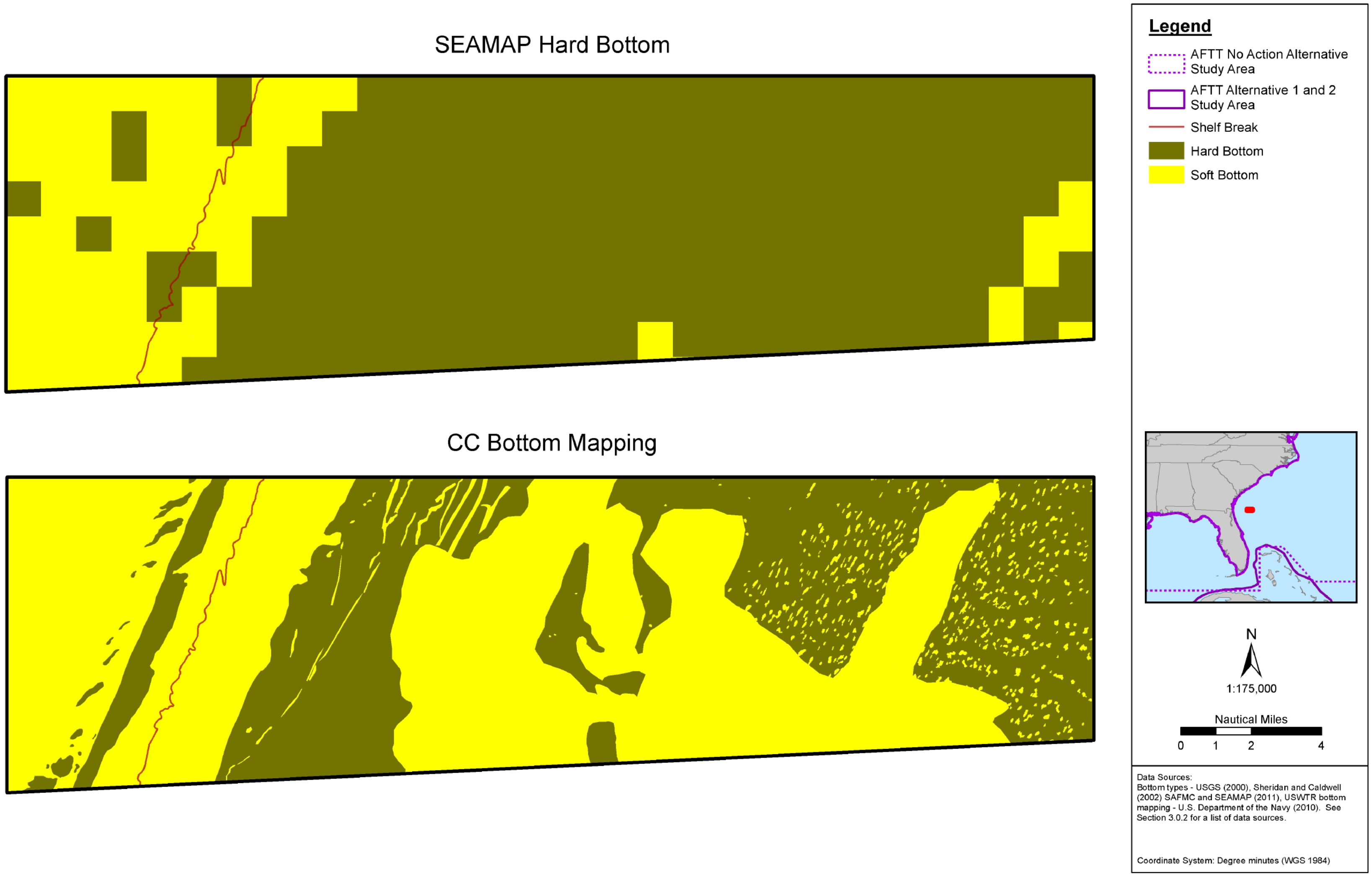

Figure 3.3-6: Comparison of Bottom Types within a Portion of the Southeast U.S. Continental Shelf Large Marine Ecosystem and Open Ocean Areas from Different Sources

AFTT: Atlantic Fleet Training and Testing; CC: training range; SAFMC: South Atlantic Fishery Management Council; SEAMAP: Southeast Area Monitoring and Assessment Program; USGS: U.S. Geological Survey encrusted with invertebrates, including sponges, sea cucumbers, soft corals, and sea whips, which provide food and shelter for many smaller invertebrates.

Distribution

Hard bottoms occur in all large marine ecosystems and the open ocean. However, the bottom types vary across the Study Area (Figures 3.3-1 through 3.3-4) and are depicted by at least seven studies:

- United States Geological Survey (2000)
- Sheridan and Caldwell (2002)
- Southeast Area Monitoring and Assessment Program (SEAMAP) – South Atlantic (2001) and Udouj (2007); mapped presence/absence of hard bottom and possible hard bottom in one-minute grid cells on the continental shelf, based on various data sources and assumptions. The program also mapped hard bottom habitat beyond the continental shelf off North Carolina, South Carolina, Georgia, and Florida (Udouj 2007)
- Gulf of Mexico Fishery Management Council (2005)
- Gulf States Marine Fisheries Commission (2008)
- Detailed mapping from multibeam sonar surveys in the southeast (U.S. Department of the Navy 2010) and Scotian Shelf Large Marine Ecosystem (Todd and Kostylev 2011)
- Hard bottom along the shelf break ridge in the South Atlantic Large Marine Ecosystem was created based on depth occurrence of documented hard bottom features along the shelf break (50-100 m), followed by connection of areas to form a single polygon from Cape Hatteras, NC, to the eastern tip of Florida

The West Greenland Shelf Large Marine Ecosystem has numerous rocky banks, such as the Fyllas Bank (Aquarone and Adams 2009). The Grand Banks and Flemish Cap occur in the eastern part of the Newfoundland-Labrador Large Marine Ecosystem and are important to fisheries (Aquarone and Adams 2009).

Rocky hard bottoms are common in the Gulf of Maine and northern extent of the Northeast U.S. Continental Shelf Large Marine Ecosystem. Mapping of bottom geology by the United States Geological Survey (2000) shows bands of bedrock offshore from areas north of Cape Cod and an area between Georges and German Banks (Figure 3.3-1). Cobble and pebble habitats occur in the subtidal areas around New Hampshire, southern Maine, and southern Nova Scotia (Valentine et al. 2005).

The mapping studies show a strikingly different distribution of bottom types in portions of shelf area they cover. There may be far more hard bottom in the Northeast U.S. Continental Shelf Large Marine Ecosystem than the U.S. Geological Survey indicates. Substrate types on German Bank in the Scotian Shelf Large Marine Ecosystem are also mapped from multibeam sonar surveys (Todd and Kostylev 2011). The mapped area ranges in depth from 30 to 250 m, and is predominantly hard bottom (glacial till and bedrock). United States Geological Survey (2000) classified the same area as predominately sand, sand/gravel, and gravel based on various grab samples and interpolation between samples, suggesting a significant underestimation of hard bottom substrate. Conversely, there may be less hard bottom areas in the Southeast U.S. Continental Shelf Large Marine Ecosystem than the South Atlantic Fishery Management Council suggests. The U.S. Department of the Navy (2010) mapping suggests more soft bottom than indicated on Southeast Area Monitoring and Assessment Program—South Atlantic (2001) maps (Figures 3.3-5 and 3.3-6); much of the area Southeast Area Monitoring and Assessment Program (SEAMAP) –South Atlantic classified as “hard bottom” lacks hard substrate classifications (e.g., pavement, rock outcrop). Deepwater hard bottom areas, in particular, could be more accurately classified as mostly soft bottom, in the form of mounds composed of a mix of sediment and gravel to cobble-sized coral fragments. While the presence of hard consolidated mud is possible in the mapped area, it would likely be classified with other hard substrate given the acoustic survey method.

Coral reefs and uncolonized bedrock in Puerto Rico were mapped in Kendell et al. (2001). Hard bottom in the Gulf of Mexico was mapped in geology surveys (Sheridan and Caldwell 2002) similar to United States Geological Survey (2000), Essential Fish Habitat designations for managed species in the Gulf of Mexico (Gulf of Mexico Fishery Management Council 2005), and as a compilation of data sources (Gulf States Marine Fisheries Commission 2008).

Lack of detailed distribution information for marine substrate prompted researchers to investigate other means of predicting distribution. Watts et al. (2011) used slope of the bottom on 250 m resolution bathymetry data as an accurate indicator of hard bottom distribution of reefs off the southern coast of Australia, with greater slope meaning greater probability of reef occurrence. The same concept applied to the western Atlantic and Gulf of Mexico, suggesting the dominance of hard bottom on high relief seafloor features, including but not limited to, the continental shelf break, canyons, seamounts, and ridges.

3.3.2.7 Artificial Structures

Artificial habitats are man-made structures that provide habitat for marine organisms. Artificial habitats occur in the marine environment, either by design and intended as habitat (e.g., artificial reefs), by design and intended for a function other than habitat (e.g., oil and gas platforms and floating objects moored at specific locations in the ocean to attract fishes that live in the open ocean), or unintentionally (e.g., shipwrecks). Artificial habitats function as hard bottom by providing structural attachment points for algae and sessile invertebrates, which in turn support a community of mobile organisms that forage, shelter, and reproduce there (National Oceanic and Atmospheric Administration 2007).

Artificial habitats in the Study Area include artificial reefs, shipwrecks, oil and gas platforms, man-made shoreline structures (i.e., piers, wharfs, docks, pilings), and fish-aggregating devices (Macfadyen et al. 2009; Seaman 2007). Artificial reefs are designed and deployed in an attempt to supplement the ecological functions and services provided by coral reefs and rocky bottoms. Artificial reefs range from simple concrete blocks to highly engineered structures. When vessels sink to the seafloor, they are colonized by the encrusting and sessile marine organisms that attach to hard surfaces. Over time, the wrecks become functioning reefs.

Distribution

The distribution of mapped artificial structures in the Study Area is depicted on Figures 3.3-7 through 3.3-10 and the map data sources are listed in Table 3.3-2.

Shipwrecks occur in virtually all navigable waters worldwide. Shipwrecks are a common feature of the Scotian Shelf Large Marine Ecosystem. Thousands of shipwrecks occur off the coasts of Nova Scotia, Newfoundland, and New Brunswick (Northern Maritime Research 2010). In the Northeast U.S. Continental Shelf Large Marine Ecosystem, there are thousands of shipwrecks in the state waters of Maine, Massachusetts, Rhode Island, New York, New Jersey, Maryland, Virginia, and North Carolina (Northern Maritime Research 2010). More than 1,800 shipwrecks are scattered across the floor of the

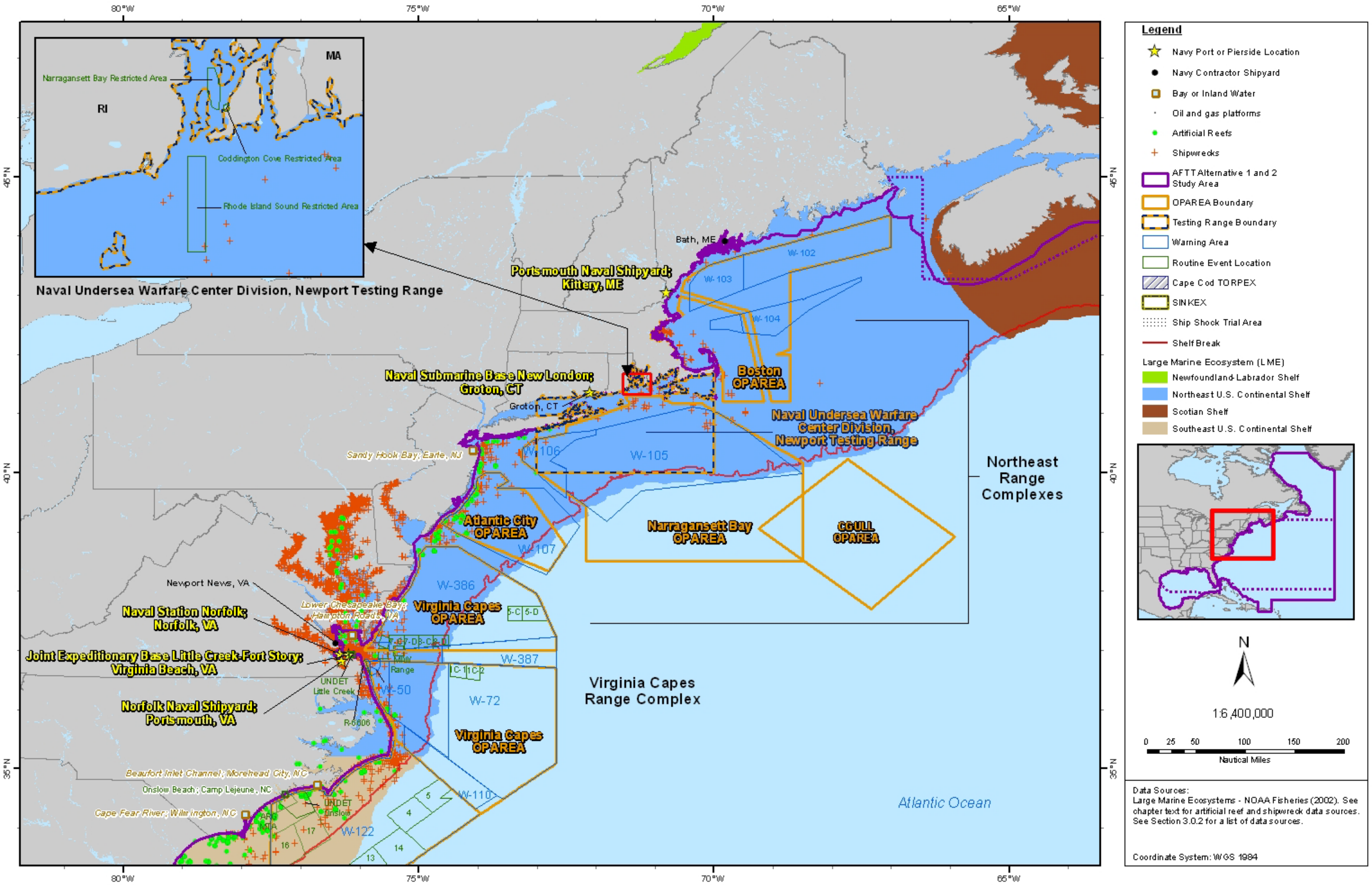

Figure 3.3-7: Map of Artificial Structures within the Northeast U.S. Continental Shelf Large Marine Ecosystem and Open Ocean Areas

AFTT: Atlantic Fleet Training and Testing; CT: Connecticut; LME: Large Marine Ecosystem; MA: Massachusetts; ME: Maine; MIW: Mine Warfare; NC: North Carolina; NJ: New Jersey; NOAA: National Oceanic and Atmospheric Administration; OPAREA: Operating Area; RI: Rhode Island; SINKEX: Sinking Exercise; TORPEX: Torpedo; UNDET: Underwater Detonation; VA: Virginia

