NATIONAL MARINE FISHERIES SERVICE
ENDANGERED SPECIES ACT
BIOLOGICAL OPINION

Agency: National Marine Fisheries Service-Office of Protected Resources
Environmental Protection Agency
US Department of Transportation-Maritime Administration
Federal Energy Regulatory Commission

Activity Considered: Initiation of consultation concerning maintenance, repair, and operation of the Northeast Gateway Liquefied Natural Gas Deepwater Port and Algonquin Pipeline Lateral in Massachusetts Bay

NER/2013/10537

Conducted by: National Marine Fisheries Service
Greater Atlantic Regional Fisheries Office

Date Issued: 21 Nov 2014

Approved by: [signature] for John Bullard

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1.0 INTRODUCTION

Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq*.), requires that each Federal agency insure that any action authorized, funded, or carried out by such agency 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 the action of a Federal agency may affect species listed as endangered or threatened under the ESA, that agency is required to consult with either the National Marine Fisheries Service (NMFS) or U.S. Fish and Wildlife Service (USFWS), depending upon the species that may be affected. In instances where NMFS or USFWS are themselves authorizing, funding, or carrying out an action that may affect listed species, the agency must conduct an intra-service consultation. The National Marine Fisheries Service's Office of Protected Resources (NMFS PR) proposes to issue an Incidental Harassment Authorization (IHA) to Northeast Gateway Energy Bridge, L.P. (NEG) for the existing Northeast Gateway Deepwater Port, which is used for the import and regasification of liquefied natural gas (LNG) in Massachusetts Bay (79 FR 60142; October 6, 2014). Since actions described in this document are authorized by NMFS PR and may affect species listed by NMFS as threatened or endangered under the ESA, we are conducting a formal intra-service section 7 consultation.

The IHA, pursuant to section 101(a)(5)(D) of the Marine Mammal Protection Act of 1972 (MMPA), as amended (16 U.S.C. 1361 et seq.), would authorize the taking of marine mammals incidental to the operation, maintenance, and repair of the NEG LNG Port, as well as the associated Pipeline Lateral, which is owned and operated by Algonquin Gas Transmission, LLC (Algonquin). The IHA would be effective from November 1, 2014, through October 31, 2015.

Consultation History

Formal ESA section 7 consultation for the construction and operation of the NEG LNG and Algonquin Pipeline Lateral was initiated by the US Department of Transportation's Marine Administration (MARAD) on August 21, 2006 and completed by us on February 5, 2007 with the issuance of our Biological Opinion (Opinion) (F/NER/2006/04293). On November 15, 2007, NEG and Algonquin submitted a letter to NMFS requesting an extension for the LNG Port construction into December 2007. Upon reviewing NEG's weekly marine mammal monitoring reports submitted under the previous IHA, NMFS PR recognized that the potential take of some marine mammals resulting from the LNG Port and Pipeline Lateral by Level B behavioral harassment likely had exceeded the original take estimates. Therefore, NMFS Northeast Regional Office (now the Greater Atlantic Regional Fisheries Office (GARFO)) reinitiated consultation with MARAD and USCG on the construction and operation of the NEG LNG facility. On November 30, 2007, NMFS GARFO issued a new Opinion, reflecting the revised construction time period and including a new ITS (F/NER/2007/07653)). The Opinion concluded that project activities were likely to result in take of North Atlantic right *(Eubalaena glacialis),* humpback *(Megaptera novaeaengliae),* and fin *(Balaenoptera physalus)* whales in the form of harassment, but were not likely to jeopardize the continued existence of these species. A complete consultation history for this action is available in the Opinion dated November 30, 2007.

On January 18, 2013, NMFS PR received a request on behalf of NEG for a new IHA for the operation, maintenance, and repair of the NEG LNG Port and the associated Algonquin Pipeline Lateral in Massachusetts Bay. NMFS PR initiated formal consultation with us in a letter received on October 17, 2013 and issued the proposed IHA in the *Federal Register* on November 18, 2013. In February of 2014, NEG withdrew their IHA application in order to revise the acoustic monitoring plan that was included in the original IHA application. Following discussions with NMFS PR, Stellwagon Bank National Marine Sanctuary (SBNMS) and GARFO, NEG proposed a new monitoring plan, which necessitated the reissuance of the proposed IHA in the *Federal Register* on October 6, 2014 (79 FR 60142). This Opinion considers the effects of the updated action, which includes the revised acoustic monitoring plan.

In addition to NMFS PR, several federal agencies including the United States Maritime Administration (MARAD), the Environmental Protection Agency (EPA), and the Federal Energy Regulatory Commission (FERC) undertook actions to authorize operation, maintenance, and repair of the NEG LNG Port as well as the Pipeline Lateral. These agencies have agreed to be co-action agencies on this consultation; therefore, their activities will be considered as part of this Opinion. MARAD issued a license, pursuant to the Deepwater Port Act of 1974, for the construction and operation of the NEG LNG Port on May 14, 2007 (expires in 2032). The EPA issued a National Pollution Discharge Elimination System (NPDES) Permit (Permit No. MA0040266) on October 11, 2007, which is currently being modified due to the higher than anticipated levels of water withdrawal necessary for the operation of the vessels. FERC has issued a Natural Gas Act section 7(c) permit with a Certificate of Public Convenience and Necessity for the Algonquin Pipeline Lateral that connects the Port with the existing HubLine natural gas pipeline for transmission throughout New England (FERC Docket Number CP05-383-000).

In addition to the modification of the NPDES permit, the EPA is modifying the Outer Continental Shelf (OCS) Air Permit pursuant to the Clean Air Act that regulates the pollutants emitted from vessels during the maintenance, repair, and operation activities of the NEG Port facility. EPA conducted an analysis of NEG's modelling and found that despite the emissions increases, the emissions will not result in air quality exceeding National Ambient Air Quality Standards (NAAQS). Therefore, EPA has determined that the emissions authorized under the modification will not affect any listed species, and as we do not have any information to contradict this determination, the OCS air permit will not be considered further in this Opinion.

2.0 DESCRIPTION OF THE PROPOSED ACTION

NMFS PR proposes to issue an IHA pursuant to the MMPA to NEG to operate, maintain, and repair a LNG Deepwater Port in the federal waters of the Outer Continental Shelf (OCS), approximately 13 miles (21 km) south-southeast of Gloucester, Massachusetts in federal waters approximately 250-270 feet deep (76-82 meters). The Port consists of two submerged turret loading (STL) buoys separated by approximately one nautical mile, each capable of mooring an Energy Bridge Regasification Vessel (EBRV) custom designed to store, transport, and vaporize approximately 4.9 to 5.3 million cubic feet (138,000 to 151,000 cubic meters) of LNG.

Each buoy is anchored to the sea floor by eight suction anchors connected to wire rope and chain mooring lines. When not connected to an EBRV, the unloading buoys are submerged approximately 82 feet (25 meters) below the sea surface. When an EBRV arrives at the Port, the unloading buoy is retrieved and locked into position, after which the natural gas is vaporized and unloaded directly into a connecting pipeline and delivered to the northeast US market through the existing pipeline infrastructure. Algonquin operates the 24-inch (0.6 meter) diameter, 16.1 mile (26 kilometer) Pipeline Lateral that will connect the Port to the existing HubLine natural gas pipeline in Massachusetts Bay.

The dual buoy design allows natural gas to be delivered in a continuous flow without interruption by having a brief overlap between arriving and departing EBRVs. At full operation, the Port is designed to deliver a base load delivery of 400 million standard cubic feet per day (mmscfd), with a peak capacity of 800 mmscfd per day with two vessels simultaneously unloading natural gas. At the average capacity of 400 mmscfd per day, 65 EBRV roundtrips per year would be required to supply the Port with a continuous flow of LNG. This represents the maximum number of roundtrips that could occur in a given year at the NEG LNG Port, although as of 2014 substantially fewer trips have occurred. At this level of operation, however, one EBRV could moor at the Deepwater Port for approximately seven to eight days and, while it is concluding the unloading process, a second could attach to the unoccupied buoy and begin unloading. In this situation, both buoys could be occupied simultaneously approximately 10% of the time.

2.1. Port Operations

Vessel Activity

EBRVs calling at the NEG Port consist of both EBRVs owned and operated by NEG and vessels chartered under long-term contracts. Two bow thrusters and one stern thruster will provide improved maneuvering when approaching the buoys. As stated previously, 65 roundtrip EBRV transits would need to take place each year to supply a continuous flow of natural gas into the pipeline. EBRVs transiting to the NEG Port from cargo sources generally south of Gibraltar or coming north from areas such as Trinidad would most likely be traversing the Great South Channel right whale critical habitat area and would enter the Boston Traffic Separation Scheme (TSS) near the entry point of the TSS as soon as practicable. EBRVs transiting to the NEG Port from cargo sources in northern Europe or the Middle Eastern region will generally follow the Great Circle approach to North America. The most practical point at which the EBRVs might enter the Boston TSS will be in the Off Race Point area generally north of the point before the TSS angles to the southeast (Figure 1).

EBRVs carrying LNG typically travel at speeds up to 19.5 knots. However, NEG EBRVs currently reduce speed to 12 knots within the TSS year-round, and to a maximum of 10 knots from Apri1 1-July 31 in the Great South Channel (GSC) seasonal management area (SMA), January 1-May 15 in Cape Cod Bay, and from March 1-April 30 in the Off Race Point SMA.

Regasification System

Once an EBRV is connected to a buoy, the vaporization of LNG and send-out of natural gas can begin. The LNG is first pressurized using high pressure LNG pumps and is then injected into deck-mounted shell-and-tube vaporization units which would warm and vaporize the LNG to natural gas. Approximately 2.5% of the EBRV's LNG is used to fuel onboard natural gas-fired boilers, which produces steam to heat fresh water circulated through the shell-and-tube vaporizers in a closed-loop system. Each EBRV has six shell-and-tube vaporizers on board, with up to five typically in operation at any one time, with the sixth available as back up, or for use during peak demand.

Water withdrawal

Although no water intake or discharge is used for the regasification process, the normal water use requirements of NEG's fleet of EBRVs is approximately 56 million gallons per day (MGD) of intake at a rate of approximately 0.45 feet per second (fps). Of this volume, approximately 54 million gallons are used to support machinery cooling and the operation of the vessel's safety water curtain and then discharged. The remaining two million gallons are retained as ballast water and water to support crew needs (e.g., sanitary needs and potable water).

In an effort to make the Port more environmentally benign, NEG conceived of a process whereby EBRVs could reduce the need for intake and discharge of machinery cooling water and increase operational efficiency during regasification activities. This process has become known as the heat recovery system (HRS) mode of operation. In the HRS mode of operation, circulating water from the closed-loop regasification process is used to capture the heat generated by the ship's machinery to help warm and regasify the LNG passing through the shell-and-tube vaporizers. As this warmed water is circulated through the vaporizers around the LNG, it captures the cold from the LNG. This now cooled water is routed back to the vessel's machinery as its source of cooling water to prevent the machinery from overheating. When operating in the HRS mode, the flow rate required by the EBRVs to maintain safe operations can be reduced from the required intake and discharge rate of 56 MGD and 54 MGD, respectively, to an intake and discharge rate as low as 2.77 MGD and 0.87 MGD, because machinery cooling water is no longer required while in the HRS mode of operation.

EBRVs can only operate in the HRS mode when actively engaged in the regasification process, which takes approximately eight days to complete (EIS-EIR 2006). In the 2007 Opinion, it was believed that HRS could be achieved at a minimal natural gas send-out rate of approximately 150 mmscfd. Operations to date, however, have shown that the HRS mode of operation is not stable below 200 mmscfd. Below this 200 mmscfd send-out rate, there is not a sufficient amount of cooling capacity generated during the closed-loop regasification process to support the vessels' machinery cooling needs at the volume and intake rate necessary to ensure safe operation (56 MGD of intake at an intake rate of approximately 0.45 feet per second). Once the regasification process has begun, EBRVs can typically enter the HRS mode of operation within approximately four hours. The HRS system represents new technology to reduce water usage during regasification. To date no technology or modification to the HRS system has been identified that would allow for further reduction in water consumption at a lower regasification rate.

If the EBRV cannot maintain operation in the HRS mode, it must revert to the intake and discharge of water to support machinery cooling, which is critical to maintaining the safe operation of any vessel. The existing NPDES permit allows a daily volume of seawater discharge based on one four-hour period per day when the EBRV is not operating in HRS. This means that if a situation occurs whereby an EBRV cannot operate in the HRS mode for a period of more than four hours on any given day the vessel must leave the Port or face the risk of exceeding its NPDES Permit. Therefore, EPA has proposed to modify the NPDES permit to increase the amount of seawater withdrawal authorized per day.

Water Discharge

During the initial permitting process, NEG calculated the average daily discharge temperature from EBRVs based on activities associated with the commercial delivery of cargo and the ability of the EBRVs to engage the HRS mode of operation. Based upon this initial calculation, NEG estimated that the average change in temperature of discharge from each EBRV's main condenser cooling system and auxiliary cooling system would be approximately 2.6ºC and 5.5ºC (4.7ºF and 9.9ºF), respectively. The final EIS/EIR evaluated impacts to the surrounding environment based upon these calculated discharge temperatures. The EPA, in turn, set the daily maximum limits on temperature change in the Port's NPDES Permit to be consistent with the findings of the final EIS/EIR.

Based on three years of onboard monitoring, NEG has determined that actual changes in the temperature of machinery cooling water are governed by both the steam plant cooling water flow rate and the management of excess steam. Specifically, operations have revealed that as the flow rate of seawater to the main condenser decreases and/or the management of EBRV excess steam is required, the resulting temperature of the discharge water from the main condenser will increase. Based upon the range of activities that have occurred at the Port over the past three years that have the potential to affect the flow rate of EBRV machinery cooling water and the management of EBRV steam (e.g., safety, security, maintenance, repair and commissioning events), NEG has determined that the daily average change in temperature from ambient from an EBRV's main condenser cooling system ranged from approximately 4ºC to 12ºC (7.2ºF to 21.6ºF) depending on operating conditions. The daily average change in temperature of an EBRV from its auxiliary condenser cooling system remains consistent with what was described in the final EIS/EIR.

Because the change in temperature of EBRV discharge water is based on the operational need of the vessel and is beyond the direct control of NEG, they have been unable to conduct operations at the Port without exceeding the 2.6ºC (4.7ºF) threshold anticipated in the final EIS/EIR and the Port's NPDES Permit. Therefore, EPA has proposed to modify the NPDES permit to increase the daily average change in temperature to 12ºC above ambient.

2.2. Maintenance and Repair

Per the requirements of the MARAD License and Port Operations Manual, NEG must conduct weekly inspections of the Port by a support vessel, as well as annual inspections of the STL Buoy, flexible riser, mooring system, and pipeline end manifold (PLEM) by a remotely operated vehicle (ROV) and/or diver launched from a vessel of opportunity. These activities will consist of approximately 65 support vessel transits per year, which accounts for the 52 weekly inspections plus an additional 13 trips to provide support to the Port and EBRVs as necessary. Vessels used for repair and maintenance activities will be travelling from a local port between Quincy and Gloucester, Massachusetts. Regular maintenance activities typically are short in duration (several days or less) to perform and are only performed during daylight hours and during periods of good weather. The Pipeline Lateral is also inspected regularly in accordance with U.S. Department of Transportation requirements.

Routine maintenance activities are typically performed by small (vessels less than 300 gross tons) vessels. Such activities include attaching and detaching and/or cleaning the buoy pick up line to the STL buoy, performing surveys and inspections with a remotely operated vehicle, and cleaning or replacing parts (e.g., bulbs, batteries, etc.). NEG and/or Algonquin may also elect to run an intelligent pig (an internal inspection device) down the Pipeline Lateral to assess its condition. This particular activity will take place approximately every 10 years and will require an EBRV and several larger, construction-type vessels and may take several weeks to complete.

In addition to regularly scheduled maintenance activities, NEG needs to respond to unanticipated events at the Port and Pipeline Lateral that require urgent maintenance and/or repair activities. While proper care and maintenance of the NEG Port facilities should minimize the likelihood of an unanticipated maintenance and/or repair event, unanticipated activities may occur from time to time if facility components become damaged or malfunction. Unanticipated repairs may range from relatively minor activities requiring minimal equipment and one or two diver support vessels to major activities requiring larger construction-type vessels similar to those used to support the construction and installation of the facility.

Minor repair activities could include fixing flange or valve leaks, replacing faulty pressure transducers, or replacing the STL Buoy messenger line. This type of work would likely take a few hours to perhaps a few weeks depending on the nature of the repair. A dive vessel would likely be the main vessel used to support minor repair work. However, the type of diving spread and corresponding vessel (four-point anchor vessel or dynamically positioned [DP]) needed to support the spread would be dictated by the technical requirements of the repair work, the water depth at the work location, and the availability of vessels.

Major repair activities, although unlikely, may include repairing or replacement the Flexible Riser, STL Buoy, anchor chain(s), pipeline manifolds or a section of the Pipeline Lateral. As mentioned previously this type of work would likely require the use of large specialty construction vessels such as those used during the construction and installation of the NEG Port and Pipeline Lateral. The duration of a major unplanned activity would again depend upon the type of repair work involved. These types of major repair activities would require careful planning and coordination and could take a few weeks to several months to complete.

2.3. Minimization Measures

NMFS PR and NEG have proposed to incorporate several measures into the project design to minimize impacts on endangered species. Since this Opinion covers activities under the authority of several Federal agencies that issue permits for various portions of the operation, maintenance, and repair of the proposed NEG LNG Port, NMFS PR, as the lead Federal action agency, has proposed to incorporate impact minimization measures as part of the IHA. The proposed IHA includes a complete list of these measures. The primary minimization and monitoring measures include the following:

- All individuals onboard EBRV vessels and maintenance and repair vessels will be trained for marine mammal sighting and ship strike avoidance measures;
- Upon entering the TSS and areas where North Atlantic right whales are known to occur, observers will be posted to visually monitor for the presence of marine mammals within 2-miles of the EBRV vessels;
- Compliance with standard reporting requirements while within the North Atlantic Right Whale Mandatory Ship Reporting Area;
- Reducing speed to 12 knots within the TSS year-round, and to a maximum of 10 knots from Apri1-July 31 in the Great South Channel (GSC) seasonal management area (SMA), January 1-May 15 in Cape Cod Bay, and from March 1-April 30 in the Off Race Point SMA;
- If a marine mammal detection is reported by NAVTEX, NOAA Weather Radio, SAS and/or an acoustic monitoring buoy, the look-out shall concentrate visual monitoring efforts towards the areas of the most recent detection;
- Keeping all project vessels 500 yards away from North Atlantic right whales and 100 yards away from all other marine mammals to the extent possible;
- Ceasing any construction vessel movement and/or stop any noise emitting activities that exceed a source level of 139 dB re 1 μPa in the event that a North Atlantic right whale comes to within a distance of 500 yards from the source (or 100 yards from any whale other than a right whale). Repair and maintenance work may resume after the marine mammal is positively reconfirmed outside the established zones (500 or 100 yards) or 30 minutes have passed without a redetection.

2.3.1. Monitoring Activities

In addition to marine mammal observers on all vessels, NEG and Algonquin have used acoustic receivers to monitor for the presence of whale vocalizations in the vicinity of the Port. The NEG Port's MARAD/USCG License, NMFS's 2007 Opinion, ITS and, previous IHAs, as well as the National Marine Sanctuary Act (NMSA) Section 304 (d) Recommendations, required NEG to monitor the noise environment in Massachusetts Bay for five years during full operations in the vicinity of the Port and Pipeline Lateral using an array of 19 Marine Autonomous Recording Units (MARUs) (Figure 1). The MARUs were deployed in April 2007 to collect preconstruction and active construction data and were removed in July 2013, when NEG understood the five year monitoring period expired. The MARUs collected archival noise data and were not designed to provide real-time or near-real-time information about vocalizing whales. Rather, the acoustic data collected by the MARUs was analyzed to document the seasonal occurrences and overall distributions of whales (primarily fin, humpback and right whales) within approximately 10 nm of the NEG.

The overall intent of the MARU system was to provide better information for both regulators and the general public regarding the acoustic footprint associated with both construction and the long-term operation of the NEG Port and Pipeline Lateral in Massachusetts Bay, as well as the distribution of vocalizing marine mammals during NEG Port operation. The objective was to determine if full operation of the Port was having a negative effect on the movements and distribution of marine mammals in Massachusetts Bay. As the Port has not been in "full operation" as contemplated in the original authorizations (65 transits a year), NEG has proposed a modification to the monitoring plan such that the MARU array will only be deployed if the Port experiences a significant increase in activity (i.e. more than five shipments in a 30-day period, or more than twenty shipments over a six month period).

Under circumstances when the Port is not achieving this high level of operation, NEG has proposed to monitor noise levels produced by vessels as they operate within the Port area. The modeled underwater acoustic impacts presented in the proposed IHA rely primarily on estimated source levels derived from similar vessels and operations. This proposed monitoring plan will measure the actual sound levels that are introduced into the underwater environment, reducing any uncertainty associated with source levels used as modeling inputs for the analysis presented in the proposed IHA.

Underwater noise monitoring will be conducted to obtain a representative acoustic signature of vessel transit, docking, maintenance, onboard regasification operational scenarios, and maintenance activities. NEG will conduct the short-term passive acoustic monitoring to document sound levels during the initial operational event for the 2014-2015 heating season and for any deliveries that occur outside of the winter heating season. Additional monitoring will be conducted for any scheduled and unscheduled maintenance or repair activities that have potential to result in significant noise levels (i.e. DP thrusters).

Autonomous Marine Recording (AMAR) units will be deployed one day prior to the identified monitoring events and retrieved one day after these events, utilizing a vessel similar to that described for MARU deployment and retrieval. Information pertaining to forecasted delivery levels at or above the stated trigger will be provided to NEG in advance, giving adequate time for monitoring systems to be put in place prior to the first forecasted delivery event. The field monitoring program will be used to verify actual distances to thresholds and these values will be compared to the impact distances predicted from modeling.

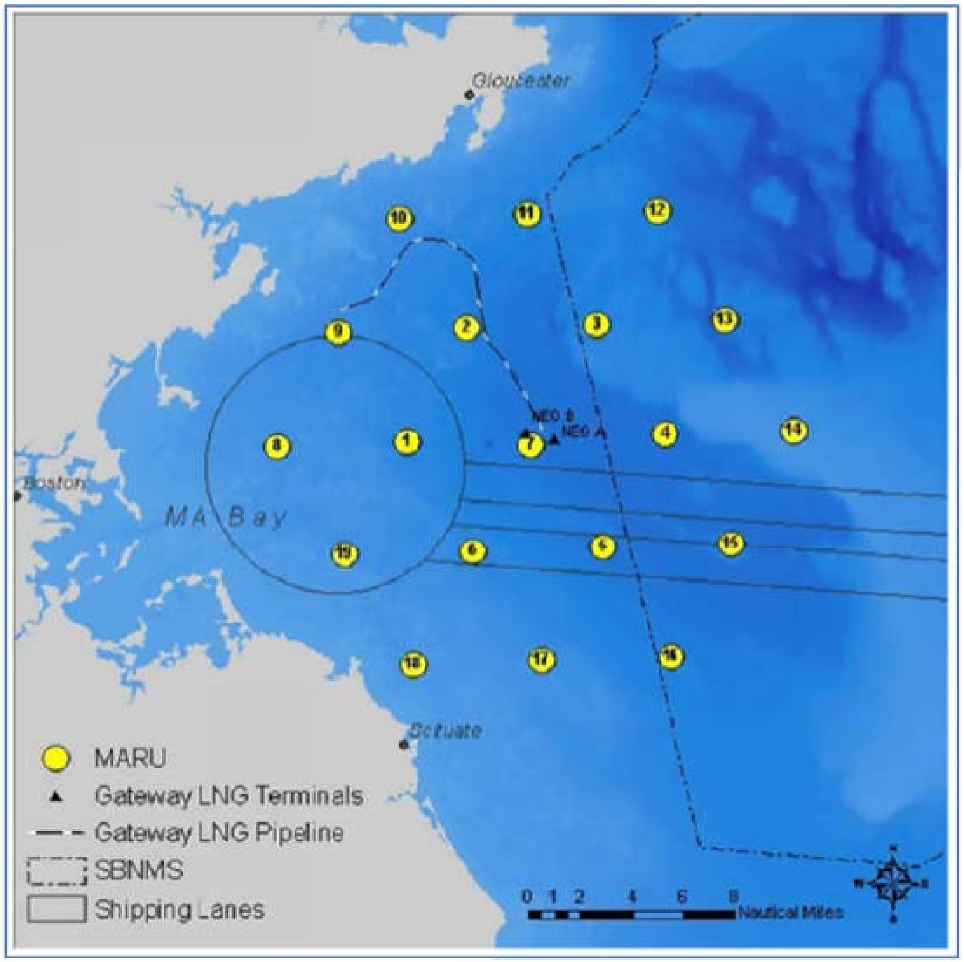

Figure 1. The location of 19 Marine Autonomous Recording Units (MARUs) that were deployed in Massachusetts Bay between 2007 and 2013 to detect whale vocalizations.

In addition to the source level monitoring discussed above, the proposed IHA requires NEG to deploy 10 auto-detection buoys (ABs) within the Separation Zone of the TSS for the operational life of the Project (Figure 2). The AB system shall be the primary detection mechanism that alerts the EBRV Master to the occurrence of right whales, heightens EBRV awareness, and triggers necessary mitigation actions as described above. Each AB continuously screens the low-frequency acoustic environment (less than 1,000 Hertz) for right whale contact calls occurring within an approximately five nautical mile radius from each buoy (the AB's detection range) and ranks detections on a scale from one to ten. Each AB transmits all detection data for detections of rank greater than or equal to six via Iridium satellite link to the Cornell server website every 20 minutes. The data collected from the AB buoys will be analyzed to document the seasonal occurrences and overall distributions of whales within 10 nm of the NEG Port and will measure and document the noise budget of Massachusetts Bay so as to eventually assist in determining whether or not an overall increase in noise in the Bay associated with the project might be having a potentially negative impact on marine mammals.

