REQUEST FOR REGULATION AND LETTER OF AUTHORIZATION FOR THE INCIDENTAL TAKING OF MARINE MAMMALS RESULTING FROM U.S. NAVY JOINT LOGISTICS OVER-THE-SHORE TRAINING IN VIRGINIA AND NORTH CAROLINA

Submitted to:

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LIST OF ACRONYMS AND ABBREVIATIONS

˚ C	degrees Celsius
CFR	Code of Federal Regulations
CV	coefficient of variation
dB	decibel
EA	Environmental Assessment
EIS/OIES	Environmental Impact Statement / Overseas Environmental Impact Statement
ELCAS (M)	Elevated Causeway System, Modular
ESA	Endangered Species Act
˚ F	degrees Fahrenheit
FR	Federal Register
ft.	foot / feet
FTX	field training exercise
humvee	high mobility multipurpose wheeled vehicle
Hz	hertz
JEB	Joint Expeditionary Base
JLOTS	Joint Logistics Over-the-Shore Training
km	kilometer
km^2	square kilometer
kHz	kilohertz
kW	kilowatt
LOA	Letter of Authorization
µPa	micropascal
m	meter
MMPA	Marine Mammal Protection Act
NMFS	National Marine Fisheries Service
ppt	parts per thousand
psu	practical salinity unit
re	referenced to
rms	root mean square
SEL	sound exposure level
TL	transmission loss
U.S.	United States
USC	United States Code
USFWS	United States Fish and Wildlife Service
°	degrees (geographic unit)
‘	minutes (geographic unit)
“	seconds (geographic unit)

1. INTRODUCTION AND DESCRIPTION OF ACTIVITIES

1.1. Introduction

The Department of the Navy (Navy) has prepared this consolidated request for regulations and a Letter of Authorization (LOA) for the incidental taking (as defined in Chapter 5, Take Authorization Requested) of marine mammals during activities associated with Joint Logistics Over-the-Shore training (JLOTS) from 2015 through 2019. The training activities evaluated in this document are limited to the temporary construction and dismantling of the Elevated Causeway System, Modular (ELCAS [M]), which would occur over approximately 30 days, no more than once per year at JEB Little Creek-Fort Story, and once per year at Camp Lejeune.

The Marine Mammal Protection Act (MMPA) of 1972, as amended (16 United States Code [USC] Section [§] 1371(a)(5)), authorizes the issuance of regulations for the incidental taking of marine mammals by a specified activity for a period of not more than five years. The issuance occurs when the Secretary of Commerce, after notice has been published in the Federal Register and opportunity for comment has been provided, finds that such taking will have a negligible impact on the species and stocks of marine mammals and will not have an unmitigable adverse impact on their availability for subsistence uses. The National Marine Fisheries Service (NMFS) has promulgated implementing regulations under 50 Code of Federal Regulations (CFR) § 216.101-106 that provide a mechanism for allowing the incidental, but not intentional, taking of marine mammals while engaged in a specific activity.

This LOA application has been prepared in accordance with the applicable regulations and the MMPA, as amended by the National Defense Authorization Act for Fiscal Year 2004 (Public Law [PL] 108-136) and its implementing regulations. The bases of this request for a Letter of Authorization are: (1) the analysis of spatial and temporal distributions of protected marine mammals in the JLOTS activity area, (2) the review of training activities that have the potential to incidentally take marine mammals per the *Draft Environmental Assessment for Joint Logistics Over-the-Shore Training at Joint Expeditionary Base Little Creek-Fort Story Virginia Beach, Virginia and Marine Corps Base Camp Lejeune Jacksonville, North Carolina*, (Draft EA) and (3) a technical risk assessment to determine the likelihood of effects. This chapter describes those training activities that are likely to result in Level B harassment, Level A harassment, or mortality under the MMPA. Of the Navy activities analyzed in the Draft JLOTS EA, the Navy has determined that only the temporary pile driving and removal associated with the ELCAS (M) exercise have the potential to affect marine mammals that may be present within the activity area.

1.2. Background

The Navy's mission is to organize, train, equip, and maintain combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. The mission is mandated by federal law (Title 10 USC § 5062), which ensures the readiness of the naval forces of the United States.[1] JLOTS training is needed to support the Navy's requirements for prompt and sustained combat, and to coordinate with other military branches, consistent with Title 10 USC § 5062. Joint Publication 4.01-6, *Joint Logistics Over-the-Shore (JLOTS)*, requires that Navy units, along with their Marine Corps and Army

[1] Title 10, Section 5062 of the United States 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."

counterparts, conduct realistic and routine JLOTS exercises to ensure continued combat and humanitarian relief readiness.

JLOTS is the movement of cargo and personnel from ships to shore in areas that do not have existing fixed port facilities. Two locations are being considered to conduct the required training: Joint Expeditionary Base (JEB) Little Creek-Fort Story in Virginia Beach, Virginia (Figure 1-1); and Marine Corps Base Camp Lejeune in Jacksonville, North Carolina (Figure 1-2). JEB Little Creek-Fort Story consists of two non-contiguous installations approximately 8 miles (13 kilometers [km]) apart: the 2,380-acre (963 hectare) Little Creek site (Little Creek), and the 1,458-acre (590-hectare) Fort Story site (Fort Story). Camp Lejeune is approximately 143,000 acres (57,870 hectares).

Figure 1-1. Location of JEB Little Creek-Fort Story

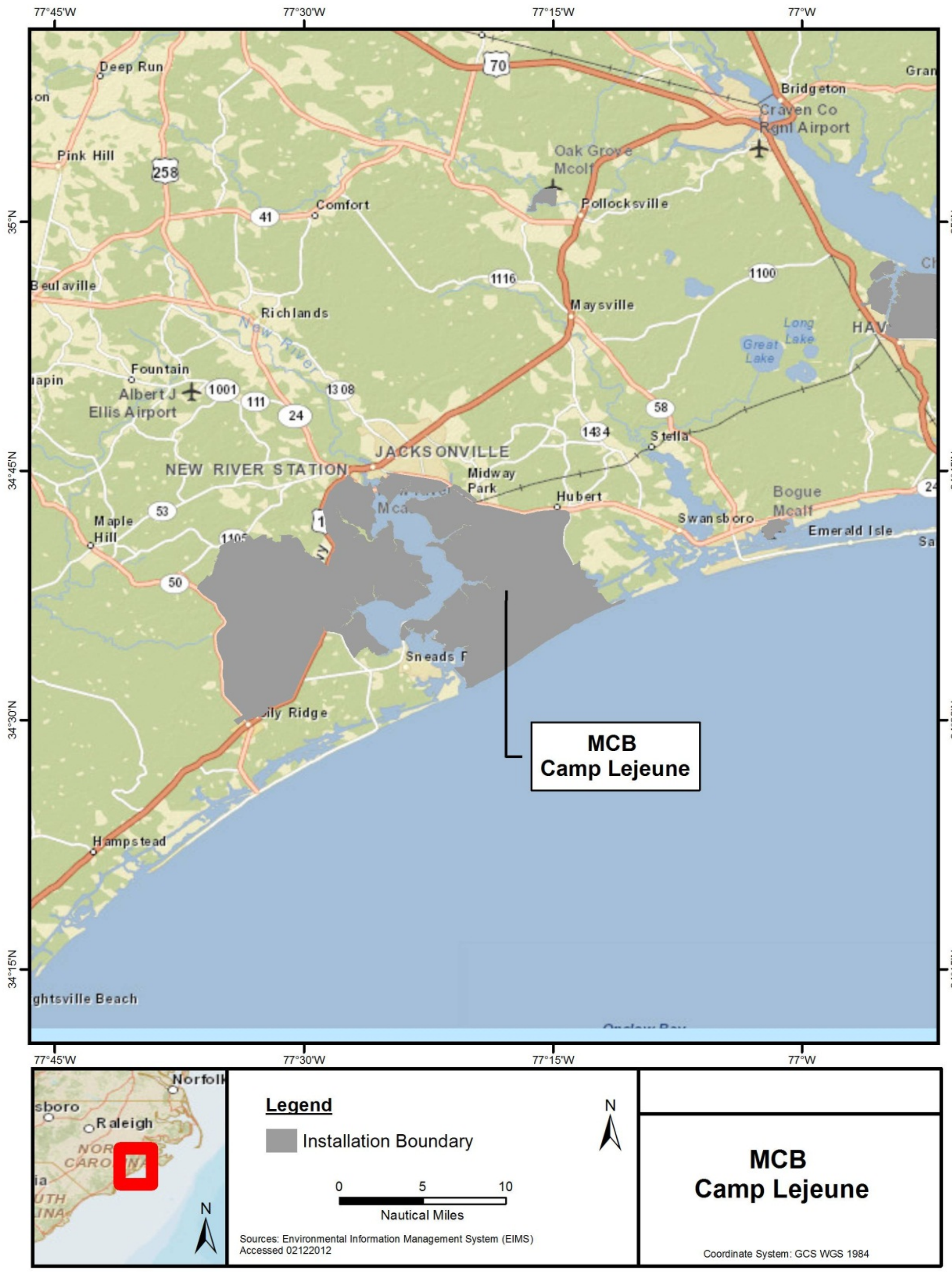


Figure 1-2. Location of MCB Camp Lejeune

1.3. Overview of Training Activities

JLOTS training consists of several, coordinated exercises (FTXs) conducted under the conditions in which the activity would normally occur (i.e., in the field as opposed to classroom or simulated training). The Proposed Action consists of a combination of FTXs conducted in a full-scale annual JLOTS event lasting for up to 60 days, and quarterly and routine unit-level FTXs that would take place independent of the annual JLOTS event. The FTXs that would be conducted include the following:

- **Use of the Improved Navy Lighterage System.** The Improved Navy Lighterage System is used to move personnel, cargo containers, and rolling stock directly from ships anchored offshore to land. The Improved Navy Lighterage System has four modular components: causeway ferry, roll on/roll off discharge facility, floating causeway, and warping tug. The first three are assembled from interchangeable, interlocking floating modules. The causeway ferry is used to transfer cargo from the ship to shore (either bare beach or a pier); the roll on/roll off discharge facility is a floating platform or transfer dock onto which the ship lowers its ramp to offload cargo for transfer to a causeway ferry or landing craft. Warping tugs install, tend, and maintain the other system components.

  Routine training at JEB Little Creek-Fort Story occurs during appropriate tidal conditions for in-water exercises. Typically exercises include warping tug maneuvers, causeway ferry approach and landings, cargo marshalling, and small-scale tent encampments. A typical routine training event includes two lighter, amphibious, resupply, cargo vehicles, two high mobility multipurpose wheeled vehicles (humvees), and a D-7R bulldozer on shore; and two to four causeway ferries and a warping tug offshore.