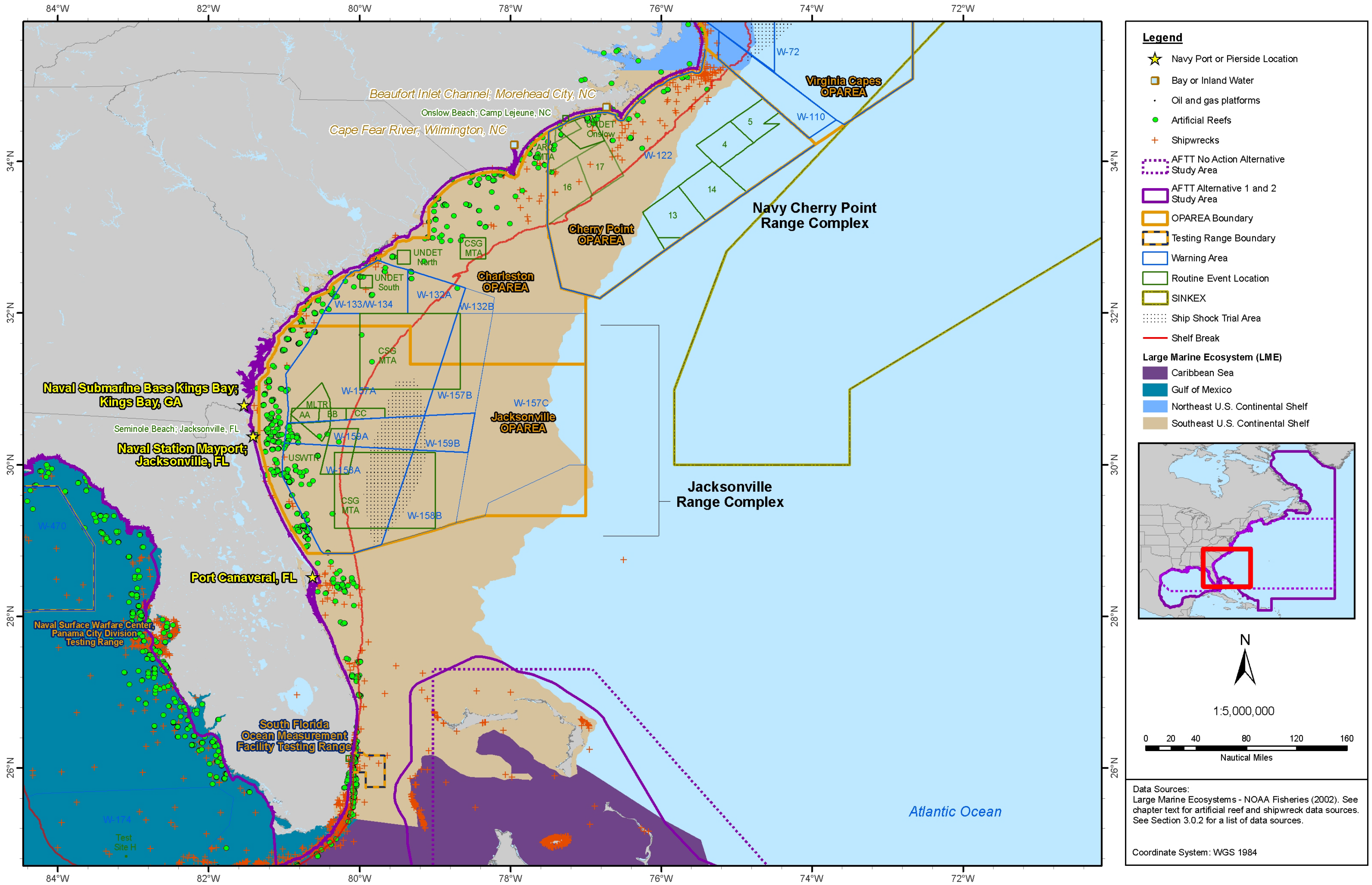

Figure 3.3-8: Map of Artificial Structures within the Southeast U.S. Continental Shelf Large Marine Ecosystem and Open Ocean Areas

AFTT: Atlantic Fleet Training and Testing; ARG MTA: Amphibious Readiness Group Mine Training Area; CSG MTA: Carrier Strike Group Mine Training Area; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; OPAREA: Operating Area; NC: North Carolina; NOAA: National Oceanic and Atmospheric Administration; SINKEX: Sinking Exercise; UNDET: Underwater Detonation; USWTR: Undersea Warfare Training Range

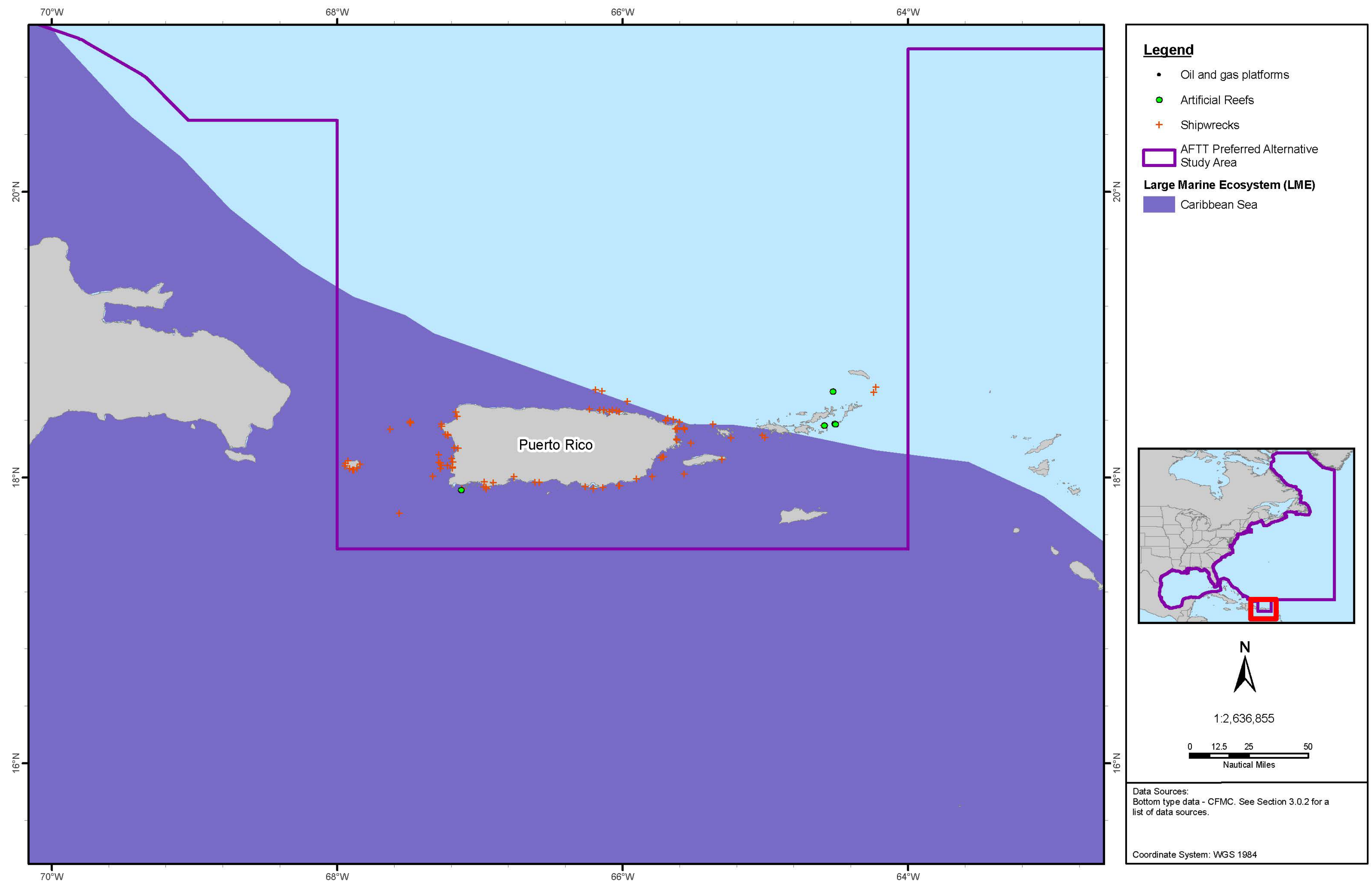

Figure 3.3-9: Map of Artificial Structures within the Southeast U.S. Continental Shelf, Caribbean Sea, and Eastern Portion of the Gulf of Mexico Large Marine Ecosystems

AFTT: Atlantic Fleet Training and Testing; CFMC: Caribbean Fishery Management Council

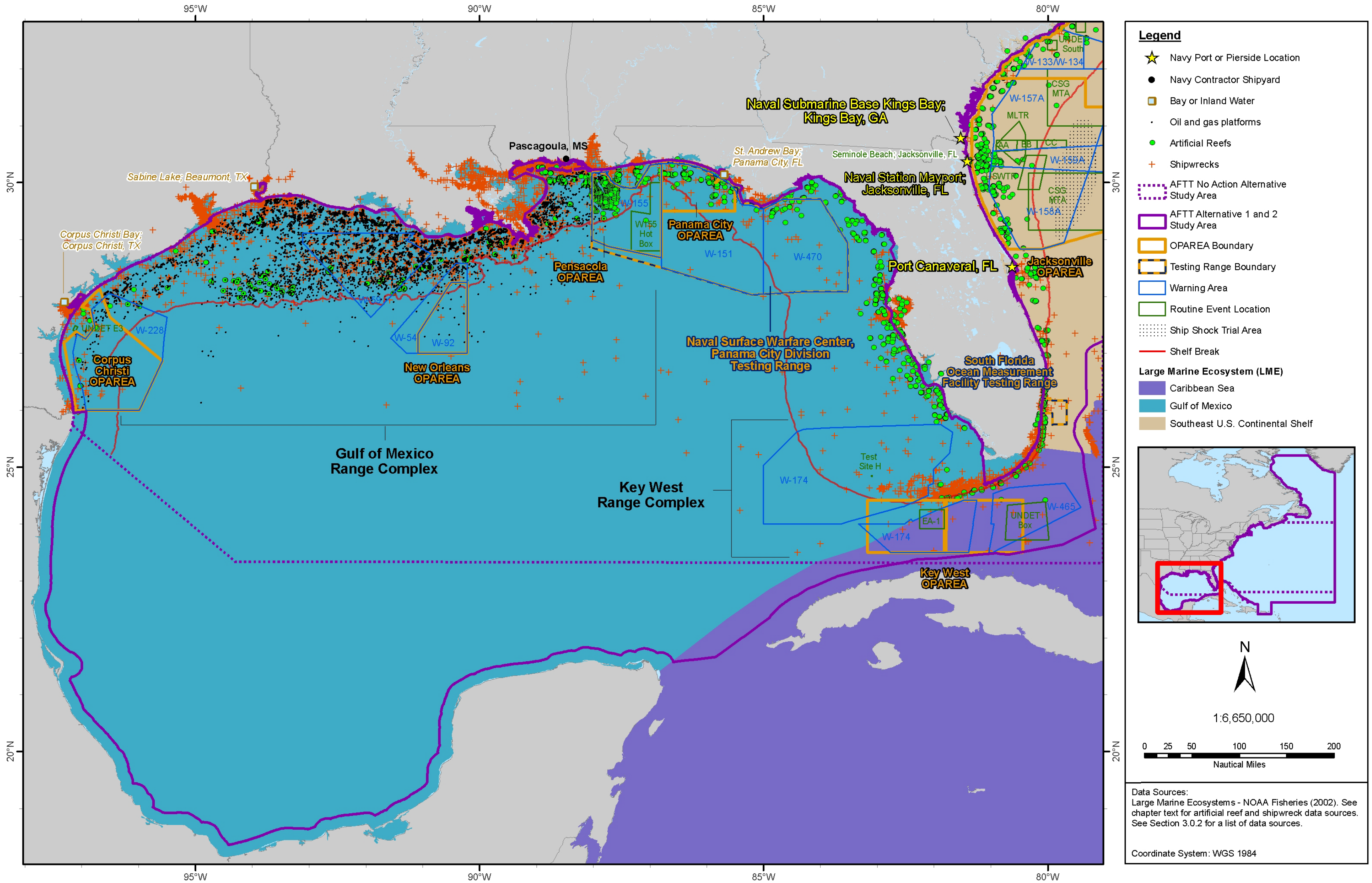

Figure 3.3-10: Map of Artificial Structures within the Western Portion of the Gulf of Mexico Large Marine Ecosystem

AFTT: Atlantic Fleet Training and Testing; CSG MTA: Carrier Strike Group Mine Training Area; FL: Florida; GA: Georgia; MLTR: Missile Laser Training Range; MS: Mississippi; OPAREA: Operating Area; TX: Texas; USWTR: Undersea Warfare Training Range

Table 3.3-2: Geographic Information System Data Sources for Artificial Structures on Figures 3.3-7 to 3.3-10

Large Marine Ecosystems	Spatial Data References
Northeast U.S. Continental Shelf	(Delaware Division of Fish and Wildlife 2002, 2008; Freeman and Walford 1974a, b, c; National Oceanic and Atmospheric Administration 2002; Screamingreel 2003; Treasure Expeditions 2004)
Southeast U.S. Continental Shelf	(Bureau of Land Management 1976; Florida Fish and Wildlife Conservation Commission 2004; Freeman and Walford 1976; Georgia Department of Natural Resources 2001; National Oceanic and Atmospheric Administration 2002; NOAA Coastal Services Center 1998; North Carolina Division of Marine Fisheries 2005; Southeast Area Monitoring and Assessment Program—South Atlantic 2001; Veridian Corporation 2001; Virginia Marine Resources Commission 2005, 2009)
Caribbean Sea	(Berg and Berg 1989; Cerame Vivas 1988; Handler 2001; Simonsen 2000; Waterproof Charts Inc. 1998)
Gulf of Mexico	(Alabama Department of Conservation and Natural Resource Marine Resources Division 2005; Bureau of Ocean Energy Management 2012; Florida Fish and Wildlife Conservation Commission 2004; Mississippi Department of Marine Resources 2001, 2003; National Oceanic and Atmospheric Administration 2002; Texas Parks and Wildlife Department 1999, 2003; Veridian Corporation 2001)

Chesapeake Bay (Chesapeake Bay Program 2009). The concentrations of shipwrecks around North Carolina's cape shoals are known as the "Graveyard of the Atlantic." Over 2,000 shipwrecks are documented in Florida state waters, some dating back to the days of Spanish exploration (Northern Maritime Research 2010). There are also a large number of wrecks in the Gulf of Mexico (Veridian Corporation 2001).

Most artificial reef development in marine waters was implemented and monitored by individual state programs; information published by state government websites on artificial reef programs is summarized in this section. In preparing this document, no information on artificial reefs in the Scotian Shelf, West Greenland, or Newfoundland-Labrador Large Marine Ecosystems was found. In the central part of the Northeast U.S. Continental Shelf Large Marine Ecosystem, artificial reefs occur off the coasts of Massachusetts (Nantucket Sound), Rhode Island (The Nature Conservancy 2010), New York (New York State Department of Environmental Conservation 2010), New Jersey (New Jersey Department of Environmental Protection Division of Fish & Wildlife 2010), Delaware (Delaware Department of Natural Resources and Environmental Control 2010), Maryland (Maryland Department of Natural Resources 2010), and Virginia (Virginia Marine Resources Commission 2009). Delaware, Maryland, and New Jersey are cooperating to develop a 1 square-mile ($mi.^2$) (2.6 square-kilometer [km^2]) regional reef site (Del-Jersey-Land Inshore Site) where retired Navy vessels will be sunk (Delaware Department of Natural Resources and Environmental Control 2010).