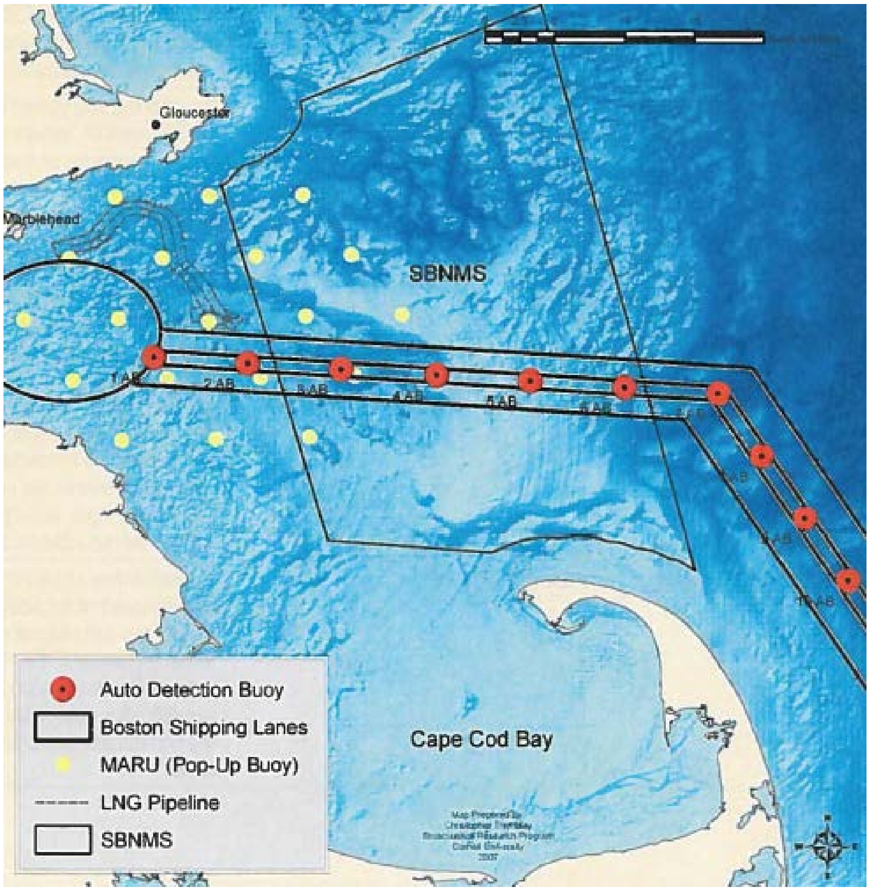

Figure 2. Location of the 10 auto-detection buoys (ABs) within the separation zone of the TSS in Massachusetts Bay.

2.4. Action Area

The action area is defined in 50 CFR 402.02 as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." The action area for this consultation consists of the two buoy sites, the pipeline route, and surrounding waters that will be ensonified by noise associated with Port activities. In addition, the action area of this consultation also consists of the vessel transit paths for all vessel traffic associated with the project, including the Boston TSS and the approaches to the TSS from the EBRVs point of entry into the US EEZ, as well as the route of construction vessel transits from local ports to the pipeline and Port sites. As described in Section 2.1, EBRVs transiting to the NEG port from cargo sources in northern Europe or the Middle Eastern region will generally follow the Great Circle approach to North America. The most practical point at which the EBRVs might enter the Boston TSS will be in the Off Race Point area generally north of the point before the TSS angles to the southeast. Figure 3 indicates the action area, which is delineated by the typical routes from Egypt and Trinidad, which represents the broadest probable range within which EBRVs may be transiting. The action area encompasses approximately 44,000 square miles.

The gas transmission pipeline begins at the existing HubLine pipeline approximately three miles east of Marblehead Neck, Massachusetts. From this point, the pipeline extends toward the northeast crossing the territorial waters of the town of Marblehead, the city of Salem, the city of Beverly, and the town of Manchester-by-the-Sea for approximately 6.1 miles (9.8 kilometers). The transmission line route continues to the southeast for approximately 4.8 miles (7.7 kilometers) crossing state and federal waters. This consultation considers all direct and indirect effects in this action area through the lifespan of the Project (i.e. the expiration of the MARAD license in 2032), or until such time a reinitiation trigger is met (see section 12).

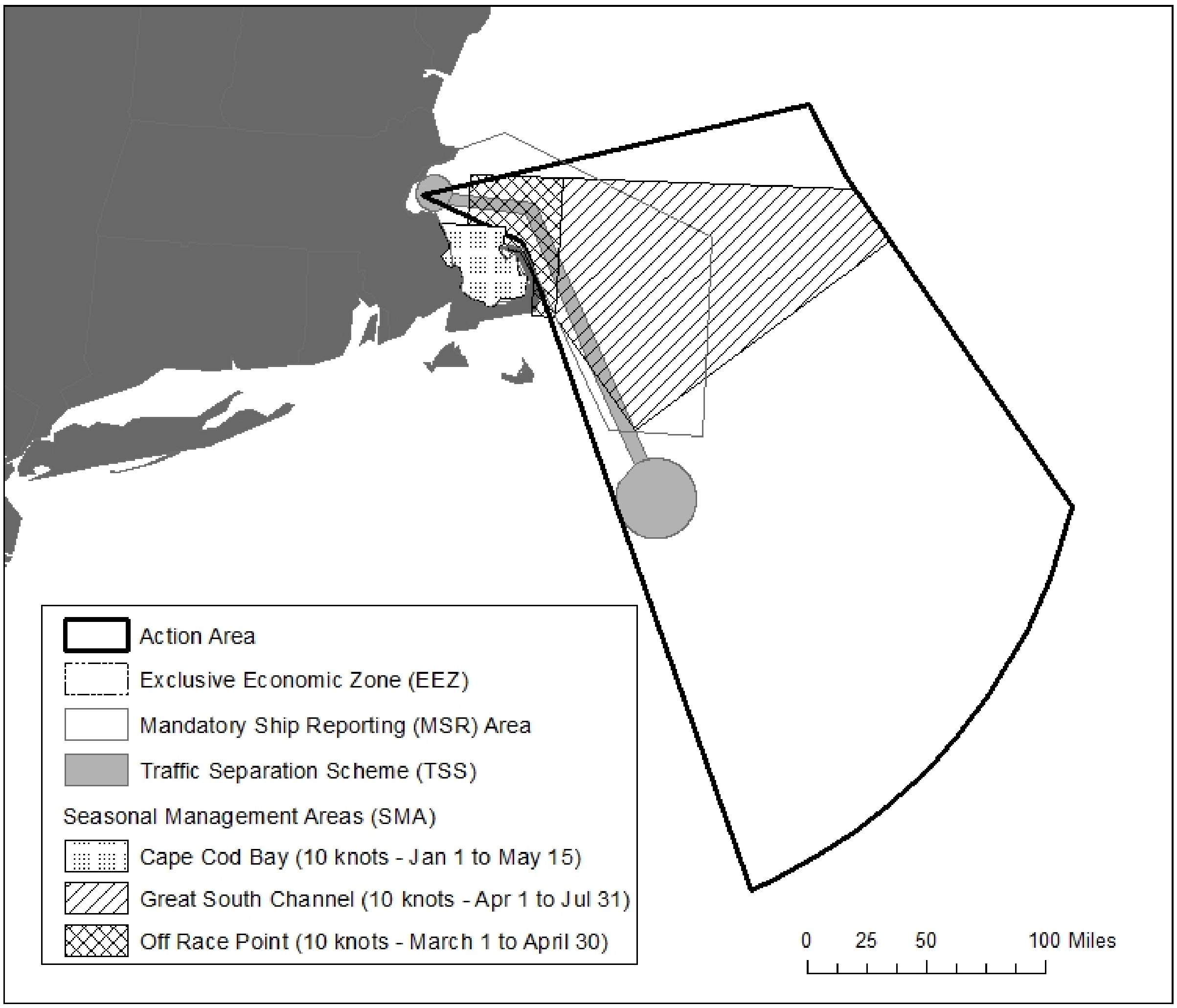

Figure 3. The action area for the proposed operation, maintenance and repair of the NEG LNG Port. The boundaries within the EEZ are based on the anticipated range of transit routes for vessels heading to the Port from Trinidad and Egypt.

3.0 LISTED SPECIES IN THE ACTION AREA

3.1. Listed species in the action area that will not be adversely affected by the action

We have determined that the actions being considered in the Opinion are not likely to adversely affect listed species of: Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus);*blue whale

(*Balaenoptera musculus*); sperm whale (*Physeter macrocephalus*); hawksbill sea turtles *(Eretmocheiys)*; green sea turtles (*Chelonia mydas*)*;* the NW Atlantic DPS of loggerhead sea turtles (*Caretta caretta*); Kemp's ridley sea turtles (*Lepidochelys kempii*); and leatherback sea turtles (*Dermochelys coriacea*). Below, we present our rationale for these determinations.

Hawksbill Sea Turtles

The EIS/EIR (2006) identifies the hawksbill turtle (*Eretmochelys imbricata*) as a listed species in the area. The hawksbill sea turtle is uncommon in the waters of the continental United States. Hawksbills prefer coral reefs, such as those found in the Caribbean and Central America. Hawksbills feed primarily on a wide variety of sponges but also consume bryozoans, coelenterates, and mollusks. The Culebra Archipelago of Puerto Rico contains especially important foraging habitat for hawksbills. Nesting areas in the western North Atlantic include Puerto Rico and the Virgin Islands. There are accounts of hawksbills in South Florida and individuals have been sighted along the East Coast as far north as Massachusetts, although sightings north of Florida are rare. Hawksbills occasionally have been found stranded as far north as Cape Cod, in the vicinity of the action area, but many of these strandings were observed after hurricanes or offshore storms. Based on this information, we have determined that hawksbill sea turtles are extremely unlikely to occur in the action area. As such, effects of the action on the species will be discountable will not be considered further in this Opinion.

Green, leatherback, Kemp's ridley, and loggerhead Sea Turtles

Effects of operation, maintenance, and repair of the NEG LNG Port on listed loggerhead, Kemp's ridley, leatherback, and green sea turtles were considered in the previous Opinion dated November 30, 2007. The Opinion concluded that construction and operation activities were not likely to adversely affect these species. The determination was based on the following conclusions; 1) although the physical disturbance of sediments and associated benthic resources from the port and pipeline sites could reduce the availability of sea turtle prey in the affected areas, the reductions would be localized and temporary, and that foraging turtles were not likely to be affected by the reductions, 2) interactions with sea turtles were extremely unlikely to occur during the transit of EBRVs to and from the NEG terminal, 3) interactions between sea turtles and construction vessels were extremely unlikely because construction vessels travel at speeds at or below ten knots, allowing fast moving sea turtles to avoid interactions and observers will be present watching for sea turtles present in the surrounding waters, and 4) sea turtles are extremely unlikely to be exposed to injurious or disturbing levels of sound from construction and operation noises.

Our 2007 Opinion indicated that the installation of the pipeline and the associated plowing and trenching activities were the activities that were most likely to affect sea turtles due to destruction of benthic prey resources and increased turbidity that might impact foraging success. The maintenance and repair work being considered as part of the action in this Opinion may involve limited excavation of portions of the pipeline, which will take place using diver-operated jetting or dredging tools. These activities will disturb the benthic environment and result in temporarily increased turbidity, but never on the scale of the initial pipeline installation. As indicated in the 2007 Opinion, NEG modelled that jetting activity for the initial pipeline installation could result in turbidity levels as high as 5,000-20,000 mg/L in the upper water column immediately above the jetting apparatus while jetting was ongoing. They also modelled that sediment concentrations would decrease to 500 mg/L in two hours, and 200 mg/L in three hours. Near background concentrations would be seen after 12 hours. As maintenance and repair work on the pipeline would be of a significantly smaller scale, it is anticipated that the resulting turbidity effects would be proportionally smaller. Sea turtles are known to be taken in hopper dredges, but are not likely to be impacted by hand-operated dredging equipment due to the much lower suction power and slower speed of hand-operated dredges. In addition, the dredge will be manipulated by a diver on the sea floor who will be able to maintain dredge contact with the sea floor and avoid any sea turtles in the path of the dredge.

In our 2007 Opinion, we determined that the proposed action was not likely to lead to additional vessel strikes of listed sea turtles. This was based on the fact that sea turtles are thought to avoid large LNG vessels, or else could be pushed out of the impact zone by prop wash or bow wake. Therefore, we anticipate that interactions with sea turtles, while possible, are extremely unlikely to occur during the transit of EBRVs to and from the NEG terminal. We also determined that interactions between sea turtles and maintenance and repair vessels are extremely unlikely as these vessels will be traveling at speeds at or below ten knots, which allows for fast moving sea turtles to avoid interactions. Satellite tracking studies of sea turtles in the Northeast found that turtles mainly occurred in areas where the water depth was between approximately 16 and 49 feet (Ruben and Morreale 1999). The water depth in the Port area is around 250 feet, and it gets deeper closer to the EEZ boundary. Although it is still possible that sea turtles can occur in the action area, we determined that the low speed and relatively small number of vessels, as well as the low likelihood of encountering a turtle, would lead to an undetectable increase in the number of ship collisions. The proposed maintenance and repair activities will increase the number of vessel transits between the NEG Port and the shore, but as these vessels will be operating under speed restrictions (10 knots or less), this increase should not lead to any effects that weren't considered in the 2007 Opinion.

In our 2007 Opinion, we considered the effects of Port operation and construction noise on listed sea turtles. Sea turtles are thought to be far less sensitive to sound than marine mammals. Although vessel and thruster noise are within the limited range of frequencies they can detect, evidence suggests that sound levels of 110-126 dB re 1 μ Pa are required before sea turtles can detect a sound (Ridgway 1969). McCauley (2000) noted that dB levels of 166 dB re 1 μ Pa were required before any behavioral reaction was observed. All project related noise sources were expected to diminish to below this threshold within very short distances. If a sea turtle was close enough to the sound source to detect noise at or above 166 dB re 1 μ Pa., it would swim away from the sound source. As such, we determined that sea turtles are not likely to be adversely affected by operational and construction noise. Maintenance and repair operations will not introduce any new sources of underwater noise not previously considered in the 2007 Opinion and we do not have any new information that calls into question the sound thresholds for effects on sea turtles used in the analysis in the 2007 Opinion. The 2007 Opinion, incorporated by reference herein, concluded that exposure to elevated levels of underwater noise was not likely to adversely affect any listed sea turtles, and this conclusion remains valid for this consultation. Therefore, these species will not be considered further in this Opinion.

Blue and Sperm Whale

LNG carrier transits to and from the Port during the course of operations are the only activities that have the potential to impact sperm and blue whales, as these species generally occur further offshore and are rare in the vicinity of the Port and Pipeline.

Our 2007 Opinion determined that the effect that the small number of project related vessel transits would have on the number of whales struck by vessels cannot be meaningfully measured, and is therefore, insignificant. The maintenance and repair activities associated with the proposed action will not add vessel transits in the area where blue and sperm whales would be anticipated to occur. The 2007 Opinion, incorporated by reference herein, concluded that the risk of vessel strike associated with the proposed number of EBRV transits a year (no more than 65) was insignificant, and this conclusion remains valid for this consultation.

The transit of an EBRV from its point of entry into the US EEZ to the Port site may expose whales along its path to potentially disturbing levels of noise. However, sperm and blue whales are only likely to be exposed to noise during a very limited portion of the EBRV transit through the action area due to their offshore distribution. In addition, because the vessel will be moving through the area, an individual sperm or blue whale within the ensonified field around the vessel would not be exposed to disturbing levels of sound throughout the entire transit of the vessel within the action area. The maximum pass by sound level of a EBRV travelling at 13 knots was measured during a monitoring event in the Gulf of Mexico. At 100 meters the maximum noise detected was 132 dB re 1 μPa (100 to 2,000 Hz) (Tetratech 2011). Although this noise level is well below the threshold for injury, it is possible that whales could be exposed to noise levels that could trigger a behavioral response. Although studies on sperm and blue whale responses to anthropogenic noise and vessel activity are very limited, responses similar to those witnessed in other whales have been documented (Gaskin 1964, Reeves 1992, Gordon *et al.* 1992, Lockyer 1981, in Richardson *et al.* 1995). Due to the limited potential for exposure, the moderate sound levels, and the limited duration of exposure, we determined that sperm and blue whales are not likely to be adversely affected by vessel noise associated with the NEG EBRV transits. Maintenance and repair operations will not introduce any new sources of underwater noise not previously considered in the 2007 Opinion and we do not have any new information that calls into question the sound thresholds for effects on whales used in the analysis in the 2007 Opinion. The 2007 Opinion, incorporated by reference herein, concluded that exposure to elevated levels of underwater noise was not likely to adversely affect blue and sperm whales, and this conclusion remains valid for this consultation. Therefore, these species will not be considered further in this Opinion.

Atlantic Sturgeon

The Atlantic sturgeon is a subspecies of sturgeon distributed along the eastern coast of North America from Hamilton Inlet, Labrador, Canada to Cape Canaveral, Florida, USA (Scott and Scott, 1988; ASSRT, 2007; T. Savoy, CT DEP, pers. comm.). NMFS has delineated U.S. populations of Atlantic sturgeon into five DPSs (77 FR 5880 and 77 FR 5914). These are: the Gulf of Maine, New York Bight, Chesapeake Bay, Carolina, and South Atlantic DPSs. After emigration from the natal estuary, subadults and adults travel within the marine environment, typically in waters less than 50 meters in depth, using coastal bays, sounds, and ocean waters (Vladykov and Greeley 1963; Murawski and Pacheco 1977; Dovel and Berggren 1983; Smith 1985; Collins and Smith 1997; Welsh *et al.* 2002; Savoy and Pacileo 2003; Stein *et al.* 2004a; Laney *et al.* 2007; Dunton *et al.* 2010; Erickson *et al.* 2011; Wirgin and King 2011). As the depth of the water in the Port area is76 to 82 meters, we do not anticipate that Atlantic sturgeon will be present in the area where repair and maintenance activities will be occurring; nor would they occur in the area through which the EBRVs will be transiting. However, as repair and maintenance vessels will be transiting to the NEG Port from ports along the Massachusetts coast, it is possible that the species could occur along the shallower portions of the vessels' transit paths. Since the noise levels produced by these vessels would be well below the thresholds for injury (206 dB re 1 μPa Peak and 187 dB re 1μPa^2-s cSEL) or behavioral modification (150 dB re 1 μPa RMS) for fish, there will not be any acoustic effects to the species.

Although there is limited information on vessels strikes and sturgeon, we know that sturgeon may be killed as a result of being struck by boat hulls or propellers. The factors relevant to determining the risk to these species from vessel strikes vary, but may be related to size and speed of the vessels, navigational clearance (i.e., depth of water and draft of the vessel) in the area where the vessel is operating, and the behavior of individuals in the area (e.g., foraging, migrating, etc.). Vessel strikes appear to result from interactions with large vessels, such as tankers, although some vessel strikes likely result from interactions with small recreational or commercial fishing vessels equipped with outboard motors (Brown and Murphy 2010).

Although there is a risk of vessel collision due to the proposed action, the number of vessel transits made by NEG maintenance and repair vessels (65 per year), will lead to only a minor increase in total vessel traffic within Massachusetts Bay. As discussed below, estimates of vessel transits in Massachusetts Bay exceed 58,000 annually. Given the less than 0.1% increase in vessel transits due to maintenance and repair activities, and as the vessels will be restricted to a speed of 10 knots or less, we anticipate that the proposed action would not lead to a detectable increase in vessel strikes of sturgeon in the action area. As all effects of the proposed action will be insignificant, Atlantic sturgeon will not be considered further in this Opinion.

Right Whale Critical Habitat

Critical habitat for right whales has been designated for Cape Cod Bay (CCB), Great South Channel (GSC), and coastal Florida and Georgia (outside of the action area). The habitat features identified in this designation include copepods (prey), and oceanographic conditions created by a combination of temperature and depth that are conducive for calving and nursing. Although a portion of right whale critical habitat overlaps with the action area (GSC portion of the Boston TSS), there is no evidence to suggest that maintenance, repair, and operation of the proposed LNG terminal would have any adverse effects on the habitat features in the specific areas designated as right whale critical habitat. Although water withdrawal and discharge may have an effect on the copepod distribution in the vicinity of the Port (see section 6.4), it is not anticipated that these effects will be detectable in the designated critical habitat, which is approximately 20 miles away at its closest point. The EBRV transit path is the only portion of the action that could occur in right whale critical habitat, and the transient passage of vessels will have no effect on copepod distribution. As effects of the proposed action will have no more than an insignificant effect on right whale critical habitat, it will not be considered further in this Opinion.

3.2. Listed species in the action area that may be adversely affected by the action

This section presents information on NMFS listed species in the action area that may be adversely affected by the proposed action and the biological and ecological information relevant to formulating the Biological Opinion. Information on each species' life history, its habitat and distribution, and other factors necessary for its survival are included to provide background for analyses in later sections of this Opinion.

The following endangered or threatened species under our jurisdiction are known to be present in the action area for this consultation, and may be adversely affected by the proposed action:

Cetaceans	
North Atlantic Right whale (*Eubalaena glacialis*)	Endangered
Humpback whale (*Megaptera novaeangliae*)	Endangered
Fin whale (*Balaenoptera physalus*)	Endangered
Sei whale (*Balaenoptera borealis*)	Endangered

3.2.1. North Atlantic Right Whale

Historically, right whales have occurred in all the world's oceans from temperate to subarctic latitudes (Perry *et al.* 1999). In both southern and northern hemispheres, they are observed at low latitudes and in nearshore waters where calving takes place in the winter months, and in higher latitude foraging grounds in the summer (Clapham *et al.* 1999; Perry *et al.* 1999).

The North Atlantic right whale (*Eubalaena glacialis*) has been listed as endangered under the ESA since 1973. Originally called the "northern right whale," it was listed as endangered under the Endangered Species Conservation Act, the precursor to the ESA in June 1970. The species is also designated as depleted under the MMPA.

In December 2006, we completed a comprehensive review of the status of right whales in the North Atlantic and North Pacific Oceans. Based on the findings from the status review, we concluded that right whales in the Northern Hemisphere exist as two species: North Atlantic right whale (*Eubalaena glacialis*) and North Pacific right whale (*Eubalaena japonica*). We determined that each of the species is in danger of extinction throughout its range. In 2008, based on the status review, we listed the endangered right whale (*Eubalaena spp.*) as two separate endangered species: the North Atlantic right whale (*E. glacialis*) and North Pacific right whale (*E. japonica*) (73 FR 12024; March 6, 2008).

The International Whaling Commission (IWC) recognizes two right whale populations in the North Atlantic: a western and eastern population (IWC 1986). It is thought that the eastern population migrated along the coast from northern Europe to northwest Africa. The current distribution and migration patterns of the eastern North Atlantic right whale population, if extant, are unknown. Sighting surveys from the eastern Atlantic Ocean suggest that right whales present in this region are rare (Best *et al.*, 2001) and it is unclear whether a viable population in the eastern North Atlantic still exists (Brown 1986, NMFS 1991a). Photoidentification work has shown that some of the whales observed in the eastern Atlantic were previously identified as western Atlantic right whales (Kenney 2002). This Opinion will focus on the western North Atlantic right whale (*Eubalaena glacialis*), which occurs in the action area.

Habitat and Distribution

Western North Atlantic right whales generally occur from the southeast U.S. to Canada (*e.g.*, Bay of Fundy and Scotian Shelf) (Kenney 2002; Waring *et al.* 2013). Like other right whale species, they follow an annual pattern of migration between low latitude winter calving grounds and high latitude summer foraging grounds (Perry *et al.* 1999; Kenney 2002).

The distribution of right whales seems linked to the distribution of their principal zooplankton prey, calanoid copepods (Winn *et al.* 1986; NMFS 2005a; Baumgartner and Mate 2005; Waring *et al.* 2012). Right whales are most abundant in Cape Cod Bay between February and April (Hamilton and Mayo 1990; Schevill *et al.* 1986; Watkins and Schevill 1982) and in the Great South Channel in May and June (Kenney *et al.* 1986; Payne *et al.* 1990; Kenney *et al.* 1995; Kenney 2001) where they have been observed feeding predominantly on copepods of the genera *Calanus* and *Pseudocalanus* (Baumgartner and Mate 2005; Waring *et al.* 2011). Right whales also frequent Stellwagen Bank and Jeffreys Ledge, as well as Canadian waters including the Bay of Fundy and Browns and Baccaro banks in the summer through fall (Mitchell *et al.* 1986; Winn *et al.* 1986; Stone *et al.* 1990). The consistency with which right whales occur in such locations is relatively high, but these studies also note high interannual variability in right whale use of some habitats. Calving is known to occur in the winter months in coastal waters off of Georgia and Florida (Kraus *et al.* 1988). Calves have also been sighted off the coast of North Carolina during winter months, suggesting the calving grounds may extend as far north as Cape Fear, NC. In the North Atlantic, it appears that not all reproductively active females return to the calving grounds each year (Kraus *et al.* 1986; Payne 1986). Patrician *et al.* (2009) analyzed photographs of a right whale calf sighted in the Great South Channel in June 2007 and determined the calf appeared too young to have been born in the known southern calving area. Although it is possible the female traveled south to New Jersey or Delaware to give birth, evidence suggests that calving in waters off the northeastern U.S. is possible.