- **Construction and Use of the Elevated Causeway System, Modular.** The ELCAS (M) is a temporary pier constructed from the beach into the water past the surf zone. It consists of a series of 24- by 40-foot (ft.) (7.3- by 12.2-meter [m]) pontoon sections joined together and supported by piles driven into the sea floor. The beach end of the pier is anchored into the sand. The ELCAS (M) is typically constructed to a length of 1,500 ft. (457 m) with 119 supporting piles for training. At the end of the exercise, the ELCAS (M), including the piles, is removed and the beach is re-graded to its original elevation.

- **Construction and Use of the Floating Causeway[2].** The floating causeway is a temporary pier that extends from the beach through the surf zone to a distance of up to 1,200 ft. (366 m). The term "floating causeway" refers to any modular pier constructed at the waterfront and extending into nearshore waters. In any floating pier configuration, the beach end is anchored into the sand. An area approximately 30 ft. (9 m) wide, 80 ft. (24 m) long, and 5 ft. (1.5 m) deep (sometimes referred to as a "duck pond") is excavated in the tidal zone using bulldozers to stabilize the causeway as it transitions from the land to sea. The individual causeway sections can be further secured to the subaqueous bottom with anchors. The area is graded to its pre-training elevation at the end of the exercise. Up to two floating causeways are constructed during an annual JLOTS exercise. Either the Navy or the Army could be responsible for constructing one or both of these structures.

[2] "floating causeway" refers to any modular pier extending into nearshore waters; it may be the Navy's Floating Causeway system, the Army's Trident Pier, or an administrative pier.

- **Use of the Amphibious Bulk Liquid Transfer System and Tactical Water Purification System.** Amphibious Bulk Liquid Transfer System is used to transfer potable water (standing in for petroleum and other liquids) from ship to shore. The Tactical Water Purification System uses state-of-the-art reverse osmosis technology to produce potable water from any source, including salt water and nuclear, biological, and chemical contaminated water. Only clean hoses and components are utilized during training. Approximately 100,000 to 200,000 gallons (378,541 to 757,082 liters) of water, typically obtained from a public water supply system or a ship's desalinized supply, are transferred during any one exercise. The Amphibious Bulk Liquid Transfer System uses a floating hose marked with affixed chemlights.

- **Cargo Marshalling and Movement.** Rolling stock and containerized cargo (equipment and supplies) are moved to shore to certify that the expeditionary piers were built correctly. A cargo set of approximately 250 vehicles and 100 containers typically comprises the bulk of what is transferred from ship-to-shore during an annual JLOTS event. Vehicles and equipment that have been dismantled for transport are reassembled in a marshalling or staging area for transfer to inland locations. Transport from the landing points to the marshalling and staging area is by semi-truck trailers. To facilitate the movement of wheeled vehicles on the sand, a roll-out mat system may be used. Mats typically 10 ft. (3 m) wide and made of polyester mesh material are rolled out onto the sand and staked to the ground to create routes. From the marshalling and staging area, transport to inland locations is via existing dune breaks and roads.

- **Tent Encampment.** Tent encampments consist of personnel billeting tents; command, communications and operations tents; maintenance facilities; medical tents; portable galley facilities; portable latrine and shower facilities; and laundry facilities. Approximately 300 tents are erected and up to 3,000 personnel are temporarily billeted during an annual JLOTS event. In addition to the main camp, smaller tent facilities are set up on or near the landing beach to support shoreline operations.

Only the ELCAS (M) FTX involves activities that have the potential to harm or harass marine mammals by introducing sound levels into the water that could exceed established criteria for injury and behavioral disturbance. Therefore, the other FTXs described above are not addressed further in this application.

1.3.1. Elevated Causeway System, Modular

The ELCAS (M) is a temporary pier constructed from the beach into the water past the surf zone. It provides a means of delivering containers, vehicles, and bulk cargo ashore without lighterage craft having to enter the surf zone. The ELCAS (M) consists of a series of 24- by 40-ft. (7.3- by 12.2-m) pontoon sections joined together and supported by piles driven into the sea floor.

The beach end of the pier is anchored into the sand. Bulldozers are used to modify an area above the mean high water mark approximately 30 ft. (9 m) wide, 25 ft. (7.6 m) long in order to build the correct grade to allow vehicles to drive off the pier. It is then anchored onto the beach by pushing some of the sand back into the modified area (Figure 1-3).

To build the pier, piles are driven into the sand with a diesel-powered impact hammer. The piles used typically are hollow, half-inch steel uncapped piles, 24 inches (0.5 m) in diameter, and can be of various lengths (38 ft. [11.6 m], 57 ft. [17.4 m], or 76 ft. [23.2 m]) depending on local bathymetry (Figure 1-4). The depth to which the piles are driven is between 30 and 40 ft. (9.1 to 12.2 m) and installation takes approximately 15 minutes per pile. Typically, 6 piles would be installed in a day. Two pile drivers are generally used, but not simultaneously: while one is driving a pile, the other is being re-positioned for the next pile. Construction may take up to 20 days. A pier length of 1,500 ft (457 m) is typical for training, with approximately 119 supporting piles.

Once the ELCAS (M) is constructed (Figure 1-5), offloading operations are similar to those of a conventional pier. Container-handling operations consist primarily of transferring containers from lighterage vessels (e.g., Landing Craft Utility or Landing Craft Mechanized) to the pier. Empty trucks or trailers are driven onto a turntable at the seaward end of the ELCAS (M) and are loaded with containers using the same cranes from construction. The ELCAS (M) is wide enough to accommodate two-way traffic. Rolling stock may be lifted by crane to the pier and driven to the beach as well. Operations typically involve the use of two forklifts and an average of six cargo trucks a day during the exercise. Power for the operation of the turntable and the lighting of the ELCAS (M) is provided by up to two 30-kilowatt (kW) and two 100-kW generators.

The ELCAS (M) is dismantled by removing the pontoon sections and extracting the piles with a vibratory hammer, which takes approximately 6 minutes per pile, over the course of 10 days. Typically, 12 piles are removed in a day. On the beach, the modified area re-graded to its original elevation.

Figure 1-3. Assembly of Pier Connection on Beach

Figure 1-4. Pile Driving During ELCAS (M) Construction

Figure 1-5. Navy Elevated Causeway System, Modular

2. DURATION AND LOCATION OF ACTIVITIES

The ELCAS (M) FTX may be conducted in the activity area any time of year, but no more than once annually at JEB Little Creek-Fort Story, and once annually at Camp Lejeune. Table 2-1 summarizes the type and duration of pile driving for a single ELCAS (M) FTX.

Table 2-1. Details of ELCAS (M) FTX Pile Driving

Pile Description	Component	Method	Duration per Pile (minutes)	Piles per Day	Strikes per Pile	Total Number of Days
24-inch diameter steel pipe piles (uncapped)[1]	Pile Installation	Impact	15	6	500	20
	Pile Removal	Vibratory	6	12	n/a	10
Total Pile Driving Days (annually[2])						30 days

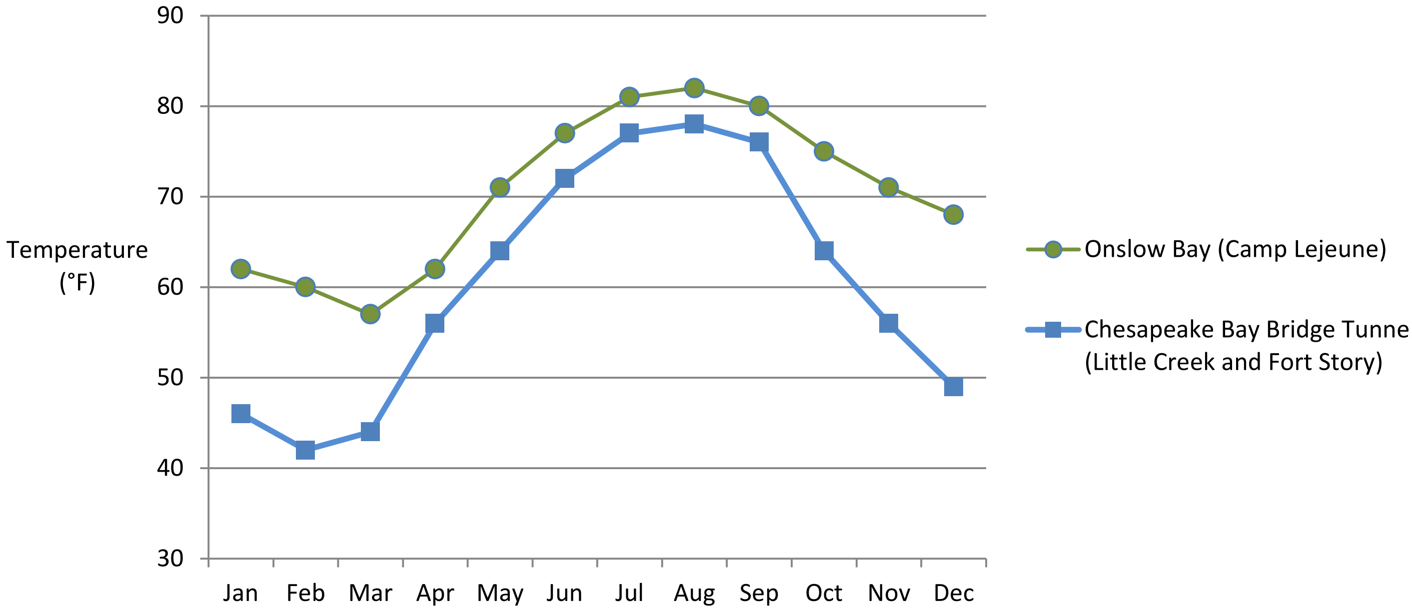
[1]Pile lengths may be 38 ft. (11.6 m), 57 ft. (17.4 m), or 76 ft. (23.2 m); [2]pile driving would take place once annually at each location

The primary activity area consists of nearshore waters where the ELCAS (M) FTX would take place, along with adjacent waters out to a distance of 3 nautical miles (5.5 km). Table 2-2 summarizes the physical characteristics of the waters off each installation, and Figure 2-1 illustrates average seasonal water temperatures. Figures 2-2 through 2-4 illustrate notional ELCAS (M) locations at each installation.