Artificial reef programs are active in the Southeast U.S. Continental Shelf Large Marine Ecosystem. North Carolina, South Carolina, Georgia, and the eastern and southern portions of Florida have a growing number of artificial reefs in their coastal and offshore waters (North Carolina Division of Marine Fisheries 2005; South Atlantic Fishery Management Council 2009). Roughly half of these sites are in waters off the east coast of Florida. The largest of the artificial reef complexes in North Carolina is called the Oregon Inlet Reef, composed of two ships, one trawler, numerous pipes, over 60 reef balls (artificial reef modules), and parts of ships (North Carolina Division of Marine Fisheries 2005). More than 790 artificial reefs are documented on Florida's east coast (Florida Fish and Wildlife Conservation

Commission 2010; South Atlantic Fishery Management Council 2009). Many offshore reefs are designated as special management zones (South Atlantic Fishery Management Council 2009).

States in the Gulf of Mexico Large Marine Ecosystem have been active in deploying artificial reefs for more than 50 years. Alabama has more than 800 $mi.^2$ (2,070 km^2) of habitat for deployment of artificial reefs (Alabama Department of Conservation and Natural Resources 2008). Mississippi (Mississippi Department of Marine Resources 2010), Louisiana (Louisiana Department of Wildlife and Fisheries 2009), and Texas (Texas Parks and Wildlife Department 2007) have inshore and offshore artificial reefs. Most of Louisiana's offshore reef sites are made of retired oil and gas platforms. The world's largest artificial reef was established off Grand Isle, Louisiana (Louisiana Department of Wildlife and Fisheries 2009). Like other states, Louisiana also acquired abandoned military equipment to use as artificial reef material.

Oil and gas rigs are found throughout the Gulf of Mexico Large Marine Ecosystem. In 2012, there were 7,089 offshore oil production facilities in federal waters (Bureau of Ocean Energy Management 2012) (Figure 3.3-10). Many of the non-functioning structures were left in place to serve as artificial reefs (National Oceanic and Atmospheric Administration 2007).

3.3.3 Environmental Consequences

This section evaluates how and to what degree the activities described in Chapter 2 (Description of Proposed Action and Alternatives) could impact marine habitats in the Study Area. Tables 2.8-1 through 2.8-3 present the baseline and proposed training and testing activity locations for each alternative (including number of events and ordnance expended). Each marine habitat stressor is introduced, analyzed by alternative, and analyzed for training activities and testing activities. Table F-1 in Appendix F shows the warfare areas and associated stressors that were considered for analysis. Stressors vary in intensity, frequency, duration, and location within the Study Area. The following stressors are applicable to marine habitats in the Study Area and are analyzed because they have the potential to alter the quality or quantity of marine habitats for associated living resources:

- Acoustic (impacts from explosives on or near the bottom)
- Physical disturbance and strike (impacts from military expended materials and seafloor devices)

Non-explosive acoustic sources do not change the substrate type of the bottom, and energy stressors do not change the substrate type by their surface orientation and nature. Entanglement and ingestion stressors do not alter bottom types. In the remainder of this section, marine habitats are referred to as marine substrates to reflect the subset of marine habitats being evaluated.

3.3.3.1 Acoustic Stressors

This section analyzes the potential impacts of explosions on or near the bottom resulting from training and testing activities within the Study Area. Consequences of these impacts are variable among substrate types.

3.3.3.1.1 Impacts from Explosives

An explosive detonated on or near the seafloor could alter the substrate, associated biogenic habitats, and inhabiting biological communities. The potential impact on marine substrate is assessed according to size of charge (net explosive weight, charge radius), height above the bottom, substrate types in the area, and equations linking all these factors.

An explosive charge would produce high energy that would be absorbed and reflected by the bottom. Hard bottom would mostly reflect the charge (Berglind et al. 2009), whereas a crater would be formed in soft bottom (Gorodilov and Sukhotin 1996). For a specific size of explosive charge, crater depths and widths would vary depending on depth of the charge and substrate type. There is a nonlinear relationship between crater size and depth of water, with relatively small crater sizes in the shallowest water, followed by a spike in size at some intermediate depth, and a decline to an average flat line at greater depth (Gorodilov and Sukhotin 1996; O'Keeffe and Young 1984). Radii of the craters reportedly vary little among unconsolidated substrate types (O'Keeffe and Young 1984). On substrate types with nonadhesive particles (everything except clay), the effects should be temporary, whereas craters in clay may persist for years (O'Keeffe and Young 1984). Soft substrate moves around with the tides and currents and depressions are only short-lived (days – weeks) unless they are maintained.

On hard substrates, energy from bottom detonations is reflected to a greater degree than corresponding detonations on soft bottom (Berglind et al. 2009; Keevin and Hempen 1997). The amount of consolidated substrate (i.e., bedrock) converted to unconsolidated sediment from surface explosions varies according to material types and degree of consolidation (i.e., rubble, bedrock). Due to lack of accurate and specific information on hard bottom types, the worst-case scenario for hard bottom impacted is equal to the area of soft bottom impacted.

3.3.3.1.1.1 No Action Alternative

Training Activities

Relevant training activities under the No Action Alternative include explosives used during mine countermeasures, mine neutralization using remotely operated vehicles, and mine neutralization explosive ordnance disposal (see Table 2.8-1). Specific locations for these activities under the No Action Alternative are listed in Table 3.3-3 and are shown on Figures 3.3-1 through 3.3-10. The intersections of explosives on or near the bottom and surveyed marine substrates are listed below.

- Northeast U.S. Continental Shelf Large Marine Ecosystem (Virginia Capes [VACAPES] Range Complex [W-50]): Sandy soft bottom and artificial reefs around the perimeter. Bottom types are less than 30 m deep.
- Southeast U.S. Continental Shelf Large Marine Ecosystem:
    - Cherry Point Operating Area (OPAREA) (underwater detonation area): Sandy soft bottom, hard bottom, artificial reefs, shipwrecks, and artificial structures around the perimeter. Bottom types are less than 30 m deep.
    - Jacksonville (JAX) Range Complex (underwater detonation areas): Sandy soft bottom and hard bottom, higher concentrations of hard bottom adjacent to boxes. Bottom types are less than 30 m deep.

The determination of impact is based on worst-case scenarios: 5 and 20 lb. (net explosive weight) explosions on the bottom. Realistically, not all charges are placed on the bottom, and mitigation measures help prevent hard bottom impacts (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). The number of bottom explosions modeled is assumed to be approximately half the number of charges.

Table 3.3-3: Explosives on or near the Bottom for Training Activities in the No Action Alternative

Training Area	Net Explosive Weight (lb.)	Number of Charges	Total Impact Footprint (km^2)	Hard Substrate		Soft Substrate		Unknown Substrate	
				km^2	% Impact	km^2	% Impact	km^2	% Impact
Northeast U.S. Continental Shelf Large Marine Ecosystem									
VACAPES (W-50)	5	15	0.00081	0	0	421	0.0002	0	0
	20	6	0.00081		0		0.0002		0
Total	*na*	*na*	*0.00162*		*0*		*0.0004*		*0*
Southeast U.S. Continental Shelf Large Marine Ecosystem									
Cherry Point (UNDET Area)	20	5	0.000675	217	0.0003	1,414	<0.0001	0	0
JAX (UNDET Areas North and South)	20	3	0.000405	67	0.0006	541	0.0001	0	0
Total	*na*	*na*	*0.00108*	*284*	*0.0004*	*1,955*	*0.0001*	*0*	*0*

Note: Substrate areas depicted on Figures 3.3-1 and 3.3-2.
JAX: Jacksonville Range Complex; km^2: square kilometer; lb.: pound; m^2: square meter; UNDET Area: underwater detonation area; VACAPES: Virginia Capes Range Complex

The depth of mine neutralization areas varies from 10 to 30 m. The depth (h) and radius (R) of the crater are calculated using the charge radius (r_0) multiplied by a number determined from solving for h or R along a nonlinear relationship between [depth of water/r_0] and [h or R/r_0] (Gorodilov and Sukhotin 1996).

Crater diameter = (30 x charge radius) x 2, Crater depth = (5 x charge radius) x 2

The charge radius is calculated by solving for radius in the geometry of a spherical volume (1 lb. per cubic inches [in.^{3}] of trinitrotoluene [TNT] x number of pounds). A 20 lb. (9.07 kg) net explosive weight charge (r_0 = 0.36 ft. or 0.11 m) on a sandy bottom would produce a maximum crater size of approximately 21.5 ft. (6.5 m) in diameter ([30 x 0.36 ft.] x 2) and 1.8 ft. (0.5 m) deep (5 x 0.36 ft.). The crater area of the charge on a sandy bottom would be 364 ft.^{2} (34 m^2). Displaced sand adds another radius to the sides of the crater (O'Keeffe and Young 1984), yielding a diameter of 43 ft. (13 m) and 1,457 ft.^{2} (135 m^2) for the total area of impacted substrate. Mine neutralization training activities occur within a small area of the continental shelf (Figures 3.3-1 to 3.3-10). Based on the number of charges and impact area per year, the worst-case scenarios for explosive impacts on or near the bottom is approximately 0.27 acres (ac.) (0.00108 km^2) of the surveyed hard bottom within the Southeast U.S. Continental Shelf Large Marine Ecosystem (Table 3.3-3). No mapped hard bottoms are present to be impacted in the Northeast U.S. Continental Shelf Large Marine Ecosystem.

Testing Activities

Relevant testing activities in the No Action Alternative include airborne mine neutralization systems testing, airborne towed minesweeping test, and Naval Sea Systems Command ordnance operations (Tables 2.8-2 and 2.8-3). General locations for No Action mine neutralization testing activities are listed in Table 3.3-4 and shown on Figures 3.3-1 through 3.3-10. The intersections of explosives on or near the bottom and mapped marine substrates are listed below:

- Northeast U.S. Continental Shelf Large Marine Ecosystem (VACAPES OPAREA [W-50, W-72]): Sandy soft bottom and artificial reefs around the perimeter. Bottom types are less than 30 m deep.
- Gulf of Mexico Large Marine Ecosystem (Naval Surface Warfare Center, Panama City Division Testing Range): Sandy bottoms grading to silt and clay seaward of shelf break, hard bottom areas landward and along the shelf break, most artificial reefs and wrecks landward of shelf break.

The impact areas for 5, 10, 20, 75, 650, and 3,625 lb. net explosive weight charges were calculated using the equation employed for calculating a 20 lb. charge impact (i.e., crater radius = 30 x charge radius). Realistically, not all charges are detonated on the bottom and mitigation measures help prevent hard bottom impacts (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). The number of bottom explosions modeled is assumed to be half the number of charges for all types except line charges. Line charges are placed in the surf zone, so all charges were assumed to be on the bottom; however, there is no potential for these charges to overlap hard bottom. Based on the number of charges and impact areas per year, the worst-case scenarios for hard bottom impacts are 0.60 ac. (0.00243 km^2) and 0.18 ac. (0.00074km^2) in the Northeast U.S. Continental Shelf and Gulf of Mexico Large Marine Ecosystems, respectively (Table 3.3-4).

Table 3.3-4: Explosives on or near the Bottom for Testing Activities in the No Action Alternative

Testing Areas	Net Explosive Weight (lb.)	Number of Charges	Total Impact Footprint (km^2)	Hard Substrate		Soft Substrate		Unknown Substrate	
				km^2	% Impact	km^2	% Impact	km^2	% Impact
Northeast U.S. Continental Shelf Large Marine Ecosystem									
VACAPES (W-50, W-72)	5	45	0.00243	20	0.0121	50,727	<0.0001	0	0
Gulf of Mexico Large Marine Ecosystem									
NSWC PCD	5	20	0.00108	3,610	<0.0001	74,991	<0.0001	0	0
	10	26	0.00221		0.0001		<0.0001		0
	20	2	0.00027		<0.0001		<0.0001		0
	75	2	0.000652		<0.0001		<0.0001		0
	650	12	0.0165		0.0005		<0.0001		0
	3,625	3	0.019971		0*		<0.0001		0
Total	*na*	*na*	*0.040683*		0.0006		0.0001		0

Note: Substrate areas depicted on Figures 3.3-1 and 3.3-4.
km^2: square kilometer; lb.: pound; m^2: square meter; NSWC PCD: Naval Undersea Warfare Center, Panama City Division; OPAREA: Operating Area; VACAPES: Virginia Capes Range Complex
* Hard substrate impacts unlikely due to placement in surf zone (Appendix A).

3.3.3.1.1.2 Alternative 1

Training Activities

Relevant training activities under Alternative 1 are the same as the No Action Alternative, except for the addition of civilian port defense activities. The specific locations for these activities under Alternative 1 are listed in Table 3.3-5 and are shown on Figures 3.3-1 to 3.3-10. The intersections of explosives on or near the bottom and mapped marine substrates are listed below.

- Northeast U.S. Continental Shelf Large Marine Ecosystem (VACAPES): Shelf substrate sandy soft bottom, sparse hard bottom, artificial structures (primarily nearshore), shelf break feature, and open-ocean substrate silt/mixed soft bottom.
- Southeast U.S. Continental Shelf Large Marine Ecosystem:
    - Cherry Point OPAREA: Shelf substrate sandy soft bottom, abundant hard bottom, artificial structures (primarily nearshore), shelf break feature, and open-ocean substrate sand/silt/mixed soft bottom.
    - JAX Range Complex: Shelf substrate sandy soft bottom, abundant hard bottom, artificial structures (primarily nearshore), shelf break feature, and open-ocean substrate sand/silt/mixed soft bottom, and abundant hard bottom.
- Caribbean Sea and Gulf of Mexico Large Marine Ecosystems (Key West Range Complex): Shelf substrate gravel/sand/silt/clay/mixed soft bottom, sparse-abundant hard bottom, artificial structures (primarily nearshore), shelf break feature, and open-ocean substrate gravel/sand/silt/clay/mixed soft bottom and sparse artificial structures.
- Gulf of Mexico Large Marine Ecosystem (Gulf of Mexico [GOMEX] Range Complex): Shelf substrate sand/silt/clay/mixed soft bottom, sparse/patchy hard bottom, artificial structures (primarily nearshore), shelf break feature, and open-ocean substrate sand/silt/clay/mixed soft bottom and sparse artificial structures.

The determination of impact is based on worst-case scenarios: 0.25, 5, 10, 20, 60, and 100 lb. (net explosive weight) explosions on the bottom. In reality, not all charges are detonated on the bottom and mitigation measures help prevent hard bottom impacts (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). The number of bottom explosions modeled is assumed to be approximately half the number of charges, with the exception of 0.25 lb. charges, which were all assumed to occur on the bottom.

The mine neutralization training activities could occur over a larger area, given the added flexibility of conducting activities anywhere within the specified range complexes. Based on the number of charges and impact areas per year, the worst-case scenarios for hard bottom impacts are 13.15 ac. (0.05322 km^2), 0.57 ac. (0.00242 km^2), 0.16 ac. (0.00065 km^2), and 0.31 ac. (0.00125 km^2) in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, Caribbean Sea, and Gulf of Mexico Large Marine Ecosystems (Table 3.3-5).