The location of some portion of the population during the winter months remains unknown (NMFS 2005a). However, recent aerial surveys conducted under the North Atlantic Right Whale Sighting Survey (NARWSS) program have indicated that some individuals may reside in the northern Gulf of Maine during the winter. In 2008, 2009, 2010, and 2011, right whales were sighted on Jeffreys and Cashes Ledges, Stellwagen Bank, and Jordan Basin during December to February (Khan *et al.* 2009, 2010, 2011, 2012). Results from winter surveys and passive acoustic studies suggest that animals may be dispersed in several areas including Cape Cod Bay (Brown *et al.* 2002) and offshore waters of the southeastern U.S. (Waring *et al.* 2012). On multiple days in December 2008, congregations of more than 40 individual right whales were observed in the Jordan Basin area of the Gulf of Maine, leading researchers to believe this may be a wintering ground (NOAA 2008). Telemetry data have shown lengthy and somewhat distant excursions into deep water off the continental shelf (Mate *et al.* 1997) as well as extensive movements over the continental shelf during the summer foraging period (Mate *et al.* 1992; Mate *et al.* 1997; Bowman 2003; Baumgartner and Mate 2005). Knowlton *et al.* (1992) reported several long-distance movements as far north as Newfoundland, the Labrador Basin, and southeast of Greenland; in addition, resightings of photographically identified individuals have been made off Iceland, arctic Norway, and in the old Cape Farewell whaling ground east of Greenland. The Norwegian sighting (September 1999) is one of only two sightings in the 20th century of a right whale in Norwegian waters, and the first since 1926. Together, these long-range matches indicate an extended range for at least some individuals and perhaps the existence of important habitat areas not presently well described. Similarly, records from the Gulf of Mexico (Moore and Clark 1963; Schmidly *et al.* 1972) represent either geographic anomalies or a more extensive historic range beyond the sole known calving and wintering ground in the southeastern United States. The frequency with which right whales occur in offshore waters in the southeastern United States remains unclear (Waring *et al.* 2012).

Distribution in the action area

New England waters include important foraging habitat for right whales. At least some right whales are present in these waters throughout most months of the year, with concentrations observed in the Cape Cod Bay and Great South Channel critical habitat areas. Right whales are most abundant in Cape Cod Bay between February and April (Hamilton and Mayo 1990; Schevill *et al.* 1986; Watkins and Schevill 1982) and in the Great South Channel in May and June (Kenney *et al.* 1986; Payne *et al.* 1990) where they have been observed feeding predominantly on copepods, largely of the genera *Calanus* and *Pseudocalanus* (Waring *et al.* 2005). Right whales also frequent Stellwagen Bank and Jeffrey's Ledge, as well as Canadian waters including the Bay of Fundy and Browns and Baccaro Banks, in the spring and summer months. Recent data collected by passive acoustic buoys in the SBNMS indicate that right whales may use the sanctuary, particularly the northern portion, more heavily and over a broader range of seasons than previously thought (NEFSC unpublished data). Research suggests that right whales must locate and exploit extremely dense patches of zooplankton to feed efficiently (Mayo and Marx 1990). These dense zooplankton patches are thus likely a primary characteristic of the spring, summer, and fall right whale habitats (Kenney *et al.* 1986, 1995). The characteristics of acceptable prey distribution in these areas are not well known (Waring *et al.* 2005).

Abundance estimates and trends

An estimate of the pre-exploitation population size for the North Atlantic right whale is not available. As is the case with most wild animals, an exact count of North Atlantic right whales cannot be obtained. However, abundance can be reasonably estimated as a result of the extensive study of western North Atlantic right whale population. IWC participants from a 1999 workshop agreed to a minimum direct-count estimate of 263 right whales alive in 1996 and noted that the true population was unlikely to be much greater than this estimate (Best *et al.* 2001). Based on a census of individual whales using photo-identification techniques and an assumption of mortality for those whales not seen in seven years, a total of 299 right whales was estimated in 1998 (Kraus *et al.* 2001), and a review of the photo-ID recapture database on October 29, 2012 indicated that 455 individually recognized whales were known to be alive during 2010 (Waring *et al.* 2014).

This number represents a minimum population size. The minimum number alive population index for the years 1990-2010 suggests a positive and slowly accelerating trend in population size. These data reveal a significant increase in the number of catalogued whales with a geometric mean growth rate for the period of 2.8% (Waring *et al.* 2014).

A total of 338 right whale calves were born from 1993 to 2011 (Waring *et al.* 2014). The mean calf production for this 19-year period is estimated to be 17.8/year (Waring *et al.* 2014). Calving numbers have been variable, with large differences among years, including a second largest calving season in 2000/2001 with 31 right whale births (Waring *et al.* 2014). The three calving years (97/98; 98/99; 99/00) prior to this record year provided low recruitment levels with only 11 calves born. The 2000-2011 calving seasons were remarkably better with 31, 21, 19, 17, 28, 19, 23, 23, 39, 19, and 22 births, respectively (Waring *et al.* 2014). However, the western North Atlantic stock has also continued to experience losses of calves, juveniles, and adults.

As is the case with other mammalian species, there is an interest in monitoring the number of females in this western North Atlantic right whale population since their numbers will affect the population trend (whether declining, increasing or stable). Kraus *et al.* (2007) reported that, as of 2005, 92 reproductively-active females had been identified, and Schick *et al.* (2009) estimated 97 breeding females. From 1983 to 2005, the number of new mothers recruited to the population (with an estimated age of 10 for the age of first calving), varied from 0-11 each year with no significant increase or decline over the period (Kraus *et al.* 2007). By 2005, 16 right whales had produced at least six calves each, and four cows had at least seven calves. Two of these cows were at an age that indicated a reproductive life span of at least 31 years (Kraus *et al.* 2007). As described above, the 2000/2001-2006/2007 calving seasons had relatively high calf production and have included several first time mothers (*e.g.*, eight new mothers in 2000/2001). However, over the same time period, there have been continued losses to the western North Atlantic right whale population, including the death of mature females, as a result of anthropogenic mortality (like that described in Henry *et al.* 2011, below). Of the 12 serious injuries and mortalities in 2005-2009, at least six were adult females, three of which were carrying near-term fetuses and four of which were just starting to bear calves (Waring *et al.* 2011). Since the average lifetime calf production is 5.25 calves (Fujiwara and Caswell 2001), the deaths of these six females represent a loss of reproductive potential of as many as 32 animals. However, it is important to note that not all right whale mothers are equal with regards to calf production. Right whale #1158 had only one recorded calf over a 25-year period (Kraus *et al.* 2007). In contrast, one of the largest right whales on record, "Stumpy," as a prolific breeder, successfully rearing calves in 1980, 1987, 1990, 1993, and 1996 (Moore *et al.* 2007). Stumpy was killed in February 2004 of an apparent ship strike (NMFS 2006a). At the time of her death, she was estimated to be 30 years of age and carrying her sixth calf; the near-term fetus also died (NMFS 2006a).

Abundance estimates are an important part of assessing the status of the species. However, for section 7 purposes, the population trend (*i.e.,* whether increasing or declining) provides better information for assessing the effects of a proposed action on the species. As described in previous Opinions, data collected in the 1990s suggested that right whales were experiencing a slow but steady recovery (Knowlton *et al.* 1994). However, Caswell *et al.* (1999) used photo-identification data and modeling to estimate survival and concluded that right whale survival decreased from 1980 to 1994. Modified versions of the Caswell *et al.* (1999) model as well as several other models were reviewed at the 1999 IWC workshop (Best *et al.* 2001). Despite differences in approach, all of the models indicated a decline in right whale survival in the 1990s with female survival particularly affected (Best *et al.* 2001). In 2002, NMFS NEFSC hosted a workshop to review right whale population models to examine: (1) potential bias in the models, and (2) changes in the subpopulation trend based on new information collected in the late 1990s (Clapham *et al.* 2002). Three different models were used to explore right whale survivability and to address potential sources of bias. Although biases were identified that could negatively affect the results, all three modeling techniques resulted in the same conclusion: survival had continued to decline according to these three models and seemed to be affecting females disproportionately (Clapham *et al.* 2002). Increased mortalities in 2004 and 2005 were cause for serious concern (Kraus *et. al* 2005). Calculations indicate that this increased mortality rate would reduce population growth by approximately 10% per year (Kraus *et. al* 2005), in conflict with the 2.8% positive trend from 1990-2010 noted above by Waring *et al.* (2014). Despite the preceding, examination of the minimum number alive population index calculated from the individual sightings database for the years 1990-2010 suggest a positive and slowly accelerating trend in population size (Waring *et al.* 2014). These data reveal a significant increase in the number of catalogued right whales alive during this period (Waring *et al.* 2014). As described above, the mean growth rate estimated in the latest stock assessment report was 2.8% (Waring *et al.* 2014).

Reproduction

Healthy reproduction is critical for the recovery of the North Atlantic right whale (Kraus *et al.* 2007). Researchers have suggested that the population has been affected by a decreased reproductive rate (Best *et al.* 2001; Kraus *et al.* 2001). Kraus *et al.* (2007) reviewed reproductive parameters for the period 1983-2005, and estimated calving intervals to have changed from 3.5 years in 1990 to more than five years between 1998-2003, and then decreased to just over three years in 2004 and 2005.

Factors that have been suggested as affecting the right whale reproductive rate include reduced genetic diversity (and/or inbreeding), contaminants, biotoxins, disease, and nutritional stress. Although it is believed that a combination of these factors is likely affecting right whales (Kraus *et al.* 2007), there is currently no evidence to support this. The dramatic reduction in the North Atlantic right whale population due to commercial whaling may have resulted in a loss of genetic diversity that could affect the ability of the current population to successfully reproduce (*i.e.*, decreased conceptions, increased abortions, and increased neonate mortality). One hypothesis is that the low level of genetic variability in this species produces a high rate of mate incompatibility and unsuccessful pregnancies (Frasier *et al.* 2007). Analyses are currently underway to assess this relationship further and to examine the influence of genetic characteristics on the potential for species recovery (Frasier *et al.* 2007). Studies by Schaeff *et al.* (1997) and Malik *et al.* (2000) indicate that western North Atlantic right whales are less genetically diverse than southern right whales. Similarly, while contaminant studies have confirmed that right whales are exposed to and accumulate contaminants, researchers could not conclude that these contaminant loads were negatively affecting right whale reproductive success since PCB and DDT concentrations were lower than those found in other affected marine mammals (Weisbrod *et al.* 2000). Another suite of contaminants (i.e. antifouling agents and flame retardants) that disrupt reproductive patterns and have been found in other marine animals, raises new concerns (Kraus *et* *al.* 2007). Recent data also support a hypothesis that chromium, an industrial pollutant, may be a concern for the health of the North Atlantic right whales and that inhalation may be an important exposure route (Wise *et al.* 2008).

A number of diseases could be also affecting reproduction, although tools for assessing disease factors in free-swimming large whales currently do not exist (Kraus *et al.* 2007). Once developed, such methods may allow for the evaluation of diseases on right whales. Impacts of biotoxins on marine mammals are also poorly understood, yet there is some data showing that marine algal toxins may play significant roles in mass mortalities of large whales (Rolland *et al.* 2007). Although there are no published data concerning the effects of biotoxins on right whales, researchers conclude that right whales are being exposed to measurable quantities of paralytic shellfish poisioning (PSP) toxins and domoic acid via trophic transfer from their prey upon which they feed (Durbin *et al.* 2002, Rolland *et al.* 2007).

Data on food-limitation are difficult to evaluate (Kraus *et al.* 2007). North Atlantic right whales seem to have thinner blubber than right whales from the South Atlantic (Kenney 2002; Miller *et al.* (2011). Miller *et al.* (2011) suggests that lipids in the blubber are used as energetic support for reproduction in female right whales. In the same study, blubber thickness was also compared among years of differing prey abundances. During a year of low prey abundance, right whales had significantly thinner blubber than during years of greater prey abundance. The results suggest that blubber thickness is indicative of right whale energy balance and that the marked fluctuations in the North Atlantic right whale reproduction have a nutritional component (Miller *et al.* (2011)).

Modeling work by Caswell *et al.* (1999) and Fujiwara and Caswell (2001) suggests that the North Atlantic Oscillation (NAO), a naturally occurring climatic event, affects the survival of mothers and the reproductive rate of mature females, and Clapham et al (2002) also suggests it affects calf survival. Greene *et al.* (2003) described the potential oceanographic processes linking climate variability to reproduction of North Atlantic right whales. Climate-driven changes in ocean circulation have had a significant impact on the plankton ecology of the Gulf of Maine, including effects on *Calanus finmarchicus*, a primary prey resource for right whales. Researchers found that during the 1980s, when the NAO index was predominately positive, *C. finmarchicus* abundance was also high; when a record drop occurred in the NAO index in 1996, *C. finamarchicus* abundance levels also decreased significantly. Right whale calving rates since the early 1980s seem to follow a similar pattern, where stable calving rates were noted from 1982-1992, but then two major, multi-year declines occurred from 1993 to 2001, consistent with the drops in copepod abundance. It has been hypothesized that right whale calving rates are a function of both food availability and the number of females available to reproduce (Greene *et al.* 2003; Greene and Pershing 2004). Such findings suggest that future climate change may emerge as a significant factor influencing the recovery of right whales. Some believe the effects of increased climate variability on right whale calving rates should be incorporated into future modeling studies so that it may be possible to determine how sensitive right whale population numbers are to variable climate forcing (Greene and Pershing 2004).

Anthropogenic Mortality

The potential biological removal (PBR)[1] for the Western Atlantic stock of North Atlantic right whale is 0.9 (Waring *et al.* 2014). Right whale recovery is negatively affected by anthropogenic mortality. From 2007 to 2011, right whales had the highest proportion relative to their population of reported entanglement and ship strike events of any species (Waring *et al.* 2014). Given the small population size and low annual reproductive rate of right whales, human sources of mortality may have a greater effect on population growth rate than for other large whale species (Waring *et al.* 2014). For the period 2007-2011, the annual human-caused mortality and serious injury rate for the North Atlantic right whale averaged 4.75 per year (Waring *et al.* 2014). This is derived from two components: 1) incidental fishery entanglement records at 3.25 per year and 2) ship strike records at 0.8 per year. These numbers represent the minimum values for serious injury and mortality for this period. Given the range and distribution of right whales in the North Atlantic, and the fact that positively buoyant species like right whales may become negatively buoyant if injury prohibits effective feeding for prolonged periods, it is highly unlikely that all carcasses will be observed (Moore *et. al.* 2004; Glass *et al.* 2009). Moreover, carcasses floating at sea often cannot be examined sufficiently and may generate false negatives if they are not towed to shore for further necropsy (Glass *et al.* 2009). Decomposed and/or unexamined animals represent lost data, some of which may relate to human impacts (Waring *et al.* 2012).

Considerable effort has been made to examine right whale carcasses for the cause of death (Moore *et al.* 2004). Examination is not always possible or conclusive because carcasses may be discovered floating at sea and cannot be retrieved, or may be in such an advanced stage of decomposition that a complete examination is not possible. Wave action and post-mortem predation by sharks can also damage carcasses, and preclude a thorough examination of all body parts. It should be noted that mortality and serious injury event judgments are based upon the best available data and later information may result in revisions (Henry *et al.* 2012). Of the 6 total confirmed right whale mortalities (2007-2011) described in Waring *et al.* (2014), four were confirmed to be entanglement mortalities and two were confirmed to be ship strike mortalities. Serious injury involving right whales was documented for ten entanglement events and two ship strike events. In three of the entanglement cases, the fate of the animals were unknown.

Although disentanglement is often unsuccessful or not possible for many cases, there are several documented cases of entanglements for which the intervention of disentanglement teams averted a likely serious injury (Waring *et al.* 2014). Even when entanglement or vessel collision does not cause direct mortality, it may weaken or compromise an individual so that subsequent injury or death is more likely (Waring *et. al* 2014). Some right whales that have been entangled were later involved in ship strikes (Hamilton *et al.* 1998) suggesting that the animal may have become debilitated by the entanglement to such an extent that it was less able to avoid a ship. Similarly, skeletal fractures and/or broken jaws sustained during a vessel collision may heal, but then compromise a whale's ability to efficiently filter feed (Moore *et al.* 2007). A necropsy of right whale #2143 ("Lucky") found dead in January 2005 suggested the animal (and her near-term fetus) died after healed propeller wounds from a ship strike re-opened and became infected as a result of pregnancy (Moore *et al.* 2007, Glass *et al.* 2008). Sometimes, even with a successful

1 Potential biological removal is the product of minimum population size, one-half the maximum net productivity rate and a "recovery" factor for endangered, depleted, threatened stocks, or stocks of unknown status relative to optimum sustainable population.

disentanglement, an animal may die of injuries sustained by fishing gear (e.g. RW #3107) (Waring *et al.* 2014).

Whales often free themselves of gear following an entanglement event, and as such, scarification analysis of living animals may provide better indications of fisheries interactions rather than entanglement records (Waring *et al.* 2014). A review of scars on identified individual right whales over a period of 30 years (1980–2009) documented 1,032 definite, unique entanglements events on the 626 individual whales identified (Knowlton et al. 2012). Most individual whales (83%) were entangled at least once, and almost half of them (306 of 626) were definitely entangled more than once. About a quarter of the individuals identified in each year (26%) were entangled in that year. Juveniles and calves were entangled at higher rates than were adults. Based on photographs of catalogued animals from 1935 through 1995, Hamilton *et al.* (1998) estimated that 6.4% of the North Atlantic right whale population exhibits signs of injury from vessel strikes.

Right whales are expected to be affected by climate change; however, no significant climate change-related impacts to right whales have been observed to date. The impact of climate change on cetaceans is likely to be related to changes in sea temperatures, potential freshening of sea water due to melting ice and increased rainfall, sea level rise, the loss of polar habitats, and the potential decline of forage.

The North Atlantic right whale currently has a range of sub-polar to sub-tropical waters. An increase in water temperature would likely result in a northward shift of range, with both the northern and southern limits moving poleward. The northern limit, which may be determined by feeding habitat and the distribution of preferred prey, may shift to a greater extent than the southern limit, which requires ideal temperature and water depth for calving. This may result in an unfavorable effect on the North Atlantic right whale due to an increase in the length of migrations (MacLeod 2009) or a favorable effect by allowing them to expand their range.

The indirect effects to right whales that may be associated with sea level rise are the construction of sea-wall defenses and protective measures for coastal habitats, which may impact coastal marine species and may interfere with migration (Learmonth *et al.* 2006). The effect of sea level rise to cetaceans is likely negligible.

The direct effects of increased CO_2 concentrations, and associated decrease in pH (ocean acidification), on marine mammals are unknown (Learmonth *et al.* 2006). Marine plankton is a vital food source for many marine species. Studies have demonstrated adverse impacts from ocean acidification on the ability of free-swimming zooplankton to maintain protective shells as well as a reduction in the survival of larval marine species. A decline in marine plankton could have serious consequences for the marine food web.

Summary of North Atlantic Right Whale Status

In March 2008, NMFS listed the North Atlantic right whale as a separate, endangered species (*Eubalaena glacialis*) under the ESA. This decision was based on an analysis of the best scientific and commercial data available, taking into consideration current population trends and abundance, demographic risk factors affecting the continued survival of the species, and ongoing conservation efforts. NMFS determined that the North Atlantic right whale is in danger of extinction throughout its range because of: (1) overuse for commercial, recreational, scientific, or educational purposes; (2) the inadequacy of existing regulatory mechanisms; and (3) other natural and manmade factors affecting its continued existence.

Previous models estimated that the right whale population in the Atlantic numbered 300 (+/- 10%) (Best *et al.* 2001). However, an October 2012 review of the photo-ID recapture database indicated that 455 individually recognized right whales were known to be alive in 2010 (Waring *et al.* 2014). The 2000/2001-2010/2011 calving seasons had relatively high calf production (31, 21, 19, 17, 28, 19, 23, 23, 39, 19, and 22 calves, respectively) and included additional first time mothers (*e.g.*, eight new mothers in 2000/2001) (Waring *et al.* 2009, 2014).

Over the five-year period 2007-2011, the annual human-caused mortality and serious injury rate for the North Atlantic right whale averaged 4.75 per year (Waring *et al.* 2014). This represents an absolute minimum number of the right whale serious injury and mortalities for this period. Given the range and distribution of right whales in the North Atlantic, it is highly unlikely that all carcasses will be observed. Scarification analysis indicates that some whales do survive encounters with ships and fishing gear. However, the long-term consequences of these interactions are unknown. Right whales are adversely affected by human causes of mortality. This mortality appears to have a greater impact on the population growth rate of right whales, compared to other baleen whales in the western North Atlantic, given the small population size and low annual reproductive rate of right whales (Waring *et al.* 2014).

A variety of modeling exercises and analyses indicate that survival probability declined in the 1990s (Best *et al.* 2001), and mortalities in 2004-2005, including a number of adult females, also suggested an increase in the annual mortality rate (Kraus *et al.* 2005). Nonetheless, a census of the minimum number alive population index calculated from the individual sightings database as of October 29, 2012 for the years 1990-2010 suggest a positive trend in numbers of right whales (Waring *et al.* 2014). In addition, calving intervals appear to have declined to three years in recent years (Kraus *et al.* 2007), and calf production has been relatively high over the past several seasons.

3.2.2. Humpback Whale

Humpback whales inhabit all major ocean basins from the equator to subpolar latitudes. With the exception of the northern Indian Ocean population, they generally follow a predictable migratory pattern in both southern and northern hemispheres, feeding during the summer in the higher near-polar latitudes and migrating to lower latitudes in the winter where calving and breeding takes place (Perry *et al.* 1999). Humpbacks are listed as endangered under the ESA at the species level and are considered depleted under the MMPA. Therefore, information is presented below regarding the status of humpback whales throughout their range.

North Pacific, Northern Indian Ocean, and Southern Hemisphere

Humpback whales in the North Pacific feed in coastal waters from California to Russia and in the Bering Sea. They migrate south to wintering destinations off Mexico, Central America, Hawaii, southern Japan, and the Philippines (Carretta *et al.* 2011). Although the IWC only considered one stock (Donovan 1991) there is evidence to indicate multiple populations migrating between their summer/fall feeding areas to winter/spring calving and mating areas within the North Pacific Basin (Angliss and Outlaw 2007, Carretta *et al.* 2011).

We recognize three management units within the U.S. EEZ in the Pacific for the purposes of managing this species under the MMPA. These are: the California-Oregon-Washington stock (feeding areas off the U.S. west coast), the central North Pacific stock (feeding areas from Southeast Alaska to the Alaska Peninsula) and the western North Pacific stock (feeding areas from the Aleutian Islands, the Bering Sea, and Russia) (Carretta *et al.* 2011). Because fidelity appears to be greater in feeding areas than in breeding areas, the stock structure of humpback whales is defined based on feeding areas (Carretta *et al.* 2011). Recent research efforts via the Structure of Populations, Levels of Abundance, and Status of Humpback Whales (SPLASH) Project estimate the abundance of humpback whales to be just under 20,000 whales for the entire North Pacific, a number that doubles previous population predictions (Calambokidis *et al.* 2008). There are indications that the California-Oregon-Washington stock was growing in the 1980s and early 1990s, with a best estimate of 8% growth per year (Carretta *et al.* 2011). The best available estimate for the California-Oregon-Washington stock is 2,043 whales (Carretta *et al.* 2011). The central North Pacific stock is estimated at 4,005 (Allen and Angliss 2011), and various studies report that it appears to have increased in abundance at rates between 6.6%-10% per year (Allen and Angliss 2011). Although there is no reliable population trend data for the western North Pacific stock, as surveys of the known feeding areas are incomplete and many feeding areas remain unknown, minimum population size is currently estimated at 732 whales (Allen and Angliss 2011).

The Northern Indian Ocean population of humpback whales consists of a resident stock in the Arabian Sea, which apparently does not migrate (Minton *et al.* 2008). The lack of photographic matches with other areas suggests this is an isolated subpopulation. The Arabian Sea subpopulation of humpback whales is geographically, demographically, and genetically isolated, residing year-round in sub-tropical waters of the Arabian Sea (Minton *et al.* 2008). Although potentially an underestimate due to small sample sizes and insufficient spatial and temporal coverage of the population's suspected range, based on photo-identification, the abundance estimate off the coast of Oman is 82 animals [60-111 95% confidence interval (CI)](Minton *et al.* 2008).

The Southern Hemisphere population of humpback whales is known to feed mainly in the Antarctic, although some have been observed feeding in the Benguela Current ecosystem on the migration route west of South Africa (Reilly *et al.* 2008). The IWC Scientific Committee recognizes seven major breeding stocks, some of which are tentatively further subdivided into substocks. The seven major breeding stocks, with their respective breeding ground estimates in parenthesis, include Southwest Atlantic (6,251), Southeast Atlantic (1,594), Southwestern Indian Ocean (5,965), Southeastern Indian Ocean (10,032), Southwest Pacific (7,472), Central South Pacific (not available), and Southeast Pacific (2,917) (Reilly *et al.* 2008). The total abundance estimate of 36,600 humpback whales for the Southern Hemisphere is negatively biased due to no available abundance estimate for the Central South Pacific subpopulation and only a partial estimate for the Southeast Atlantic subpopulation. Additionally, these abundance estimates have been obtained on each subpopulation's wintering grounds, and the possibility exists that the entire population does not migrate to the wintering grounds (Reilly *et al.* 2008).

Like other whales, Southern Hemisphere humpback whales were heavily exploited for commercial whaling. Although they were given protection by the IWC in 1963, Soviet-era whaling data made available in the 1990s revealed that 48,477 Southern Hemisphere humpback whales were taken from 1947 to 1980, contrary to the original reports to the IWC which accounted for the take of only 2,710 humpbacks (Zemsky *et al.* 1995; IWC 1995; Perry *et al.* 1999).

Gulf of Maine (North Atlantic)

Humpback whales from most Atlantic feeding areas calve and mate in the West Indies and migrate to feeding areas in the northwestern Atlantic during the summer months. Most of the humpbacks that forage in the Gulf of Maine visit Stellwagen Bank and the waters of Massachusetts and Cape Cod bays. Previously, the North Atlantic humpback whale population was treated as a single stock for management purposes, however due to the strong fidelity to the region displayed by many whales, the Gulf of Maine stock was reclassified as a separate feeding stock (Waring *et al.* 2012). The Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and northern Norway are the other regions that represent relatively discrete subpopulations. Sightings are most frequent from mid-March through November between 41°N and 43°N, from the Great South Channel north along the outside of Cape Cod to Stellwagen Bank and Jeffreys Ledge (CeTAP 1982) and peak in May and August. Small numbers of individuals may be present in this area, including the waters of Stellwagen Bank, year-round. They feed on small schooling fishes, particularly sand lance and Atlantic herring, targeting fish schools and filtering large amounts of water for their associated prey. Humpback whales may also feed on euphausiids (krill) as well as on capelin (Waring *et al.* 2010; Stevick *et al.* 2006).