Table 2-2. Physical Characteristics of the Proposed JLOTS Locations

Location	Joint Expeditionary Base		Camp Lejeune
	Little Creek	Fort Story	
Substrate	Sand with shell debris[1, 2]		Low sedimentation; hardbottom in some areas; littered with rocks and boulders[3, 4, 5, 6, 7]
Average Depth	3 ft. (1 m) near shore; 15 ft. (4.5 m) past 600 ft. (183 m) from shore[8]	5 ft. (1.5 m) near shore; 20 ft. (6.1 m) at 500 ft. (152 m) from shore[8]	10 ft. (3 m) near shore; 20 ft. (6 m) at 500 ft. (152 m) from shore[8,9]
Salinity	18 – 21 ppt; higher in fall, lower in spring[10, 11]	>24 ppt; higher in fall, lower in spring[10, 11]	30 psu (mouth of New River) to 35 psu in Onslow Bay[12]; higher in fall, lower in spring[13]

Sources: [1]Lamont-Doherty Earth Observatory 1997; [2]National Oceanic and Atmospheric Administration 1983; [3]Southeast Area Monitoring and Assessment Program 2001; [4]Coastal Ocean Research Monitoring Program; [5]Riggs et al. 1998; [6]Newton et al. 1971; [7]Pilkey et al. 1977; [8]National Oceanic and Atmospheric Administration 2014; [9]U.S. Marine Corps 2009; [10]Chesapeake Bay Program 2008; [11]Chesapeake Bay Foundation n.d.; [12]Mallin and McIver 2010; [13]Deaton et al. 2010



Sources: National Oceanic and Atmospheric Administration 2013a, 2014a

Figure 2-1. Average Water Temperatures at the Proposed JLOTS Locations

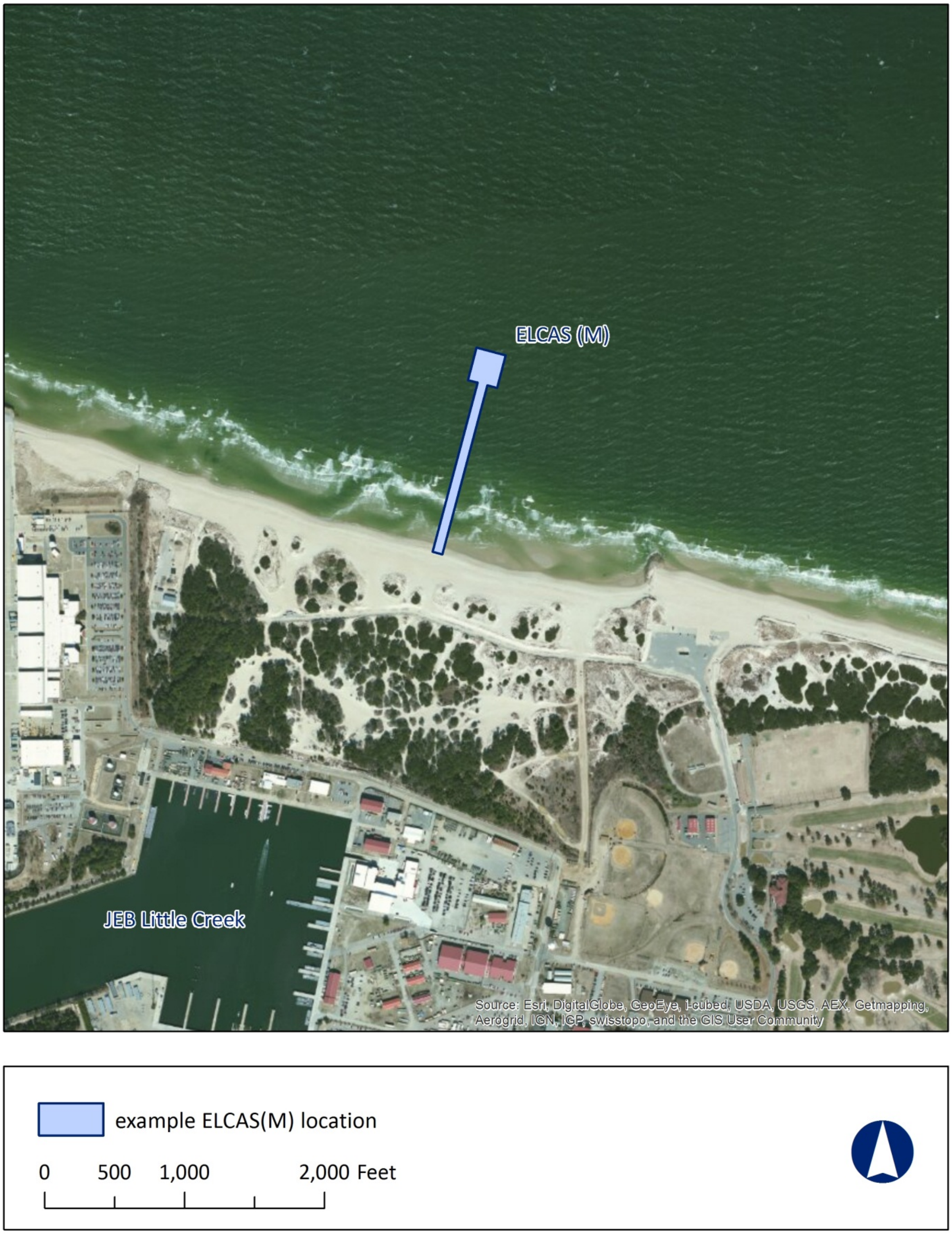


Figure 2-2. Notional Location of ELCAS (M) at Anzio Beach (Little Creek)

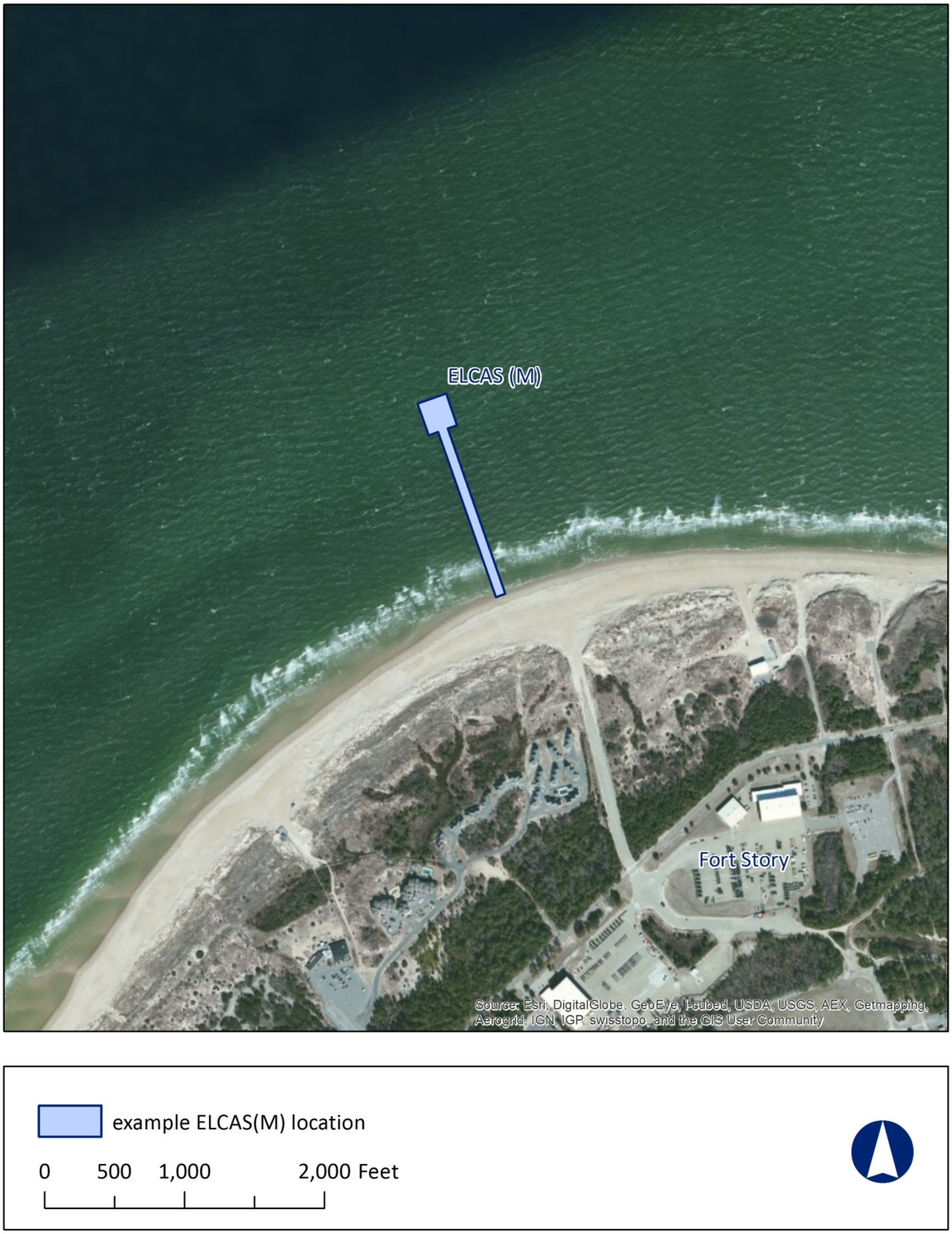


Figure 2-3. Notional Location of ELCAS (M) at Utah Beach (Fort Story)

Figure 2-4. Notional Location of ELCAS (M) at Onslow Beach (Camp Lejeune)

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3. MARINE MAMMAL SPECIES AND NUMBERS

The Navy reviewed marine mammal species occurring in waters off the Atlantic coast between Virginia and North Carolina, and determined that those listed in Table 3-1 may occur in the vicinity of the Proposed Action. Marine species' densities were derived from the Navy's Marine Species Density Database and Technical Report (U.S. Department of the Navy 2012).

Consultation for the West Indian manatee (*Trichechus manatus*) was completed with the U.S. Fish and Wildlife Service; based on the results of the consultation take is not anticipated.