Table 3.3-5: Explosives on or near the Bottom for Training Activities in Alternative 1 and 2

Training Areas	Net Explosive Weight (lb.)	Number of Charges	Total Impact Footprint (km^2)	Hard Substrate		Soft Substrate		Unknown	
				km^2	% Impact	km^2	% Impact	km^2	% Impact
Northeast U.S. Continental Shelf Large Marine Ecosystem									
Northeast	20	0.4	0.000054	475	<0.0001	161,213	<0.0001	0	<0.0001
VACAPES	0.25	1,440	0.01008	31	0.0330	95,485	<0.0001	0	0
	5	42	0.002268		0.0074		<0.0001		0
	10	2	0.00017		0.0006		<0.0001		0
	20	116.4	0.015714		0.0514		<0.0001		0
	60	78	0.033852		0.1107		<0.0001		0
	100	2	0.00122		0.0040		<0.0001		0
Total	*na*	*na*	*0.063358*	*506*	*0.0105*	*256,698*	<0.0001	*0*	<0.0001
Southeast U.S. Continental Shelf Large Marine Ecosystem									
Cherry Point	10	1	0.000085	4,704	<0.0001	59,516	<0.0001	0	0
	20	1.4	0.000189		<0.0001		<0.0001		0
	60	2	0.000868		<0.0001		<0.0001		0
JAX	10	1	0.000085	67,195	<0.0001	104,602	<0.0001	0	0
	20	2.4	0.000324		<0.0001		<0.0001		0
	60	2	0.000868		<0.0001		<0.0001		0
Total	*na*	*na*	*0.002419*	*71,899*	<0.0001	*161,118*	<0.0001	*0*	0
Caribbean Sea and Gulf of Mexico Large Marine Ecosystems									
Key West	10	1	0.000085	*20,502*	<0.0001	*51,635*	<0.0001	*14,954*	<0.0001
	20	1	0.000135		<0.0001		<0.0001		<0.0001
	60	1	0.000434		<0.0001		<0.0001		<0.0001
Total	*na*	*na*	*0.000654*		<0.0001		<0.0001		<0.0001
Gulf of Mexico Large Marine Ecosystem									
GOMEX	5	10	0.00054	*8,480*	<0.0001	*133,024*	<0.0001	*2,415*	<0.0001
	10	1	0.000085		<0.0001		<0.0001		<0.0001
	20	1.4	0.000189		<0.0001		<0.0001		<0.0001
	60	1	0.000434		<0.0001		<0.0001		<0.0001
Total	*na*	*na*	*0.001248*		<0.0001		<0.0001		<0.0001

Note: Substrate areas depicted on Figures 3.3-1 to 3.3-4.
GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; km^2: square kilometer; lb.: pound; m^2: square meter; VACAPES: Virginia Capes Range Complex

Testing Activities

Relevant testing activities in Alternative 1 include airborne mine neutralization systems testing, airborne projectile-based mine clearance systems, airborne towed minesweeping test, mine countermeasure mission package testing, ordnance testing with line charges, and mine countermeasures/neutralization testing. (Tables 2.8-2 and 2.8-3). The general locations for Alternative 1 activities are listed in Table 3.3-6 and shown on Figures 3.3-1 through 3.3-10. The intersections of explosives on or near the bottom and mapped marine substrates are listed below:

- Northeast U.S. Continental Shelf Large Marine Ecosystem (VACAPES): Shelf substrate sandy soft bottom, sparse hard bottom, artificial structures (primarily nearshore), shelf break feature, and open-ocean substrate silt/mixed soft bottom.
- Southeast U.S. Continental Shelf Large Marine Ecosystem (JAX): Shelf substrate sandy soft bottom, abundant hard bottom, artificial structures (primarily nearshore), shelf break feature, and open-ocean substrate sand/silt/mixed soft bottom, and abundant hard bottom.
- Gulf of Mexico Large Marine Ecosystem:
    - Shelf substrate sand/silt/clay/mixed soft bottom, sparse/patchy hard bottom, artificial structures (primarily nearshore), shelf break feature, and open-ocean substrate sand/silt/clay/mixed soft bottom and sparse artificial structures.
    - Naval Surface Warfare Center, Panama City Division Testing Range: Sandy bottoms grading to silt and clay seaward of shelf break, hard bottom areas landward and along the shelf break, most artificial reefs and wrecks landward of shelf break.

Table 3.3-6: Explosives on or near the Bottom for Testing Activities in Alternative 1

Testing Areas	Net Explosive Weight (lb.)	Number of Charges	Total Impact Footprint (km^2)	Hard Substrate		Soft Substrate		Unknown Substrate	
				km^2	% Impact	km^2	% Impact	km^2	% Impact
Northeast U.S. Continental Shelf Large Marine Ecosystem									
VACAPES	5	63	0.003402	*31*	0.0111	*95,485*	<0.00001	*0*	0
	650	3	0.004125		0.0135		<0.00001		0
Total	*na*	*na*	*0.007527*		*0.0246*		<0.00001		0
Southeast U.S. Continental Shelf Large Marine Ecosystem									
JAX	5	12	0.000648	*67,195*	<0.00001	*104,602*	<0.00001	*0*	0
	10	10	0.00085		<0.00001		<0.00001		0
Total	*na*	*na*	*0.001498*		<0.00001		<0.00001		0
Gulf of Mexico Large Marine Ecosystem									
Gulf of Mexico	5	6	0.000324	74,310	<0.00001	629,178	<0.00001	762,242	<0.00001
	10	10	0.00085		<0.00001		<0.00001		<0.00001
	100	3	0.00183		<0.00001		<0.00001		<0.00001
NSWC PCD	5	81	0.004347	3,610	0.0001	74,991	<0.00001	0	0
	20	3	0.000405		<0.00001		<0.00001		0
	650	8	0.011		0.0003		<0.00001		0
	3,625	3	0.019971		0*		<0.00001		0
Total	*na*	*na*	*0.038727*	*77,920*	<0.00001	*704,169*	*<0.00001*	*762,242*	*<0.00001*

Note: Substrate areas depicted on Figures 3.3-1 to 3.3-4.

JAX: Jacksonville Range Complex; km^2: square kilometer; lb.: pound; m^2: square meter; NSWC PCD: Naval Undersea Warfare Center, Panama City Division; VACAPES: Virginia Capes Range Complex

* Hard substrate impacts unlikely due to placement in surf zone (Appendix A).

The impact areas for 5, 10, 20, 100, 650, and 3,625-lb. charges were calculated using the equation employed for calculating a 20 lb. charge impact (i.e., crater radius = 30 x charge radius). In reality, not all charges are detonated on the bottom and mitigation measures help prevent hard bottom impacts (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). The number of bottom explosions modeled is assumed to be half the number of charges for all types except line charges. Line charges are placed in the surf zone, so all charges were assumed to be on the bottom; however, there is no potential for these charges to overlap hard bottom. Based on the number of charges and impact areas per year, the worst-case scenarios for hard bottom are 1.86 ac. (0.00753 km^2), 0.37 ac. (0.00149 km^2), and 4.63 ac. (0.01876 km^2) in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems, respectively (Table 3.3-6).

3.3.3.1.1.3 Alternative 2 (Preferred Alternative)

Training Activities

Relevant training activities for Alternative 2 are the same as Alternative 1. Locations for Alternative 2 activities are expanded to range complexes and are listed in Table 3.3-5 and depicted on Figures 3.3-1 through 3.3-10. The number of charges and intersections of range complexes and mapped marine habitats are the same as Alternative 1. Likewise, the potential impacts from Alternative 2 training are identical to those of Alternative 1.

Testing Activities

Relevant testing activities for Alternative 2 are the same as Alternative 1 (Tables 2.8-2 and 2.8-3). The general locations for Alternative 2 activities are listed in Table 3.3-7 and shown on Figures 3.3-1 through 3.3-10. The intersections of locations and mapped marine habitats are the same as Alternative 1. However, the number of charges has increased relative to Alternative 1.

The impact areas for 5, 10, 20, 75, and 650 lb. charges were calculated using the equation employed for calculating a 20 lb. charge impact (i.e., crater radius = 30 x charge radius). In reality, not all charges are detonated on the bottom and mitigation measures help prevent hard bottom impacts (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring). The number of bottom explosions modeled is assumed to be half the number of charges for all types except line charges. Line charges are placed in the surf zone, so all charges were assumed to be on the bottom; however, there is no potential for these charges to overlap hard bottom. Based on the number of charges and impact areas per year, the worst-case scenarios for hard bottom impacts are 1.99 (0.00807 km^2), 0.42 (0.00171 km^2), and 4.83 ac. (0.01955 km^2) in the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems (Table 3.3-7).

3.3.3.1.1.4 Substressor Impact on Marine Substrate as Essential Fish Habitat

Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of explosives on or near the bottom during training and testing activities may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of non-living substrates that constitute Essential Fish Habitat and Habitat Areas of Particular Concern. The AFTT Essential Fish Habitat Assessment report states that explosive impacts to hard bottom substrate are determined to be permanent and minimal throughout the Study Area (U.S. Department of the Navy 2013). The impacts on soft bottom are determined to be short term and minimal (U.S. Department of the Navy 2013). Mitigation measures should avoid impacts to surveyed hard bottom, as defined in the Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring). Impacts on water column as Essential Fish Habitat are summarized in corresponding resource sections (e.g., invertebrates, fish) because they are impacts on the organisms themselves.

Table 3.3-7: Explosives on or near the Bottom for Testing Activities in Alternative 2

Testing Areas	Net Explosive Weight (lb.)	Number of Charges	Total Impact Footprint (km^2)	Hard Substrate		Soft Substrate		Unknown Substrate	
				km^2	% Impact	km^2	% Impact	km^2	% Impact
Northeast U.S. Continental Shelf Large Marine Ecosystem									
VACAPES	5	73	0.003942	31	0.0129	95,485	<0.0001	0	0
	650	3	0.004125		0.0135		<0.0001		0
Total	*na*	*na*	*0.008067*		0.0264		<0.0001		0
Southeast U.S. Continental Shelf Large Marine Ecosystem									
JAX	5	16	0.000864	67,195	<0.0001	104,602	<0.0001	0	0
	10	10	0.00085		<0.0001		<0.0001		0
Total	*na*	*na*	0.001714		<0.0001		<0.0001		0
Gulf of Mexico Large Marine Ecosystem									
Gulf of Mexico	5	7	0.000378	74,310	<0.0001	629,178	<0.0001	762,242	<0.0001
	10	10	0.00085		<0.0001		<0.0001		<0.0001
	100	4	0.00244		<0.0001		<0.0001		<0.0001
NSWC PCD	5	85.5	0.004617	3,610	0.0001	74,991	<0.0001	0	0
	20	2	0.00027		<0.0001		<0.0001		0
	650	8	0.011		0.0003		<0.0001		0
	3,625	4	0.026628		0*		<0.0001		0
Total	*na*	*na*	*0.046183*	77,920	<0.0001	704,169	<0.0001	762,242	<0.0001

Note: Substrate areas depicted on Figures 3.3-1 to 3.3-4.
JAX: Jacksonville Range Complex; km^2: square kilometer; lb.: pound; m^2: square meter; NSWC PCD: Naval Undersea Warfare Center, Panama City Division; VACAPES: Virginia Capes Range Complex
* Hard substrate impacts unlikely due to placement in surf zone (Appendix A).

3.3.3.2 Physical Disturbance and Strike Stressors

This section analyzes the potential impacts of the various types of physical disturbance and strike stressors resulting from the Navy conducting its training and testing activities within the Study Area. Bottom substrates are potentially subject to physical disturbance by military expended materials and seafloor devices associated with Navy training and testing. This analysis includes the potential impacts of (1) military expended materials to include non-explosive practice munitions and fragments from high-explosive munitions, and (2) seafloor devices. Physical disturbances and strikes by vessels and in-water devices are not considered since these types of occurrences would cause damage to the vessel or device and are avoided when possible.

Impacts from physical disturbances or strikes resulting from Navy training and testing activities to biogenic habitats associated with hard bottom (e.g., corals, sponges, tunicates, oysters, mussels, kelp, etc.) and soft bottom (e.g., seagrass, macroalgae, etc.) substrates are discussed in detail within Sections 3.8 (Marine Invertebrates) and 3.7 (Marine Vegetation), respectively. Potential impacts to the underlying substrates (soft, hard, or artificial) are analyzed here.

3.3.3.2.1 Impacts from Military Expended Materials

This section analyzes the potential for physical disturbance to marine substrates from the following categories of military expended materials: (1) non-explosive practice munitions, (2) fragments from high-explosive munitions, and (3) expended materials other than munitions, such as sonobuoys, ship hulks, expendable targets and aircraft stores (fuel tanks, carriages, dispensers, racks, carriages, or similar types of support systems on aircraft that could be expended). Areas expected to have the greatest amount of expended materials are the Northeast U.S. Continental Shelf Large Marine Ecosystem, the Southeast U.S. Continental Shelf Large Marine Ecosystem, and the Gulf Stream Open Ocean Area (specifically within the VACAPES and JAX Range Complexes). For a discussion of the types of activities that use military expended materials, where they are used, and how many events would occur under each alternative, see Section 3.0.5.3.3.3 (Military Expended Material Strikes). Military expended materials have the potential to physically disturb marine substrates to the extent that they impair the substrate's ability to function as a habitat. These disturbances can result from several sources, including the impact of the expended material contacting the seafloor, the covering of the substrate by the expended material, or alteration of the substrate from one type to another.

The potential for military expended materials to physically impact marine substrates as they come into contact with the seafloor depends on several factors. These factors include, but are not limited to, the size, shape, type, mass, and speed of the material through the water column; the amount of the material expended; the frequency of training or testing; 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 damage caused by a strike is proportional to the force of the strike, slower speeds may result in lesser impacts. Due to the water depth at which most training and testing events take place, a direct strike on either hard bottom or artificial structures (e.g., artificial reefs and shipwrecks) is unlikely to occur with sufficient force to damage the substrate. Any potential damage would be to a small portion of the structural habitat. The value of these substrates as habitat, however, is not entirely dependent on the precise shape of the structure. An alteration in shape or structure caused by military expended materials would not necessarily reduce the habitat value of either hard bottom or artificial structures. In softer substrates (e.g., sand, mud, silt, clay, and composites), the impact of the expended material coming into contact with the seafloor, 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. During Navy training and testing, countermeasures such as flares and chaff are introduced into marine habitats. These types of military expended materials are not expected to impact marine habitats as strike stressors, given their size and low velocity when deployed compared to projectiles, bombs, and missiles.

Another potential physical disturbance that military expended materials could have on marine substrates would be to cover them or to alter the type of substrate and, therefore, its function as habitat. The majority of military expended materials that settle on hard bottoms or artificial substrates, while covering the seafloor, will serve a similar habitat function as the substrate it is covering by providing a hard surface on which organisms can attach (Figures 3.3-11 and 3.3-12). An exception would be expended materials, like the parachutes utilized to deploy sonobuoys, lightweight torpedoes, expendable mobile anti-submarine warfare training targets, and other devices from aircraft, that would not provide a hard surface for colonization. In these cases, the hard bottom or artificial substrate covered by the expended material would not be physically damaged, but would have an impaired ability to function as a habitat for colonizing or encrusting organisms.

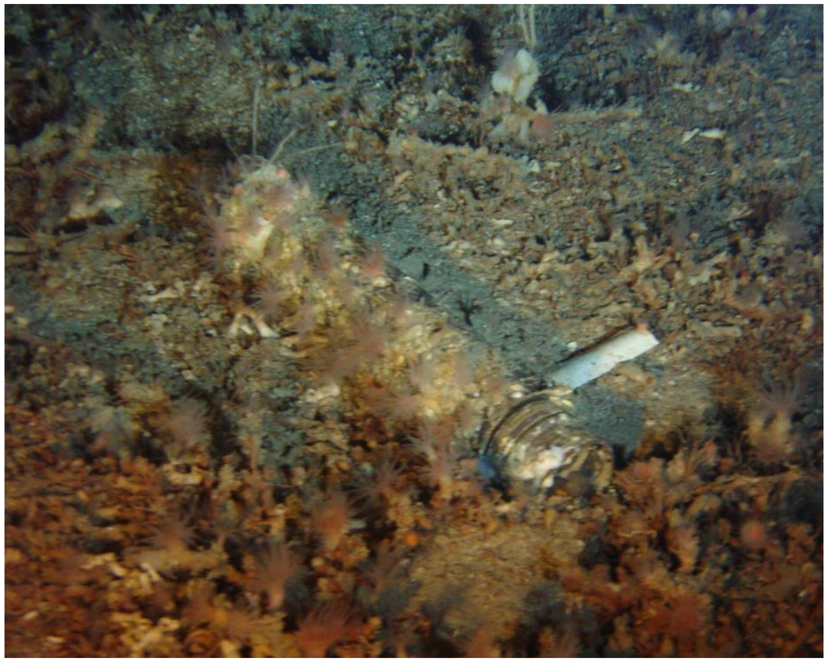

Figure 3.3-11: A MK 58 Smoke Float Observed in an Area Dominated by Coral Rubble on the Continental Slope

Note: Observed at approximately 350 m in depth and 60 nm east of Jacksonville, Florida. Of note is the use of the smoke float as a colonizing substrate for a cluster of sea anemones (U.S. Department of the Navy 2010).