In winter, whales from waters off New England, Canada, Greenland, Iceland, and Norway migrate to mate and calve primarily in the West Indies, where spatial and genetic mixing among these groups occurs (Waring *et al.* 2014). Various papers (Clapham and Mayo 1990; Clapham 1992; Barlow and Clapham 1997; Clapham *et al.* 1999) summarize information gathered from a catalogue of photographs of 643 individuals from the western North Atlantic population of humpback whales. These photographs identified reproductively mature western North Atlantic humpbacks wintering in tropical breeding grounds in the Antilles, primarily on Silver and Navidad banks north of the Dominican Republic. The primary winter range also includes the Virgin Islands and Puerto Rico (NMFS 1991a). Acoustic recordings made on Stellwagen Bank National Marine Sanctuary in 2006 and 2008 detected humpback song in almost all months, including throughout the winter (Vu *et al.* 2012). This confirms the presence of male humpback whales in the area (a mid-latitude feeding ground) through the winter in these years. In addition, photographic records from Newfoundland have shown a number of adult humpbacks remain there year-round, particularly on the island's north coast. In collaboration with colleagues in the French islands of St. Pierre and Miquelon, a new photographic catalogue and concurrent matching effort is being undertaken for this region (J. Lawson, DFO, pers. comm.).

Humpback whales use the Mid-Atlantic as a migratory pathway to and from the calving/mating grounds, but it may also be an important winter feeding area for juveniles. Since 1989, observations of juvenile humpbacks in the Mid-Atlantic have been increasing during the winter months, peaking January through March (Swingle *et al.* 1993). Biologists theorize that non-reproductive animals may be establishing a winter feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. Swingle *et al.* (1993) identified a shift in distribution of juvenile humpback whales in the nearshore waters of Virginia, primarily in winter months. Identified whales using the Mid-Atlantic area were found to be residents of the Gulf of Maine and Atlantic Canada (Gulf of St. Lawrence and Newfoundland) feeding groups, suggesting a mixing of different feeding populations in the Mid-Atlantic region. Strandings of humpback whales have increased between New Jersey and Florida since 1985, consistent with the increase in Mid-Atlantic whale sightings. Strandings between 1985 and 1992 were most frequent September through April in North Carolina and Virginia waters, and were composed primarily of juvenile humpback whales of no more than 11 meters in length (Wiley *et al.* 1995).

Abundance Estimates and Trends

Photographic mark-recapture analyses from the Years of the North Atlantic Humpback (YONAH) project gave an ocean-basin-wide estimate of 11,570 animals during 1992/1993 and an additional genotype-based analysis yielded a similar but less precise estimate of 10,400 whales (95% CI. = 8,000-13,600) (Stevick *et al.* 2003; Waring *et al.* 2014). For management purposes under the MMPA, the estimate of 11,570 individuals is regarded as the best available estimate for the North Atlantic population (Waring *et al.* 2014). The minimum population estimate for the Gulf of Maine stock is 823 whales, derived from a 2008 mark-recapture based count (Waring *et al.* 2014).

Population modeling, using data obtained from photographic mark-recapture studies, estimates the growth rate of the Gulf of Maine stock to be 6.5% for the period 1979-1991 (Barlow and Clapham 1997). More recent analysis for the period 1992-2000 estimated lower population growth rates ranging from 0% to 4.0%, depending on calf survival rate (Clapham *et al.* 2003 in Waring *et al.* 2014). However, it is unclear whether the apparent decline in growth rate is a bias result due to a shift in distribution documented for the period 1992-1995, or whether the population growth rates truly declined due to high mortality of young-of-the-year whales in U.S. Mid-Atlantic waters (Waring *et al.* 2014). Regardless, calf survival appears to have increased since 1996, presumably accompanied by an increase in population growth (Waring *et al.* 2012). Stevick *et al.* (2003) calculated an average population growth rate of 3.1% in the North Atlantic population overall for the period 1979-1993.

Anthropogenic Injury and Mortality

The PBR for the Gulf of Maine stock of humpback whale is 2.7. As with other large whales, the major known sources of anthropogenic mortality and injury of humpback whales occur from fishing gear entanglements and ship strikes. For the period 2007-2011, the minimum annual rate of human-caused mortality and serious injury to the Gulf of Maine humpback whale stock averaged 11.2 animals per year (Waring *et al.* 2014). This value includes incidental fishery interaction records, 9.2; and records of vessel collisions, 2.0 (Waring et al. 2014). Between 2007 and 2011, humpback whale entanglements accounted for 8 mortalities and 36.5 serious injuries

(Waring *et al.* 2014). In 2007-2011 there are 10 reports of serious injuries and mortalities as a result of shipstrike. It was assumed that all of these events involved members of the Gulf of Maine stock of humpback whales unless a whale was confirmed to be from another stock. In reports prior to 2007, only events involving whales confirmed to be members of the Gulf of Maine stock were included. There were also many carcasses that washed ashore or were spotted floating at sea for which the cause of death could not be determined. Decomposed and/or unexamined animals (e.g., carcasses reported but not retrieved or no necropsy performed) represent 'lost data,' some of which may relate to human impacts (Henry *et al.* 2012; Waring *et al.* 2012).

Based on photographs taken from 2000-2002 of the caudal peduncle and fluke of humpback whales, Robbins and Mattila (2004) estimated that at least half (48-57%) of the sample (187 individuals) was coded as having a high likelihood of prior entanglement. Evidence suggests that entanglements have occurred at a minimum rate of 8-10% per year. Scars acquired by Gulf of Maine humpback whales between 2000 and 2002 suggest a minimum of 49 interactions with gear. Based on composite scar patterns, male humpback whales appear to be more vulnerable to entanglement than females. Males may be subject to other sources of injury that could affect scar pattern interpretation. Of the images obtained from a humpback whale breeding ground, 24% showed raw injuries, presumably a result from agonistic interactions. However, current evidence suggests that breeding ground interactions alone cannot explain the higher frequency of healed scar patterns among Gulf of Maine male humpback whales (Robbins and Matilla 2004).

Humpback whales, like other baleen whales, may also be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources resulting from a variety of activities including fisheries operations, vessel traffic, and coastal development. Currently, there is no evidence that these types of activities are affecting humpback whales. However, Geraci *et al.* (1989) provide strong evidence that a mass mortality of humpback whales in 1987-1988 resulted from the consumption of mackerel whose livers contained high levels of saxitoxin, a naturally occurring red tide toxin, the origin of which remains unknown. The occurrence of a red tide event may be related to an increase in freshwater runoff from coastal development, leading some observers to suggest that such events may become more common among marine mammals as coastal development continues (Clapham *et al.* 1999). There were three additional known cases of a mass mortality involving large whale species along the East Coast between 1998 and 2008. In the 2006 mass mortality event, 21 dead humpback whales were found between July 10 and December 31, 2006, triggering NMFS to declare an unusual mortality event (UME) for humpback whales in the Northeast United States. The UME was officially closed on December 31, 2007 after a review of 2007 humpback whale strandings and mortality showed that the elevated numbers were no longer being observed. The cause of the 2006 UME is listed as "undetermined," and the investigation has been closed, though could be re-opened if new information becomes available.

Changes in humpback whale distribution in the Gulf of Maine have been found to be associated with changes in herring, mackerel, and sand lance abundance associated with local fishing pressures (Stevick *et al.* 2006; Waring *et al.* 2014). Shifts in relative finfish species abundance correspond to changes in observed humpback whale movements (Stevick *et al.* 2006). However, whether humpback whales were adversely affected by these trophic changes is unknown.

Humpback whales are expected to be affected by climate change; however, no significant climate change-related impacts to humpback whales have been observed to date. The impact of climate change on cetaceans is likely to be related to changes in sea temperatures, potential freshening of sea water due to melting ice and increased rainfall, sea level rise, the loss of polar habitats, and the potential decline of forage.

Of the main factors affecting distribution of cetaceans, water temperature appears to be the main influence on geographic ranges of cetacean species (MacLeod 2009). Humpback whales are distributed in all water temperature zones, therefore, it is unlikely that their range will be directly affected by an increase in water temperature.

The indirect effects to humpback whales that may be associated with sea level rise are the construction of sea-wall defenses and protective measures for coastal habitats, which may impact coastal marine species and may interfere with migration (Learmonth *et al.* 2006). Cetaceans are unlikely to be directly affected by sea level rise, although important coastal bays for humpback breeding could be affected (IWC 1997).

The direct effects of increased CO_2 concentrations, and associated decrease in pH (ocean acidification), on marine mammals are unknown (Learmonth *et al.* 2006). Marine plankton is a vital food source for many marine species. Studies have demonstrated adverse impacts from ocean acidification on the ability of free-swimming zooplankton to maintain protective shells as well as a reduction in the survival of larval marine species.

Summary of Humpback Whale Status

The best available population estimate for humpback whales in the North Atlantic Ocean is 11,570 animals, and the best recent estimate for the Gulf of Maine stock is 823 whales (Waring *et al.* 2014). Anthropogenic mortality associated with fishing gear entanglements and ship strikes remains significant. In the winter, mating and calving occurs in areas located outside of the U.S. where the species is afforded less protection. Despite all of these factors, current data suggest that the Gulf of Maine humpback stock is steadily increasing in size (Waring *et al.* 2014). This is consistent with an estimated average trend of 3.1% in the North Atlantic population overall for the period 1979-1993 (Stevick *et al.* 2003). With respect to the species overall, there are also indications of increasing abundance for the California-Oregon-Washington, central North Pacific, and Southern Hemisphere stocks: Southwest Atlantic, Southeast Atlantic, Southwest Indian Ocean, Southeast Indian Ocean, and Southwest Pacific. Trend data is lacking for the western North Pacific stock, the central South Pacific and Southeast Pacific subpopulations of the southern hemisphere humpback whales, and the northern Indian Ocean humpbacks.

3.2.3. Fin Whale

The fin whale (*Balaenoptera physalus*) is listed as endangered under the ESA and also is designated as depleted under the MMPA. Fin whales inhabit a wide range of latitudes between 20-75°N and 20-75°S (Perry *et al.* 1999). The fin whale is widely distributed in the North Atlantic and occurs from the Gulf of Mexico and Mediterranean Sea northward to the edges of the Arctic ice pack (NMFS 1998b). The overall pattern of fin whale movement is complex, consisting of a less obvious north-south pattern of migration than that of right and humpback whales. Based on acoustic recordings from hydrophone arrays, Clark (1995) reported a general southward flow pattern of fin whales in the fall from the Labrador/Newfoundland region, past Bermuda, and into the West Indies. The overall distribution may be based on prey availability, as this species preys opportunistically on both invertebrates and fish (Watkins *et al.* 1984). Fin whales feed by gulping prey concentrations and filtering the water for the associated prey. Fin whales are larger and faster than humpback and right whales and are less concentrated in nearshore environments.

Pacific Ocean

Within U.S. waters of the Pacific, fin whales are found seasonally off the coast of North America and Hawaii and in the Bering Sea during the summer (Allen and Angliss 2010). Although stock structure in the Pacific is not fully understood, we recognize three fin whale stocks in U.S. Pacific waters for the purposes of managing this species under the MMPA. These are: Alaska (Northeast Pacific), California/Washington/Oregon, and Hawaii (Carretta *et al.* 2011). Reliable estimates of current abundance for the entire Northeast Pacific fin whale stock are not available (Allen and Angliss 2010). A provisional population estimate of 5,700 was calculated for the Alaska stock west of the Kenai Peninsula by adding estimates from multiple surveys (Allen and Angliss 2010). This can be considered a minimum estimate for the entire stock because the surveys covered only a portion of its range (Allen and Angliss 2010). An annual population increase of 4.8% between 1987-2003 was estimated for fin whales in coastal waters south of the Alaska Peninsula (Allen and Angliss 2010). This is the first estimate of population trend for North Pacific fin whales; however, it must be interpreted cautiously due to the uncertainty in the initial population estimate and the population structure (Allen and Angliss 2010). The best available estimate for the California/Washington/Oregon stock is 3,044, which is likely an underestimate (Carretta *et al.* 2011). The best available estimate for the Hawaii stock is 174, based on a 2002 line-transect survey (Carretta *et al.* 2011).

Stock structure for fin whales in the Southern Hemisphere is unknown. Prior to commercial exploitation, the abundance of Southern hemisphere fin whales was estimated at 400,000 (IWC 1979, Perry *et al.* 1999). There are no current estimates of abundance for Southern Hemisphere fin whales. Since these fin whales do not occur in U.S. waters, there is no recovery plan or stock assessment report for the Southern Hemisphere fin whales.

North Atlantic

NMFS has designated one population of fin whales in U.S. waters of the North Atlantic (Waring *et al.* 2012). This species is commonly found from Cape Hatteras northward. Researchers have suggested the existence of fin whale subpopulations in the North Atlantic based on local depletions resulting from commercial overharvesting (Mizroch and York 1984) or genetics data (Bérubé *et al.* 1998). Photo-identification studies in western North Atlantic feeding areas, particularly in Massachusetts Bay, have shown a high rate of annual return by fin whales, both within years and among years (Seipt *et al.* 1990) suggesting some level of site fidelity. The Scientific Committee of the International Whaling Commission (IWC) has proposed stock boundaries for North Atlantic fin whales. Fin whales off the eastern United States, Nova Scotia, and southeastern coast of Newfoundland are believed to constitute a single stock of fin whales under the present IWC scheme (Donovan 1991). However, it is uncertain whether the proposed boundaries define biologically isolated units (Waring *et al.* 2014).

During the 1978-1982 aerial surveys, fin whales accounted for 24% of all cetaceans and 46% of all large cetaceans sighted over the continental shelf between Cape Hatteras and Nova Scotia (Waring *et al.* 2014). Underwater listening systems have also demonstrated that the fin whale is the most acoustically common whale species heard in the North Atlantic (Clark 1995). The single most important area for this species appeared to be from the Great South Channel, along the 50 meter isobath past Cape Cod, over Stellwagen Bank, and past Cape Ann to Jeffreys Ledge (Hain *et al.*1992).

Like right and humpback whales, fin whales are believed to use North Atlantic waters primarily for feeding, and more southern waters for calving. However, evidence regarding where the majority of fin whales winter, calve, and mate is still scarce. Clark (1995) reported a general pattern of fin whale movements in the fall from the Labrador/Newfoundland region, south past Bermuda and into the West Indies, but neonate strandings along the U.S. Mid-Atlantic coast from October through January suggest the possibility of an offshore calving area (Hain *et al.* 1992).

Fin whales achieve sexual maturity at 6-10 years of age in males and 7-12 years in females (Jefferson *et al.* 2008), although physical maturity may not be reached until 20-30 years (Aguilar and Lockyer 1987). Conception is believed to occur in tropical and subtropical areas during the winter with birth of a single calf after an 11-12 month gestation (Jefferson *et al.* 2008). The calf is weaned 6-11 months after birth (Perry *et al.* 1999). The mean calving interval is 2.7 years (Agler *et al.* 1993).

The predominant prey of fin whales varies greatly in different geographical areas depending on what is locally available (IWC 1992). In the western North Atlantic, fin whales feed on a variety of small schooling fish (*i.e.*, herring, capelin, sand lance).

Population Trends and Status

Various estimates have been provided to describe the current status of fin whales in western North Atlantic waters. One method used the catch history and trends in Catch Per Unit Effort (CPUE) to obtain an estimate of 3,590 to 6,300 fin whales for the entire western North Atlantic (Perry *et al.* 1999). Hain *et al.* (1992) estimated that about 5,000 fin whales inhabit the Northeastern U.S. continental shelf waters. The 2013 Stock Assessment Report (SAR) gives a best estimate of abundance for fin whales in the western North Atlantic of 3,522 (CV = 0.27). However, this estimate must be considered extremely conservative in view of the incomplete coverage of the known habitat of the stock and the uncertainties regarding population structure and whale movements between surveyed and unsurveyed areas (Waring *et al.* 2014). The minimum population estimate for the western North Atlantic fin whale is 2,817 (Waring *et al.* 2014). However, there are insufficient data at this time to determine population trends for the fin whale (Waring *et al.* 201). The PBR for the western North Atlantic fin whale is 5.6.

Other estimates of the abundance of fin whales in the North Atlantic are presented in Pike *et al.* (2008) and Hammond *et al.* (2011). Pike *et al.* (2008) estimates the abundance of fin whales to be 27,493 (CV 0.2) in waters around Iceland and the Denmark Strait. Hammond *et al.* (2008) estimates the abundance of 19,354 (CV 0.24) fin whales in the eastern North Atlantic.

Anthropogenic Injury and Mortality

The major known sources of anthropogenic mortality and injury of fin whales include entanglement in commercial fishing gear and ship strikes. The minimum annual rate of confirmed human-caused serious injury and mortality to North Atlantic fin whales in U.S. and Canadian waters from 2007 to 2011 was 3.7 (Waring *et al.* 2014). This value includes incidental fishery interaction records, 2.3; and records of vessel collisions, 1.4. Fin whales are believed to be the cetacean most commonly struck by large vessels (Laist *et al.* 2001). In addition, hunting of fin whales continued well into the 20th century. Fin whales were given total protection in the North Atlantic in 1987 with the exception of an aboriginal subsistence whaling hunt for Greenland (Gambell 1993; Caulfield 1993). However, Iceland has increased its whaling activities in recent years and reported a catch of 136 whales in the 1988/89 and 1989/90 seasons (Perry *et al.* 1999), seven in 2006/07, and 273 in 2009/2010. Fin whales may also be adversely affected by habitat degradation, habitat exclusion, acoustic trauma, harassment, or reduction in prey resources resulting from a variety of activities.

Fin whales are expected to be affected by climate change; however, no significant climate change-related impacts to fin whales have been observed to date. The impact of climate change on cetaceans is likely to be related to changes in sea temperatures, potential freshening of sea water due to melting ice and increased rainfall, sea level rise, the loss of polar habitats, and the potential decline of forage.

Of the factors affecting geographic distribution of cetaceans, water temperature appears to be the main influence, with other factors primarily influencing how individuals are distributed within their ranges(MacLeod 2009). Cetacean species most likely to be affected by increases in water temperature are those with ranges restricted to non-tropical waters and with a preference for shelf waters. Fin whales are distributed in all water temperature zones, therefore, it is unlikely that their range will be directly affected by an increase in water temperature.

The indirect effects to fin whales that may be associated with sea level rise are the construction of sea-wall defenses and protective measures for coastal habitats, which may impact coastal marine species and may interfere with migration (Learmonth *et al.* 2006). The effect of sea level rise to fin whales is likely negligible.

The direct effects of increased CO_2 concentrations, and associated decrease in pH (ocean acidification), on marine mammals are unknown (Learmonth *et al.* 2006). Marine plankton is a vital food source for many marine species. Studies have demonstrated adverse impacts from ocean acidification on the ability of free-swimming zooplankton to maintain protective shells as well as a reduction in the survival of larval marine species. A decline in marine plankton could have serious consequences for the marine food web.

Summary of Fin Whale Status

Information on the abundance and population structure of fin whales worldwide is limited. We recognize three fin whale stocks in the Pacific for the purposes of managing this species under the MMPA. Reliable estimates of current abundance for the entire Northeast Pacific fin whale stock are not available (Angliss *et al.* 2001). Stock structure for fin whales in the Southern Hemisphere is unknown and there are no current estimates of abundance for Southern Hemisphere fin whales. As noted above, the best population estimate for the western North Atlantic fin whale is 3,522 and the minimum population estimate is 2,817. The 2013 SAR indicates that there are insufficient data at this time to determine population trends for the fin whale. Fishing gear appears to pose less of a threat to fin whales in the North Atlantic Ocean than to North Atlantic right or humpback whales. However, commercial whaling for fin whales in the North Atlantic has resumed and fin whales continue to be struck by large vessels. Based on the information currently available, for the purposes of this Opinion, we consider the population trend for fin whales to be undetermined.

3.2.4. Sei Whale

The sei whale (*Balaenoptera borealis*) is listed as endangered under the ESA and is designated as depleted under the MMPA. Sei whales are a widespread species in the world's temperate, subpolar, subtropical, and tropical marine waters. Sei whales reach sexual maturity at 5-15 years of age. The calving interval is believed to be two to three years (Perry *et al.* 1999

North Pacific and Southern Hemisphere

The IWC only considers one stock of sei whales in the North Pacific (Donovan 1991), but for NMFS management purpose under the MMPA, sei whales within the Pacific U.S. EEZ are divided into three discrete non-contiguous areas: 1) waters around Hawaii, 2) California, Oregon, and Washington waters, and 3) Alaskan waters (Carretta *et al.* 2011). There are no abundance estimates for sei whales in the entire eastern North Pacific. The best estimate of abundance for California, Oregon, and Washington waters out to 300 nautical miles is 126 (CV=0.53) sei whales (Barlow and Forney 2007; Forney 2007; Carretta *et al.* 2011). No fishery related serious injuries or mortalities have been documented from 2004 through 2008 in the eastern North Pacific stock of sei whales (Carretta *et al.* 2011).

During 2002-2008 there was one reported ship strike mortality in Washington in 2003 (NMFS) Northwest Regional Office, unpublished data). The Hawaiian stock includes animals found both within the Hawaiian Islands EEZ and in adjacent international waters; however, because data on abundance, distribution, and human-caused impacts are largely lacking for international waters, the status of this stock is evaluated based on data from U.S. EEZ waters of the Hawaiian Islands (Carretta *et al.* 2011). The best estimate of abundance for the Hawaiian stock of sei whales is 77 (CV=1.06). Between 2004 and 2008, no human-caused serious injury or mortality was documented in the Hawaiian stock of sei whales (Carretta *et al.* 2011). The stock structure of sei whales in the Southern Hemisphere is unknown. Like other whale species, sei whales in the Southern Hemisphere were heavily impacted by commercial whaling, particularly in the mid-20th century as humpback, fin, and blue whales became scarce. Sei whales were protected by the IWC in 1977 after their numbers had substantially decreased and they also became more difficult to find (Perry *et al.* 1999). Since Southern Hemisphere sei whales do not occur in U.S. waters, there is no stock assessment report for Southern Hemisphere sei whales.

North Atlantic

NMFS considers sei whales in the North Atlantic as one stock, known as the Nova Scotia stock (formerly known as the Western North Atlantic stock). Sei whales occur in deep water throughout their range, typically over the continental slope or in basins situated between banks (NMFS 1998b). In the Northwest Atlantic, it is speculated that the whales migrate from south of Cape Cod along the eastern Canadian coast in June and July, and return on a southward migration again in September and October (Waring *et al.* 2014). Olsen *et al.* (2009) tracked a tagged sei whale that moved from the Azores to off eastern Canada; however, such a migration remains unverified. Within the U.S. Atlantic EEZ, the sei whale is most common on Georges Bank and into the Gulf of Maine/Bay of Fundy region during spring and summer, primarily in deeper waters. Recent springtime research in the Southwestern Gulf of Maine, suggests sei whales are reasonably common in this area in most years (Baumgartner *et al.* 2011).

Although sei whales may prey upon small schooling fish and squid, available information suggests that calanoid copepods and euphausiids are the primary prey of this species (Flinn *et al.* 2002). Sei whales are occasionally seen feeding in association with right whales in the southern Gulf of Maine and in the Bay of Fundy. However, there is no evidence to demonstrate interspecies competition between these species for food resources.

There is limited information on the stock identity of sei whales in the North Atlantic (Waring *et al.* 2012). For purposes of the Marine Mammal Stock Assessment Reports, and based on a proposed IWC stock definition, NMFS recognizes the sei whales occurring from the U.S. East Coast to Cape Breton, Nova Scotia, and east to 42°W as the "Nova Scotia stock" of sei whales (Waring *et al.* 2012).

Abundance Estimates and Trends

The 2011 abundance estimate of 357 sei whales (CV=0.52) is considered the best available for the Nova Scotia stock of sei whales according to the 2013 SAR (Waring *et al.* 2014). This estimate is considered extremely conservative because all of the known range of this stock was not surveyed, and because of uncertainties regarding population structure and whale movements between surveyed and unsurveyed areas. Hammond *et al.* (2011) estimates the abundance of sei whales in European Atlantic waters to be 619 (CV of 0.34) for identified sightings identified to species. The minimum population estimate for this sei whale stock is 236 (Waring *et al.* 2014). Current and maximum net productivity rates are unknown for this stock. There are insufficient data to determine trends of the sei whale population (Waring *et al.* 2014).

Anthropogenic Injury and Mortality

The PBR for the Nova Scotia stock sei whale is 0.5. Few instances of injury or mortality of sei whales due to entanglement or vessel strikes have been recorded in U.S. waters, possibly because sei whales typically inhabit waters farther offshore than most commercial fishing operations, or perhaps entanglements do occur but are less likely to be observed. The minimum annual rate of confirmed human-caused serious injury and mortality to Nova Scotian sei whales from 2007 to 2011 was 1.0 (Waring *et al.* 2014), which includes 0.4 fishery interaction records and 0.6 vessel collision records. Other impacts noted above for other baleen whales may also occur in this species (e.g., habitat degradation, etc.).

Sei whales are expected to be affected by climate change; however, no significant climate change-related impacts to sei whales have been observed to date. The impact of climate change on cetaceans is likely to be related to changes in sea temperatures, potential freshening of sea water due to melting ice and increased rainfall, sea level rise, the loss of polar habitats and the potential decline of forage.

Of the main factors affecting distribution of cetaceans, water temperature appears to be the main influence on geographic ranges of cetacean species (MacLeod 2009). Sei whales currently range from sub-polar to tropical waters. An increase in water temperature may be a favorable effect on sei whales, allowing them to expand their range into higher latitudes (MacLeod 2009).

The indirect effects to sei whales, that may be associated with sea level rise, are the construction of sea-wall defenses and protective measures for coastal habitats, which may impact coastal marine species and may interfere with migration (Learmonth *et al.* 2006). The effect of sea level rise to sei whales is likely negligible.