Table 3-1. Marine Mammals Potentially Occurring in the Joint Logistics Over-the-Shore Activity Area

Common Name	Scientific Name	Status		Stock(s)	Stock Abundance Best (CV) / Min[1]	Density in Activity Area[2] (per km^2)	
		ESA	MMPA			JEB Little Creek - Fort Story	Camp Lejeune
Mysticetes							
fin whale	*Balaenoptera physalus*	E	strategic; depleted	Western North Atlantic	3,522 (0.27) / 2,817	0.00	
humpback whale	*Megaptera novaeangliae*	E	depleted	Gulf of Maine	823 (0) / 823	0.000034	0.00009
North Atlantic right whale	*Eubalaena glacialis*	E	strategic; depleted	Western North Atlantic	444 (0) / (444)	0.000033	
sei whale	*Balaenoptera borealis*	E	strategic; depleted	Nova Scotia	357 (0.52) / 236	0.000101	
Odontocetes							
Atlantic spotted dolphin	*Stenella frontalis*	--	--	Western North Atlantic	26,798 (0.66) / 16,151	0.0007728	0.153
bottlenose dolphin[3]	*Tursiops truncatus*	--	strategic	Northern North Carolina Estuarine System	950 (0.23) / 785	0.159	0.169871
			strategic	Southern North Carolina Estuarine System	2,454 (0.53) / 1,614		
			strategic; depleted	Western North Atlantic Southern Migratory Coastal	12,482 (0.32) / 9,591		

[1]Waring et al. 2013; [2]U.S. Department of the Navy 2012; [3]National Marine Fisheries Service 2010, 2010a, 2012, 2012a; CV = coefficient of variation

4. AFFECTED SPECIES STATUS AND DISTRIBUTION

Four main types of marine mammals are generally recognized: cetaceans (whales, dolphins, and porpoises), pinnipeds (seals, sea lions, and walruses), sirenians (manatees, dugongs, and sea cows), and other marine carnivores (sea otters and polar bears) (Jefferson et al. 2008; Rice 1998). The order Cetacea is divided into two suborders – Odontoceti and Mysticeti. The toothed whales, dolphins, and porpoises (Odontocetes) range in size from slightly longer than 3.3 ft. (1 m) to more than 60 ft. (18 m) and have teeth, which they use to capture and consume individual prey. The baleen whales (suborder Mysticetes) are universally large (more than 15 ft. [5 m] as adults). They are batch feeders that use this baleen instead of teeth to engulf, suck, or skim large numbers of prey, such small schooling fish, shrimp, or microscopic sea animals (i.e. plankton) from the water or out of ocean floor sediments (Heithaus and Dill 2008). Detailed reviews of the different groups of cetaceans can be found in Perrin et al. (2009). Marine mammal distribution is influenced by many factors, primarily patterns of major ocean currents, which in turn affect prey productivity. The continuous movement of water from the ocean bottom to the surface creates a nutrient-rich, highly productive environment for marine mammal prey (Jefferson et al. 2008). For most cetaceans, prey distribution, abundance, and quality largely determine where they occur at any specific time (Heithaus and Dill 2008). Most of the baleen whales are migratory, but many of the toothed whales do not migrate in the strictest sense. Instead, they undergo seasonal dispersal or shifts in density.

4.1 Mysticetes

4.1.1 Fin Whale

The fin whale is found in all of the world’s oceans, and is the second largest species of whale (Jefferson et al. 2008). Four management stocks have been identified by NMFS; individuals of the Western North Atlantic stock could occur in the activity area. Fin whales prefer temperate and polar waters and are rarely seen in warm tropical waters (Reeves et al. 2002). They typically congregate in areas of high productivity and spend most of their time in coastal and shelf waters but can often be found in waters approximately 2,000 m deep (Aissi et al. 2008; Reeves et al. 2002). Fin whales are often seen closer to shore after periodic patterns of upwelling (underwater motion) and the resultant increased prey density (Azzellino et al. 2008). In addition to krill, herring, capelin, sand lance, copepods, and squid are preyed upon by this species (Goldbogen et al. 2006; Jefferson et al. 2008; National Marine Fisheries Service 2013). Like most other mysticetes, fin whales are not expected to occur in groups (National Marine Fisheries Service 2013).

The Chesapeake Bay region is considered to be a normal part of the range of the fin whale. Recent records of fin whales in the Chesapeake Bay area include a single dead animal beached in Ocean View, east of Naval Station Norfolk, in 2012 (Nealon 2012), and another dead individual in the middle Chesapeake Bay near the Maryland / Virginia border in February 2014 (Phillips pers. comm. 2014).

Aerial observations in Onslow Bay, North Carolina, from August 2009 through August 2010 resulted in the sighting of a single fin whale (U.S. Department of the Navy 2010). The closest limited occurrence is predicted to occur in winter in shelf waters and steeply sloping waters over the shelf break between Cape Lookout and Cape Hatteras (U.S. Department of the Navy 2008). The likelihood of this species occurring in the shallow inshore waters off JEB Little Creek-Fort Story or Camp Lejeune is very low.

4.1.2 Humpback Whale

Humpback whales are distributed worldwide in all major oceans and most seas. Individuals of the Gulf of Maine stock could occur in the activity area. They typically are found during the summer on high-latitude feeding grounds and during the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where calving occurs. Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep oceanic waters during migration (Calambokidis et al. 2001; Clapham and Mattila 1990).

Humpback whales feed on a variety of invertebrates and small schooling fishes. The most common invertebrate prey are krill; the most common fish prey are herring, mackerel, sand lance, sardines, anchovies, and capelin (Clapham and Mead 1999). Feeding occurs both at the surface and in deeper waters, wherever prey is abundant. The humpback whale is the only species of baleen whale that shows strong evidence of cooperation when feeding in large groups (D'Vincent et al. 1985). Humpback feeding habitats are typically shallow banks or ledges with high seafloor relief (Hamazaki 2002; Payne et al. 1990).

On breeding grounds, females with calves occur in much shallower waters than other groups of whales, and breeding adults use deeper waters farther offshore (Ersts and Rosenbaum 2003; Smultea 1994). Humpback whale groups are typically small and (except for mother/calf pairs) unstable, and individuals frequently change associates. Stable groups which remain together in feeding areas over weeks or even years have occasionally been recorded, but these represent an exception and their basis is not clear (Clapham n.d.).

Humpback whales are most likely to occur in the mouth of the Chesapeake Bay between January and March; however, based on sighting and stranding data in both Mid-Atlantic waters and the Chesapeake Bay, they could be found in the area year-round (Barco et al. 2002; Swingle et al. 1993). Photo-identification data support the repeated use of the Mid-Atlantic region by individual humpback whales (Barco et al. 2002). Barco et al. suggest that the mid-Atlantic region may be where some mother humpbacks wean and separate from their calves. The most recent documented sighting of a humpback whale near the activity area occurred during Navy transect surveys in April 2014 (Engelhaupt pers. comm. 2014) off north Virginia Beach.

Sightings off North Carolina peak from April through May during the northbound migration, and from September through December, during the southbound migration. Many sightings and strandings are juveniles, suggesting that this region may be an important habitat for younger animals (Wiley et al. 1995). Most sightings are made in waters from 66 to 240 ft. (20 to 73 m) deep although some individuals have been sighted in shallower areas (U.S. Department of the Navy 2008). The likelihood of this species' occurrence in the shallow nearshore waters off JEB Little Creek-Fort Story or Camp Lejeune is low.

4.1.3 North Atlantic Right Whale

The western North Atlantic right whale population ranges primarily from calving grounds in coastal waters of the southeastern United States to feeding grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence. Most sightings are concentrated within five high-use areas: coastal waters of the southeastern U.S. (Georgia and Florida), Cape Cod and Massachusetts bays, the Great South Channel, the Bay of Fundy, and the Nova Scotian Shelf (Winn et al. 1986; Silber and Clapham 2001).

North Atlantic right whales feed primarily on copepods (largely of the genera *Calanus* and *Pseudocalanus*). Research suggests that this species locates and exploits extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). During spring and early summer, foraging takes place both near the surface and at depth (Parks et al. 2011). As summer progresses, North Atlantic right whales will follow prey to deeper waters (Baumgartner et al. 2003).

North Atlantic right whales are most often seen as individuals or pairs (New England Aquarium 2013); occasionally they are observed in larger social or breeding aggregations known as surface active groups (Parks et al. 2007). They have been observed in waters off Cape Henry and Virginia Beach during fall and spring aerial surveys, and occasional occurrences have been documented inside the lower Chesapeake Bay itself. There are also regular seasonal occurrences in Onslow Bay during winter months (Northeast Fisheries Science Center 2014). Individuals potentially observed in the activity area are expected to be in transit to and from winter calving grounds off the east coast of Florida. Occurrences of this species in the shallow nearshore waters off JEB Little Creek-Fort Story or Camp Lejeune are expected to be rare.

4.1.4 Sei Whale

Sei whales have a worldwide distribution and are found primarily in cold temperate to subpolar latitudes. During the winter, sei whales are found from 20° N to 23° N and during the summer from 35° N to 50° N (Horwood 2009; Masaki 1976, 1977; Smultea et al. 2010). The species' Nova Scotia stock range overlaps with the activity area. Similar to North Atlantic right whales, sei whales spend the summer feeding in high latitudes and return to lower latitudes to calve in winter. They are usually observed in deeper waters far from the coastline.

Feeding occurs primarily around dawn, which appears to be correlated with vertical migrations of prey species that include krill, copepods, small schooling fish, and squid (Horwood 2009).

Sei whales are usually observed singly or in small groups of 2-5 animals, but are occasionally found in larger (30-50) loose aggregations (National Marine Fisheries Service 2012). No recent observations of sei whales in the Chesapeake Bay or Onslow Bay have been recorded, and the likelihood of their occurrence in waters off JEB Little Creek-Fort Story or Camp Lejeune is extremely low.

4.2 Odontocetes

4.2.1 Atlantic Spotted Dolphin

This species is found in nearshore tropical to warm-temperate waters, predominantly over the continental shelf and upper slope. In the western Atlantic, this species is distributed from New England to Brazil and is found in the Gulf of Mexico as well as the Caribbean Sea (Perrin 2008). Atlantic spotted dolphin sightings have been concentrated in the slope waters north of Cape Hatteras, but in the shelf waters south of Cape Hatteras sightings extend into the deeper slope and offshore waters of the mid-Atlantic.

Atlantic spotted dolphins are highly gregarious, and are frequently observed in mixed-aged groups numbering up to several hundred individuals. Smaller subgroups, this species can be age and sex segregated to a small degree. Tightly bonded mother and calf pairs are typical to the age of 3 (Herzing n.d.).

The Atlantic spotted dolphin regularly occurs in the nearshore waters south of Chesapeake Bay and near the continental shelf edge and continental slope waters north of this region, usually at least 4.9 to 12.4

miles (8 to 20 km) offshore (Payne et al. 1984; Mullin and Fulling 2003; Davis et al. 1998; Perrin 2002; Perrin et al. 1994). Therefore, while it is unlikely to occur in the shallow waters where the JLOTS exercises would take place, it is more probable at Camp Lejeune than at JEB Little Creek-Fort Story. Navy density data suggest this species may be more likely to occur during summer months (U.S. Department of the Navy 2012).

4.2.2 Bottlenose Dolphin

Along the U.S. east coast, the bottlenose dolphin stock structure is well studied. Of the management stocks identified by NMFS, three may occur in the JLOTS activity area: the Northern North Carolina Estuarine System stock, the Southern North Carolina Estuarine System stock, and the Western North Atlantic Southern Migratory Coastal stock. The bottlenose dolphin occurs in tropical to temperate waters of the Atlantic Ocean as well as inshore, nearshore, and offshore waters of the Gulf of Mexico and U.S. east coast. They occur in most enclosed or semi-enclosed seas in habitats ranging from shallow, murky, estuarine waters to also deep, clear offshore waters in oceanic regions (Jefferson et al. 2008; Wells et al. 2009). Bottlenose dolphins are also often found in bays, lagoons, channels, and river mouths and are known to occur in very deep waters of some ocean regions. Open ocean populations occur far from land; however, population density appears to be highest in nearshore areas (Scott and Chivers 1990). They are common in the lower Chesapeake Bay and in Onslow Bay (Chesapeake Bay Program 2012; McAlarney et al. 2011).