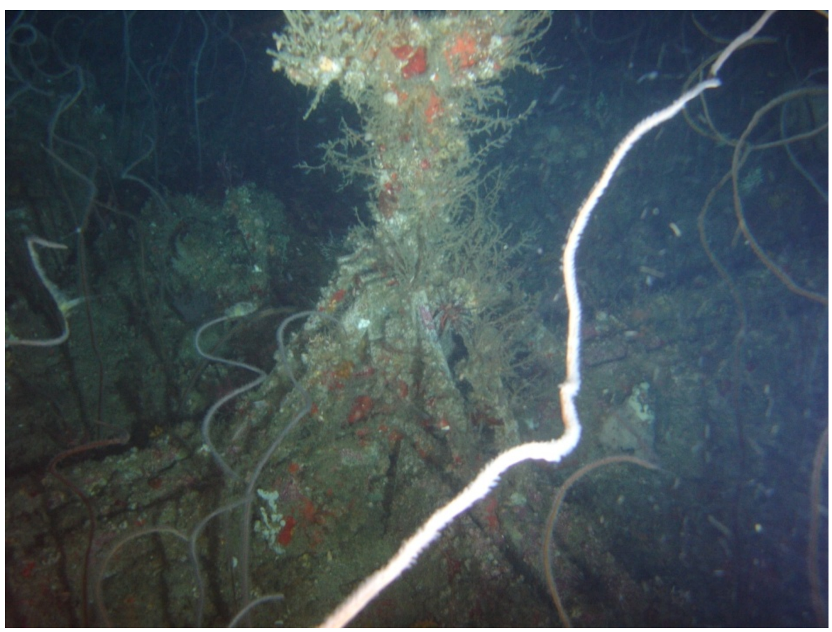

Figure 3.3-12: An Unidentified, Non-Military Structure on Hard Bottom

Note: Observed on the ridge system that runs parallel to the shelf break at approximately 80 m in depth and 55 nm east of Jacksonville, Florida. Of note is that encrusting organisms and benthic invertebrates readily colonize the artificial structure to a similar degree as the surrounding rock outcrop (U.S. Department of the Navy 2010).

Most military expended materials 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 found associated with hard bottom environments (U.S. Department of the Navy 2010, 2011). Expended materials that settle in the shallower, more dynamic environments of the continental shelf would likely be eventually covered over by sediments due to currents and other coastal processes or encrusted by organisms. In the deeper waters of the continental slope and beyond where currents do not play as large of a role, expended materials may remain exposed on the surface of the substrate with minimal change for extended periods (Figure 3.3-13). Softer expended materials, such as parachutes, would also not damage the sediments, but could impair their ability to function as a habitat to some degree.

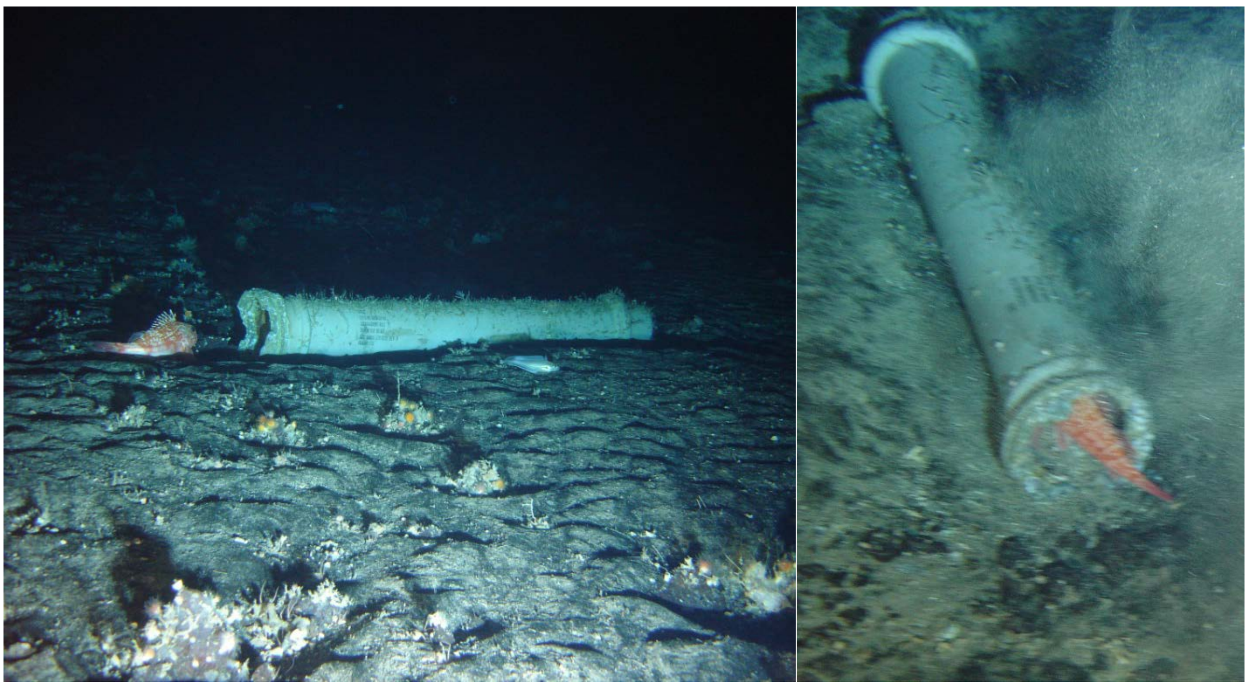

Figure 3.3-13: A 76-millimeter Cartridge Casing on Soft Bottom and a Blackbelly Rosefish (*Helicolenus dactylopterus*) Using the Casing for Protection When Disturbed

Note: The casing was observed in a sandy area on the continental slope approximately 425 m in depth and 70 nm east of Jacksonville, Florida. The casing has not become covered by sediments due to the depth and the relatively calm, current-free environment.

One unique type of military expended material, due to its size, is ship hulks. Sinking exercises involve the use of a target (ship hulk or stationary artificial target) against which explosive and non-explosive munitions are fired; these exercises are conducted in a manner that results in the sinking of the target. The exercise lasts for four to eight hours over one to two days. Sinking exercises would only occur in waters exceeding 3,000 m in depth (Figures 3.3-1 and 3.3-4). The level of potential impact from sinking exercises depends on the amount of munitions and type of weapons used, which are situational and training-need dependent (U.S. Department of the Navy 2005). Potential military expended materials from sinking exercises include the ship hulk and shell fragments. Expended materials that settle to the seafloor would not affect the stability of the seafloor or cause disturbance to natural ocean processes (U.S. Department of the Navy 2005). The level of impact from a ship hulk landing on marine substrates would depend on the size of the ship hulk and the type of substrate it settles upon. Areas of hard bottom may experience some fragmentation or breaks as the ship settles to the seafloor. While the ship hulk would cover a large portion of the seafloor relative to that covered by other types of expended materials, it would support the same type of communities as the hard substrate it covered and likely provide more complexity and relief, which are important habitat features for hard bottom communities. Areas of unconsolidated sediments would experience a temporarily large increase in turbidity as sediment is suspended in the water column. Settlement of the ship to the seafloor would also likely leave a large depression in the substrate where sediment was displaced. The soft substrates covered by the ship would no longer be able to serve their function in supporting a soft bottom community, having been replaced by a hard structure more suitable for attaching and encrusting organisms.

To determine the potential level of disturbance that military expended materials have on soft and hard bottom substrates, an analysis to determine the impact footprint was conducted for each range complex and testing range for each alternative. Three main assumptions were made that result in the impact footprints calculated being considered overestimates. First, within each category of expended items (e.g., bombs, missiles, rockets, large-caliber projectiles, etc.), the size of the largest item that would be expended was used to represent the sizes of all items in the category. For example, the footprints of missiles used during training exercises range from 1.6 to 37.4 $ft.^2$ (0.15 to 3.5 m^2). For the analyses, all missiles were assumed to be equivalent to the largest in size, or 37.4 $ft.^2$ (3.5 m^2). Second, it was also assumed that the impact of the expended material on the seafloor was twice the size of its actual footprint. This assumption accounts for any displacement of sediments at the time of impact as well as any subsequent movement of the item on the seafloor due to currents or other forces. This should more accurately reflect the potential disturbance to soft bottom habitats, but should overestimate disturbance to hard bottom habitats since no displacement of the substrate would occur. Third, items with casings (e.g., small-, medium-, and large-caliber munitions; flares; sonobuoys; etc.) have their impact footprints doubled to account for both the item and its casing. Items and their casings were assumed to be the same size, even though depending on the munitions, one of them is often smaller than the other.

Once the impact footprints were calculated, two analyses were performed for each range complex: (1) potential impact to the soft bottom habitats in that range complex if all expended materials settled in areas with unconsolidated sediments, and (2) potential impact to the hard bottom habitats in that range complex if all expended materials settled in areas containing hard substrates. During the analyses, the same dimensions were used for high-explosive munitions as were used for non-explosive practice munitions. The total area of the seafloor covered by the expended materials should be similar regardless of whether the item is intact or fragmented, despite the fact that high-explosive munitions will explode in the air, at the surface, or in the water column and only fragments would make it to the substrate. Table 3.3-8 provides the total amount of mapped substrate occurring within each of the range complexes and testing ranges. For the purpose of the analyses, any portions of the seafloor with an unknown substrate type were assumed to be composed of soft sediments based on the low bathymetric relief in these areas (Watts et al. 2011). Tables 3.3-9 through 3.3-13 provide the results of the impact analyses for each training or testing alternative.

Table 3.3-8: Amount of Each Marine Substrate within Each Training and Testing Area in the Study Area

Training and Testing Areas	Marine Substrates (km^2)		
	Hard Substrate	Soft Substrate	Unknown Substrate
Northeast U.S. Continental Shelf Large Marine Ecosystem			
Northeast	475	161,213	0
NUWCDIVNPT	0	36,612	0
VACAPES	30	95,485	0
Southeast U.S. Continental Shelf Large Marine Ecosystem			
Navy Cherry Point	4,704	59,516	0
JAX	67,195	104,602	0
SFOMF	159	1,517	0
Caribbean and Gulf of Mexico Large Marine Ecosystems			
Key West	20,502	51,635	14,954
Gulf of Mexico Large Marine Ecosystem			
GOMEX	8,481	133,024	2,415
NSWC PCD	3,610	74,991	0
Northeast and Southeast U.S. Continental Shelf, Caribbean, and Gulf of Mexico Large Marine Ecosystems			
AFTT Study Area	159,845	1,693,400	9,091,832
Other AFTT Areas	58,298	1,078,633	9,074,463

GOMEX: Gulf of Mexico Range Complex; JAX: Jacksonville Range Complex; km^2: square kilometers; NSWC PCD: Naval Surface Warfare Center, Panama City Division; NUWCDIVNPT: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes Range Complex

Table 3.3-9: Numbers and Impacts of Military Expended Materials Proposed for Use during Training Exercises as Part of the No Action Alternative

Military Expended Materials	Size (m^2)	Impact Footprint (m^2)	Range Complex															
			Northeast		VACAPES		Navy Cherry Point		JAX		Key West		GOMEX		AFTT Study Area		Other AFTT Areas	
			Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)
Bombs																		
Bombs (Explosive)	0.7544	10.4892	0	0	20	210	0	0	0	0	0	0	4	42	0	0	1	10
Bombs (Non-Explosive)	0.7544	10.4892	0	0	555	5,821	811	8,507	696	7,300	0	0	292	3,063	0	0	0	0
Projectiles																		
Small-Caliber (Non-Explosive)	0.0028	0.0113	0	0	1,299,600	14,685	199,240	2,251	502,440	5,678	0	0	39,600	447	0	0	0	0
Medium-Caliber (Explosive)	0.0052	0.0208	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium-Caliber (Non-Explosive)	0.0052	0.0208	0	0	226,750	4,716	39,075	813	68,825	1,432	36,000	749	34,880	726	0	0	0	0
Large-Caliber (Explosive)	0.0938	0.3751	0	0	858	322	78	29	390	146	0	0	0	0	0	0	700	263
Large-Caliber (Non-Explosive)	0.0938	0.3751	0	0	3,844	1,442	1,392	522	2,372	890	0	0	1,240	465	0	0	0	0
Missiles (Explosive)	3.4715	6.9430	0	0	178	1,236	44	305	88	611	0	0	0	0	0	0	11	76
Missiles (Non-Explosive)	2.8801	5.7602	0	0	112	645	8	46	15	86	0	0	0	0	0	0	0	0
Rockets (Explosive)	0.0742	0.1484	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rockets (Non-Explosive)	0.0742	0.1484	0	0	3,700	549	0	0	0	0	0	0	0	0	0	0	0	0
Grenades (Explosive)	0.0097	0.0193	0	0	0	0	0	0	80	2	0	0	20	0	0	0	0	0
Countermeasures																		
Chaff (Cartridges)	0.0001	0.0002	0	0	19,978	4	6,164	1	4,684	1	30,000	6	3,764	1	0	0	0	0
Flares	0.1133	0.4532	0	0	676	306	577	261	515	233	4,500	2,039	1,840	834	0	0	0	0
Acoustic Countermeasures	0.0289	0.1155	0	0	14	2	37	4	37	4	0	0	7	1	0	0	0	0
Targets																		
Airborne Targets	3.6270	7.2540	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Targets	0.5344	1.0687	0	0	667	712	187	200	519	555	0	0	67	72	0	0	0	0
Sub-Surface Targets	0.1134	0.2268	272	62	212	48	268	61	820	186	0	0	48	11	0	0	0	0
Mine Shapes	2.3960	4.7920	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ship Hulk (Sinking Exercise)	29,370	58,740	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	352,440
Other																		
Torpedo (Explosive)	3.0861	6.1721	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
Lightweight Torpedo Accessories	0.0939	0.1879	5	1	8	2	9	2	31	6	0	0	2	0	0	0	0	0
Heavyweight Torpedo Accessories	0.0150	0.3007	22	7	7	2	10	3	32	10	0	0	1	0	0	0	0	0
AMNS Neutralizer (Explosive)	0.1513	0.3026	0	0	30	9	0	0	0	0	0	0	0	0	0	0	0	0
AMNS Neutralizer (Non-Explosive)	0.1513	0.3026	0	0	180	54	27	8	27	8	0	0	0	0	0	0	0	0
Sonobuoys (Explosive)	0.1134	0.5669	340	193	360	204	360	204	360	204	0	0	351	199	0	0	0	0
Sonobuoys (Non-Explosive)	0.1134	0.5669	2,134	1,210	4,444	2,519	1,472	835	19,837	11,245	0	0	66	37	0	0	428	243
Parachutes – Large	0.8400	1.6800	238	400	173	291	227	381	763	1,282	0	0	12	20	0	0	0	0
Parachutes – Small	0.2642	0.5284	2,747	1,451	5,221	2,759	2,049	1,083	20,767	10,974	0	0	460	243	0	0	428	226
Anchor Blocks	0.5806	1.1613	0	0	12	14	10	12	6	7	0	0	0	0	0	0	0	0
Endcaps and Pistons	0.0004	0.0007	0	0	20,654	14	6,741	5	5,199	4	34,500	24	5,604	4	0	0	0	0
Total			**5,758**	**3,323**	**1,588,253**	**36,568**	**258,786**	**15,533**	**628,503**	**40,863**	**105,000**	**2,818**	**88,257**	**6,165**	**0**	**0**	**1,575**	**353,264**