The direct effects of increased CO_2 concentrations, and associated decrease in pH (ocean acidification), on marine mammals are unknown (Learmonth *et al.* 2006). Marine plankton is a vital food source for many marine species. Studies have demonstrated adverse impacts from ocean acidification on the ability of free-swimming zooplankton to maintain protective shells as well as a reduction in the survival of larval marine species. A decline in marine plankton could have serious consequences for the marine food web.

Summary of Sei Whale Status

The best estimate of abundance for the Nova Scotia stock of sei whales is 357 (Waring *et al.* 2014). There are insufficient data to determine trends of the Nova Scotian sei whale population. The minimum annual rate of confirmed human-caused serious injury and mortality to Nova Scotian sei whales from 2007 to 2011 was 1.0 (Waring *et al.* 2014). Information on the status of sei whale populations worldwide is similarly lacking. There are no abundance estimates for sei whales in the entire eastern North Pacific, however the best estimate of abundance for California, Oregon, and Washington waters out to 300 nautical miles is 126 (Carretta *et al.* 2011). The stock structure of sei whales in the Southern Hemisphere is unknown. Based on the information currently available, for the purposes of this Opinion, NMFS considers the population trend for sei whales to be undetermined.

4.0 GLOBAL CLIMATE CHANGE

The discussion below presents background information on predicted global climate change and information on past and predicted future effects of global climate change throughout the range of the listed species considered here. Additionally, we present the available information on predicted effects of climate change in the action area and how listed whales may be affected by those predicted environmental changes over the life of the proposed action (i.e., the 19 years remaining on the 25-year Deepwater Port permit; expires in 2032). Any effects resulting from the operation, maintenance and repair of the NEG LNG Port and the Pipeline Lateral are expected to be confined to the 19 year operational life of the Port (i.e., 2013- 2032).

Climate change is relevant to the Status of the Species, Environmental Baseline and Cumulative Effects sections of this Opinion; rather than include partial discussion in several sections of this Opinion, we are synthesizing this information into one discussion.

4.1 Background Information on Global Climate Change

The global mean temperature has risen 0.76ºC (1.36°F) over the last 150 years, and the linear trend over the last 50 years is nearly twice that for the last 100 years (Intergovernmental Panel on Climate Change (IPCC) 2007a) and precipitation has increased nationally by 5%-10%, mostly due to an increase in heavy downpours (NAST 2000). There is a high confidence, based on substantial new evidence, that observed changes in marine systems are associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels, and changes in algal, plankton, and fish abundance (IPCC 2007b); these trends are most apparent over the past few decades. Information on future impacts of climate change in the action area is discussed below.

Climate model projections exhibit a wide range of plausible scenarios for both temperature and precipitation over the next century. Both of the principal climate models used by the National Assessment Synthesis Team (NAST) project warming in the southeast by the 2090s, but at different rates (NAST 2000): the Canadian model scenario shows the southeast U.S. experiencing a high degree of warming, which translates into lower soil moisture as higher temperatures increase evaporation; the Hadley model scenario projects less warming and a significant increase in precipitation (about 20%). The scenarios examined, which assume no major interventions to reduce continued growth of world greenhouse gases (GHG), indicate that temperatures in the U.S. will rise by about 3º-5ºC (5º-9ºF) on average in the next 100 years which is more than the projected global increase (NAST 2000). A warming of about 0.2ºC (0.4°F) per decade is projected for the next two decades over a range of emission scenarios (IPCC 2007a). This temperature increase will very likely be associated with more extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions. Climate warming has resulted in increased precipitation, river discharge, and glacial and sea-ice melting (Greene *et al.* 2008).

The past three decades have witnessed major changes in ocean circulation patterns in the Arctic, and these were accompanied by climate associated changes as well (Greene *et al.* 2008). Shifts in atmospheric conditions have altered Arctic Ocean circulation patterns and the export of freshwater to the North Atlantic (Greene *et al.* 2008, IPCC 2006). With respect specifically to the North Atlantic Oscillation (NAO), changes in salinity and temperature are thought to be the result of changes in the earth's atmosphere caused by anthropogenic forces (IPCC 2006). The NAO impacts climate variability throughout the northern hemisphere (IPCC 2006). Data from the

1960s through the present show that the NAO index has increased from minimum values in the 1960s to strongly positive index values in the 1990s and somewhat declined since (IPCC 2006). This warming extends over one kilometer (0.62 miles) deep and is deeper than anywhere in the world oceans and is particularly evident under the Gulf Stream/ North Atlantic Current system (IPCC 2006). On a global scale, large discharges of freshwater into the North Atlantic subarctic seas can lead to intense stratification of the upper water column and a disruption of North Atlantic Deepwater (NADW) formation (Greene *et al.* 2008, IPCC 2006). There is evidence that the NADW has already freshened significantly (IPCC 2006). This in turn can lead to a slowing down of the global ocean thermohaline (large-scale circulation in the ocean that transforms low density upper ocean waters to higher density intermediate and deep waters and returns those waters back to the upper ocean), which can have climatic ramifications for the whole earth system (Greene *et al.* 2008).

While predictions are available regarding potential effects of climate change globally, it is more difficult to assess the potential effects of climate change over the next few decades on coastal and marine resources on smaller geographic scales, especially as climate variability is a dominant factor in shaping coastal and marine systems. The effects of future change will vary greatly in diverse coastal regions for the U.S. Warming is very likely to continue in the U.S. over the next 25 to 50 years regardless of reduction in GHGs, due to emissions that have already occurred (NAST 2000). It is very likely that the magnitude and frequency of ecosystem changes will continue to increase in the next 25 to 50 years, and it is possible that the rate of change will accelerate. Climate change can cause or exacerbate direct stress on ecosystems through high temperatures, a reduction in water availability, and altered frequency of extreme events and severe storms. Water temperatures in streams and rivers are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods when they are of greatest concern (NAST 2000). In some marine and freshwater systems, shifts in geographic ranges and changes in algal, plankton, and fish abundance are associated with high confidence with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation (IPCC 2007a).

A warmer and drier climate is expected to result in reductions in stream flows and increases in water temperatures. Expected consequences could be a decrease in the amount of dissolved oxygen in surface waters and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing rate (Murdoch *et al.* 2000). Because many rivers are already under a great deal of stress due to excessive water withdrawal or land development, and this stress may be exacerbated by changes in climate, anticipating and planning adaptive strategies may be critical (Hulme 2005). A warmer-wetter climate could ameliorate poor water quality conditions in places where human-caused concentrations of nutrients and pollutants other than heat currently degrade water quality (Murdoch *et al.* 2000). Increases in water temperature and changes in seasonal patterns of runoff will very likely disturb fish habitat and affect recreational uses of lakes, streams, and wetlands. Surface water resources in the southeast are intensively managed with dams and channels and almost all are affected by human activities; in some systems water quality is either below recommended levels or nearly so. A global analysis of the potential effects of climate change on river basins indicates that due to changes in discharge and water stress, the area of large river basins in need of reactive or proactive management interventions in response to climate change will be much higher for basins impacted by dams than for basins with free-flowing rivers (Palmer *et al.* 2008). Human-induced disturbances also influence coastal and marine systems, often reducing the ability of the systems to adapt so that systems that might ordinarily be capable of responding to variability and change are less able to do so. Because stresses on water quality are associated with many activities, the impacts of the existing stresses are likely to be exacerbated by climate change. Within 50 years, river basins that are impacted by dams or by extensive development may experience greater changes in discharge and water stress than unimpacted, free-flowing rivers (Palmer *et al.* 2008).

While debated, researchers anticipate: 1) the frequency and intensity of droughts and floods will change across the nation; 2) a warming of about 0.2^{o}C (0.4°F) per decade; and 3) a rise in sea level (NAST 2000). A warmer and drier climate will reduce stream flows and increase water temperature resulting in a decrease of DO and an increase in the concentration of nutrients and toxic chemicals due to reduced flushing. Sea level is expected to continue rising; during the 20th century global sea level increased 15 to 20 cm (6-8 inches).

4.2 Species Specific Information on Anticipated Effects of Climate Change

The impact of climate change on cetaceans is likely to be related to changes in sea temperatures, potential freshening of sea water due to melting ice and increased rainfall, sea level rise, the loss of polar habitats and potential shifts in the distribution and abundance of prey species. Of the main factors affecting distribution of cetaceans, water temperature appears to be the main influence on geographic ranges of cetacean species (Macleod 2009). As such, depending on habitat preferences, changes in water temperature due to climate change may affect the distribution of certain species of cetacean. For instance, fin and humpback whales are distributed in all water temperatures zones, therefore, it is unlikely that their range will be directly affected by an increase in water temperatures (MacLeod 2009). However, North Atlantic right whales and sei whales, which currently have a range of sub-polar to sub-tropical, may respond to an increase in water temperature by shifting their range northward, with both the northern and southern limits moving poleward.

There are many potential direct and indirect effects that global climate change may have on marine mammal prey abundance and distribution, which in turn, poses potential behavioral and physiological effects to marine mammals, including listed whales. Changes in climate patterns, ocean currents, storm frequency, rainfall, salinity, melting ice, and an increase in river inputs/runoff (nutrients and pollutants) will all directly affect the distribution, abundance and migration of prey species (Waluda *et al.* 2001; Tynan and DeMaster 1997; Learmonth *et al.* 2006). These changes will likely have several indirect effects on marine mammals, which may include changes in distribution including displacement from ideal habitats, decline in fitness of individuals, population size due to the potential loss of foraging opportunities, abundance, migration, community structure, susceptibility to disease and contaminants, and reproductive success (Macleod 2009). Global climate change may also result in changes to the range and abundance of competitors and predators which will also indirectly affect marine mammals (Learmonth *et al.* 2006). For example, climate-driven changes in ocean circulation have had a significant impact on the plankton ecology of the Gulf of Maine, including effects on *Calanus finmarchicus*, a primary prey resource for right and sei whales (Greene *et al*. 2003). More information, is therefore, needed in order to determine the potential impacts global climate change will have on the timing and extent of population movements, abundance, recruitment, distribution and species composition of prey (Learmonth *et al.* 2006).

4.3 Effects of climate Change to Listed Species in the Action Area

As there is significant uncertainty in the rate and timing of change as well as the effect of any changes that may be experienced in the action area due to climate change, it is difficult to predict the impact of these changes on listed species; however, we have considered the available information to consider likely impacts to these species in the action area. The proposed actions under consideration extend through the lifetime of the MARAD permit (2032); thus, we consider the likely effect of climate change during the period from 2014 to 2032.

As described above, the impact of climate change on cetaceans is likely to be related to changes in sea temperatures, potential freshening of seawater due to melting ice and increased rainfall, sea level rise, the loss of polar habitats, and potential shifts in the distribution and abundance of prey species. These impacts, in turn, are likely to affect the distribution of species of whales. As described previously, listed species of whales may be found throughout the action area. Within this portion of the action area, the most likely effect to whales from climate change would be if warming temperatures led to changes in the seasonal distribution of whales. This may mean that ranges and seasonal migratory patterns are altered to coincide with changes in prey distribution on foraging grounds located outside of the action area, which may result in an increase or decrease of listed species of whales in the action area. As humpback and fin whales are distributed in all water temperature zones, it is unlikely that their range will be directly affected by an increase in water temperature; however, for right and sei whales, increases in water temperature may result in a northward shift of their range. This may result in an unfavorable effect on the North Atlantic right whale due to an increase in the length of migrations (Macleod 2009) or a favorable effect by allowing them to expand their range. However, over the life of the action (to 2032) it is unlikely that this possible shift in range will be observed due the extremely small increase in water temperature predicted to occur during this period (i.e., less than 1.5°C); if any shift does occur, it is likely to be minimal and thus, it seems unlikely that this small increase in temperature will cause a significant effect to whales or a significant modification to the number of whales likely to be present in the action area to the year 2032.[2] As such, we do not anticipate any shifts in the species range that would change the way we have conducted our effects analysis in this Opinion.

Summary of Climate Change

As discussed above, we considered the potential impact of climate change on listed species in the action area through the lifetime of the action (2032). Available information would indicate that

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[2] Frumhoff *et al*. 2007 predicted Northeast ocean sea surface temperatures to increase somewhere between 2.8 and 4.4°C by 2100. As predictive models on sea surface temperature changes in Massachusetts Bay were not available, the latter serves as the best available information on sea surface temperature changes in the action area as a result of climate change.

temperatures in the action area may increase up to 1.1°C over the life of this proposed action. This may result in some minor changes in distribution of listed species in the action area. No detectable changes in distribution, abundance or behavior of listed species are anticipated as a result of climate change during the timeframe of the project. In our analysis we considered that listed species may be present in the action area and may be conducting a variety of behaviors and this broad analysis encompasses any anticipated changes as a result of climate change.

5.0 ENVIRONMENTAL BASELINE

Environmental baselines for biological opinions include the past and present impacts of all state, federal or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 CFR § 402.02). The environmental baseline for this Opinion includes the effects of several activities that may affect the survival and recovery of the listed species in the action area.

5.1. Federal Actions That Have Undergone Section 7 Consultation

We have undertaken several ESA section 7 consultations to address the effects of various federal actions on threatened and endangered species in the action area. Each of those consultations sought to develop ways of reducing adverse impacts of the action on listed species.

Authorization of Fisheries through Fishery Management Plans

We have authorized the operation of several fisheries in the action area under the authority of the Magnuson-Stevens Fishery Conservation Act and through Fishery Management Plans (FMPs) and their implementing regulations. Commercial and recreational fisheries in the action area employ gear that is known to injure, and/or kill whales. In the Northeast Region (Maine through Virginia), formal ESA section 7 consultations have been conducted on the American lobster and the Atlantic sea scallop FMP fisheries. These consultations have considered effects to loggerhead, green, Kemp’s ridley and leatherback sea turtles, Atlantic sturgeon as well as ESA-listed whales. In each of these Opinions, we concluded that the ongoing action was likely to adversely affect but was not likely to jeopardize the continued existence of any Atlantic sturgeon, sea turtle or whale species or DPS. Each Opinion included an incidental take statement (ITS) exempting a certain amount of lethal and/or non-lethal take (i.e., capture and/or injury) of Atlantic sturgeon and/or sea turtles resulting from interactions with the fishery. The exempted take is primarily associated with interactions with fishing gear. No take was authorized for listed whales. In each Opinion, we concluded that the potential for interactions between listed species and fishing vessels (*i.e.*, vessel strikes) was extremely low. In all of these consultations we have also concluded that any effects to prey and/or habitat would be insignificant and discountable. We have also determined that the Atlantic herring and surf clam/ocean quahog fisheries do not adversely affect any species of listed sea turtles or whales.

On December 16, 2013, we completed a formal Biological Opinion on seven FMPs (Batch Fishery BiOp) managing the Northeast Multispecies, Monkfish, Spiny Dogfish, Atlantic Bluefish, Northeast Skate Complex, Mackerel/Squid/Butterfish, and Summer Flounder/Scup/Black Sea Bass fisheries. In the Batch Fishery BiOp we determined that the fisheries may adversely affect, but are not likely to jeopardize, the continued existence of North Atlantic right whales, humpback whales, fin whales, and sei whales, or loggerhead (specifically, the NWA DPS), leatherback, Kemp's ridley, and green sea turtles, any of the five DPSs of Atlantic sturgeon, or GOM DPS Atlantic salmon. The ITS exempted take of these species associated with interactions with fishing gear. The ITS did not exempt any take of listed whales.

5.2. Other Activities

Maritime Industry

Private and commercial vessels, including fishing vessels, operating in the action area of this consultation also have the potential to interact with whales. The effects of fishing vessels, recreational vessels, or other types of commercial vessels on ESA-listed species may involve disturbance or injury/mortality due to collisions or entanglement in anchor lines. It is important to note that minor vessel collisions may not kill an animal directly, but may weaken or otherwise affect it so it is more likely to become vulnerable to effects such as entanglement. Listed species may also be affected by fuel oil spills resulting from vessel accidents. Fuel oil spills could affect animals through the food chain. However, these spills typically involve small amounts of material that are unlikely to adversely affect listed species. Larger oil spills may result from severe accidents, although these events would be rare and involve small areas. No direct adverse effects on listed whales resulting from fishing vessel fuel spills have been documented.

Pollution

Anthropogenic sources of marine pollution, while difficult to attribute to a specific Federal, state, local, or private action, may affect whales in the action area. Sources of pollutants in the action area include atmospheric loading of pollutants such as PCBs; storm water runoff from coastal towns, cities, and villages; runoff into rivers emptying into bays; groundwater discharges; sewage treatment plant effluents; and oil spills.

Nutrient loading from land-based sources, such as coastal communities and agricultural operations, is known to stimulate plankton blooms in closed or semi-closed estuarine systems. The effect to larger embayments is unknown. Contaminants could degrade habitat if pollution and other factors reduce the food available to marine animals.

Non-Federally Regulated Fishery Operations

State fisheries operate in the state waters of Massachusetts. Very little is known about the level of interactions with listed species in fisheries that operate strictly in state waters. Impacts of state fisheries on endangered whales are addressed as appropriate through the MMPA take reduction planning process. We are actively participating in a cooperative effort with the Atlantic States Marine Fisheries Commission (ASMFC) and member states to standardize and/or implement programs to collect information on level of effort and bycatch of protected species in state fisheries. When this information becomes available, it can be used to refine take reduction plan measures in state waters.

5.3. Reducing Threats to ESA-listed Whales

Atlantic Large Whale Take Reduction Plan

The Atlantic Large Whale Take Reduction Plan (ALWTRP) reduces the risk of serious injury to or mortality of large whales due to incidental entanglement in U.S. commercial trap/pot and gillnet fishing gear. The ALWTRP focuses on the critically endangered North Atlantic right whale, but is also intended to reduce entanglement of endangered humpback and fin whales. The plan is required by the MMPA and has been developed by NMFS. The ALWTRP covers the U.S. Atlantic EEZ from Maine through Florida (26°46.5°N), which includes the action area. The measures associated with the ALWTRP reduce anthropogenic effects on listed species within the action area by attempting to reduce mortality and injury due to fishing gear entanglement and vessel strike; the two biggest threats to the recovery of the right whale as discussed in the 2005 Recovery Plan.

Regulatory actions are directed at reducing serious entanglement injuries and mortalities of whales from fixed gear fisheries (*i.e.*, trap/pot and gillnet fisheries). The non-regulatory component of the ALWTRP is composed of four principal parts: (1) gear research and development, (2) disentanglement, (3) the Sighting Advisory System (SAS), and (4) education/outreach**.** The first ALWTRP went into effect in 1997.

Regulatory Measures to Reduce the Threat of Entanglement on Whales

The regulatory component of the Plan includes a combination of broad fishing gear modifications and time-area restrictions supplemented by progressive gear research to reduce the chance that entanglements will occur, or that whales will be seriously injured or die as a result of an entanglement (50 C.F.R. § 229.32). The long-term goal, established by the 1994 Amendments to the MMPA, is to reduce entanglement related serious injuries and mortalities of right, humpback and fin whales to insignificant levels approaching zero within five years of its implementation. Despite these measures, entanglements, some of which resulted in serious injuries or mortalities, continued to occur. Because serious injury and mortality of right, humpback, and fin whales have continued to occur due to gear entanglements, new and revised regulatory measures have been issued since the original plan was developed.

Non-Regulatory Components of the ALWTRP

Gear Research and Development

The NEFSC has identified proposed metrics that will be used to monitor effectiveness of the ALWTRP measures. They project that five years of data would be required before a change may be able to be detected. The analysis of that data would not be able to occur until 2016 due to the availability of the five years of data after new regulations have been in place.

Large Whale Disentanglement Program

Entanglement of whales can happen anywhere along the U.S. eastern seaboard, including the action area. In response to this fact, we created the Whale Disentanglement Network. The Network is managed by us, purchasing equipment to be located at strategic spots along the Atlantic coastline, supporting training for fishermen and biologists, purchasing telemetry equipment, etc. In 1995 we issued a permit to Provincetown Center for Coastal Studies (PCCS) to disentangle large whales. Additionally, we and PCCS have established a large whale disentanglement program, also referred to as the Atlantic Large Whale Disentanglement Network (ALWDN), based on successful disentanglement efforts by many researchers and partners. Memorandums of Agreement were also issued between us and other Federal government agencies to increase the resources available to respond to reports of entangled large whales anywhere along the U.S. eastern seaboard. We have established agreements with many coastal states to collaboratively monitor and respond to entangled whales. As a result of the success of the disentanglement network, we believe whales that may otherwise have succumbed to complications from entangling gear have been freed and have survived.

Ship Strike Reduction Program

The Ship Strike Reduction Program is currently focused on protecting the North Atlantic right whale, but the operational measures are expected to reduce the incidence of ship strike on other large whales to some degree. The program consists of five basic elements and includes both regulatory and non-regulatory components: 1) operational measures for the shipping industry, including speed restrictions and routing measures, 2) section 7 consultations with Federal agencies that maintain vessel fleets, 3) education and outreach programs, 4) a bilateral conservation agreement with Canada, and 5) continuation of ongoing measures to reduce ship strikes of right whales (*e.g.*, Sighting Advisory System (SAS), ongoing research into the factors that contribute to ships trikes, and research to identify new technologies that can help mariners and whales avoid each other).

The regulatory measures delineated below have been implemented to reduce vessel strikes.

- Restricting Vessel Approach to Right Whales - In one recovery action aimed at reducing vessel-related impacts, including disturbance, NMFS published an interim final rule in February 1997 restricting vessel approach to right whales (62 FR 6729, February 13, 1997) to a distance of 500 yards. This rule is expected to reduce the potential for vessel collisions and other adverse vessel-related effects in the environmental baseline.
- Mandatory Ship Reporting System (MSR) - Ships entering the northeast and southeast MSR boundaries are required to report the vessel identity, date, time, course, speed, destination, and other relevant information. In return, the vessel receives an automated reply with the most recent right whale sightings or management areas and information on precautionary measures to take while in the vicinity of right whales.
- Vessel Speed Restrictions - Seasonal Management Areas are supplemented by Dynamic Management Areas (DMAs) that are implemented for 15 day periods in

areas in which right whales are sighted outside of SMA boundaries (73 FR 60173; October 10, 2008). DMAs can be designated anywhere along the U.S. eastern seaboard, including the action area, when NOAA aerial surveys or other reliable sources report aggregations of three or more right whales in a density that indicates the whales are likely to persist in the area. NOAA requests that mariners route around these zones or transit through them at 10 knots or less. Compliance with these zones is voluntary.

- Marine Mammal Health and Stranding Response Program (MMHSRP) - NMFS was designated the lead agency to coordinate the MMHSRP which was formalized by the 1992 Amendments to the MMPA. Through this program, NMFS coordinates a marine mammal stranding response program to assist stranded marine mammals and collect related data.

Magnuson-Stevens Fishery Conservation and Management Act

There are numerous regulations issued under the authority of the Magnuson-Stevens Fishery Conservation and Management Act that may benefit ESA-listed species. Many fisheries are subject to different time and area closures. Additionally, gear restrictions and modifications required for fishing regulations may also decrease the risk of entanglement with endangered species. A complete listing of fishery regulations, including those fisheries in the action area, can be found at: http://www.nero.noaa.gov/nero/regs/info.html.

Neptune LNG Deepwater Port

Although there are several LNG terminals proposed and/or licensed along the US east coast, the only other currently existing terminal within the action area for this consultation is the Neptune LNG Deepwater Port. Nonetheless, we acknowledge that other offshore oil, gas, and alternative energy projects may impact the species being considered in this consultation, as they are all highly migratory and can be affected by activities anywhere in a wide range that encompasses areas throughout the North Atlantic Ocean.

The Neptune terminal is nearly identical in technology and operation to the NEG terminal, and is located approximately 3 miles north of the NEG terminal. Biological opinions were issued for this project on January 12, 2007 and July 12, 2010, which concluded that the construction, operation, maintenance and repair of the Neptune facility was likely to result in acoustic harassment of listed right, humpback, and fin whales. Construction of the Neptune Port was completed in November 2009. Operational impacts associated with the Neptune Port will overlap in space and time with operation-related impacts of the NEG Port. The Neptune Port may contribute up to an additional 50 roundtrip LNG carrier transits per year through the Boston TSS. Similar to the NEG Port, the Neptune vessels use thrusters to maneuver at the buoys for approximately 10-30 minutes per vessel arrival. In the environmental impact statement (EIS) for the NEG project, the USCG reports that the two Ports are located far enough away from each other such that the sound fields will not overlap. Nonetheless, the existence of two ports will increase the total ensonified area within the action area, thus potentially increasing the number of animals exposed to acoustic disturbance. Recently, MARAD announced Neptune's intention to suspend accepting shipments, thus, potentially reducing the number of large EBRVs in the area for the immediate future.

Anthropogenic Noise

There has been growing concern among the scientific community about the effects of increasing levels of ocean noise on marine organisms, particularly marine mammals. Marine animals rely on hearing to communicate with conspecifics and derive information about their environment. Acoustic impacts from anthropogenic noise can include auditory trauma, temporary or permanent loss of hearing sensitivity, habitat exclusion, habituation, and disruption of other normal behavior patterns such as feeding, migration, and communication.

In July and August of 2007, Tetra Tech (2011) measured underwater ambient noise levels for comparison to noise produced by certain construction activities at the NEG Port and Algonquin Pipeline Lateral. The ambient noise levels in the action area were determined to range between 105 and 125 dB re 1µPa (Tetra Tech (2011). In addition, ambient noise levels have been measured in the nearby SBNMS and Cape Cod Bay. Ambient noise levels in the SBNMS are highly variable, and range from 50-140 dB re 1µPa (Neptune 2005). Measurements taken in Cape Cod Bay from January-May (periods of low shipping volume) indicate ambient noise levels around or above 110 dB re 1µPa (Neptune 2005). Daily fluctuations in ambient noise are most likely attributable to shipping traffic, although some types of offshore construction noise can propagate over long distances underwater.

NMFS and the Navy have been working to better understand and establish a policy for monitoring and managing acoustic impacts on marine mammals from anthropogenic sound sources in the marine environment. It is expected that the policy on managing anthropogenic sound in the oceans will provide guidance for programs such as the use of acoustic deterrent devices in reducing marine mammal-fishery interactions and review of federal activities and permits for research involving acoustic activities.