Bottlenose dolphins typically occur in groups of 2 – 15 individuals, but significantly larger groups have also been reported (Shane et al. 1986; Kerr et al. 2005). Coastal bottlenose dolphins typically exhibit smaller group sizes than the larger offshore form, as water depth appears to be a significant influence on group size (Shane et al. 1986). Shallow, confined areas typically support smaller group sizes, some degree of regional site fidelity, and limited movement patterns (Shane et al. 1986; Wells et al. 1987). Bottlenose dolphins have a varied diet, feeding on small fish, crustaceans, and squid (Wells and Scott 2002).

An Unusual Mortality Event (UME) was declared for bottlenose dolphins along the Atlantic coast in June 2013 and is ongoing to date. An increased number of strandings have occurred from New York to Florida, with 345 taking place in Virginia and 181 in North Carolina. Off JEB Little Creek-Fort Story and Camp Lejeune, 32 and 10 bottlenose dolphin strandings have occurred, respectively, since the declaration of the UME. The UME is being tentatively attributed to cetacean morbilivirus, but further research is ongoing (National Marine Fisheries Service 2014).

5. TAKE AUTHORIZATION REQUESTED

The United States Department of the Navy requests a regulation and a 5-year Letter of Authorization for the take of marine mammals incidental to the proposed action in the JLOTS activity area for the period from 2015 through 2019. The term "take," as defined in Section 3 (16 USC § 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 National Defense Authorization Act of Fiscal Year 2004 (Public Law 108-136) amended the definition of harassment 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 USC § 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). The proposed action constitutes military readiness activities as that term is defined in Public Law 107-314 because activities constitute "training and operations of the armed forces that relate to combat" and constitute "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 USC § 1362(18)(B)(i) and (ii)].

The JLOTS Draft EA considered all training activities undertaken in the activity area that have the potential to result in the MMPA defined take of marine mammals. The stressors associated with these activities included the following:

- Impulsive and non-impulsive sounds (underwater noise from pile driving and vessels)
- Physical disturbance or strikes (vessels and in-water equipment and activities)
- Entanglement (equipment deployed during JLOTS exercises)

The Navy determined that one stressor, impulsive and non-impulsive sounds from pile driving, could potentially result in the incidental taking of a marine mammal from training activities within the activity area. Impulsive and non-impulsive sounds have the potential to result in incidental takes of marine mammals by harassment or injury. The acoustic analysis described in the JLOTS Draft EA and in this request for an LOA attempts to quantify potential exposures of marine mammals to sound levels that could result in behavioral disturbance or injury.

5.1 Incidental Take Request for Impulsive and Non-Impulsive Sources

A detailed analysis of effects due to marine mammal exposures to impulsive and non-impulsive sources in the JLOTS activity area is shown in Chapter 6 (Numbers and Species Taken). Table 5-1 summarizes the Navy's final incidental take request for training activities by species annually and as a summation over a 5-year period.

Based on the analysis in Chapter 6 - *Numbers and Species Taken*, the Navy requests 550 total Level B harassments for bottlenose dolphins and 250 total Level B harassments for Atlantic spotted dolphins that may result from JLOTS training activities over the 5-year period. The Navy does not anticipate any marine mammal injuries, strandings, or mortalities from impulsive and non-impulsive sources to occur.

Table 5-1. Species-specific Level A and Level B Incidental Takes for JLOTS Training Activities

Species	Annual				Total (5 years)				Total Incidental Takes Requested	
	JEB Little Creek - Fort Story		Camp Lejeune		JEB Little Creek - Fort Story		Camp Lejeune			
	Level		Level		Level		Level		Level	
	A	B	A	B	A	B	A	B	A	B
North Atlantic right whale	0	0	0	0	0	0	0	0	**0**	**0**
fin whale	0	0	0	0	0	0	0	0	**0**	**0**
humpback whale	0	0	0	0	0	0	0	0	**0**	**0**
sei whale	0	0	0	0	0	0	0	0	**0**	**0**
bottlenose dolphin	0	50	0	60	0	250	0	300	**0**	**550**
Atlantic spotted dolphin	0	0	0	50	0	0	0	250	**0**	**250**

6. NUMBERS AND SPECIES TAKEN

The methods for estimating the number and types of exposure are described in the sections below, followed by the method for quantifying exposures of marine mammals to sources of energy exceeding those threshold values. Exposure of each was determined by:

- The potential of each species to be impacted by the acoustic sources as determined by acoustic criteria for marine mammals.
- The potential presence of each species and their estimated density inside the range to effect.
- The range to effect for impact installation and vibratory extraction (estimated by taking into account the source levels, propagation loss, and thresholds at which each acoustic criterion is met).

Potential exposures were calculated by multiplying the density of each marine mammal species potentially present by the total impacted area for each threshold value, rounding the result to the closest integer, and then multiplying that result by the potential number of days of pile driving. An introduction to the fundamentals of acoustics and use of the decibel unit can be found in Appendix A.

Assessing whether a sound may disturb or injure a marine mammal involves understanding the characteristics of the acoustic source and the potential effects that sound may have on the animal's physiology and behavior. Although it is known that sound is important for marine mammal communication, navigation, and foraging (National Research Council 2003, 2005), there are many unknowns in assessing impacts such as the potential interaction of different effects and the biological significance of responses by marine mammals to sound exposures (Nowacek et al. 2007; Southall et al. 2007). Furthermore, many factors other than the received level of sound may affect an animal's reaction, such as the animal's physical condition, prior experience with the sound, and proximity to the source of the sound (Nowacek et al. 2007).

Acoustically-mediated behaviors, including social interactions, foraging, and navigation, may be particularly vulnerable to disturbance during pile-driving activities, and it is important to understand the source characteristics of marine mammal vocalizations in order to address potential for disturbance. The following sections address hearing and sound production of all marine mammals that may be present in the project area during pile driving.

6.1 Marine Mammal Hearing and Vocalization

All marine mammals studied can use sound to forage, orient, socially interact with others, and detect and respond to predators. Measurements of marine mammal sound production and hearing capabilities provide some basis for assessment of whether exposure to a particular sound source may affect a marine mammal behaviorally or physiologically.

Marine mammal hearing abilities are quantified using live animals by either behavioral audiometry or electrophysiology. Behavioral audiograms, which are plots of animals' exhibited hearing threshold versus frequency, are obtained from captive, trained live animals using standard testing procedures with appropriate controls and are considered to be a more accurate representation of a subject's hearing abilities. Behavioral audiograms of marine mammals are difficult to obtain because many species are too large, too rare, and too difficult to acquire and maintain. Consequently, our understanding of a species' hearing ability may be based on the behavioral audiogram of a single individual or small group of animals. In addition, captive animals may be exposed to local ambient sounds and other environmental factors that could affect their hearing abilities and may not accurately reflect the hearing abilities of free-swimming animals. For animals not available in captive or stranded settings (including large whales and rare species) estimates of hearing capabilities are made based on physiological structures, vocal characteristics, and extrapolations from related species.

Direct measurements of hearing sensitivity exist for approximately 25 of the nearly 130 species of marine mammals. Table 6-1 summarizes sound production and hearing capabilities for marine mammals that have the potential to occur in the JLOTS activity area.

Table 6-1. Hearing and Vocalization Ranges for Marine Mammal Functional Hearing Groups and Species Potentially Occurring Within the JLOTS Activity Area

Functional Hearing Group	Species	Vocalization		FHG Hearing Ability Frequency Range
		Frequency Range	Source Level (dB re 1 µPa at 1 m)	
Mid-frequency	Atlantic spotted dolphin, bottlenose dolphin	100 Hz to > 100 kHz	118 to 236	150 Hz to 160 kHz
Low-frequency	fin whale, humpback whale, North Atlantic right whale, sei whale	10 Hz to 20 kHz	129 to 195	7 Hz to 22 kHz

Sources: Richardson et al. 1995; Southall et al. 2007

6.1.1 Mid-frequency Cetaceans

Atlantic spotted dolphins and bottlenose dolphins are mid-frequency cetaceans; functional hearing for these species is conservatively estimated to be between approximately 150 Hz and 160 kHz (Southall et al. 2007). In general, odontocetes (including mid-frequency cetaceans) produce sounds across the widest band of frequencies. Their social vocalizations range from a few hundreds of Hz to tens of kHz with source levels in the range of 100 to 170 dB re 1 µPa (Richardson et al. 1995). As mentioned earlier, they also generate specialized clicks used in biosonar (echolocation) at frequencies above 100 kHz to detect, localize, and characterize underwater objects such as prey (Au 1993). Echolocation clicks have source levels that can be as high as 229 dB re 1 µPa peak-to-peak (Au et al. 1974).

6.1.2 Low-Frequency Cetaceans

The following members of the low-frequency cetacean group (mysticetes) have the potential to occur in the activity area: fin whale, humpback whale, North Atlantic right whale, and sei whale. Functional hearing in low-frequency cetaceans is conservatively estimated to be between about 7 Hz and 22 kHz (Southall et al. 2007).

Because of animal size and the availability of specimens, direct measurements of mysticete whale hearing are unavailable, therefore inferences have been made from vocalizations, ear structure, and field observations. Mysticete cetaceans produce low-frequency sounds that range in the tens of Hz to several kHz that most likely serve social functions such as reproduction, but may serve an orientation function as well (Green 1994; Green et al. 1994). Humpback whales are the notable exception within the mysticetes, with some calls exceeding 10 kHz. These sounds can be generally categorized as low-frequency moans; bursts or pulses; or more complex songs (Edds-Walton 1997). Source levels of most mysticete cetacean sounds range from 150 to 190 dB re 1 μPa (Richardson et al. 1995). Table 6-1 summarizes hearing and vocalization for marine mammals that could occur in the JLOTS activity area.

6.2 Sound Exposure Criteria and Thresholds

Since 1997, NMFS has used generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (70 FR 1871). Current NMFS practice regarding exposure of marine mammals to pile driving sounds is that cetaceans exposed to impulsive sounds ≥180 re 1 μPa rms are considered to have been taken by Level A (i.e., injurious) harassment. Level A injury thresholds have not been established for non-impulsive sounds such as vibratory pile driving, but the Navy has applied the threshold values for impulsive sounds to vibratory sound in this analysis.

Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to underwater sounds below the injury threshold, but ≥ 160 dB re 1 μPa rms for impulsive sounds (e.g., impact pile driving) and ≥120 dB re 1 μPa rms for non-impulsive noise (e.g., vibratory pile driving or extraction).