AFTT: Atlantic Fleet Training and Testing; AMNS: Airborne Mine Neutralization System; GOMEX: Gulf of Mexico; JAX: Jacksonville; m^2: square meters; VACAPES: Virginia Capes

Table 3.3-10: Numbers and Impacts of Military Expended Materials Proposed for Use during Testing Exercises as Part of the No Action Alternative

Military Expended Materials	Size (m^2)	Impact Footprint (m^2)	Range Complex																			
			Northeast		VACAPES		Navy Cherry Point		JAX		SFOMF		Key West		GOMEX		NSWC PCD		AFTT Study Area		Other AFTT Areas	
			Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)
Bombs																						
Bombs (Explosive)	0.7544	10.4892	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombs (Non-Explosive)	0.7544	10.4892	0	0	655	6,870	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Projectiles																						
Small-Caliber (Non-Explosive)	0.0028	0.0113	0	0	800	9	0	0	0	0	0	0	0	0	2,000	23	6,000	68	0	0	0	0
Medium-Caliber (Explosive)	0.0052	0.0208	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Medium-Caliber (Non-Explosive)	0.0052	0.0208	0	0	42,210	878	0	0	16,000	333	0	0	0	0	0	0	5,272	110	0	0	0	0
Large-Caliber (Explosive)	0.0938	0.3751	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Large-Caliber (Non-Explosive)	0.0938	0.3751	148	56	0	0	0	0	0	0	0	0	0	0	148	56	300	113	0	0	0	0
Missiles (Explosive)	3.4715	6.9430	0	0	5	35	0	0	5	35	0	0	0	0	0	0	0	0	0	0	0	0
Missiles (Non-Explosive)	2.8801	5.7602	4	23	128	737	0	0	5	29	0	0	0	0	4	23	0	0	0	0	0	0
Rockets (Explosive)	0.0742	0.1484	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rockets (Non-Explosive)	0.0742	0.1484	0	0	264	39	0	0	113	17	0	0	0	0	0	0	0	0	0	0	0	0
Countermeasures																						
Chaff (Cartridges)	0.0001	0.0002	72	0	2,000	0	120	0	120	0	0	0	0	0	672	0	0	0	0	0	0	0
Flares	0.1133	0.4532	0	0	1,852	839	35	16	35	16	0	0	0	0	888	402	0	0	0	0	0	0
Acoustic Countermeasures	0.0289	0.1155	58	7	30	3	0	0	28	3	0	0	0	0	0	0	0	0	0	0	0	0
Targets																						
Airborne Targets	3.6270	7.2540	0	0	110	798	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Targets	0.5344	1.0687	2	2	360	385	0	0	40	43	0	0	0	0	2	2	0	0	0	0	2	2
Sub-Surface Targets	0.1134	0.2268	16	4	71	16	7	2	27	6	0	0	0	0	7	2	0	0	0	0	5	1
Mine Shapes	2.3960	4.7920	0	0	42	201	0	0	50	240	0	0	0	0	0	0	112	537	0	0	0	0
Other																						
Torpedo (Explosive)	3.0861	6.1721	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	49
Torpedo (Non-Explosive)	0.9396	1.8792	0	0	2	4	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0
Lightweight Torpedo Accessories	0.0939	0.1879	9	2	13	2	0	0	17	3	0	0	0	0	0	0	0	0	0	0	12	2
Heavyweight Torpedo Accessories	0.0150	0.3007	34	10	0	0	0	0	25	8	0	0	0	0	0	0	0	0	0	0	17	5
AMNS Neutralizer (Explosive)	0.1513	0.3026	0	0	90	27	0	0	0	0	0	0	0	0	0	0	40	12	0	0	0	0
AMNS Neutralizer (Non-Explosive)	0.1513	0.3026	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	24	0	0	0	0
Sonobuoys (Explosive)	0.1134	0.5669	224	127	172	98	112	63	152	86	0	0	0	0	112	63	0	0	0	0	184	104
Sonobuoys (Non-Explosive)	0.1134	0.5669	460	261	1,076	610	224	127	526	298	0	0	0	0	206	117	0	0	0	0	620	351
Parachutes – Large	0.8400	1.6800	458	769	13	22	0	0	8	14	0	0	0	0	0	0	0	0	0	0	0	0
Parachutes – Small	0.2642	0.5284	16	8	1,257	664	231	122	553	292	0	0	0	0	211	111	0	0	0	0	625	330
Anchor Blocks	0.5806	1.1613	0	0	164	190	0	0	50	58	0	0	0	0	0	0	378	439	0	0	0	0
Endcaps and Pistons	0.0004	0.0007	72	0	3,852	3	155	0	155	0	0	0	0	0	1,560	1	0	0	0	0	0	0
Aircraft Stores, Ballast, Weapon Carriages	2.6013	5.2026	0	0	4,830	25,129	0	0	516	2,685	0	0	30	156	75	390	0	0	1,275	6,633	0	0
Total			**1,573**	**1,269**	**59,996**	**37,561**	**884**	**330**	**18,427**	**4,169**	**0**	**0**	**30**	**156**	**5,885**	**1,191**	**12,182**	**1,302**	**1,275**	**6,633**	**1,473**	**846**

AFTT: Atlantic Fleet Training and Testing; AMNS: Airborne Mine Neutralization System; GOMEX: Gulf of Mexico; JAX: Jacksonville; m^2: square meters; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWC: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes

Table 3.3-11: Numbers and Impacts of Military Expended Materials Proposed for Use during Training Exercises as Part of Alternatives 1 and 2

Military Expended Materials	Size (m^2)	Impact Footprint (m^2)	Range Complex															
			Northeast		VACAPES		Navy Cherry Point		JAX		Key West		GOMEX		AFTT Study Area		Other AFTT Areas	
			Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)
Bombs																		
Bombs (Explosive)	0.7544	10.4892	0	0	64	671	32	336	32	336	0	0	4	42	0	0	1	10
Bombs (Non-Explosive)	0.7544	10.4892	0	0	610	6,398	1,163	12,199	1,261	13,227	0	0	335	3,514	0	0	0	0
Projectiles																		
Small-Caliber (Non-Explosive)	0.0028	0.0113	27,500	311	3,857,600	43,591	543,740	6,144	1,534,500	17,340	0	0	73,200	827	0	0	227,500	2,571
Medium-Caliber (Explosive)	0.0052	0.0208	0	0	49,936	1,039	21,226	442	46,120	959	0	0	6,352	132	0	0	320	7
Medium-Caliber (Non-Explosive)	0.0052	0.0208	700	15	807,810	16,802	215,149	4,475	415,075	8,634	56,000	1,165	24,388	507	0	0	33,520	697
Large-Caliber (Explosive)	0.0938	0.3751	0	0	6,644	2,492	866	325	4,448	1,668	0	0	284	107	0	0	796	299
Large-Caliber (Non-Explosive)	0.0938	0.3751	0	0	1,804	677	934	350	1,832	687	0	0	1,276	479	0	0	537	201
Missiles (Explosive)	3.4715	6.9430	4	28	190	1,319	91	632	178	1,236	8	56	8	56	0	0	11	76
Missiles (Non-Explosive)	2.8801	5.7602	0	0	2	12	0	0	2	12	0	0	0	0	0	0	0	0
Rockets (Explosive)	0.0742	0.1484	0	0	3,800	564	0	0	3,800	564	0	0	380	56	0	0	0	0
Rockets (Non-Explosive)	0.0742	0.1484	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grenades (Explosive)	0.0097	0.0193	52	1	74	1	28	1	24	0	0	0	28	1	0	0	0	0
Countermeasures																		
Chaff (Cartridges)	0.0001	0.0002	0	0	1,792	0	7,304	1	5,788	1	30,000	6	728	0	0	0	0	0
Flares	0.1133	0.4532	6	3	628	285	1,962	889	1,668	756	4,512	2,045	1,852	839	0	0	0	0
Acoustic Countermeasures	0.0289	0.1155	0	0	19	2	37	4	39	5	0	0	9	1	0	0	0	0
Targets																		
Airborne Targets	3.6270	7.2540	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Targets	0.5344	1.0687	11	12	1,538	1,644	364	389	1,067	1,140	0	0	92	98	0	0	44	46
Sub-Surface Targets	0.1134	0.2268	116	26	447	101	125	28	1,492	338	0	0	5	1	0	0	122	28
Mine Shapes	2.3960	4.7920	0	0	48	230	24	115	12	58	0	0	0	0	0	0	0	0
Ship Hulk (Sinking Exercise)	29,370	58,740	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	58,740
Other																		
Torpedo (Explosive)	3.0861	6.1721	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6
Lightweight Torpedo Accessories	0.0939	0.1879	1	0	5	1	2	0	25	5	0	0	1	0	0	0	2	0
Heavyweight Torpedo Accessories	0.0150	0.3007	19	6	6	2	1	0	20	6	0	0	0	0	0	0	34	10
AMNS Neutralizer (Explosive)	0.1513	0.3026	0	0	72	22	0	0	0	0	0	0	20	6	0	0	0	0
AMNS Neutralizer (Non-Explosive)	0.1513	0.3026	0	0	570	172	71	21	71	21	0	0	112	34	0	0	0	0
Sonobuoys (Explosive)	0.1134	0.5669	170	96	443	251	183	104	1,113	631	0	0	70	40	0	0	0	0
Sonobuoys (Non-Explosive)	0.1134	0.5669	2,055	1,165	4,501	2,552	1,464	830	20,360	11,542	0	0	149	84	0	0	438	248
Parachutes – Large	0.8400	1.6800	82	138	371	623	99	166	1,271	2,135	0	0	3	5	0	0	122	205
Parachutes – Small	0.2642	0.5284	2,344	1,239	5,295	2,798	1,798	950	22,627	11,956	12	6	163	86	0	0	462	244
Anchor Blocks	0.5806	1.1613	0	0	422	490	20	23	38	44	6	7	36	42	0	0	0	0
Endcaps and Pistons	0.0004	0.0007	6	0	2,420	2	9,266	6	7,456	5	34,512	24	2,580	2	0	0	0	0
Total			**33,066**	**3,039**	**4,747,110**	**82,741**	**805,948**	**28,432**	**2,070,319**	**73,306**	**125,050**	**3,309**	**112,144**	**6,996**	**0**	**0**	**263,911**	**63,390**

AFTT: Atlantic Fleet Training and Testing; AMNS: Airborne Mine Neutralization System; GOMEX: Gulf of Mexico; JAX: Jacksonville; m^2: square meters; VACAPES: Virginia Capes

Table 3.3-12: Numbers and Impacts of Military Expended Materials Proposed for Use during Testing Activities as Part of Alternative 1

Military Expended Materials	Size (m^2)	Impact Footprint (m^2)	Range Complex																			
			Northeast		VACAPES		Navy Cherry Point		JAX		SFOMF		Key West		GOMEX		NSWC PCD		AFTT Study Area		Other AFTT Areas	
			Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)
Bombs																						
Bombs (Explosive)	0.7544	10.4892	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombs (Non-Explosive)	0.7544	10.4892	0	0	823	8,633	0	0	240	2,517	0	0	0	0	0	0	0	0	0	0	0	0
Projectiles																						
Small-Caliber (Non-Explosive)	0.0028	0.0113	0	0	6,333	72	3,333	38	3,333	38	0	0	0	0	24,000	271	6,000	68	2,000	23	0	0
Medium-Caliber (Explosive)	0.0052	0.0208	0	0	10,200	212	200	4	10,200	212	0	0	0	0	0	0	0	0	2,800	58	0	0
Medium-Caliber (Non-Explosive)	0.0052	0.0208	1,400	29	153,670	3,196	22,200	462	65,600	1,364	0	0	6,000	125	1,400	29	17,030	354	2,800	58	0	0
Large-Caliber (Explosive)	0.0938	0.3751	0	0	1,797	674	0	0	339	127	0	0	339	127	0	0	40	15	3,920	1,470	0	0
Large-Caliber (Non-Explosive)	0.0938	0.3751	296	111	4,611	1,730	0	0	769	288	0	0	561	210	148	56	260	98	6,680	2,506	0	0
Missiles (Explosive)	3.4715	6.9430	8	56	94	649	0	0	36	246	0	0	0	0	4	28	0	0	0	0	0	0
Missiles (Non-Explosive)	2.8801	5.7602	0	0	591	3,401	0	0	57	325	0	0	3	17	8	46	0	0	1	6	0	0
Rockets (Explosive)	0.0742	0.1484	0	0	184	27	0	0	184	27	0	0	0	0	0	0	0	0	0	0	0	0
Rockets (Non-Explosive)	0.0742	0.1484	0	0	1,897	282	0	0	496	74	0	0	0	0	0	0	0	0	0	0	0	0
Countermeasures																						
Chaff (Cartridges)	0.0001	0.0002	144	0	3,592	1	1,200	0	1,452	0	0	0	0	0	4,272	1	0	0	0	0	0	0
Flares	0.1133	0.4532	0	0	3,000	1,360	200	91	200	91	0	0	0	0	4,000	1,813	0	0	0	0	0	0
Acoustic Countermeasures	0.0289	0.1155	108	12	62	7	0	0	184	21	0	0	0	0	28	3	0	0	40	5	0	0
Targets																						
Airborne Targets	3.6270	7.2540	0	0	110	798	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Targets	0.5344	1.0687	4	4	850	908	0	0	273	292	0	0	0	0	10	11	0	0	3	3	0	0
Sub-Surface Targets	0.1134	0.2268	111	25	428	97	5	1	181	41	0	0	0	0	33	7	0	0	0	0	8	2
Mine Shapes	2.3960	4.7920	0	0	98	470	0	0	108	518	0	0	0	0	6	29	395	1,893	0	0	0	0
Other																						
Torpedo (Explosive)	3.0861	6.1721	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	49	0	0
Torpedo (Non-Explosive)	0.9396	1.8792	0	0	28	53	0	0	6	11	0	0	0	0	0	0	0	0	0	0	0	0
Lightweight Torpedo Accessories	0.0939	0.1879	127	24	227	43	0	0	166	31	0	0	0	0	12	2	0	0	20	4	0	0
Heavyweight Torpedo Accessories	0.0150	0.3007	122	37	41	12	0	0	222	67	0	0	0	0	44	13	0	0	28	8	0	0
AMNS Neutralizer (Explosive)	0.1513	0.3026	0	0	126	38	0	0	24	7	0	0	0	0	12	4	161	49	0	0	0	0
AMNS Neutralizer (Non-Explosive)	0.1513	0.3026	0	0	24	7	0	0	24	7	0	0	0	0	0	0	120	36	0	0	0	0
Sonobuoys (Explosive)	0.1134	0.5669	320	181	796	451	112	63	152	86	0	0	1,312	744	112	63	0	0	0	0	184	104
Sonobuoys (Non-Explosive)	0.1134	0.5669	1,549	878	5,292	3,000	200	113	2,313	1,311	0	0	2,640	1,497	524	297	0	0	420	238	320	181
Parachutes – Large	0.8400	1.6800	1,604	2,695	209	351	0	0	86	145	0	0	0	0	0	0	0	0	12	20	0	0
Parachutes – Small	0.2642	0.5284	48	25	5,841	3,086	205	108	2,440	1,289	0	0	2,640	1,395	555	293	0	0	420	222	328	173
Anchor Blocks	0.5806	1.1613	0	0	203	236	0	0	53	62	52	60	0	0	0	0	1,079	1,253	0	0	0	0
Endcaps and Pistons	0.0004	0.0007	144	0	6,592	5	1,400	1	1,652	1	0	0	0	0	8,272	6	0	0	0	0	0	0
Aircraft Stores, Ballast, Weapon Carriages	2.6013	5.2026	0	0	6,330	32,932	0	0	516	2,685	0	0	30	156	75	390	0	0	1,275	6,633	0	0
Total			**5,985**	**4,078**	**214,048**	**62,730**	**29,055**	**882**	**91,306**	**11,886**	**52**	**60**	**13,525**	**4,271**	**43,515**	**3,362**	**25,085**	**3,765**	**20,427**	**11,304**	**840**	**461**