6.0 EFFECTS OF THE ACTION

This section of the Opinion assesses the direct and indirect effects of NEG's operation, and maintenance and repair activities on threatened and endangered species or critical habitat, together with the effects of other activities that are interrelated or interdependent. Indirect effects are those that are caused later in time, but are still reasonably certain to occur. This Opinion examines the likely effects of the proposed actions on ESA listed species of whales and their habitat in the action area within the context of the species' current and projected status, the environmental baseline and cumulative effects. Because there is no critical habitat in the action area, none will be affected. We have not identified any interrelated or interdependent activities.

Various aspects of the ongoing operation and maintenance of the NEG LNG terminal will impact the water column, and thus may affect listed whales or their prey. After reviewing the project description, Biological Assessment, and mitigation measures proposed by the applicant and by NMFS PR, we have found that several of these impacts will be discountable or insignificant, and therefore may affect, but are not likely to adversely affect listed whales. Our rationale for these determinations is provided in the following sections. We have identified water withdrawal, vessel collisions, and acoustic disturbance as the potential impacts of greatest concern. As such, these effects will be considered separately in Sections 6.4, 6.5, and 6.6. We consider effects at the project through 2032.

6.1. Species Presence in the Action Area

As explained in section 3, several listed species are likely to be present in the action area at various times of the year and may therefore be affected either directly or indirectly by the operation of the NEG LNG terminal and the Algonquin Pipeline Lateral. The primary concern for endangered whales involves interactions with project vessels and acoustic harassment due to the noise associated with ongoing operational and occasional maintenance and repair work.

North Atlantic right, humpback and fin whales have all been sighted in Massachusetts Bay waters, although sightings in the immediate vicinity of the Port are less common than in the neighboring waters of Stellwagen Bank and Cape Cod Bay. In general, right whales can be anticipated to be in Massachusetts and Cape Cod Bays from December through July, humpback whales can be found in Massachusetts waters year-round, with peaks between May and August, and fin whales may be in Massachusetts waters year-round, with peaks during the summer months. Although right whale sightings are concentrated in the Cape Cod Bay and Great South Channel feeding areas, the Gulf of Maine serves as an important spring and summer nursery/feeding area. Therefore, right whales may be transiting near the NEG Port. Data collected at the MARU acoustic array between 2008 and 2010 indicated when fin, humpback, and right whales were present in the action area, as well as their general distribution within the array (BRP 2011, 2010; Figure 1):

- Fin Whales – Fin whales were present almost consistently year-round. Detections occurred most often in the eastern half of the MARU array (MARU-12, -13, -14, -15, and 16)
- Humpback Whales - Humpback whales were present almost consistently from early March through December. Detections occurred most often in the eastern half of the MARU array (MARU-3, -4, -5, -6, -7, -12, -13, -14, -15, -16 and -17)
- North Atlantic Right Whales - Right whales were detected most frequently in the area from February to May, through June in 2008, and during December in 2010. Detections occurred most often in the southeastern portion of the MARU array within SBNMS (MARU-4, -5, -13, -14, -15, -16, -17 and -18).

Sei whales are known to occur in northeast waters, but tend to remain further offshore in deep water near shelf edges. Sightings of sei whales near the Port are rare, and the previous Opinion for the construction and operation of the NEG LNG Port determined that sei whales were not likely to be adversely affected by the proposed activities. However, during the construction of the nearby Neptune LNG Port, marine mammal observers sighted one whale that was tentatively identified as a sei whale within the vicinity of the construction activities. Therefore, it is possible that the species may occur within the vicinity of the NEG Port.

All four species of whale may also occur in the portion of the action area that encompasses the transit path of the EBRVs from their point of entry into the EEZ to the Port site.

6.2. Effects of Maintenance and Repair Work

Potential effects of pipeline and Port maintenance and repair activities on listed whales include:

- Interactions with maintenance and repair equipment;
- Water quality degradation (turbidity, contaminants, discharges);
- Light pollution;
- Water withdrawal (see section 6.4);
- Increased risk of vessel strike due to construction-related vessel traffic (see section 6.5); and
- Acoustic disturbance and harassment (see section 6.6).

For purposes of this Opinion, maintenance and repair activities include all inspections, maintenance, and repairs that are necessary to keep the Port and pipeline operating safely and efficiently. This includes routine, scheduled inspections of the Port and Pipeline and their components as well as unscheduled repairs that may be deemed necessary as a result of routine inspections. In general, the term "maintenance" is used to describe routine, planned inspections and the term "repair" is used to describe unplanned work done on the Port or Pipeline components in order to address deficiencies noted during inspections or routine operations.

Maintenance activities include attaching and detaching and/or cleaning the buoy pick up line to the STL buoy, performing surveys and inspections with a remotely operated vehicle, and cleaning or replacing parts (eg., bulbs, batteries, etc.) on the floating navigation buoys. Approximately every 10 years, NEG will run an intelligent pig down the pipeline to assess its condition. This particular activity will require several larger, construction-type vessels and several weeks to complete. Any replacement of Pipeline or Port components, or other unanticipated work that needs to be done as a result of these inspections would be characterized as "unplanned repairs." Unplanned repairs can be classified as "minor" or "major." Minor repairs are typically shorter in duration and could include fixing flange or valve leaks, replacing faulty pressure transducers, or repairing a stuck valve. These kinds of repairs require only one diver support vessel with three or four anchors to hold its position. Minor repairs could take from a few days to one to two weeks depending on the nature of the problem. Major repairs are longer in duration and unlikely to occur, but could include damage to a riser or umbilical and their possible replacement, damage to the pipeline and manifolds, or anchor chain replacement. Major repairs could take one to four weeks and possibly longer and would typically require large construction vessels similar to those used to install the pipeline and set the buoy and anchoring system. These vessels will typically mobilize from local ports within Massachsetts. Major repairs require upfront planning, equipment procurement, and mobilization of vessels and saturation divers.

Interactions with Maintenance and Repair Equipment

Although the specifics of repair work cannot be known until the work is ready to happen, repairs are expected to involve a limited subset of activities. The most extensive type of repair work that is reasonably foreseeable would involve limited excavation of the Pipeline. This work would be done by divers using hand-operated dredging or jetting equipment. The use of ROVs may also be required during maintenance operations.

It is not anticipated that there would be any interactions between hand-operated jetting or dredging devices and a whale. For an interaction to occur, a whale would have to be at the benthos within the vicinity of the hand-held jetting or dredging device. As listed species of whales will not occur on the benthos, any interactions with either device will not occur. In addition, as any cable or hose associated with the devices will be taut, there is no risk of entanglement. Based on this information, we have concluded that there will be no interactions between whales and hand-held jetting or dredging devices and therefore there will be no direct effects to whales from this activity.

Water Quality Degradation

Increased Turbidity

Of the possible repair activities that may cause increased turbidity, jetting is expected to generate the most turbidity and disturbance of bottom sediments. Sediment transport modeling conducted for jetting activity for a similar project indicates that initial turbidity could reach 5,000-20,000 mg/L in the upper water column immediately above the jetting apparatus while jetting is ongoing in areas where the sediment is composed of fine sand (NEG 2006). However, sediment concentrations would decrease to 500 mg/L within two hours, and 200 mg/L within three hours after jetting activities have been completed. The aerial extent of impact (greater than 20 mg/l) within 12 hours of the completion of a jetting event was 1 x 0.35 nm. Near-background concentrations would be seen after 12 hours. In areas with clay sediment, the model indicates that the sediment concentration in the water column would be lower than for sand (500-1000 mg/L), but the aerial extent of increased suspended sediment would be larger (1 x 1.4 nm) and of longer duration (30 hours).

No information is available on the effects of total suspended solids (TSS) on whales; however, studies of the effects of turbid waters on fish suggest that concentrations of suspended solids can reach thousands of milligrams per liter before an acute toxic reaction is expected (Burton 1993). TSS is most likely to affect whales if a plume causes a barrier to normal behaviors. As whales are highly mobile they are likely to be able to avoid any sediment plume by modifying their movements around the area experiencing turbidity. While the increase in suspended sediments may cause whales to alter their normal movements, any change in behavior is likely to be insignificant as it will only involve minor, temporary movements to alter their course out of the sediment plume. Based on this information, any increase in suspended sediment is not likely to affect the movement of whales between foraging areas or while migrating or otherwise negatively affect listed species in the action area. Based on this information, and the fact that any suspended sediment will be of relatively short duration (i.e. 12 to 30 hours for each event), it is likely that the effect of the suspension of sediment resulting from maintenance and repair activities, on whales will be insignificant.

Exposure to Contaminated Sediments

As presented in the Northeast Gateway Energy Bridge Deepwater Port and Northeast Gateway Pipeline Lateral Screening Level Assessment of Marine Sediments Report (TRC 2005), sediment samples collected along the Pipeline Lateral Route found that concentrations of metals and PCBs were below NOAA probable effects levels ((PELs)– the concentration above which adverse effects are frequently expected) with the exception of cadmium at one sample site and nickel at two sample sites. Polynuclear aromatic hydrocarbons (PAHs) were reported above NOAA threshold effects levels ((TEL) – the concentration below which adverse effects are expected to be observed only rarely) at every sample location, but no levels were reported above the NOAA PEL. However, the laboratory method detection limits (MDLs – the minimum concentration that can be reliably detected in a sample) for many PAHs were above the NOAA TELs and PELs. Therefore, some uncertainty exists regarding the concentration of PAHs along the Pipeline Lateral route. Four pesticides were reported above NOAA TELs at four of the five sample locations, but none exceeded NOAA PELs. Most of the sediments along the Pipeline Lateral route are silty clay, meaning that adsorption and colloid formation characteristic of these sediments would likely result in minimal dissolution of contaminants into the water column and thus minimal exposure to marine organisms. In addition, water quality monitoring in the vicinity of nearby dredging and disposal operations showed no evidence of an increase in the concentrations of dissolved contaminants over background levels (FERC 2001), indicating that contaminants remain attached to sediment particles during typical dredging operations. Given this information, and since excavation of limited portions of the Pipeline Lateral will result in less resuspension than typical dredging projects, the amount of contaminant dissolution will not be susceptible to meaningful measurement. Therefore, the effects of pipeline excavation on contaminant dissolution will be insignificant.

The exposure of whales to contaminants within their environment occurs almost exclusively through their food sources, with contaminants bioaccumulating in their systems via a process of biomagnification. Based on the above information, the temporary and localized disturbance of these sediments during the proposed action's maintenance and repair activities will not result in detectable levels of dissolved contaminants in the water column and thus, in lower trophic levels. Therefore, whales will not experience measurable increases of chemical contaminants in their tissues from the consumption of prey items in the vicinity of the NEG Port operations. Any effects to whales from the disturbance of these sediments will be insignificant. Since other sources of turbidity and seafloor disturbance will be minimal compared to that caused by jetting operations, the overall effect of project repairs on listed species due to turbidity and exposure to contaminants is insignificant.

Marine Debris

Personnel will be present onboard the barges and support vessels throughout maintenance and repair activities, thus presenting some potential for accidental releases of debris overboard. As noted in the Environmental Baseline section, whales may be adversely affected if they become entangled in marine debris. The discharge and disposal of garbage and other solid debris from vessels by lessees is prohibited by the MMS (30 CFR 250.300) and the USCG (MARPOL Annex V, Public Law 100-220 [Statute 1458]). The discharge of plastics is strictly prohibited. In addition, an environmental coordinator will be on site to ensure that environmental standards are adhered to and adverse interactions between project equipment and listed species do not occur.

Therefore, maintenance and repair activities are will not result in increased marine debris.

Light Pollution

Repair activities would take place 24 hours per day, seven days per week during the repair period. Maintenance and repair and support vessels would be required to display lights when operating at night, and deck lights would be required to illuminate work areas. However, use of lights will be limited to areas where work is actually taking place, and all other lights would be extinguished. Lights would be downshielded to illuminate the deck, and would not intentionally illuminate surrounding waters. If whales or their prey are attracted to the lights, it could increase the potential for interaction with equipment or associated turbidity. However, due to the nature of project activities, listed species and their prey are more likely to be temporarily displaced by seafloor disturbance, turbidity, and noise (see section 6.6) than attracted by lighting. As such, we have determined that any effects of project lighting on whales will be insignificant.

6.3. Effects of Operation

Potential effects of Port operation on listed whales include:

- Water quality degradation and increased marine debris;
- Entanglement directly in project components or indirectly through displaced fishing effort;
- Exposure to fuel and LNG spills;
- Light pollution;
- Water withdrawal (see Section 6.4);
- Increased risk of vessel collisions (see Section 6.5); and
- Acoustic disturbance and harassment (see Section 6.6).

Water Quality Degradation

Water quality in the vicinity of the proposed project can be affected by increased turbidity associated with long-term anchor chain sweep as described above, routine discharges generated by EBRVs while buoyed, and accidental releases of marine debris.

<u>Increased Turbidity</u>

According to modeling by the applicant, maximum turbidity expected under a worst-case scenario (100-year storm event) would be 686 mg/L, with silt transport limited to 7,527 feet. This degree of turbidity would only be expected during extreme storm events in December and March. However, some increase in suspended sediment would be expected at all times due to the movement of anchor chains under normal sea conditions. A detailed Anchor Chain Turbidity Analysis was performed in support of the final EIS/EIR (see Appendix H of the 2006 EIS/EIR). According to the analysis, the erosion area during a 100-year storm event would be approximately 19.5 acres at each buoy (39 acres for the two buoys), and the volume of eroded sediments would be about 11,650 ft^3 for each anchor. The analysis concluded that sediment transport and turbidity associated with anchor chain movement at the NEG Port is minimal in comparison to natural conditions (e.g., storms). Because the proposed action does not involve any physical or mechanical changes to the Port facility that would expand or result in greater interactions with substrate in the immediate vicinity, both the analyses and conclusions regarding impacts to benthic resources from habitat loss and turbidity remain consistent with the findings of the 2006 EIS/EIR and are herein incorporated by reference. Although slightly elevated levels of TSS may be present within 7,527 feet of the outer extent of the lost foraging habitat due to silt transport, the total area affected represents a highly localized impact. Whales would be able to easily avoid turbid areas by swimming above the height of the turbidity plume. Based on this information, the effect of increased turbidity due to anchor chain sweep will be undetectable to whales in the action area.

Contaminated Sediments

The exposure of whales to contaminants within their environment occurs almost exclusively through their food sources, with contaminants bioaccumulating in their systems via a process of biomagnification. The temporary and localized disturbance of these sediments during the proposed operation activities will not result in detectable levels of dissolved contaminants in the water column and thus, in lower trophic levels. Therefore, whales will not experience measurable increases of chemical contaminants in their tissues from the consumption of prey items in the vicinity of the NEG Port operations. Any effects to whales from the disturbance of these sediments will be insignificant. Since other sources of turbidity and seafloor disturbance will be minimal compared to that caused by jetting operations, the overall effect of project repairs on listed species due to turbidity and exposure to contaminants is insignificant.

Routine Discharges

Routine discharges associated with project operation include LNG warming water during the first and last days of regasification cycles, auxiliary cooling water, hotelling and sanitary wastes (treated wastewater, graywater, and food waste), brine water discharged from the freshwater generator, untreated seawater from the water safety curtain (fire safety system), and intermittent storm water runoff. All food waste, graywater, and blackwater would be treated at an onboard sewage treatment facility. An average of 0.005 mgd of treated wastewater would be discharged per day at the Port location. All other wastes would be retained onboard and properly discharged at sea according to MARPOL standards while EBRVs are in transit outside US waters. To minimize the potential for an accidental discharge of oil, blackwater, graywater, or bilge water, each EBRV is equipped with an oil monitoring system, which detects oil in excess of allowed percentages, and a Marine Sanitation Device, which is required to be inspected annually by a qualified engineer. Such procedures are part of the required Spill Control and Countermeasures (SPCC) plan, which includes a spill contingency plan and maintenance of Material Safety Data Sheets for all hazardous materials stored on board. The plan also requires materials to be kept on board that would be necessary to contain and clean up small spills.

Routine discharges would also include cooling water discharges. Water used to warm LNG during regasification would be recirculated to cool the main condenser. Based upon the range of activities that occurred at the Port during its three years of operation (2008-2010) that have the potential to affect the flow rate of EBRV machinery cooling water and the management of EBRV steam (e.g., safety, security, maintenance, repair and commissioning events), NEG has determined that the daily average change in temperature from ambient from an EBRV's main condenser cooling system ranged from approximately 4ºC to 12ºC (7.2ºF to 21.6ºF) depending on operating condition. Under the worst case scenario, it is anticipated that the EBRVs could discharge up to 54 mgd of heated seawater.

According to the EIA and the annual water quality monitoring reports (2008-2010), the thermal plume monitoring conducted at the NEG Port demonstrates that despite the higher discharge temperatures from the main condenser, changes in water quality and the extent of the thermal plume observed were smaller than those predicted in the final EIS/EIR and well within the existing NPDES Permit limits, which requires that measured temperatures at the 500-meter sampling location not exceed ambient temperature conditions. At sampling locations between the outfall and 500-meter location, much of the variation along the transect was within measurement accuracy and no temperature measurements exceeded ambient water temperatures by 0.5ºC (0.9ºF). The difference between the water quality from the seawater discharge of the EBRV and the surrounding water quality was not easily distinguishable and, therefore, is unlikely to be biologically meaningful.

NEG has modeled the thermal plume associated with the maximum potential daily discharge rate and temperature from the both the EBRV's main condenser cooling system and auxiliary cooling system using CORMIX (version 6.0-GT). The results of the CORMIX model indicated that summer conditions would produce an estimated maximum 0.8ºC (1.4ºF) surface temperature change within 50 meters of the EBRV. Within 500 meters of the EBRV, the CORMIX model indicated an estimated 0.5ºC (0.9ºF) summer surface temperature change and 0.31ºC (0.6ºF) for winter surface temperature change. The model results indicate that the discharge would be small compared with the available mixing volume and would mix quickly to near ambient temperatures. As the monitoring and modelling data indicate that the change in temperature downdrift of the EBRV is likely to be minor (less than 0.8ºC at 50 meters; less than 0.5ºC at 500 meters), the discharge of heated water will not have a detectable effect on the behavior of whales in the vicinity of the Port. Based on the information above, routine discharges due to NEG Port operations are likely to have an insignificant effect.

Entanglement

The buoy structure involves 16 anchor chains radiating out from the buoys and attached to suction anchors in the seafloor. As the anchor chain is 18 inches in diameter and the wire anchor cable is six inches in diameter, they do not likely to pose an entanglement risk. Chains and wire cables of this size are likely to be too stiff to wrap around and entangle a whale. Although it is possible that a whale might swim into one of the chains, it is not likely that the interaction would result in an entanglement. Four-inch diameter recovery lines would also be present in the water column. Rope recovered from entangled whales is typically one inch or less in diameter. Although there is not enough information about the logistics of entanglements to rule out the possibility that a four-inch diameter rope could potentially entangle a whale, we are not aware of any entanglement case involving rope of this size. In addition, the number of these lines in the water would be minimal—one vertical line and one surface line per buoy. Based on this information, it is extremely unlikely that a whale would become entangled in project components.

The safety zone required around the EBRVs could permanently exclude fishing activities from the Port site. This could displace fishing gear that would have been present in the project location to other areas surrounding the Port. It is difficult to quantify how much fishing activity would be displaced and where it would be displaced to. NOAA landings data indicate that the gear types used most in the vicinity of the Port are otter trawls and lobster pots (USCG 2006b).Displacement of otter trawls into areas with higher whale densities than the Port site will not increase impacts to whales because otter trawls are not known to interact with whales. Displacement of lobster traps into areas where whales are more heavily concentrated than at the Port site could result in a higher risk of entanglement; however, given the relatively limited amount of gear to be moved, and the fact that the total amount of gear in the water would not increase, the effect will not be detectable. As such, effects from displaced gear are insignificant.

Exposure to Fuel/LNG Spills

LNG is commonly composed of 95-97% methane, with the remainder a combination of ethane, propane, and other heavier gases. It is considered a flammable liquid, and the vapor is odorless, colorless, and non-toxic. When mixed with air, natural gas is only flammable when concentrations are in the range of 5-15%. Unconfined natural gas vapor clouds do not explode, but as the level of confinement increases, the potential to explode also increases. In all cases, an ignition source is required for a fire or explosion to occur. LNG does not dissolve in water, and is rapidly converted to vapor as it is warmed. Although the vapor is initially heavier than air due to its cold temperature, once warmed it is quickly dispersed into the atmosphere by the wind.

The primary hazard conditions associated with LNG include:

- Thermal radiation (flux) hazards – Thermal radiation hazards can result from ignition of an LNG pool or ignition of a flammable LNG vapor cloud. Thermal radiation is the heat felt from the source, and can result in burns.
- Cryogenic hazards – LNG is a cryogenic liquid that quickly cools the materials it comes in contact with, and can cause extreme thermal stress. Potential hazards for marine organisms would include exposure to extremely cold temperatures resulting in frostbite or death, or asphyxiation by concentrated natural gas vapors above the surface of the water. LNG vapors are non-toxic, but can displace enough air to make the atmosphere temporarily unsafe for air-breathing mammals.
- Rapid phase transition (RPT) – RPT occurs when LNG comes in direct contact with warmer water. In some cases, the rapid, uncontrolled expansion of LNG as it changes phase from a liquid to a gas could result in an explosion caused by the physical energy released during the rapid expansion of the liquid to a gas. However, the hazard zones from an RPT would be much smaller than those from vapor cloud or pool fire hazards, and are considered the lowest concern of the potential LNG hazards.

Although these hazards represent a possible avenue of impact to endangered whales in the project area should a spill or other LNG release occur, the likelihood of an LNG spill or accident is considered extremely rare. During the past 40 years, more than 80,000 LNG carrier voyages have taken place, covering more than 100 million miles, without major accidents or safety problems, either in Port or on the high seas (Pitblado 2004 in Hightower *et al.* 2004). Over the life of the industry, eight marine incidents worldwide have resulted in LNG spills, with some damage, but no cargo fires have occurred. Seven incidents have been reported with ship structural damage, two from groundings; but no spills were recorded.

Spills are most likely to occur due to intentional events, collisions with other vessels, or accidental groundings. During the independent risk assessment conducted for the evaluation of the NEG project, groundings were eliminated as a plausible scenario due to the offshore nature of the Port. Similarly, incidents due to sea-state, weather, mooring, and connection operating conditions were also excluded from the range of credible scenarios. Intentional events and accidental collision were carried forward for analysis, but due to the safety and exclusion zones surrounding LNG carriers, intentional events and collisions are still considered unlikely scenarios. The analysis concluded that the likelihood of a powered collision was once every 1,484 years for the NEG Port, and the likelihood of a drifting collision was once in 9,091 years (AcuTech 2006). In addition, should an incident occur, the impacts would be limited to the immediate vicinity of the spill within approximately one hour of the spill, due to the properties of LNG described above. As such, the potential for listed whales to come into contact with harmful LNG spills is considered discountable.

Similarly, fuel oil releases are possible; however, since the vessels associated with the Port would not be carrying oil as cargo, the only oil available for release would be oil carried in fuel tanks. Small releases of fuel oil due to fishing and other small vessel operations do occur; however, small amounts of fuel accidentally released in the course of normal operations are not expected to adversely affect whales. A large scale oil spill could have major adverse impacts on listed species or their prey. However, a large scale oil spill would only occur in the event of a collision or grounding, which for reasons stated above, would be extremely unlikely for the proposed action.

Light Pollution

NEG will be required to maintain adequate vessel lighting while the vessel is moored at the Port and in regasification mode. While moored, deck floodlights shall be operating in sufficient quantities to provide a safe working environment for vessel crew engaged in the regasification efforts. The EBRV is to be sufficiently lighted while moored to the Port to allow other vessels traversing the area to see and avoid the vessel. Lighting is downward shielded for full illumination on the deck of the vessel, and would not be directed at the surrounding waters. This should reduce attraction of marine organisms to the EBRV, but even if prey species were attracted to the vessel, thus attracting whales, the vessel would be stationary and therefore pose no risk of strike or other adverse impacts.

6.4. Effects of Water Withdrawal

The withdrawal and discharge of seawater associated with the operation of the NEG LNG facility is authorized under the NPDES permit issued by EPA. EPA is currently modifying the NPDES permit for the NEG LNG Port due to the proposal to significantly increase the volume of water used by the EBRVs.

Ballast and cooling water withdrawal at the Port as the EBRVs unload cargo could potentially impinge and entrain marine organisms. Screening of the ballast intake chests and low intake velocity would prevent direct impingement or entrainment of whales. However, zooplankton and ichthyoplankton, which serve as prey for whale species, could be removed by ballast and cooling water intake. The proposed annual water use at the Port will be 11 billion gallons per year. Potential daily water use at the Port could be as high as 56 MGD per vessel. In addition, in order to support standard EBRV water use requirements, EBRVs will require a maximum seawater intake rate of 0.45 feet per second. As a result, impacts to plankton resources from entrainment are anticipated.

Under the above water-use scenario, Tetra Tech conducted an environmental analysis on the potential impacts to marine mammals and their prey (Tetra Tech 2011 in Excelerate Energy, L.P. 2013). To evaluate impacts to phytoplankton under the increased water usage, the biomass of phytoplankton lost from the Massachusetts Bay ecosystem was estimated based on the method presented in the final EIS/EIR (2006). Phytoplankton densities of 65,000 to 390,000 cells/gallon were multiplied by the annual planned activities of withdrawal rate of 11 billion gallons to estimate a loss of 7.15×10^{14} to 4.29×10^{15} cells per year. Assuming a dry-weight biomass of 10^{-10} to 10^{-11} gram per cell (g/cell), an estimated 7.2 kg to 429 kg of biomass per year would be lost from Massachusetts Bay under the proposed activity. An order of magnitude estimate of the effect of this annual biomass loss on the regional food web can be calculated assuming a 10 percent transfer of biomass from one trophic level to the next (Sumich 1988) following the method used in the final EIS/EIR. This suggests that the loss of 7.2 kg to 429 kg of phytoplankton will result in the loss of about 0.7 kg to 42.9 kg of zooplankton, less than 0.1 kg to 4.3 kg of small planktivorous fish, and up to 0.4 kg of large piscivorous fish (approximately equivalent to a single one pound striped bass). Relative to the biomass of these trophic levels in the project area, this biomass loss is minor and consistent with the findings in the final EIS/EIR. Results are summarized in Table 1.