6.3 Limitations of Existing Noise Criteria

To date, there is no research or data supporting a response by odontocetes to non-impulsive sounds from vibratory pile driving as low as the 120 dB re 1 μPa rms threshold. The application of the 120 dB rms re 1μPa threshold can be problematic because this threshold level can be either at or below the ambient noise level of certain locations. For example, noise levels at some industrialized ports in Puget Sound, WA, have been measured at between 120 and 130 dB re 1μPa (Washington State Department of Transportation 2012). Assuming a 120 dB disturbance threshold in such environments implies any animals in the area will be disturbed with or without additional pile driving noise. This has led to analyses that may be overly conservative, and as a result of these issues, the threshold level is subject to ongoing discussion (74 FR 41684). NMFS is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (National Oceanic and Atmospheric Administration 2013). The 120 dB re 1 μPa rms threshold level for non-impulsive noise originated from research conducted by Malme et al. (1984, 1988) for California gray whale response to non-impulsive industrial sounds such as drilling operations. Note: The 120 dB re 1 μPa rms *non-impulsive* sound threshold should not be confused with the 120 dB re 1 μPa rms *impulsive* sound criterion established for migrating bowhead whales in the Arctic as a result of research in the Beaufort Sea (Richardson et al. 1995; Miller et al. 1999).

6.4 Underwater Sound from Pile Driving

Sound levels produced by pile driving are greatly influenced by factors including pile type, driving method, and the physical environment in which the activity takes place. A number of studies have examined sound pressure levels recorded from underwater pile driving projects in California and Washington, creating a large body of data for impact driving of steel pipe piles.

To determine the most appropriate sound pressure levels for this project, data from studies which met the following parameters were considered:

- Pile size and type: 24-inch diameter steel sheet piles
- Installation method: vibratory and/or impact hammer
- Physical environment : water depth, sediment type

Table 2-2 under *Duration and Location of Activities* above details the physical characteristics of the waters and substrate off the proposed JLOTS locations. Source levels were selected from NAVFAC Atlantic's comprehensive dataset based on similarity to site conditions at JEB Little Creek-Fort Story (sand with shell debris sediments, average depth 1 – 5 meters), and Camp Lejeune (lower sedimentation with hard-bottom in some areas, depth around 7 meters), equipment (i.e., diesel hammer), and lack of conditions that might introduce extra noise into the measurements (e.g., riverine environments). Calculated averages[3] of selected source levels used as proxies for modeling are detailed summarized in Table 6-2.

Table 6-2. Summary of Source Levels Selected

Method	Location	dB re 1µPa rms	dB re 1µPa peak	dB re 1µPa^{2}sec SEL
Impact Installation	JEB Little Creek-Fort Story	188	207	179
	Camp Lejeune	189	207	183
Vibratory Removal	JEB Little Creek-Fort Story	160	n/a	n/a
	Camp Lejeune			

[3] All averages were calculated by converting decibel values to linear values using the formula $y=10^{(x_1/15)}$, where x_1 is the dB value. Linear values were averaged and the calculated value was re-converted to dB by $x_2=15*\log_{10}(y_{avg})$. All values included in the table were used for averaging.

Modeling sound propagation is useful in evaluating noise levels to determine distance from the pile driving activity that certain sound levels may travel. The decrease in acoustic intensity as a sound wave propagates outward from a source is known as transmission loss (TL). The formula for transmission loss is:

$$TL = B * log_{10}\left(\frac{R_1}{R_2}\right) + C * R_1, \text{ where}$$

B = logarithmic (predominantly spreading) loss

C = linear (scattering and absorption) loss

R_1 = range from source in meters

R_2 = range from driven pile to original measurement location (generally 10 m for pile driving activities)

The amount of linear loss (C) is proportional to the frequency of a sound. Due to the low frequencies of sound generated by impact and vibratory pile driving, this factor was assumed to be zero for all calculations in this assessment and transmission loss was calculated using only logarithmic spreading. Therefore, using practical spreading (B=15), the revised formula for transmission loss is TL = 15 log_{10} (R_1/10).

The practical spreading loss model (TL =15 log_{10} (R_1/10)) discussed above was used to calculate the underwater propagation of pile driving sound in and around the three proposed locations. A total of 30 days of pile driving were modeled for JEB Little Creek-Fort Story and Camp Lejeune; 20 days of impact driving, and 10 days of vibratory extraction. No noise mitigation methods (bubble curtains, cofferdams, etc.) are proposed and therefore no attenuation was included in the acoustic model.

Impact driving of each pile is expected to take no more than 15 minutes. Typically, 6 piles would be installed each day, for up to 20 days. Generally, two pile drivers are used, but not simultaneously: while one is installing a pile, the other is being repositioned for the next pile.

For vibratory extraction, the acoustic model assumed that 12 piles would be extracted each day, taking 6 minutes each, over the course of 10 days.

The range to effects (Table 6-3) for underwater noise is assumed to take a circular shape around the notional pile bring driven at the furthest offshore point of the ELCAS (M) (approximately 1,500 ft. [457 m] from shore). Zones with radii larger than 1,500 ft. (457 m) will be truncated by the shoreline, and were modeled as semicircles extending to the west, north, and east in the case of JEB Little Creek-Fort Story; and north, east, and south at Camp Lejeune since the beaches at each of the locations would represent the boundary for underwater propagation. The calculated ranges assume no obstructions, and sounds will attenuate as they encounter land or other solid obstacles. As a result, the distances calculated may not actually be attained at the three locations.

Table 6-3. Calculated Range to Effects and Zones of Influence for Marine Mammals During Pile Driving

Driving Method	Threshold	Range		Area	
		JEB Little Creek-Fort Story	Camp Lejeune	JEB Little Creek-Fort Story	Camp Lejeune
Impact Installation	Injury: 180 dB re 1 µPa rms	37 yds (34 m)	44 yds (40 m)	0.001 mi^2 (0.0037 km^2)	0.002 mi^2 (0.005 km^2)
	Behavioral: 160 dB re 1 µPa rms	805 yds (736 m)	938 yds (858 m)	0.328 mi^2 (0.85 km^2)	0.446 mi^2 (1.156 km^2)
Vibratory Removal	Injury: 180 dB re 1 µPa rms	n/a		n/a	
	Behavioral: 120 dB re 1 µPa rms	5,077 yds (4,642 m)		13.07 mi^2 (33.84 km^2)	

Note: all sound levels expressed in dB re 1 µPA rms; dB = decibel; rms = root mean square; µPa = microPascal; m = meter; mi^2 = square mile; km^2 = square kilometer; n/a = not applicable; behavioral zones of influence are semi-circles based on notional distance from shore of the pile being driven; injury zones of influence are circular since they will not extend to and therefore be attenuated by land

Based on the size of the areas in which pile driving and extraction may exceed established thresholds, the Navy applied estimated densities for the six marine mammals and the number of active pile driving days, resulting in the requested number of incidental takes for each species in Table 5-1.

7. IMPACTS ON MARINE MAMMAL SPECIES OR STOCKS

Based on best available science, the Navy concludes that exposures to marine mammal species and stocks due to training activities would result in only short-term effects on most individuals exposed and would not affect annual rates of recruitment or survival for the following reasons:

- All acoustic exposures are within the behavioral effects zone (Level B harassment) only.
- Although the numbers presented in represent estimated takes under the MMPA, they are conservative (i.e., over predictive) estimates, primarily by behavioral disturbance.
- The mitigation measures described in Chapter 11 (Means of Effecting the Least Practicable Adverse Impacts – Mitigation Measures) are designed to achieve the least practicable adverse effect on marine mammal species or stocks.

Consideration of negligible impact is required for NMFS to authorize incidental take of marine mammals. By definition, an activity has a 'negligible impact' on a species or stock when the activity cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

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, and the other stimuli that are 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 and avoidance. The specific type and severity of these reactions helps determine the costs and ultimate consequences to the individual and population.

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 activity fall outside of its normal daily variations, then individuals must recover from significant costs to avoid long-term consequences.

The importance of the disruption and degree of consequence for individual marine mammals often has much to do with the frequency, intensity, and duration of the disturbance. Isolated acoustic disturbances such as pile driving extraction within the activity area usually have minimal consequences or no lasting effects for marine mammals. Marine mammals regularly cope with occasional disruption of their activities by predators, adverse weather, and other natural phenomena. It is reasonable to assume that they can tolerate occasional or brief disturbances by anthropogenic sound without significant consequences. However, prolonged disturbance, as might occur if a stationary and noisy activity were established near a concentrated area, is a more important concern. The long-term implications would depend on the degree of habituation within the population. If the marine mammals fail to habituate or become sensitized to disturbance and, as a consequence, are excluded from an important area or are subject to stress while at the important area, long-term effects could occur to individuals or the population.

The exposure estimates calculated by predictive models currently available reliably predict propagation of sound and received levels and measure a short-term, immediate response of an individual using applicable criteria. Consequences to populations are much more difficult to predict and empirical measurement of population effects from anthropogenic stressors is limited (National Research Council 2005). To predict indirect, long-term, and cumulative effects, the processes must be well understood and the underlying data available for models. In response to the National Research Council review (2005), the Office of Naval Research founded a working group to formalize the Population Consequences of Acoustic Disturbance framework. The long-term goal is to improve the understanding of how effects of marine sound on marine mammals transfer between behavior and life functions and between life functions and vital rates. This understanding will facilitate assessment of the population level effects of anthropogenic sound on marine mammals. This field and development of a state-space model is ongoing. Based on each species' life history information and the application of robust mitigation procedures proposed in Chapter 11 (*Means of Effecting the Least Practicable Adverse Impacts*), JLOTS training activities are anticipated to have a negligible impact on marine mammals within the activity area.

8. IMPACTS ON SUBSISTENCE USE

Potential impacts resulting from the proposed action will be limited to marine mammals located in the nearshore waters off JEB Little Creek-Fort Story and Camp Lejeune and will be limited to Level B harassment. Therefore, no impacts to the availability of species or stocks for subsistence use were found.

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9. IMPACTS ON MARINE MAMMAL HABITAT AND THE LIKELIHOOD OF RESTORATION

Activity components with the potential to impact marine mammal habitat as a result of the Proposed Action include temporary reduction in water quality; introduction of vessel, amphibious vehicle, and pile driving noise into the underwater environment; and temporary changes to prey distribution and abundance. Each of these components was considered in the JLOTS Draft EA and was determined to have no impact on marine mammal habitat. A summary of the analysis from the JLOTS Draft EA is included below.

9.1 Temporary Reduction in Water Quality

In activity area waters, various activities are expected to disturb sediments, resulting in a temporary decrease in water quality.

Vessel and amphibious vehicle movements would disturb sediments, with impacts of the greatest duration and intensity resulting during an annual JLOTS event. Impacts are expected to be greatest closer to shore, where landing craft would offload. Quarterly and routine cargo movement exercises (at JEB Little Creek-Fort Story only) would be less intense and last for up to three hours a day. The sandy sediment that dominates the sea floor off JEB Little Creek-Fort Story is expected to quickly settle back in place, with finer particles taking slightly longer.