AFTT: Atlantic Fleet Training and Testing; AMNS: Airborne Mine Neutralization System; GOMEX: Gulf of Mexico; JAX: Jacksonville; m^2: square meters; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWC: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes

Table 3.3-13: Numbers and Impacts of Military Expended Materials Proposed for Use during Testing Activities as Part of Alternative 2

Military Expended Materials	Size (m^2)	Impact Footprint (m^2)	Range Complex																			
			Northeast		VACAPES		Navy Cherry Point		JAX		SFOMF		Key West		GOMEX		NSWC PCD		AFTT Study Area		Other AFTT Areas	
			Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)	Number	Impact (m^2)
Bombs																						
Bombs (Explosive)	0.7544	10.4892	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bombs (Non-Explosive)	0.7544	10.4892	0	0	905	9,493	0	0	240	2,517	0	0	0	0	0	0	0	0	0	0	0	0
Projectiles																						
Small-Caliber (Non-Explosive)	0.0028	0.0113	0	0	7,633	86	3,333	38	3,333	38	0	0	0	0	28,000	316	7,000	79	2,500	28	0	0
Medium-Caliber (Explosive)	0.0052	0.0208	0	0	11,200	233	200	4	11,200	233	0	0	0	0	0	0	0	0	3,500	73	0	0
Medium-Caliber (Non-Explosive)	0.0052	0.0208	1,400	29	162,590	3,382	22,200	462	68,600	1,427	0	0	6,000	125	1,400	29	18,718	389	3,500	73	0	0
Large-Caliber (Explosive)	0.0938	0.3751	0	0	1,797	674	0	0	339	127	0	0	339	127	0	0	50	19	4,900	1,838	0	0
Large-Caliber (Non-Explosive)	0.0938	0.3751	296	111	4,811	1,805	0	0	769	288	0	0	561	210	148	56	280	105	7,100	2,663	0	0
Missiles (Explosive)	3.4715	6.9430	8	56	98	677	0	0	39	267	0	0	0	0	4	28	0	0	0	0	0	0
Missiles (Non-Explosive)	2.8801	5.7602	0	0	658	3,787	0	0	62	354	0	0	3	17	10	58	0	0	1	6	0	0
Rockets (Explosive)	0.0742	0.1484	0	0	202	30	0	0	202	30	0	0	0	0	0	0	0	0	0	0	0	0
Rockets (Non-Explosive)	0.0742	0.1484	0	0	2,087	310	0	0	546	81	0	0	0	0	0	0	0	0	0	0	0	0
Countermeasures																						
Chaff (Cartridges)	0.0001	0.0002	144	0	3,872	1	1,345	0	1,597	0	0	0	0	0	4,692	1	0	0	0	0	0	0
Flares	0.1133	0.4532	0	0	3,300	1,496	220	100	220	100	0	0	0	0	4,400	1,994	0	0	0	0	0	0
Acoustic Countermeasures	0.0289	0.1155	118	14	86	10	0	0	232	27	0	0	0	0	28	3	0	0	50	6	0	0
Targets																						
Airborne Targets	3.6270	7.2540	0	0	121	878	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Surface Targets	0.5344	1.0687	4	4	936	1,000	0	0	287	307	0	0	0	0	12	13	0	0	3	3	0	0
Sub-Surface Targets	0.1134	0.2268	128	29	471	107	9	2	199	45	0	0	0	0	39	9	0	0	0	0	16	4
Mine Shapes	2.3960	4.7920	0	0	114	546	0	0	118	565	0	0	0	0	7	34	435	2,085	0	0	0	0
Other																						
Torpedo (Explosive)	3.0861	6.1721	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	49	0	0
Torpedo (Non-Explosive)	0.9396	1.8792	0	0	30	56	0	0	7	13	0	0	0	0	0	0	0	0	0	0	0	0
Lightweight Torpedo Accessories	0.0939	0.1879	127	24	249	47	0	0	185	35	0	0	0	0	12	2	0	0	20	4	0	0
Heavyweight Torpedo Accessories	0.0150	0.3007	122	37	54	16	0	0	271	81	0	0	0	0	44	13	0	0	28	8	0	0
AMNS Neutralizer (Explosive)	0.1513	0.3026	0	0	145	44	0	0	32	10	0	0	0	0	14	4	171	52	0	0	0	0
AMNS Neutralizer (Non-Explosive)	0.1513	0.3026	0	0	77	23	0	0	32	10	0	0	0	0	0	0	140	42	0	0	0	0
Sonobuoys (Explosive)	0.1134	0.5669	514	291	950	539	204	116	244	138	0	0	1,512	857	204	116	0	0	0	0	368	209
Sonobuoys (Non-Explosive)	0.1134	0.5669	1,977	1,121	5,923	3,358	360	204	2,647	1,501	0	0	3,120	1,769	708	401	0	0	420	238	640	363
Parachutes – Large	0.8400	1.6800	2,049	3,442	227	381	0	0	91	153	0	0	0	0	0	0	0	0	12	20	0	0
Parachutes – Small	0.2642	0.5284	48	25	6,529	3,450	369	195	2,792	1,475	0	0	3,120	1,649	745	394	0	0	420	222	656	347
Anchor Blocks	0.5806	1.1613	0	0	230	267	0	0	64	74	67	78	0	0	0	0	1,203	1,397	0	0	0	0
Endcaps and pistons	0.0004	0.0007	144	0	7,172	5	1,565	1	1,817	1	0	0	0	0	9,092	6	0	0	0	0	0	0
Aircraft Stores, Ballast, Weapon Carriages	2.6013	5.2026	0	0	6,576	34,212	0	0	567	2,950	0	0	36	187	84	437	0	0	1,404	7,304	0	0
Total			**7,079**	**5,183**	**229,042**	**66,912**	**29,805**	**1,121**	**96,731**	**12,848**	**67**	**78**	**14,691**	**4,941**	**48,643**	**3,914**	**27,997**	**4,168**	**23,866**	**12,536**	**1,680**	**922**

AFTT: Atlantic Fleet Training and Testing; GOMEX: Gulf of Mexico; JAX: Jacksonville; m^2: square meters; NSWC PCD: Naval Surface Warfare Center, Panama City Division Testing Range; NUWC: Naval Undersea Warfare Center Division, Newport; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes

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3.3.3.2.1.1 No Action Alternative

Training Activities

Training activities involving military expended materials (Section 3.0.5.3.3.3, Military Expended Material Strikes) would have the potential to impact the marine substrates within the areas where the training is occurring. Each training area was evaluated to determine what level of impact could be expected under the No Action Alternative.

As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under the No Action Alternative, areas where military materials are expected to be expended include the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and Gulf of Mexico Large Marine Ecosystems and the Gulf Stream Open Ocean Area—specifically within the Northeast, VACAPES, Navy Cherry Point, JAX, Key West, and GOMEX Range Complexes, and in Other AFTT Areas. However, the largest potential impacted area from military expended materials occurs in Other AFTT Areas (sinking exercises) (Tables 3.3-9).

To determine the percentage of the total soft bottom or hard bottom substrate potentially impacted within a range complex, the total impacted area for each range complex from Table 3.3-9 was divided by the total amount of that particular substrate type within the same range complex as provided in Table 3.3-8. Results of this analysis are provided in Table 3.3-14.

Table 3.3-14: Potential Impact of Military Expended Materials from Training Activities on Soft and Hard Bottom Substrates Annually within Each Range Complex

Training Areas	Percent Impact to Soft Bottom		Percent Impact to Hard Bottom	
	No Action Alternative	Alternatives 1 and 2	No Action Alternative	Alternatives 1 and 2
Northeast U.S. Continental Shelf Large Marine Ecosystem				
Northeast	0.0000021	0.0000019	0.0006996	0.0006397
VACAPES	0.0000383	0.0000867	0.1218923	0.2758042
Southeast U.S. Continental Shelf Large Marine Ecosystem				
Navy Cherry Point	0.0000261	0.0000478	0.0003302	0.0006044
JAX	0.0000391	0.0000701	0.0000608	0.0001091
Caribbean and Gulf of Mexico Large Marine Ecosystems				
Key West	0.0000042	0.0000050	0.0000137	0.0000161
Gulf of Mexico Large Marine Ecosystem				
GOMEX	0.0000046	0.0000052	0.0000727	0.0000825
Northeast and Southeast U.S. Continental Shelf, Caribbean, and Gulf of Mexico Large Marine Ecosystems				
AFTT Study Area	0.0000000	0.0000000	0.0000000	0.0000000
Other AFTT Areas	0.0000035	0.0000006	0.0006060	0.0001087

GOMEX: Gulf of Mexico; JAX: Jacksonville; VACAPES: Virginia Capes

Military expended materials related to training exercises under a worst-case scenario would not impact more than 0.00009 percent of the available soft bottom habitat annually within any of the range complexes. Likewise, with the exception of VACAPES, the potential impact of the worst-case scenario on hard bottom habitats within each range complex does not exceed 0.0007 percent of the total available hard bottom. VACAPES had a higher percentage, not exceeding 0.13 percent, due to the relatively small amount of hard bottom habitat (30 km^2) that has been documented in that range complex. Given that these worst-case scenarios are highly unlikely to occur, the actual impact of military expended materials within each range complex under the No Action Alternative on either hard or soft bottom substrates will be even less than provided in Table 3.3-14. Impacts are further reduced in areas where shallow coral reefs are documented to occur with mitigation measures designed to prevent some military expended materials from impacting shallow coral reefs and their associated hard substrate foundations (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

Testing Activities

Testing activities involving military expended materials (Section 3.0.5.3.3.3, Military Expended Material Strikes) would have the potential to impact the marine substrates within the areas where the testing is occurring. As with training activities, each testing range was evaluated to determine what level of impact may be expected under the No Action Alternative.

As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under the No Action Alternative, areas involving the use of expended materials are expected to be the Northeast U.S. Continental Shelf, Southeast U.S. Continental Shelf, and the Gulf of Mexico Large Marine Ecosystems and the Gulf Stream Open Ocean Area—specifically within the South Florida Ocean Measurement Facility Testing Range; Naval Surface Warfare Center, Panama City Division Testing Range; Northeast, VACAPES, Navy Cherry Point, JAX, and GOMEX Range Complexes; and in Other AFTT Areas. However, the largest potential impacted area from military expended materials occurs in the VACAPES Range Complex (Table 3.3-10).

To determine the percentage of the total soft bottom or hard bottom substrate potentially impacted within a testing range, the total impacted area for each testing range from Table 3.3-10 was divided by the total amount of that particular substrate type within the same testing range as provided in Table 3.3-8. Results of this analysis are provided in Table 3.3-15.

Table 3.3-15: Potential Impact of Military Expended Materials from Testing Activities on Soft and Hard Bottom Substrates Annually within Each Range Complex

Testing Areas	Percent Impact to Soft Bottom			Percent Impact to Hard Bottom		
	No Action Alternative	Alternative 1	Alternative 2	No Action Alternative	Alternative 1	Alternative 2
Northeast U.S. Continental Shelf Large Marine Ecosystem						
Northeast	0.0000008	0.0000025	0.0000032	0.0002671	0.0008585	0.0010912
VACAPES	0.0000393	0.0000657	0.0000701	0.1252018	0.2091006	0.2230407
Southeast U.S. Continental Shelf Large Marine Ecosystem						
Navy Cherry Point	0.0000006	0.0000015	0.0000019	0.0000070	0.0000187	0.0000238
JAX	0.0000040	0.0000114	0.0000123	0.0000062	0.0000177	0.0000191
SFOMF	0.0000027	0.0000040	0.0000051	0.0000000	0.0000380	0.0000489
Caribbean and Gulf of Mexico Large Marine Ecosystems						
Key West	0.0000002	0.0000064	0.0000074	0.0000008	0.0000208	0.0000241
Gulf of Mexico Large Marine Ecosystem						
GOMEX	0.0000009	0.0000025	0.0000029	0.0000140	0.0000396	0.0000461
NSWC PCD	0.0000017	0.0000050	0.0000056	0.0000361	0.0001043	0.0001155
Northeast and Southeast U.S. Continental Shelf, Caribbean, and Gulf of Mexico Large Marine Ecosystems						
AFTT Study Area	0.0000001	0.0000001	0.0000001	0.0000041	0.0000071	0.0000078
Other AFTT Areas	0.0000000	0.0000000	0.0000000	0.0000015	0.0000008	0.0000016

GOMEX: Gulf of Mexico; JAX: Jacksonville; NUWC: Naval Undersea Warfare Center Division, Newport Testing Range; SFOMF: South Florida Ocean Measurement Facility Testing Range; VACAPES: Virginia Capes

Military expended materials related to testing activities under a worst-case scenario would not impact more than 0.00004 percent of the available soft bottom habitat annually within any of the range complexes or testing ranges. Likewise, with the exception of VACAPES, the potential impact of the worst-case scenario on hard bottom habitats within each testing range does not exceed 0.0003 percent of the total available hard bottom. VACAPES had a higher percentage, not exceeding 0.13 percent, due to the relatively small amount of hard bottom habitat (30 km^2) that has been documented in that range complex. Given that the likelihood of these worst case scenarios occurring is highly unlikely, the actual impact of military expended materials within each range complex under the No Action Alternative on either hard or soft bottom substrates will be even less than provided in Table 3.3-15. Impacts are further reduced in areas where shallow coral reefs are documented to occur with mitigation measures designed to prevent some military expended materials from impacting shallow coral reefs and their associated hard substrate foundations (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

3.3.3.2.1.2 Alternative 1

Training Activities

Training activities involving military expended materials (Section 3.0.5.3.3.3, Military Expended Material Strikes and Appendix A, Navy Activities Descriptions) would have the potential to impact the marine substrates within the areas in which the training is occurring. As with the No Action Alternative, each range complex was evaluated to determine what level of impact could be expected under Alternative 1.

As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under Alternative 1 the total amount of military expended materials is greater than the number expended in the No Action Alternative. However, the overall combined footprint of military expended materials actually declines from the No Action Alternative due to a reduction in ship hulks used in sinking exercise (Table 3.3-11). The activities under Alternative 1 would occur in the same geographic locations with the same types of expended materials in the same relative dimensions (excluding sinking exercises) as the No Action Alternative.

To determine the percentage of the total soft bottom or hard bottom substrate within a range complex that may potentially be impacted by military expended materials under a worst case scenario for each of the alternatives, the total impacted area for each range complex from Table 3.3-11 was divided by the total amount of that particular substrate type within the same range complex as provided in Table 3.3-8. Results of this analysis are provided in Table 3.3-14.