In addition, zooplankton losses will also increase proportionally to the increase in water withdrawn. The final EIS/EIR used densities of zooplankton determined by the sampling conducted by the Massachusetts Water Resource Authority (MWRA) to characterize the area around its offshore outfall and assumed a mean zooplankton density of 34.9×10^3 organisms per m^3. Applying this density, the proposed water withdrawal volume would result in the entrainment of 2.2×10^{10} zooplankton individuals per trip or 1.5×10^{12} individuals per year. Assuming an average biomass of 0.63×10^{-6} g per individual, this would result in the loss of 14.1 kg of zooplankton per shipment or 916.5 kg of zooplankton per year. As discussed above, biomass transfers from one trophic level to the next at a rate of about 10 percent. Therefore, this entrainment of zooplankton would result in loss of about 91.6 kg of planktivorous fish and 9.2 kg of large piscivorous fish (approximately equivalent to 18 one pound striped bass). These losses are minor relative to the total biomass of these trophic levels in Massachusetts Bay. Results are summarized in Table 1.

Finally, ichthyoplankton (fish eggs and larvae) losses and equivalent age one juvenile fish estimates under the proposed activity were made based on actual monthly ichthyoplankton data collected in the Port area from October 2005 through December 2009, and the proposed withdrawal volume of 11 billion gallons per year evenly distributed among months (0.92 billion gallons per month) as a worst-case scenario, representing the maximum number of Port deliveries during any given month. Similarly, the lower, upper, and mean annual entrainment estimates are based on the lower and upper 95 percent confidence limits of the monthly mean ichthyoplankton densities, and the monthly mean estimates multiplied by the monthly withdrawal rate of 0.92 billion gallons per month. At this withdrawal rate, approximately 106 million eggs and 67 million larvae are estimated to be lost (see Table 4.2-2 of the IHA application). The most abundant species and life stages estimated to be entrained under the proposed activity are cunner post yolk-sac larvae (33.3 million), Yellowtail flounder/*Labridae* eggs (27.4 million) and hake species eggs (18.7 million). Together, these species and life stages accounted for approximately 46 percent of the total entrainment estimated. Entrainment was estimated to be highest in June through July when 97.4 million eggs and larvae (approximately 57 percent of the annual total) were estimated to be entrained. However, since the demand for natural gas and corresponding Port activities will likely be greatest during the winter heating season (November through March), impacts from entrainment will likely be lower. Results are summarized in Table 1.

These estimated losses are not detectable given the very high natural mortality of ichthyoplankton. This comparison was done in the final EIS/EIR where ichthyoplankton losses based on historic regional ichthyoplankton densities and a withdrawal rate of approximately 2.6 billion gallons per year were represented by the equivalent number of age one fish. Under the final EIS/EIR withdrawal scenario, equivalent age one losses due to entrainment ranged from one haddock to 43,431 sand lance. Equivalent age one losses under the conditions when no NEG Port operation occurred were recalculated using NEG monitoring data in order to facilitate comparisons between the permitted scenarios. Using NEG monitoring data, withdrawal of 2.6 billion gallons per year would result in equivalent age one losses ranging from less than 1 haddock to 5,602 American sand lance. By comparison, equivalent age one losses with a withdrawal rate of 11 billion gallons per year ranged from less than 1 haddock to 23,701 sand lance. Substantially more equivalent age one Atlantic herring, pollock, and butterfish were estimated to be lost at a withdrawal rate of 2.6 billion gallons per year, while substantially more equivalent age one Atlantic cod, silver hake and hake species, cunner, and Atlantic mackerel are estimated to be lost under the proposed withdrawal of 11 billion gallons per year.

Table 1. Estimated biomass lost due to water withdrawal (11 billion gallons per year) by EBRVs at the NEG LNG Port (Excelerate Energy, L.P. 2013).

	Biomass Lost (kg/year)			
Trophic Level	**Phytoplankton**	**Zooplankton**	**Planktivorous Fish**	**Piscivorous Fish**
Phytoplankton	429 (direct)	43 (indirect)	4 (indirect)	0.4 (indirect)
Zooplankton		917 (direct)	92 (indirect)	9 (indirect)
Small Fish			60 (direct)	6 (indirect)
Total	429 (1.2 kg/day)	960 (2.6 kg/day)	156 (0.4 kg/day)	15 (0.04 kg/day)

An estimated 1,560 kg of biomass would be lost annually due to direct and indirect impacts of operation of the NEG Port (Table 1). To illustrate how the loss of plankton and fish biomass could affect the prey abundance for listed whales in the action area, Dr. Robert Kenney from the University of Rhode Island has created a bioenergetics model that compares the total amount of prey consumed by all whales of a given species occurring within Massachusetts Bay to the estimated amount of prey removed by the NEG Port under the worst-case scenario (Excelerate Energy L.P letter to NMFS; October 11, 2011).

Right whales consume almost 100 percent zooplankton, and are estimated to occur within Massachusetts Bay approximately 90 days a year (Kenney *et al.* 1985). Using the bioenergetics model, it is estimated that right whales will consume between 2,888 and 4,320 metric tons (MT) of zooplankton during this 90 day period. Removal of zooplankton by the NEG Port under worst-case conditions will result in the loss of 0.370 MT of zooplankton biomass during the 90 day residency period in Massachusetts Bay. This is a tiny fraction (0.009 to 0.013 percent) of the biomass consumed by right whales during their residency in Massachusetts Bay (Table 2).

Similarly, sei whales in the North Atlantic feed almost exclusively on zooplankton (Kenney *et al.* 1985). The bioenergetic model estimates that sei whales will consume 785 MT of biomass during their 60 day residency period in Massachusetts Bay. The operation of the NEG Port under worst-case conditions will result in the loss of about 0.247 MT of zooplankton, or about 0.031 percent of the biomass consumed by sei whales during their residency period (Table 2).

Humpback whales feed on about 95 percent small fish and 5 percent zooplankton (Kenney *et al.* 1985). The bioenergetics model estimates that humpback whales will consume 31,000 MT of biomass during their 243 day residency in Massachusetts Bay. Under worst-case condition, the operation of the NEG Port will result in the loss of about 0.999 MT of zooplankton and 0.133 MT of small fish during this period, or about 0.06 percent of the zooplankton and less than 0.001 percent of the small fish consumed by humpback whales during their residency period (Table 2).

Fin whale diet comprises about 90 percent small fish and 10 percent zooplankton (Kenney *et al.* 1985). The bioenergetic model estimates that fin whales will consume between 11,204 and 17,795 MT of biomass, respectively, during their 243 day residency period in Massachusetts Bay. Under worst-case conditions, the operation of the NEG Port will result in the loss of about 0.999 MT of zooplankton and 0.133 MT of small fish during this period. This is equivalent to between 0.056 and 0.089 percent of the zooplankton consumed by fin whales during their residency period in Massachusetts Bay, and about 0.001 percent of the small fish consumed during their residency period (Table 2).

Table 2. The proportion of the prey base for each whale species being removed due to water withdrawal at the NEG LNG Port (Excelerate Energy L.P, October 2011).

Whale Species	**Residency Period (days)**	**Number of Whales**	**Biomass Type**	**Biomass Consumed (MT/Year)**	**Biomass Removed by NEG (MT/Year)**	**Percent Biomass Removed**
Right	90	62	Zooplankton	2,888-4,320	0.370	.009-.013
Sei	60	32	Zooplankton	785	0.247	0.031
Humpback	243	199	Zooplankton	1,553	0.999	0.060
Humpback	243	199	Small Fish	29,504	0.133	< .001
Fin	243	73	Zooplankton	1,120-1,800	0.999	.056-.089
Fin	243	73	Small Fish	10083-16015	0.133	0.001

Given the very low proportion of the prey base that could potentially be removed from the action area (<0.1% for each species) by the NEG Port, the proposed water withdrawl levels will have an insignificant effect on the prey base for listed whales and thus, an insignificant effect on the energetic demands and requirements that are necessary to support daily life functions (e.g., metabolism, reproduction, locomotion).

6.5 Increased Risk of Vessel Strike

Collision with vessels remains a source of anthropogenic mortality for whales. The presence of the NEG facility will lead to increased vessel traffic during maintenance and repair work and long-term operation that would not exist but for the existence of the NEG Port. We have considered whether this increase in vessel traffic could result in an increased risk of vessel strike to listed species. Due to the limited information available regarding the incidence of ship strike and the factors contributing to ship strike events, it is difficult to determine how a particular number of vessel transits or a percentage increase in vessel traffic will translate into a number of likely ship strike events or percentage increase in collision risk. In spite of being one of the primary known sources of direct anthropogenic mortality to whales, ship strikes remain relatively rare, stochastic events, and an increase in ship traffic would not necessarily translate into a corresponding increase in ship strike events. Since 1970, the Everett LNG terminal in Massachusetts has received 619 vessel calls, with annual transits increasing since 1999 to approximately 50 shipments per year (Neptune 2005). Additionally, during operations to date, NEG has received 14 vessel calls from 2008 through 2010. No vessel strike events have been reported for any of these vessels, all of which transit the same waters of Massachusetts Bay. Nonetheless, the risk of ship/whale interactions is a cumulative risk. It also remains possible that an interaction could have occurred between a whale and a tanker calling at the Everett terminal without being detected.

Massachusetts Bay

Large whales, particularly right whales, are vulnerable to injury and mortality from ship strikes. Due to the overlap of heavy shipping traffic and high whale density, Massachusetts Bay is a high risk area for ship strike events. Jensen and Silber (2003) report 36 documented ship strikes in Massachusetts waters from 1975-2002 (6 right whales, 10 humpbacks, 7 fin, 7 minke, 1 sei, and 5 of unknown species). Between 2002 and 2007, there were 24 additional confirmed or suspected ship strikes reported in Massachusetts waters (1 minke, 4 right, 11 humpback, 2 fin, 1 sei, 5 unknown; NMFS 2007). However, some of these reported locations represent where carcasses were found, and not necessarily where the whales were actually struck. It should also be noted that these numbers represent a minimum number of whales struck by vessels, as many ship strikes go undetected or unreported, and many whale carcasses are never recovered. Although right whales are not the species reported struck most often overall, the low abundance of right whales suggests that right whales are struck proportionally more often than any other species of large whale (Jensen and Silber 2003).

The proposed IHA, as well as the license from MARAD, requires NEG to implement a number of mitigation measures to reduce the likelihood of a NEG vessel (EBRV, maintenance, repair, or support) interacting with a whale while in Massachusetts Bay. The ship strike mitigation measures are summarized below, but for complete details on the appropriate implementation of the following strategies see the NEG Marine Mammal Detection, Mitigation, and Response Plan (MMDMRP) analyzed in the 2007 Opinion and incorporated herein by reference.

- Designated crew members with watch standing duties will undergo a NOAA-approved training regarding marine mammal presence and collision avoidance procedures. Watches will be maintained while all vessels are underway. NOAA-certified marine mammal observers (MMOs) will be used on maintenance and repair vessels utilizing dynamic positioning (DP) thrusters.
- All repair vessels greater than or equal to 300 gross tons must maintain a speed of 10 knots or less, unless extraordinary circumstances dictate the need for an alternate speed. Vessels of less than 300 gross tons carrying supplies or crew between the shore and the repair site shall contact the Mandatory Ship Reporting System (MSRS), the USCG, or the MMO's at the repair site before leaving shore for reports of recent right whale sightings or active Dynamic Management Areas (DMAs) and, consistent with navigation safety, restrict speeds to 10 knots or less within 5 miles (8 kilometers) of any sighting location and within any existing DMA.
- Vessels transiting through the Cape Cod Canal and Cape Cod Bay between January l and May 15 must reduce speed to 10 knots or less (unless extraordinary circumstances dictate the need for an alternate speed), follow the recommended routes charted by NOAA to reduce interactions between right whales and shipping traffic, and avoid identified aggregations of right whales in the eastern portion of Cape Cod Bay.
- MMOs (if required on a DP vessel) and/or designated watch standing crew onboard maintenance and repair vessels will direct a moving vessel to go into high alert and slow speed of four knots or less if a whale is sighted within 1,000 meters of the vessel and a sighting within 750 meters will result in idle speed and/or ceasing all movement unless extraordinary circumstances dictate the need for an alternate speed.
- An array of passive acoustic detection buoys have been installed in the Boston TSS that meets the criteria specified by NOAA in recommendations to the USCG under the National Marine Sanctuaries Act. The system will provide near real-time information on the presence of vocalizing whales in the shipping lanes.
- Prior to entering areas where right whales are known to occur, including the Great South Channel and SBNMS, EBRV operators will consult recent right whale sighting and/or DMA information through NAVTEX, NOAA Weather Radio, NOAA's Right Whale Sighting Advisory System (SAS) or other means to obtain the latest sighting information. Vessel operators will also receive active detections from the passive acoustic array prior to and during transit through the northern leg of the Boston TSS where the buoys are installed.
- In response to active right whale sightings or DMAs (detected either acoustically or through the SAS), EBRVs will take appropriate actions to minimize the risk of striking whales, including maintaining a speed of 10 knots or less if the vessel is within the DMA or within an 8 nm radius centered on the location of the sighting and posting additional observers.
- Designated watchstanding crew members will undergo NOAA-approved training regarding marine mammal presence and collision avoidance procedures.

- Vessels shall utilize the Boston TSS on approach and departure from the Port and/or the repair/maintenance area at the earliest practicable point of transit (subject to extraordinary circumstances dictating vessel navigation).
- EBRVs and support vessels will travel at 10 knots maximum within Massachusetts Bay when transiting to/from the Port outside of the TSS unless extraordinary circumstances dictate the need for an alternate speed.
- EBRVs will transit at 10 knots maximum year-round in the Off Race Point management area and from April 1-July 31 in the Great South Channel SMA, unless hydrographic, meteorological, or traffic conditions dictate an alternative speed to maintain the safety or maneuverability of the vessel.
- In such cases where speeds in excess of the 10 knot speed maximums as described above are required, the reasons for the deviation, the speed at which the vessel is operated, the location, and the time and duration of such deviation will be documented in the logbook of the vessel and reported to the NMFS NER Section 7 Coordinator.
- All vessels will comply with the year-round Mandatory Ship Reporting System (MSR).
- If whales are seen within 1,000 meters of the buoy, then the EBRVs will wait until the whale leaves the area before departing, unless an extraordinary circumstance requires that departure is not delayed.

Ship strike injuries to whales take two forms: (1) propeller wounds characterized by external gashes or severed tail stocks; and (2) blunt trauma injuries indicated by fractured skulls, jaws, and vertebrae, and massive bruises that sometimes lack external expression (Laist *et al.* 2001). Collisions with smaller vessels may result in propeller wounds or no apparent injury, depending on the severity of the incident. Laist *et al.* (2001) reports that of 41 ship strike accounts that reported vessel speed, no lethal or severe injuries occurred at speeds below 10 knots, and no collisions have been reported for vessels traveling less than six knots. As discussed in the Status of the Species section, all whales are potentially subject to collisions with ships. However, due to their critical population status, slow speed, and behavioral characteristics that cause them to remain at the surface, vessel collisions pose the greatest threat to right whales. As females are more critical to a population's ability to replace its numbers and grow, the premature loss of even one reproductively mature female could hinder the species' likelihood of recovering.

As discussed in the Environmental Baseline, to address the occurrence of ship strikes of endangered right whales along the US east coast, we have implemented measures to regulate speed in the approaches to major Port entrances, including the approaches to Boston (50 CFR §224.105). Tankers bound for the NEG LNG terminal are required to comply with these regulations when in Massachusetts Bay. Because right whales have been sighted year-round in Massachusetts waters, NEG has agreed to consult recent right whale sighting information and/or DMA zones prior to entering areas where right whales are known to occur, and slow to 10 knots or less and post additional lookouts in the vicinity of active sighting locations or DMAs.

Limited data are available on whale behavior in the vicinity of an approaching vessel and the hydrodynamics of whale/vessel interactions. However, the measures proposed by NEG above are in accordance with measures outlined in NMFS Ship Strike Reduction Program and are the best, available means of reducing ship strikes of right whales. Most ship strikes have occurred at vessel speeds of 13-15 knots or greater (Jensen and Silber 2003; Laist *et al.* 2001). An analysis by

Vanderlaan and Taggart (2006) showed that at speeds greater than 15 knots, the probability of a ship strike resulting in death increases asymptotically to 100%. At speeds below 11.8 knots, the probability decreases to less than 50%, and at 10 knots or less the probability is further reduced to approximately 30%. The seasonal management time periods developed through the right whale ship strike reduction strategy were designed to capture the majority of predictable right whale concentrations (Merrick 2005). Although these measures have been developed specifically with right whales in mind, the speed reduction is likely to provide protection for other large whales in Massachusetts Bay as well, as these species are generally faster swimmers and are more likely to be able to avoid oncoming vessels. In addition, all vessels operators and lookouts will receive training on prudent vessel operating procedures to avoid vessel strikes with all protected species.

EEZ to the Great South Channel

The mitigation measures currently employed within Massachusetts Bay do not apply to the part of the action area that is southeast of the Great South Channel SMA (Figure 3). This area (roughly 30,000 square miles) makes up approximately two-thirds of the action area. Right whales, which prefer near-shore areas, are less likely to occur in that area (Figure 4). However, humpback, fin, and sei whales could occur in that portion of the action area when EBRVs transit to Massachusetts Bay.

Figure 4. The sighting locations of right whales between January 2013 and November 2014. The Great South Channel SMA is indicated just to the northeast of the TSS (NEFSC 2014).

Maintenance and Repair Vessel Traffic

Depending on the specific maintenance and repair activity required, different types and numbers of support vessels will be transiting to and from the Port site from local ports. These vessels may include dive support vessels, anchored barges, and dynamically positioned vessels. Vessels for most routine maintenance and minor repairs would originate from an onshore base located between Quincy, Massachusetts and Gloucester, Massachusetts. The exact number and nature of transits will depend on the type of activity and cannot be specified at this time. However, while transiting to and from the construction sites, supply vessels, and dive support vessels would travel at approximately 10 knots. While actually engaged in operations, including surveys and installation of project components, the vessels would move at speeds less than 10 knots.

The number of large commercial vessel transits in Massachusetts Bay has been estimated at approximately 3,413 annual transits in 2006 (Hatch *et al.* 2008). An independent risk assessment conducted for the USCG in relation to the Neptune and NEG LNG projects also accounted for an additional 54,914 transits from medium-sized cruise ships, roll-on/roll-off ferries, whale watch vessels, commercial fishing vessels, and dredging vessels (USCG 2006). Overall, an estimate 58,327 vessel trips likely occur annually in Massachusetts Bay. It is important to note that the total does not include vessel traffic contributed by private recreational vessels. The small number of additional transits contributed by maintenance and repair support vessels represents a minimal increase in overall vessel traffic in the area. In addition, the majority of these transits will be occurring between Boston and the pipeline and Port sites. Sightings increase closer to the Port site, but the presence of a real-time passive acoustic array within the TSS will allow detection and localization of whales as the vessels approach. Additionally, vessels transiting to and from the Ports in Boston will monitor information from the array so that as they approach the NEG Port they can adjust their movements and speeds accordingly. The on-site environmental coordinator will be able to provide information to approaching vessels about the locations of whales nearby, observers will be posted on vessels, and vessels can reduce speed, increase vigilance, or alter course accordingly. As such, at the typical operating speeds of the vessels described above and with the proposed mitigation measures in place, it is not anticipated that the increase in maintenance and repair vessel traffic will result in a detectable increase in ship strikes. Therefore, the likelihood of the maintenance and repair-related vessel traffic resulting in collision with a whale is insignificant.

EBRV and Support Vessel Transits

The EBRVs that will be carrying cargo to the NEG terminal may pose a greater risk to whales due to their deep draft, which increases the zone of potential impact with whales that are sub-surface. In addition, the greater mass of larger vessels increases the likelihood that serious injury or death to the whale will result from any collision. The mitigation measures currently employed within Massachusetts Bay are expected to be effective for EBRV transits; but as discussed above, they do not apply to the portion of the action area southeast of the Great South Channel. A maximum of 65 EBRVs a year will be transiting through this 30,000 square mile area per year as they transit to the NEG Port. In an analysis by Laist *et al*. (2001), 53 out of 58 (~91%) documented vessel whale strikes occurred over or near the continental shelf, probably reflecting the concentration of vessel traffic and whales in these areas. Much of this portion of the action area falls beyond the continental shelf (Figure 4), making vessel strike unlikely. Additionally, as discussed above, a maximum of 65 roundtrip EBRV transits per year will constitute a minor increase in vessel traffic in the area when compared to the 3,413 estimated annual transits by large commercial vessels in 2006. Therefore, we do not anticipate that any ship strikes will occur within the portion of the action area southeast of the Great South Channel. Combined with the implementation of the ship strike reduction measures within Massachusetts Bay, this minor increase in ship traffic throughout the action area is not expected to have a detectable effect on the number of vessel strikes in the action area. Therefore, the effect of increased EBRV vessel traffic on ship strike occurrences is expected to be insignificant.

6.6 Acoustic Effects

Sources of noise associated with the proposed action result from vessel operations (DP thruster use and support vessel transits) during Port operations and maintenance and repair activities. Below, we present background information on underwater acoustics and marine mammal hearing and response thresholds; characterize the sound sources associated with the NEG Port operations; determine which species are likely to be exposed to each type of noise; and analyze the effects of exposure to these sound sources to listed whales.

6.6.1 Background Acoustic Information and Terminology

Frequency (i.e., number of cycles per unit of time, with hertz (Hz) as the unit of measurement) and amplitude (loudness, measured in decibels (dB)) are the measures typically used to describe sound. An acoustic field from any source consists of a propagating pressure wave, generated from particle motions in the medium that causes compression and rarefaction. This sound wave consists of both pressure and particle motion components that propagate from the source. Sound in water follows the same physical principles as sound in air. The major difference is that due to the density of water, sound in water travels about 4.5 times faster than in air (approx. 4900 feet/s vs. 1100 feet/s), and attenuates much less rapidly than in air. As a result of the greater speed, the wavelength of a particular sound frequency is about 4.5 times longer in water than in air (Rogers and Cox 1988; Bass and Clarke 2003).

The level of a sound in water can be expressed in several different ways, but always in terms of dB relative to 1 micro-Pascal (µPa). Decibels are a log scale; each 10 dB increase is a ten-fold increase in sound pressure. Accordingly, a 10 dB increase is a 10x increase in sound pressure, and a 20 dB increase is a 100x increase in sound pressure.

The following are commonly used measures of sound:

- Peak sound pressure level (SPL): the maximum sound pressure level (highest level of sound) in a signal measured in dB re 1 µPa.
- Sound exposure level (SEL): the integral of the squared sound pressure over the duration of the pulse (e.g., a full pile driving strike). SEL is the integration over time of the square of the acoustic pressure in the signal and is thus an indication of the total acoustic energy received by an organism from a particular source (such as pile strikes). Measured in dB re 1µPa^2-s.
- Root Mean Square (RMS): the square root of the average squared pressures over the duration of a pulse; RMS pressure levels are generally "produced" within seconds of the operations, and represent the effective pressure, and its resultant intensity (in dB re: 1 µPa;), produced by a sound source.

6.6.2 Background Information on Acoustics and Marine Mammals

Right, Humpback, Fin, and Sei Whale Hearing

In order for whales to be adversely affected by anthropogetic noise, they must be able to perceive the noises produced by the activities. Baleen whale hearing has not been studied directly, and there are no specific data on sensitivity, frequency or intensity discrimination, or localization (Richardson *et al*. 1995) for these whales. Thus, predictions about impact on baleen whales are based on assumptions about their hearing rather than actual studies of their hearing (Richardson et al. 1995; Ketten 1998).

Ketten (1998) summarized that the vocalizations of most animals are tightly linked to their peak hearing sensitivity. Hence, it is generally assumed that baleen whales hear in the same range as their typical vocalizations, even though there are no direct data from hearing tests on any baleen whale. Most baleen whale sounds are concentrated at frequencies less than 1 kHz (Richardson et al. 1995), although humpback whales can produce songs up to 8 kHz (Payne and Payne 1985). Based on indirect evidence, at least some baleen whales are quite sensitive to frequencies below 1 kHz but can hear sounds up to a considerably higher but unknown frequency. Most of the manmade sounds that elicited reactions by baleen whales were at frequencies below 1 kHz (Richardson et al. 1995). Some or all baleen whales may hear infrasounds, sounds at frequencies well below those detectable by humans. Functional models indicate that the functional hearing of baleen whales extends to 20 Hz, with an upper range of 30 Hz. Even if the range of sensitive hearing does not extend below 20-50 Hz, whales may hear strong infrasounds at considerably lower frequencies. Based on work with other marine mammals, if hearing sensitivity is good at 50 Hz, strong infrasounds at 5 Hz might be detected (Richardson et al. 1995). Fin whales are predicted to hear at frequencies as low as 10-15 Hz. The right whale uses tonal signals in the frequency range from roughly 20 to 1000 Hz, with broadband source levels ranging from 137 to 162 dB re 1 μPa RMS (Parks and Tyack 2005). One of the more common sounds made by right whales is the "up call," a frequency-modulated upsweep in the 50–200 Hz range (Mellinger 2004). The following table summarizes the range of sounds produced by right, humpback, fin, and sei whales (Table 3; from Au et al. 2000):

Table 3. Summary of known right, humpback, fin, and sei whale vocalizations.