Anchoring and pile driving would also cause highly localized increases in turbidity as the objects contact the sea floor and displace some of the sediments. A similar disturbance would occur when anchors and piles are pulled after the end of the exercises. Each time, these impacts would be very localized and short-lived, likely lasting for a few hours only the activity.

Effects to marine mammals from temporary decreases in water quality are expected to be minimal. The ability to forage in the immediate area of a moving vessel or amphibious vehicle, anchor, or pile being driven / extracted could be impacted by the reduced visual capability in turbid waters. However, the increased level of activity and noise in these areas is expected to decrease the attractiveness of these locations for any marine species.

Increases in turbidity from the proposed action would be repetitive but temporary. The major causes of such effects (vessel and craft movement) would occur once at each location over 60 days during an annual JLOTS event; the rest during quarterly or routine training at JEB Little Creek-Fort Story only. Between each event, there would be ample time for water quality to return to pre-training levels.

9.2 Underwater Noise – Vessels and Amphibious Vehicles

The operation of craft, vessels, and amphibious equipment during training exercises would generate underwater sound. Marine mammals react to vessel-generated sounds in a variety of ways (Watkins 1986). A recent study found that low-frequency ship noise may be associated with chronic stress in baleen whales, with implications for whales in heavy ship traffic areas (Rolland et al. 2012). However, given the anticipated ambient sound levels in the high-use marine environment near JEB Little Creek-Fort Story and Camp Lejeune, the amount of sound contributed by Navy vessels during the proposed activities would be small and mostly limited to nearshore areas where whales are not likely to be present. Marine mammals transiting the waters offshore during the proposed training events may hear sounds associated with them, but any reactions would be short-term. There would not be any long-term consequences from ship noise.

9.3 Changes to Prey Distribution and Abundance

Underwater noise from vehicle, vessel, or pile driving could impact other species in the food web, including prey species that marine mammals feed upon. Impacts would differ depending on the type of prey species in the area of the activity. In addition to potential physical effects from vehicle, vessel, or pile driving noise, prey might have behavioral reactions to underwater sound. For instance, prey species might exhibit a startle reaction to noise that might include swimming to the surface or scattering away from the source. This startle and flight response is the most common secondary defense among animals (Hanlon and Messenger 1996). The abundances of prey species near the pile driving activity could be diminished for a short period before being repopulated by animals from adjacent waters. Any of these scenarios would be temporary, occurring during JLOTS in-water FTXs; and no lasting effects on prey availability or existing coastal ecology are expected.

10. IMPACTS ON MARINE MAMMALS FROM LOSS OR MODIFICATION OF HABITAT

The Proposed Action is not expected to have any habitat-related effects that could cause significant or long-term consequences for individual marine mammals or their populations. Based on the discussions in Chapter 9 *Impacts on Marine Mammal Habitat and the Likelihood of Restoration*, there will be no impacts on marine mammals resulting from loss or modification of marine mammal habitat.

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11. MEANS OF EFFECTING THE LEAST PRACTICABLE ADVERSE IMPACTS – STANDARD OPERATING PROCEDURES AND MITIGATION MEASURES

This section describes the Navy standard operating procedures and mitigation measures. Standard operating procedures are essential to maintaining safety and mission success, and in many cases have the added benefit of reducing potential environmental impacts. Mitigation measures are designed to help reduce or avoid potential impacts on marine resources. When applicable, mitigation measures developed for ELCAS (M) construction activities at Camp Lejeune are consistent with those developed as part of the *Atlantic Fleet Training and Testing EIS/OEIS* and section 7 consultation for the West Indian manatee (*Trichechus manatus*).

11.1 Standard Operating Procedures

11.1.1 Standard Watch Personnel

Ships operated by or for the Navy have personnel assigned to stand watch at all times, day and night, when moving through the water (underway). Watch personnel undertake extensive training in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent, including on-the-job instruction and a formal Personal Qualification Standard program (or equivalent program for supporting contractors or civilians), to certify that they have demonstrated all necessary skills (such as detection and reporting of floating or partially submerged objects). Watch personnel are composed of officers, enlisted men and women, and civilian equivalents. Their duties may be performed in conjunction with other job responsibilities, such as navigating the ship or supervising other personnel. While on watch, personnel employ visual search techniques, including the use of binoculars, using a scanning method in accordance with the U.S. Navy Lookout Training Handbook or civilian equivalent. After sunset and prior to sunrise, watch personnel employ night visual search techniques, which could include the use of night vision devices.

A primary duty of watch personnel is to detect and report all objects and disturbances sighted in the water that may be indicative of a threat to the ship and its crew, such as debris, a periscope, surfaced submarine, or surface disturbance. Per safety requirements, watch personnel also report any marine mammals sighted that have the potential to be in the direct path of the ship as a standard collision avoidance procedure. Because watch personnel are primarily posted for safety of navigation, range clearance, and man-overboard precautions, they are not normally posted while ships are moored to a pier. When anchored or moored to a buoy, a watch team is still maintained but with fewer personnel than when underway. When moored or at anchor, watch personnel may maintain security and safety of the ship by scanning the water for any indications of a threat (as described above).

While underway, Navy ships (with the exception of submarines) greater than 65 ft. (20 m) in length have at least two watch personnel; Navy ships less than 65 ft. (20 m) in length, surfaced submarines, and contractor ships have at least one watch person. While underway, watch personnel are alert at all times and have access to binoculars. Due to limited manning and space limitations, small boats and some craft transferring cargo from ship to shore do not have dedicated watch personnel, and the boat crew is responsible for maintaining the safety of the boat and surrounding environment.

All vessels use extreme caution and proceed at a "safe speed" so they can take proper and effective action to avoid a collision with any sighted object or disturbance and can be stopped within a distance appropriate to the prevailing circumstances and conditions.

11.1.2 Soft Starts

Soft starts are performed during impact installation each day. During a soft start, an initial set of strikes from the impact hammer at reduced energy are performed before it is able to be operated at full power and speed. The energy reduction of an individual hammer cannot be quantified because they vary by individual drivers. Also, the number of strikes will vary at reduced energy because raising the hammer at less than full power and then releasing it results in the hammer "bouncing" as it strikes the pile resulting in multiple "strikes". A benefit of a soft start is that marine species in the vicinity are provided a "warning", giving them an opportunity to leave the area at the first occurrence of the noise, prior to full capacity operation. This may result in reducing exposures to underwater noise levels that could cause behavioral disturbance or injury.

11.2 Mitigation Measures

11.2.1 Marine Species Awareness Training

Consistent with current requirements, all personnel standing watch on the bridge, Commanding Officers, Executive Officers, and Lookouts will successfully complete the Marine Species Awareness Training prior to standing watch or serving as a Lookout. The Marine Species Awareness Training is designed to improve the effectiveness of visual observations for marine resources, including marine mammals. The training provides information on sighting cues, visual observation tools and techniques, and sighting notification procedures.

11.2.2 Lookouts

Lookouts perform similar duties to standard watch personnel, and are also responsible for satisfying mitigation requirements. The Navy will have one Lookout positioned on the platform (which could include a small boat, the elevated causeway, or the shore) that will maximize the potential for sightings during pile driving and pile removal.

The Lookout positioned on the elevated causeway or the shore will be dedicated solely to diligent observation of the air and surface of the water. They will have multiple observation objectives, which include but are not limited to detecting the presence of biological resources and recreational or fishing boats, observing the mitigation zone, and monitoring for equipment and personnel safety concerns. Due to small boat manning and space restrictions, a Lookout positioned on a small boat may include a member of the boat crew, and may be responsible for tasks in addition to observing the air or surface of the water (e.g., navigation of a rigid hull inflatable boat). However, a boat Lookout will, to the maximum extent practicable and consistent with safety and training requirements, comply with the observation objectives described above for a Lookout positioned on the elevated causeway or the shore.

Mitigation will include visual observation starting 30 minutes prior to and during the exercise within a mitigation zone of 60 yards (55 m) around the pile being driven. The exercise will not commence if concentrations of floating vegetation (*Sargassum* or kelp patties) are observed in the mitigation zone. Pile driving will cease if a marine mammal is visually detected within the mitigation zone. Pile driving will re-commence if any one of the following conditions is met: (1) the animal is observed exiting the mitigation zone, (2) the animal is thought to have exited the mitigation zone based on its course and speed, or (3) the mitigation zone has been clear from any additional sightings for a period of 30 minutes.

11.2.3 Vessels

Vessels will avoid approaching marine mammals head on and will maneuver to maintain a mitigation zone of 500 yards (457 m) around observed whales and 200 yards (183 m) around all other marine mammals (except bow riding dolphins), providing it is safe to do so.

11.2.4 North Atlantic Right Whale Mid-Atlantic Migration Corridor

A North Atlantic right whale migratory route is located off the mid-Atlantic coast of the United States. This mitigation area applies from November 1 through April 30 and is defined as follows:

- Block Island Sound: The area bounded by 40°51'53.7" N / 070°36'44.9" W; 41°20'14.1" N / 070°49'44.1" W; 41°4'16.7" N / 071°51'21" W; 41°35'56.5" N / 071°38'26.1" W; then back to first set of coordinates.

- New York and New Jersey: Within a 20 nm radius of the following (as measured seaward from the COLREGS lines): 40°29'42.2" N / 073°55'57.6" W.

- Delaware Bay: Within a 20 nm radius of the following (as measured seaward from the COLREGS lines): 38˚52'27.4" North / 075˚01'32.1" West.

- Chesapeake Bay: Within a 20 nm radius of the following (as measured seaward from the COLREGS lines): 37˚00'36.9" North / 075˚57'50.5" West.

- Morehead City, North Carolina: Within a 20 nm radius of the following (as measured seaward from the COLREGS lines): 34˚41'32.0" North / 076˚40'08.3" West.

- Wilmington, North Carolina, through South Carolina, and to Brunswick, Georgia: Within a continuous area 20 nautical miles from shore and west back to shore bounded by 34˚10'30" North / 077˚49'12" West; 33˚56'42" North / 077˚31'30" West; 33˚36'30" North / 077˚47'06" West; 33˚28'24" North / 078˚32'30" West; 32˚59'06" North / 078˚50'18" West; 31˚50'00"North / 080˚33'12" West; 31˚27'00" North / 080˚51'36" West.

When transiting within the migration corridor, the Navy will practice increased vigilance, exercise extreme caution, and proceed at the slowest speed that is consistent with safety, mission, and training objectives.

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12. MINIMIZATION OF ADVERSE EFFECTS ON SUBSISTENCE USE

As detailed in Chapter 8, no impacts on the availability of species or stocks for subsistence use are anticipated. Therefore, no minimization efforts are applicable.