Military expended materials related to training exercises under a worst-case scenario would not impact more than 0.00009 percent of the available soft bottom habitat annually within any of the range complexes. Likewise, with the exception of VACAPES, the potential impact of the worst-case scenario on hard bottom habitats within each range complex does not exceed 0.0007 percent of the total available hard bottom. VACAPES had a higher percentage, not exceeding 0.28 percent, due to the relatively small amount of hard bottom habitat (29 km^2) that has been documented in that range complex. Given that the likelihood of these worst case scenarios occurring is highly unlikely, the actual impact of military expended materials within each range complex under the No Action Alternative on either hard or soft bottom substrates will be even less than provided in Table 3.3-14. Impacts are further reduced in areas where shallow coral reefs are documented to occur with mitigation measures designed to prevent some military expended materials from impacting shallow coral reefs and their associated hard substrate foundations (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

Testing Activities

Testing activities involving military expended materials (Section 3.0.5.3.3.3, Military Expended Material Strikes and Appendix A, Navy Activities Descriptions) would have the potential to impact the marine substrates within the areas the testing is occurring. Each testing range was evaluated to determine what level of impact could be expected under Alternative 1.

As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under Alternative 1 the total amount of military expended materials is greater than the amount expended in the No Action Alternative. Activities under Alternative 1 would occur in the same geographic locations using the same types of military expended materials as the No Action Alternative. Based on the total dimensions of military expended materials, there is a decline in the VACAPES Range Complex and corresponding increase in the JAX and Navy Cherry Point Range Complexes (Table 3.3-12), compared to the No Action Alternative.

To determine the percentage of the total soft bottom or hard bottom substrate within a testing range that may potentially be impacted by military expended materials under a worst case scenario for each of the alternatives, the total impacted area for each testing range from Table 3.3-12 was divided by the total amount of that particular substrate type within the same testing range as provided in Table 3.3-8. Results of this analysis are provided in Table 3.3-15.

Military expended materials related to testing activities under a worst-case scenario would not impact more than 0.00007 percent of the available soft bottom habitat annually within any of the testing ranges. Likewise, with the exception of VACAPES, the potential impact of the worst-case scenario on hard bottom habitats within each testing range does not exceed 0.0009 percent of the total available hard bottom. VACAPES had a higher percentage, not exceeding 0.21 percent, due to the relatively small amount of hard bottom habitat (29 km^2) that has been documented in that range complex. Given that the likelihood of these worst case scenarios occurring is highly unlikely, the actual impact of military expended materials within each range complex under Alternative 1 on either hard or soft bottom substrates will be even less than provided in Table 3.3-15. Impacts are further reduced in areas where shallow coral reefs are documented to occur with mitigation measures designed to prevent some military expended materials from impacting shallow coral reefs and their associated hard substrate foundations (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

3.3.3.2.1.3 Alternative 2 (Preferred Alternative)

Training Activities

Training activities involving military expended materials under Alternative 2 are exactly the same as under Alternative 1 and potential impacts would likewise be the same.

Testing Activities

Testing activities involving military expended materials (Section 3.0.5.3.3.3, Military Expended Material Strikes and Appendix A, Navy Activities Descriptions) would have the potential to impact the marine substrates within the areas the testing is occurring. Each range complex was evaluated to determine what the level of impact could be expected under Alternative 2.

As indicated in Section 3.0.5.3.3.3 (Military Expended Material Strikes), under Alternative 2 the total number of military expended materials is greater than the amount expended in Alternative 1. Activities under Alternative 2 would occur in the same geographic locations using the same types of military expended materials and the same relative dimensions as Alternative 1 (Table 3.3-13).

To determine the percentage of the total soft bottom or hard bottom substrate within a testing range that may potentially be impacted by military expended materials under a worst case scenario for each of the alternatives, the total impacted area for each testing range from Table 3.3-13 was divided by the total amount of that particular substrate type within the same testing range as provided in Table 3.3-8. Results of this analysis are provided in Table 3.3-15.

Military expended materials related to testing activities under a worst-case scenario would not impact more than 0.00007 percent of the available soft bottom habitat annually within any of the testing ranges. Likewise, with the exception of VACAPES, the potential impact of the worst-case scenario on hard bottom habitats within each testing range does not exceed 0.001 percent of the total available hard bottom. VACAPES had a higher percentage, not exceeding 0.23 percent, due to the relatively small amount of hard bottom habitat (29 km^2) that has been documented in that range complex. Given that the likelihood of these worst case scenarios occurring is highly unlikely, the actual impact of military expended materials within each range complex under Alternative 2 on either hard or soft bottom substrates will be even less than provided in Table 3.3-15. Impacts are further reduced in areas where shallow coral reefs are documented to occur with mitigation measures designed to prevent some military expended materials from impacting shallow coral reefs and their associated hard substrate foundations (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

3.3.3.2.1.4 Substressor Impact on Marine Substrate as Essential Fish Habitat

Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of military expended materials during training and testing activities may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of non-living substrates that constitute Essential Fish Habitat and Habitat Areas of Particular Concern. The AFTT Essential Fish Habitat Assessment report states that military expended material impacts to both soft and hard bottom substrates would be minimal with a duration period of long term to permanent within the Study Area (U.S. Department of the Navy 2013).

3.3.3.2.2 Impacts from Seafloor Devices

Seafloor devices represent any item used during training or testing activities that intentionally comes into contact with the seafloor, but are later recovered. These items include moored mine shapes, anchors, and robotic vehicles referred to as “crawlers.”

Mine shapes are typically deployed via surface vessels or fixed-wing aircraft. Most moored mines deployed from surface vessels are typically secured with up to a 2,700 lb. (1,225 kg) concrete mooring block (approximately 30 in. [76.2 cm] to a side). Moored mines deployed from fixed-wing aircraft enter the water and impact the bottom, becoming semi-submerged. Upon impact, the mine casing separates and the semi-buoyant mine floats through the water column until it reaches the end of the mooring line. Bottom mines are typically positioned manually and are allowed to free sink to the bottom to rest. Mine shapes are normally deployed over soft sediments and are recovered within 7 to 30 days following the completion of the training or testing events. As mine shapes are primarily deployed over soft bottom substrates, hard bottom and artificial structures should not be impacted. As a result of their temporary nature, mine shapes do not permanently impact the substrate on which they are placed, but will temporarily impair the ability of the substrate to function as a habitat for as long as the mine shape is in place.

Precision anchoring training exercises involve releasing of anchors in designated locations. The intent of these training exercises is to practice anchoring the vessel within 100 yards of the planned anchorage location. These training activities typically occur within predetermined shallow water anchorage locations near ports with seafloors consisting of soft bottom substrate. The level of impact to the soft sediments would depend on the size of the anchor used, which would vary according to vessel type. As most of these activities occur in areas subject to constant wave action and cycles of erosion and deposition, disturbed areas would likely be reworked by waves and tides shortly after the disturbance.

Crawlers are fully autonomous, battery-powered amphibious vehicles used for functions such as reconnaissance missions in territorial waters. These devices are used to classify and map underwater mines in shallow water areas. The crawler is capable of traveling 2 ft. (0.61 m) per second along the seafloor and can avoid obstacles. The crawlers are equipped with various sonar sensors and communication equipment that enable these devices to locate and classify underwater objects and mines while rejecting miscellaneous clutter that would not pose a threat. Crawlers are used in the Gulf of Mexico testing ranges for the Naval Surface Warfare Center, Panama City Division Testing Range; the east coast of Florida at the South Florida Ocean Measurement Facility Testing Range; and in the northeast in Narragansett Bay and waters used for testing by the Naval Undersea Warfare Center Division, Newport Testing Range. In the South Florida Ocean Measurement Facility Testing Range, crawler use would be restricted to the Port Everglades Restricted Anchorage Area (see Section 2.1.6.2, Sea and Undersea Space) which covers depths from shore out to 200 m and contains extensive areas of hard bottom substrate. Crawlers move over the surface of the seafloor and would not harm or alter any hard substrates encountered; therefore the hard bottom habitat would not be impaired. In soft substrates, crawlers may leave a trackline of depressed sediments approximately 24 in. (62 cm) wide (the width of the device) in their wake. However, since these crawlers operate in shallow water, any disturbed sediments would be redistributed by wave and tidal action shortly (days to weeks) following the disturbance. Any disturbance to the soft sediments would not impair their ability to function as a habitat.

As none of the seafloor devices described would have any lasting impact on either soft or hard substrates, nor permanently impair their ability to function as a habitat, no further discussion is necessary.

3.3.3.2.2.1 Substressor Impact on Marine Substrate as Essential Fish Habitat

Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of seafloor devices during training and testing activities may have an adverse effect on soft bottom substrates that constitute Essential Fish Habitat (U.S. Department of the Navy 2013). These potential impacts to soft bottom substrates would be minimal in size and temporary (recovery in days to weeks) to short term (recovery in weeks up to three years) in duration (U.S. Department of the Navy 2013). Hard bottom substrates and artificial structures should not be adversely affected by the use of seafloor devices.

3.3.4 SUMMARY OF IMPACTS ON MARINE SUBSTRATES

3.3.4.1 Combined Impacts of All Stressors

Of all the potential stressors, only explosives on or near the bottom and military expended materials have any measureable potential to impact marine habitats as a substrate for biological communities. The impact area for underwater explosions and military expended materials were all much less than one percent of the total area of documented soft bottom or hard bottom in their respective training or testing areas. The percentages are even lower for substrate impacts in the large marine ecosystems as a whole. Even multiplying by five years, the impacts are all less than one percent of the surveyed hard bottom substrate with very unlikely worst-case scenarios. Such a low percentage of bottom habitat impacted suggests there would be little impact on the ability of marine habitats to serve as substrate for biological communities from either individual stressors or combined stressors.

Chapter 5 (Standard Operating Procedures, Mitigation, and Monitoring) describes standard operating procedures, mitigation measures, and monitoring proposed to help reduce the potential impacts of explosives on or near the bottom and military expended materials on marine substrates and associated biogenic habitats.

3.3.4.1.1 No Action Alternative

The combined impact area of acoustic and physical disturbance and strike stressors proposed for training and testing events in the No Action Alternative would have minimal impact on the ability of soft shores, soft bottoms, hard shores, hard bottoms, or artificial substrates to serve their function as habitat (Table 3.3-16). The total area of mapped hard bottom (Figures 3.3-1 and 3.3-4) in the Study Area is over 39,498,559 ac. (159,845 km^2), which greatly exceeds the estimated 133 ac. (0.5378 km^2) of potential impacts given very unlikely worst case scenarios in addition to mitigation measures designed to avoid “surveyed” hard bottom or shallow coral reefs (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

Table 3.3-16: Combined Impact on Marine Substrates for the No Action Alternative

Large Marine Ecosystems	Impact Footprints (km^2)		
	Explosives On or Near Bottom	Military Expended Materials	Total
Northeast U.S. Continental Shelf	0.0041	0.0787	0.0827
Southeast U.S. Continental Shelf	0.0011	0.0609	0.0619
Caribbean Sea/Gulf of Mexico (Key West)	0.0000	0.0030	0.0030
Gulf of Mexico	0.0207	0.0087	0.0294
Other AFTT Areas	0.0000	0.3541	0.3541
AFTT Study Area	0.0000	0.0066	0.0066
Total	**0.0258**	**0.5120**	**0.5378**

AFTT: Atlantic Fleet Training and Testing; km: kilometer

3.3.4.1.2 Alternative 1

The combined impact area of impulsive stressors, physical disturbances, and strike stressors proposed for training and testing events in Alternative 1 would have minimal impact on the ability of soft shores, soft bottoms, hard shores, hard bottoms, or artificial substrates to serve their function as habitat (Table 3.3-17). The total area of mapped hard bottom (Figures 3.3-1 and 3.3-4) in the Study Area is over 39,498,559 ac. (159,845 km^2), which dwarfs the estimated 114 ac. (0.4594 km^2) of potential impacts given very unlikely worst case scenarios in addition to mitigation measures designed to avoid “surveyed” hard bottom or shallow coral reefs (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

Table 3.3-17: Combined Impact on Marine Substrates for Alternative 1

Large Marine Ecosystems	Impact Footprints (km^2)		
	Explosives On or Near Bottom	Military Expended Materials	Total
Northeast U.S. Continental Shelf	0.0709	0.1526	0.2235
Southeast U.S. Continental Shelf	0.0039	0.1145	0.1184
Caribbean Sea/Gulf of Mexico (Key West)	0.0007	0.0076	0.0083
Gulf of Mexico	0.0200	0.0141	0.0341
Other AFTT Areas	0.0000	0.0639	0.0639
AFTT Study Area	0.0000	0.0113	0.0113
Total	**0.0955**	**0.3640**	**0.4594**

AFTT: Atlantic Fleet Training and Testing; km: kilometer

3.3.4.1.3 Alternative 2 (Preferred Alternative)

The combined impact area of impulsive stressors, physical disturbances, and strike stressors proposed for training and testing events in Alternative 2 would have minimal impact on the ability of soft shores, soft bottoms, hard shores, hard bottoms, or artificial substrates to serve their function as habitat (Table 3.3-18). The total area of mapped hard bottom (Figures 3.3-1 and 3.3-4) in the Study Area is over 39,498,559 ac. (159,845 km^2), which dwarfs the estimated 127 ac. (0.5155 km^2) of potential impacts given very unlikely worst case scenarios in addition to mitigation measures designed to avoid “surveyed” hard bottom or shallow coral reefs (Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring).

Table 3.3-18: Combined Impact on Marine Substrates for Alternative 2

Large Marine Ecosystems	Impact Footprints (km^2)		
	Explosives On or Near bottom	Military Expended Materials	Total
Northeast U.S. Continental Shelf	0.0714	0.1579	0.2293
Southeast U.S. Continental Shelf	0.0041	0.1157	0.1198
Caribbean Sea/Gulf of Mexico (Key West)	0.0007	0.0530	0.0536
Gulf of Mexico	0.0208	0.0151	0.0359
Other AFTT Areas	0.0000	0.0643	0.0643
AFTT Study Area	0.0000	0.0125	0.0125
Total	**0.0970**	**0.4185**	**0.5155**

AFTT: Atlantic Fleet Training and Testing; km: kilometer

3.3.4.2 Essential Fish Habitat Determinations

Pursuant to the Essential Fish Habitat requirements of the Magnuson-Stevens Fishery Conservation and Management Act and implementing regulations, the use of explosives on or near the bottom, vessel movement, military expended materials, and seafloor devices may have an adverse effect on Essential Fish Habitat by reducing the quality and quantity of non-living substrates that constitute Essential Fish Habitat and Habitat Areas of Particular Concern. The AFTT Essential Fish Habitat Assessment report states that individual stressor impacts to non-living substrates were all either no effect or minimal and ranged in duration from temporary to permanent, depending on the habitat impacted (U.S. Department of the Navy 2013).

- Explosives could have a minimal and short term (soft bottom) to permanent (hard bottom) adverse effect on abiotic substrates
- Military expended material could have a minimal and long term to permanent adverse effect on both soft and hard bottom habitats
- Seafloor devices could have a minimal and temporary to short term adverse effect on abiotic soft substrates.

Mitigation measures should avoid impacts to surveyed hard bottom, as defined in Chapter 5, Standard Operating Procedures, Mitigation, and Monitoring. Impacts on water column as Essential Fish Habitat are summarized in corresponding resource sections (e.g., invertebrates, fish) because they are impacts on the organisms themselves.

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