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13. MONITORING AND REPORTING EFFORTS

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 (Chapter 11, *Means of Effecting the Least Practicable Adverse Impacts*), the Navy will implement monitoring efforts under the existing Integrated Comprehensive Monitoring Program 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.

13.1 Integrated Comprehensive Monitoring Program Top-Level Goals

The Integrated Comprehensive Monitoring Program is intended to coordinate monitoring efforts across all regions where the Navy trains and tests and to allocate the most appropriate level and type of effort for each range complex (U. S. Department of the Navy 2010). Originally, the Navy monitoring program was composed of a collection of "range-specific" monitoring plans, each developed individually as part of Marine Mammal Protection Act and Endangered Species Act compliance processes as environmental documentation was completed. These individual plans established specific monitoring requirements for each range complex and were collectively intended to address the Integrated Comprehensive Monitoring Program top-level goals.

A 2010 Navy-sponsored monitoring meeting in Arlington, Virginia, initiated a process to critically evaluate the Navy monitoring plans and begin development of revisions and updates to both the region-specific plans as well as the Integrated Comprehensive Monitoring Program. Discussions at that meeting as well as the following Navy and NMFS annual adaptive management meeting established a way ahead for continued refinement of the Navy's monitoring program. This process included establishing a Scientific Advisory Group of leading marine mammal scientists with the initial task of developing recommendations that would serve as the basis for a Strategic Planning Process 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 Letter of Authorization regulatory requirements.

The objective of the Strategic Planning Process 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 range complexes and testing ranges. The Strategic Planning Process must consider a range of factors in addition to the scientific recommendations including logistic, operational, and funding considerations and will be revised regularly as part of the annual adaptive management process.

Details on the Navy's marine species monitoring program including the ICMP and Strategic Planning Process can be found on the program's web portal – www.navymarinespeciesmonitoring.us.

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14. RESEARCH EFFORTS

The Navy strives to be a world leader in marine species research and has provided more than $100 million over the past 5 years to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to increase the understanding of marine species physiology and behavior with several projects ongoing in Washington.

The Navy sponsors 70 percent of all U.S. research concerning the effects of human-generated sound on marine mammals and 50 percent of such research conducted worldwide. Major topics of Navy-supported research include the following:

- Gaining a better understanding of marine species distribution and important habitat areas
- Developing methods to detect and monitor marine species before and during training
- Understanding the effects of sound on marine mammals
- Developing tools to model and estimate potential effects of sound

While dedicated research will not be conducted in conjunction with JLOTS training, the Navy has sponsored several workshops to evaluate the current state of knowledge and potential for future acoustic monitoring of marine mammals. The workshops brought together acoustic experts and marine biologists from the Navy and outside research organizations to present data and information on current acoustic monitoring research efforts and to evaluate the potential for incorporating similar technology and methods into Navy activities. The Navy supports research efforts on acoustic monitoring and will continue to investigate the feasibility of passive acoustics as a potential monitoring tool. Overall, the Navy will continue to research and contribute to university/external research to improve the state of the science regarding marine species biology and acoustic effects. These efforts include monitoring programs, data sharing with NMFS from research and development efforts, and future research as previously described.

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Appendix A

Fundamentals of Acoustics

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Bioacoustics, or the study of how sound affects living organisms, is a complex and interdisciplinary field that includes the physics of sound production and propagation, the source characteristics of sounds, and the perceptual capabilities of receivers. This appendix is intended to introduce the reader to the basics of sound measurements and sound propagation, as well as the hearing and vocal production abilities of species that may occur in the Joint Logistics Over-the-Shore (JLOTS) activity area. The potential for noise from pile driving to cause auditory masking to these species is also considered.

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.

Sound can be characterized by several factors, including frequency, intensity, and pressure (Richardson et al. 1995). Sound frequency (measured in hertz [Hz]) and intensity (amount of energy in a signal [Watts per meter^2]) are physical properties of the sound which are related to the subjective qualities of pitch and loudness (Kinsler et al. 1999). Sound intensity and sound pressure (measured in pascals [Pa]) are also related; of the two, sound pressure is easier to measure directly, and is therefore more commonly used to evaluate the amount of disturbance to the medium caused by a sound ("amplitude").

Because of the wide range of pressures and intensities encountered during measurements of sound, a logarithmic scale known as the decibel is used to evaluate these properties; in acoustics, "level" indicates a sound measurement in decibels. The decibel (dB) scale expresses the logarithmic strength of a signal (pressure or intensity) relative to a reference value of the same units. This document reports sound levels with respect to sound pressure only. Each increase of 20 dB reflects a ten-fold increase in signal pressure. In other words, an increase of 20 dB means ten times the pressure, 40 dB means one hundred times the pressure, 60 dB means one thousand times the pressure, and so on.

The sound levels in this document are given as sound pressure levels (SPL). For measurements of underwater sound, the standard reference pressure is 1 micropascal (µPa, or 10^{-6} pascals), and is expressed as "dB re 1µPa." For airborne sounds, the reference value is 20 µPa, expressed as "dB re 20 µPa." Sound levels measured in air and water are not directly comparable, and it is important to note which reference value is associated with a given sound level.

Airborne sounds are commonly referenced to human hearing using a method which weights sound frequencies according to measures of human perception, de-emphasizing very low and very high frequencies which are not perceived well by humans. This is called A-weighting, and the decibel level measured is called the A-weighted sound level (dBA). A similar method has been proposed for evaluating underwater sound levels with respect to marine mammal hearing. While preliminary weighting functions for marine mammal hearing have been developed (Southall et al. 2007), they are not yet applied to sound exposure from pile driving activities. Therefore, underwater sound levels given in this document are not weighted and evaluate all frequencies equally.

Table B-1 summarizes common acoustic terminology. Two of the most common descriptors are the instantaneous peak SPL and the root mean square SPL. The peak SPL is the instantaneous maximum or minimum over- or under-pressure observed during each sound event and is presented in dB re 1 µPa peak. The root mean square level is the square root of the energy divided by a defined time period, given as dB re 1 µPa root mean square.

Sound vs. Noise

Sound may be purposely created to convey information, communicate, or obtain information about the environment. Examples of such sounds are sonar pings, marine mammal vocalizations/echolocations, tones used in hearing experiments, and small sonobuoy explosions used for submarine detection.

Noise is undesired sound (American National Standards Institute 1994). Whether a sound is noise depends on the receiver (i.e., the animal or system that detects the sound). For example, small explosives and sonar used to locate an enemy submarine produce *sound* that is useful to sailors engaged in anti-submarine warfare, but is likely to be considered undesirable *noise* by marine mammals. Sounds produced by naval aircraft and vessel propulsion are considered noise because they represent possible energy inefficiency and increased detectability, which are undesirable.

Noise also refers to all sound sources that may interfere with detection of a desired sound and the combination of all of the sounds at a particular location (ambient noise).

Description of Noise Sources

Ambient noise in the vicinity of JLOTS training is a composite of sounds from natural sources, and typical recreational and enterprise activities such as boating, jet skiing, and military ship traffic. Ambient noise in the waters off JEB Little Creek-Fort Story and Camp Lejeune is addressed in Chapter 3.2, *Ambient Noise* of the Draft EA.

In-water construction activities associated with the ELCAS (M) FTX includes impact pile driving and vibratory extraction. The sounds produced by these activities fall into two sound types: impulsive (impact driving) and non-impulsive (vibratory extraction). Distinguishing between these two general sound types is important because of each sound type may cause different types of physical effects to marine species, particularly with regard to hearing (Ward 1997).

Table A-1: Definitions of Acoustical Terms

Term	**Definition**
Decibel [dB]	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure or intensity of the sound measured to the appropriate standard reference value. This document uses only sound pressure measurements to calculate decibel levels. The reference pressure for water is 1 micropascal (µPa) and for air is 20 µPa (approximate threshold of human audibility).
Sound Pressure Level [SPL]	Sound pressure is the force per unit area, usually expressed in micropascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. Sound pressure level is the quantity that is directly measured by a sound level meter, and is expressed in decibels referenced to the appropriate air or water standard.
Frequency, Hz	Frequency is expressed in terms of oscillations, or cycles, per second. Cycles per second are commonly referred to as hertz (Hz). Typical human hearing ranges from 20 Hz to 20,000 Hz; hearing ranges in non-humans are widely variable and species specific.
Peak Sound Pressure (unweighted), dB re 1µPa peak	The maximum absolute value of the instantaneous sound pressure expressed as dB re 1µPa peak.
Root Mean Square [rms], dB re 1µPa	The rms level is the square root of the pressure divided by a defined time period, expressed in decibels. For impulsive sounds, the rms has been defined as the average of the squared pressures over the time that comprise that portion of waveform containing 90 percent of the sound energy for one impact pile driving impulse. For non-impulsive sounds, rms energy represents the average of the squared pressures over the measurement period and is not limited by the 90 percent energy criterion. Expressed as dB re 1µPa.
Sound Exposure Level [SEL], dB re 1µPa^2 sec	Sound exposure level is a measure of energy. Specifically, it is the dB level of the time integral of the squared-instantaneous sound pressure, normalized to a 1-second period. It can be an extremely useful metric for assessing cumulative exposure because it enables sounds of differing duration to be compared in terms of total energy.
Waveforms, µPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of µPa over time (i.e., seconds).
Frequency Spectra, dB over frequency range	A graphical plot illustrating the frequency content over a given frequency range. Bandwidth is generally defined as linear (narrowband) or logarithmic (broadband) and is stated in frequency (Hz).

Term	Definition
A-Weighted Sound Level, dBA	A frequency-weighted measure used for airborne sounds only. A-weighting de-emphasizes the low and high frequency components of a given sound in a manner similar to the frequency response of the human ear and correlates well with subjective human reactions to noise. A-weighted levels are referenced to 20 µPa unless otherwise noted.
Ambient Noise Level	The background noise level, which is a composite of sounds from all sources near and far. The normal or existing level of environmental noise at a given location, given in dB referenced to the appropriate pressure standard.

Impulsive sounds (e.g., explosions, seismic airgun pulses, and impact pile driving) are brief, broadband, atonal transient sounds which can occur as isolated events or be repeated in some succession (Southall et al. 2007). Impulsive sounds are characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures (Southall et al. 2007). Impulsive sounds generally have a greater capacity to induce physical injury compared with sounds that lack these features (Southall et al. 2007).

Non-impulsive sounds can be tonal, broadband, or both. They lack the rapid rise time and can have longer durations than impulsive sounds. Non-impulsive sounds can be either intermittent or continuous sounds. Examples of non-impulsive sounds include vessels, aircraft, and machinery operations such as drilling, dredging, and vibratory pile driving (Southall et al. 2007).

In environments with non-porous boundaries (i.e., rock seafloor, rigid sides, etc.), reverberation may extend the duration of both impulsive and non-impulsive sounds.

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