Species	Signal type	Frequency Limits (Hz)	Dominant Frequencies (Hz)	Source Level (dB re 1μPa RMS)	References
North Atlantic Right	Moans Tonal Gunshots	< 400 20-1000	-- 100-2500 50-2000	-- 137-162 174-192	Watkins and Schevill (1972) Parks and Tyack (2005) Parks et al. (2005)
Humpback	Grunts	25-1900	25-1900	--	Thompson, Cummings, and Ha

	Pulses Songs	25-89 30-8000	25-80 120-4000	176 144-174	(1986) Payne and Payne (1985)
Fin	FM moans Tonal Songs	14-118 34-150 17-25	20 34-150 17-25	160-186 186	Watkins (1981), Edds (1988), Cummings and Thompson (1994) Edds (1988) Watkins (1981)
Sei	FM Sweeps	1500-3500	-	-	T. Thompson et al. 1979; Knowlton et al. 1991

Most species also have the ability to hear beyond their region of best sensitivity. This broader range of hearing probably is most likely related to their need to detect other important environmental phenomena, such as the locations of predators or prey. Among marine mammal species, considerable variation exists in hearing sensitivity and absolute hearing range (Richardson et al. 1995; Ketten 1998). However, from what is known of right, humpback, sei, and fin whale hearing and the source levels and dominant frequencies of the site assessment and characterization activities, it is expected that if these whales are present in the area where the underwater noise occurs they would be capable of perceiving those noises.

Criteria for Assessing Effects to Listed Whales

When anthropogenic disturbances elicit responses from marine mammals, it is not always clear whether they are responding to visual stimuli, the physical presence of humans or man-made structures, or acoustic stimuli. However, because sound travels well underwater, it is reasonable to assume that, in many conditions, marine organisms would be able to detect sounds from anthropogenic activities before receiving visual stimuli. As such, exploring the acoustic effects of the proposed project provides a reasonable and conservative estimate of the magnitude of disturbance caused by the general presence of a manmade, industrial structure in the marine environment, as well as effects of sound on marine mammal behavior.

Effects of noise exposure on marine organisms can be characterized by the following range of physical and behavioral responses (Richardson *et al*. 1995):

1. Behavioral reactions – Range from brief startle responses, to changes or interruptions in feeding, diving, or respiratory patterns, to cessation of vocalizations, to temporary or permanent displacement from habitat.
2. Masking – Reduction in ability to detect communication or other relevant sound signals due to elevated levels of background noise.
3. Temporary threshold shift (TTS) – Temporary, fully recoverable reduction in hearing sensitivity caused by exposure to sound.
4. Permanent threshold shift (PTS) – Permanent, irreversible reduction in hearing sensitivity due to damage or injury to ear structures caused by prolonged exposure to sound or temporary exposure to very intense sound.

5. Non-auditory physiological effects – Effects of sound exposure on tissues in non-auditory systems either through direct exposure or as a consequence of changes in behavior, e.g., resonance of respiratory cavities or growth of gas bubbles in body fluids.

NMFS is in the process of developing a comprehensive acoustic policy that will provide guidance on managing sources of anthropogenic sound based on each species' sensitivity to different frequency ranges and intensities of sound. The available information on the hearing capabilities of cetaceans and the mechanisms they use for receiving and interpreting sounds remains limited due to the difficulties associated with conducting field studies on these animals. However, current thresholds for determining potential impacts to marine mammals are as follows:

Injury	Behavioral Disturbance
180 dB RMS	120 dB RMS (continuous noise source)
	160 dB RMS (non-continuous noise source (impulsive))

These thresholds are based on a limited number of experimental studies on captive odontocetes, a limited number of controlled field studies on wild marine mammals, observations of marine mammal behavior in the wild, and inferences from studies of hearing in terrestrial mammals (NMFS 1995; Southall *et al*. 2007; Malme *et al.* 1983, 1984; Richardson *et al*. 1990,1995,1986; Tyack 1998). Marine mammal responses to sound can be highly variable, depending on the individual hearing sensitivity of the animal, the behavioral or motivational state at the time of exposure, past exposure to the noise which may have caused habituation or sensitization, demographic factors, habitat characteristics, environmental factors that affect sound transmission, and non-acoustic characteristics of the sound source, such as whether it is stationary or moving (NRC 2003). Nonetheless, the threshold levels referred to above are considered conservative based on the best available scientific information at this time and will be used in the analysis of effects for this consultation.

6.6.3 Characterization of Noise Sources

6.6.3.1 Maintenance and Repair

As stated earlier in the document, routine inspections of NEG Port mooring components occur after each buoy connection from the Port's normal support vessel. Inspections of other Port facility components such as the STL Buoy, flexible riser, mooring system, pipeline end manifold (PLEM) are conducted annually by an ROV and/or diver launched from a vessel of opportunity. Routine inspections of the Algonquin Pipeline Lateral are conducted annually by a ROV launched from a vessel of opportunity. Planned O&M activity is the annual inspection of the cathodic protection monitors by an ROV. The monitors are located at the ends of the Algonquin Pipeline Lateral and the adjacent Flowlines. Each inspection will take approximately three days and will likely be conducted with vessels similar to the NEG Port's normal support vessel.
In addition to these routine activities, there may be instances whereby unanticipated events at the NEG Port and Algonquin Pipeline Lateral necessitate emergency maintenance and/or repair activities. While the extent and number of such maintenance and repair activities at the NEG Port or the Algonquin Pipeline Lateral over its expected 25 year life cannot be accurately estimated, it is reasonable to assume that a worst-case maintenance and/or repair scenario would result in

similar types of activities and require the use of similar support vessels and equipment as used for construction.

Modeling analysis conducted by Tetra Tech concluded that the only underwater noise of critical concern during NEG Port and Algonquin Pipeline Lateral construction would be from vessel noises such as turning screws, engine noise, noise of operating machinery, and thruster use. To confirm these modeled results and better understand the noise footprint associated with construction activities at the NEG Port and the pipeline lateral, field measurements were taken of various construction activities during the 2007 NEG Port and Algonquin Pipeline Lateral construction period (Table 4;Tetra Tech 2011). Measurements were taken to establish the "loudest" potential construction measurement event. The location at the LNG Port was used to determine site-specific distances to the 120/180 dB re 1 μPa RMS isopleths for NEG Port maintenance and repair activities, and two positions within Massachusetts Bay were then used to determine site-specific distances to the 120/180 dB re 1 μPa RMS isopleths for pipeline lateral maintenance and repair activities: at PLEM and at Mid-Pipeline.

Table 4. Noise measurements of construction activities taken at the NEG LNG Port during its construction in 2007 (Tetra Tech 2011).

Activity	**Source Distance (m)**	**Sound Level (dB re: 1 μPa)**
Pipe Laying	100-300	133-147
	500-600	128-138
Crew Boat	200	131
Plowing	440-550	131-139
Backfilling	1,100-1,410	125-131
	610-1,050	129-136

Sound propagation calculations were performed to determine the noise footprint of the construction activity. The calculations took into consideration aspects of water depth, sea state, bathymetry, and seabed composition, and specifically evaluated sound energy in the range that encompasses the auditory frequencies of marine mammals and at which sound propagates beyond the immediate vicinity of the source. These results were then summed across frequencies to provide the broadband received levels at receptor locations. The modelled noise levels did not reach180 dB re 1 μPa RMS at any distance from the source, which indicates that injurious levels of sound are not expected to result from the project activities. However, the behavioral effect threshold of 120 dB re 1 μPa RMS was exceeded. The calculations indicate the distance between the source and a point (or isopleth) where noise levels drop below the threshold. The resulting isopleths delineate the zones where whales could be behaviorally effected (Table 5).

Table 5. Radii of the 120-dB SPL isopleths from the NEG and Algonquin Pipeline Lateral operation, maintenance, and repair. There were no 180 dB isopleths.

	Radius to 120 dB zone (m)
Port Operations	

One EBRV docking with Support Vessel	4,250
Two EBRV docking with Support Vessel	5,500
EBRV Regasification	<300
EBRV Transiting the TSS at 10 knots	1,750
Port Maintenance/Repair	3,600
Pipeline Maintenance	
Barge/Tug construction vessel/barge @ PLEM	3,600
Barge/Tug construction vessel/barge @ mid-pipeline	2,831

6.6.3.2 Port Operations

Bow Thrusters

Bow thrusters are used for dynamic positioning of the EBRV during docking procedures. Thruster noise is similar to the noise of large vessel transits, with peak intensities in the lower frequency ranges (10-100 Hz). Thruster operation at the NEG Port is expected to take place in bouts of 10-30 minutes at a time during docking and departure. Assuming a worst-case scenario maximum of 30 minutes per vessel arrival, this would constitute a total of approximately 32.5 hours per year (65 annual arrivals). According to Tetra Tech (2011), acoustic monitoring was conducted at the Gulf Gateway Deepwater LNG Port to estimate the amount of operational noise that can be expected at the NEG Port in Massachusetts. At the closest separation distance of 100 meters, sound levels ranged from 120 dB re 1 μPa on approach to 132 dB re 1 μPa upon connection, in the frequency of 100 to 2,000 Hz. This measurement data is consistent with the predicted source level of 160 to 170 dB re 1 μPa from normal thruster operations on a single EBRV during coupling/decoupling operations and maneuvering.

Vessel Transits (LNG carriers and support vessels)

Source level data specific to the EBRVs proposed to be used for this project are not available. However, data exist for other tankers of similar size and power. Large commercial vessels and supertankers have powerful engines and large, slow-turning propellers. These vessels produce high sound levels, mainly at low frequencies. At these frequencies the noise is dominated by propeller cavitation noise combined with dominant tones arising from the propeller blade rate (Neptune 2005). An EBRV was acoustically monitored during a transit in the vicinity of the Gulf Gateway Deepwater LNG Port in the Gulf of Mexico as it transited in a straight line (Tetra Tech 2011). The EBRV maintained constant speed, fixed machinery conditions and minimum use of the helm. Measurements were taken approximately 100 meters away from the vessel. At 13 knots, the maximum pass by sound level was measured at 132 dB re 1 μPa (100 to 2,000 Hz). At 10 knots, the measured maximum sound level was 134 dB re 1 µPa (100 to 2,000 Hz. The three knot pass was logged at 125 dB re 1 µPa (100 to 2,000 Hz) (Tetra Tech 2011). These propulsion driven EBRV sound levels are consistent with apparent source levels of 160 to 170 dB re 1 µPa, as reported in the 2006 NEG EIS/EIR.

Regasification

Due to the technology being employed, there is minimal noise associated with the regasification process itself. Acoustic output of an existing offshore LNG facility in the Gulf of Mexico utilizing the same STL buoy system technology proposed by NEG was measured over a 5-day period in 2005 to provide an estimate of the acoustic impact of the NEG Port. Nearfield measurements were completed at multiple locations off the side of the EBRV to determine variations in sound levels immediately adjacent to the hull of the vessel. Sound levels were found to vary between 120 and 130 dB re 1 µPa (100 to 2000 Hz) (Tetra Tech 2011). These levels are not expected to be readily detectable over distances extending beyond approximately 300 meters from the EBRV, dependent on site specific environmental and sea state conditions.

6.6.4 Exposure to Noise Effects

6.6.4.1 Maintenance and Repair

The endangered whale species most likely to be present near the maintenance and repair activities during the preferred May-November timeframe are humpback and fin whales. Sightings of right whales in this area and season are rare, but transient right whales have been seen in the vicinity of the proposed terminal during the summer months (Weinrich 2006; NEFSC unpublished data), so we will consider them to be present for the purposes of this analysis. Sei whales are generally found further offshore, but as mentioned previously, a whale tentatively identified as a sei whale was sighted by marine mammal observers during construction of the nearby Neptune Port, so we will consider sei whales to be potentially present also.

Exposure to Injurious Levels of Sound

No blasting, pile driving, or other activities that generate impulse sounds are anticipated during maintenance and repair work. Therefore, as all noise produced by the proposed repair and maintenance activities is expected to be non-impulsive, the threshold for injurious effects is 180 dB re 1 µPa RMS. None of the activities associated with repair and maintenance will expose listed species to noise levels as high as 180 dB re 1 µPa RMS. Therefore, no injuries or mortalities are anticipated to occur (i.e. non-auditory physiological effects or PTS as described by Richardson *et al.* 1995). Additionally, animals in the area are not anticipated to incur any temporary hearing impairment (i.e., TTS), as the modeling of source levels indicates that none of the source received levels reach 180 dB re 1 µPa RMS.

Exposure to Disturbing Levels of Sound

Maintenance and Repair of the Port

Measurements were taken to establish the "loudest" potential construction measurement event. One position within Massachusetts Bay was then used to determine site-specific distances to the 120/180 dB re 1 μPa RMS isopleths for NEG Port maintenance and repair activities:

- Construction Position 1 - Port: 70° 36.261 'W and 42° 23. 790' N

Sound propagation calculations were performed to determine the noise footprint of the construction activity. The calculations took into consideration aspects of water depth, sea state, bathymetry, and seabed composition, and specifically evaluated sound energy in the range that encompasses the auditory frequencies of marine mammals and at which sound propagates beyond the immediate vicinity of the source. These results were then summed across frequencies to provide the broadband received levels at receptor locations. The results showed that the estimated distance from the loudest activity involved in construction fell to 120 dB re 1 μPa at a distance of 3,600 meters (Table 5).

Maintenance and Repair of the Pipeline

As with construction noise at the NEG Port, to confirm modeled results and better understand the noise footprint associated with construction activities along the Algonquin Pipeline Lateral, field measurements were taken of various construction activities during the 2007 NEG Port and Algonquin Pipeline Lateral construction period. Measurements were taken to establish the loudest potential construction measurement event. Two positions within Massachusetts Bay were then used to determine site-specific distances to the 120/180 dB re 1 μPa RMS isopleths:

- Construction Position 2 - PLEM: 70° 46.755' W and 42° 28.764' N
- Construction Position 3 - Mid-Pipeline: 70° 40.842' W and 42° 31.328' N

Sound propagation calculations were performed to determine the noise footprint of the construction activity. The calculations took into consideration aspects of water depth, sea state, bathymetry, and seabed composition, and specifically evaluated sound energy in the range that encompasses the auditory frequencies of marine mammals and at which sound propagates beyond the immediate vicinity of the source. These results were then summed across frequencies to provide the broadband received levels at receptor locations. The result of the distances to the 120-dB are shown in Table 5.

6.6.4.2 Port Operation

For the purposes of understanding the noise footprint of operations at the NEG Port, measurements taken to capture operational noise (docking, undocking, regasification, and EBRV thruster use) during the 2006 Gulf of Mexico field event were taken at the source. Measurements taken during EBRV transit were normalized to a distance of 328 feet (100 meters) to serve as a basis for modeling sound propagation at the NEG Port site.

Sound propagation calculations for operational activities were then completed at two positions in Massachusetts Bay to determine site-specific distances to the 120/160/180 dB re 1 μPa RMS isopleths:

- Operations Position 1 - Port (EBRV Operations): 70° 36.261'W and 42° 23.790' N
- Operations Position 2 - Boston TSS (EBRV Transit): 70° 17.621 'W and 42°17.539' N

At each of these locations sound propagation calculations were performed to determine the noise footprint of the operation activity at each of the specified locations. Calculations were performed in accordance with Marsh and Schulkin (1985) and Richardson *et al.* (1995) and took into consideration aspects of water depth, sea state, bathymetry, and seabed composition. In addition, the acoustic modeling performed specifically evaluated sound energy in 1/3-octave spectral bands covering frequencies from 12.5 Hz to 20 kHz. The resultant underwater sound pressure levels to the 120 dB re 1 μPa RMS isopleths is presented in Table 5.

Because operational acoustic effects will occur year-round and involve vessel transits from the EBRV's entry point into the US EEZ to the Port site, all whale species being considered in this consultation have the potential to be affected to some degree by the proposed operational activities. Vessel transits are expected to be distributed fairly evenly throughout the seasons, and since there will be a vessel on buoy at all times, impacts at the Port site will be consistent throughout the year. However, it is important to consider that sounds tend to propagate slightly further in colder water, meaning that operational noise during the winter has the potential to expose animals in a somewhat wider area, although there may be fewer animals overall in the area during the winter. Species that are present only seasonally in the area will be exposed to operational noise less often than other species that are present year-round.

As established previously in relation to maintenance and repair noise, right, humpback, fin and sei whales are all known to be sensitive to sounds within the frequency ranges of vessel noise and thrusters.

6.6.5 Noise Effects on Marine Mammals

In previous sections, we concluded that listed species in the action area are not likely to be exposed to injurious levels of sound. As such, this analysis of acoustic effects from operations, maintenance, and repair will focus on behavioral disturbance that may result at the NEG Port and Algonquin Pipeline Lateral.

6.6.5.1 Maintenance and Repair

All of the noise sources associated with operation, maintenance, and repair work can be categorized as continuous non-pulses. While non-impulse noise is generally less likely to cause injury, continuous noise has been observed to elicit behavioral reactions at lower received levels. As noted previously, the species most likely to be present in the vicinity of the proposed activities during the summer months are humpback and fin whales.

The most commonly observed marine mammal behavioral responses to vessel activity include increased swim speed (Watkins 1981), horizontal and vertical (diving) avoidance (Baker *et al.* 1983; Richardson *et al.* 1985), changes in respiration or dive rate (Baker *et al* 1982; Bauer and Herman 1985; Richardson *et al.* 1985; Baker and Herman 1989; Jahoda *et al.* 2003), and interruptions or changes in feeding or social behaviors (Richardson *et al* 1985; Baker *et al.* 1982; Jahoda *et al.* 2003). Watkins *et al.* (1981) noted that passage of a tanker within 800 meters did not disrupt feeding humpback whales. Although these studies have shown a high degree of variability in the intensity of responses, perhaps due to the demographic characteristics of the individual whale, the type of vessel approach, and the social and motivational state of the animal at the time of the interaction, in all cases the changes were observed to be short-term (e.g., minutes to hours), with animals often returning to their original behavioral state even if the stimulus remained (Wartzok *et al.* 1989).

Baker *et al.* (1982) found that abrupt changes in engine speed and aggressive maneuvers such as circling the whale or crossing directly behind or in front of the whale or its projected path elicited much stronger responses than unobtrusive maneuvering (tracking in parallel to the whale and changing vessel speed only when necessary to maintain a safe distance from the whale). Reactions were even less intense during a simple straight line passby, which most closely represents the type of vessel transit that will take place as a result of the construction activities· (i.e., not targeted toward viewing whales).

Richardson *et al.* (1985) observed strong reactions in bowhead whales to approaching boats and subtler reactions to drillship playbacks, but also found that bowhead whales often occurred in areas where low frequency underwater noise from drillships, dredges, or seismic vessels was readily detectable, suggesting that bowheads may react to transient or recently begun industrial activities, but may tolerate noise from operations that continue with little change for extended periods of time (hours or days).

Watkins (1986) compiled and summarized whale responses to human activities in Cape Cod Bay over 25 years, and found that the types of reactions had shifted over the course of time, generally from predominantly negative responses (e.g., startle, avoidance, and agonistic responses) to an increasing number of uninterested or positive responses (e.g., approaching the source of activity), although trends varied by species and only emerged over relatively long spans of time (i.e., individual variability from one experience to the next remains high). Watkins also noted that whales generally appeared to habituate rapidly to stimuli that were relatively non-disturbing.

Jahoda *et al.* (2003) studied the response of 25 fin whales in feeding areas in the Ligurian Sea to close approaches by inflatable vessels and to biopsy samples. They concluded that close vessel approaches caused these whales to stop feeding and swim away from the approaching vessel. The whales also tended to reduce the time they spent at surface and increase their blow rates, suggesting an increase in metabolic rates that might indicate a stress response to the approach. In their study, whales that had been disturbed while feeding remained disturbed for hours after the exposure ended. Beale and Monaghan (2004) concluded that the significance of disturbance was a function of the distance of humans to the animals, the number of humans making the close approach, and the frequency of the approaches. These results would suggest that the cumulative effects of the various human activities in the action area would be greater than the effects of the individual activity. None of the existing studies examined the potential effects of numerous close approaches on whales or gathered information of levels of stress-related hormones in blood samples that are more definitive indicators of stress (or its absence) in animals.

One playback experiment on right whales recorded behavioral reactions to different stimuli,· including an alert signal, vessel noise, other whale social sounds, and a silent control (Nowacek *et al.* 2004). No significant response was observed in any case except the alert signal broadcast ranging from 500-4500 Hz. In response to the alert signal, whales abandoned current foraging dives, began a high power ascent, remained at or near the surface for the duration of the exposure, and spent more time at subsurface depths (1-10 m) (Nowacek *et al.* 2004). The only whale that did not respond to this signal was the sixth and final whale tested, which had potentially already been exposed to the sound five times. The lack of response to a vessel noise stimulus from a container ship and from passing vessels indicated that whales are unlikely to respond to the sounds of approaching vessels even when they can hear them (Nowacek *et al.* 2004). This nonavoidance behavior could be an indication that right whales have become habituated to the vessel noise in the ocean and therefore do not feel the need to respond to the noise or may not perceive it as a threat. In another study, scientists played a recording of a tanker using an underwater sound source and observed no response from a tagged whale 600 meters away (Johnson and Tyack 2003). These studies may suggest that if right whales are startled or disturbed by novel maintenance and repair sounds, they may temporarily abandon feeding activities, but may habituate to those sounds over time, particularly if the sounds are not associated with any adverse conditions.

From these various studies, it is possible to reach a broad conclusion that vessel activity often elicits some behavioral response in whales, although the response is usually minor and short in duration. The behavioral responses observed indicate that vessel activity may be stressful to the whales exposed to it, but the consequences of this stress on the individual whales or populations as a whole remains unknown.

We expect the right, humpback, fin, and sei whales exposed to operation, maintenance, and repair activities and associated vessel traffic to respond similarly to those observed during the studies discussed above. Those responses are likely to be highly variable, depending on the distance of a whale from a vessel, vessel speed, vessel direction, vessel noise, and the number of vessels involved.

Particular whales might not respond to the vessels at all, while in other circumstances, whales are likely to change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. For most individuals these behavioral modifications will be minor and short-term, but there is potential for individual whales to be exposed repeatedly for varying durations. Prolonged or repeated exposure could result in significant delay of foraging, migratory, or other critical behaviors, which could have a temporary, yet adverse, effect on the species. We, therefore, have determined that any listed whale exposed to noise levels in excess of 120 dB re 1µPa RMS may be harassed by the noise produced by the repair and maintenance activities associated with the NEG Port and Algonquin Pipeline Lateral.

6.6.5.2 Port Operation

All operation-related noise sources (bow thrusters, vessel transits, regasification) are continuous and long-term in nature, and thus have the potential to result in some type of behavioral disturbance to whales.

Short-term behavioral reactions of marine mammals to noise were discussed previously in relation to maintenance and repair noise. Although the noise sources associated with operation are different, the behavioral reactions to operational noise sources are expected to be very similar to the reactions discussed previously. The primary difference between maintenance and repair-related noise and operational noise is the long-term, chronic nature of the operational noise. As such, this section of the analysis will focus on the potential long-term effects of chronic exposures to levels of sound sufficient to trigger behavioral responses in baleen whales.

Displacement and Behavioral Disruption

Although the noise associated with operation is generally present at lower intensities and is expected to propagate over shorter distances than that associated with construction, sounds to which animals are exposed repeatedly over extended periods of time have greater potential to result in population-level effects. When a disturbance is introduced into an animal's environment, the animal can either abandon the site or remain in the area and tolerate the disturbance. Both types of responses have been observed in relation to industrial activities, although it is often difficult to isolate noise disturbance as the environmental factor leading to changes in marine mammal abundance in a particular area. Gray whales apparently abandoned the Guerrero Negro Lagoon in Baja California for a few years when an evaporative salt works operation increased shipping and other industrial disturbance and noise. The whales returned once the activity ceased (Gard 1974; Reeves 1977; Bryant *et al.*1984). Although no direct causal link could be made, Norris and Reeves (1978) reported decreased abundance of humpback whales along the coast of Oahu since the 1940s and 1950s, coincident with drastic increases in human activity, including shipping. However, in most cases where potential noise-induced abandonment has occurred, other environmental factors such as prey availability have not been sufficiently measured to eliminate other interpretations of the observed abandonment. On the other hand, whales are known to return year after year to feeding areas even in the presence of heavily trafficked shipping lanes and high volumes of fishing and whale watching activity, as occurs in the action area near Cape Cod Bay, the Great South Channel, and SBNMS. Gray whales continue to migrate annually along the west coast of North America despite intermittent seismic exploration in that area for decades (Malme *et al.* 1984). Bowhead whales continue to travel to the eastern Beaufort Sea each summer despite previous long-term seismic exploration in their summer and autumn range. Acoustic monitoring of the nearby Neptune Port site during construction activities revealed obvious increases in noise levels in the frequency bands relevant to right, humpback, and fin whales during the construction period compared to pre-construction noise levels (Cornell 2010). Fin and humpback whales were acoustically detected in the vicinity of the Neptune Port during all 88 days of construction activities (Cornell 2010). Although it is difficult to interpret these data or draw any conclusions, the results suggest that whales continued to use the area in spite of the elevated noise levels. However, tolerance of noise does not necessarily mean that noise is not causing stress or other negative effects.

Due to the variability in baleen whale responses to disturbing levels of noise, it is difficult to predict the reaction to the long-term operation of the proposed LNG terminal. However, since the primary operational noise source will be the occasional use of thrusters, the response would likely be similar to the response to vessel activity. Although continuous for the duration of thruster use, the noise associated with the thrusters would be transient in nature, occurring for only 10-30 minutes at a time. Whales may temporarily exhibit avoidance behavior upon start up of thruster use, but return quickly once the noise is no longer perceived as a threat, or thruster use ceases. Feeding behavior is not likely to be significantly impacted, as whales appear to be less likely to exhibit behavioral reactions or avoidance responses while engaged in feeding activities (Richardson *et al.* 1995). In addition, even if temporary displacement from the ensonified area occurs, there is no evidence to suggest that the terminal site provides more abundant foraging opportunities for whales than surrounding waters. Whale prey species are mobile, and are broadly distributed throughout Stellwagen Bank and surrounding areas. Humpback, fin, and sei whales temporarily displaced due to start-up of thrusters are likely to easily find alternate foraging locations nearby. Given their population status and because they rely on very specific conditions for feeding (dense plankton patches) and do not feed year-round, temporary, frequent interruptions in feeding behavior may be most significant to right whales. Right whales are occasionally observed feeding near Stellwagen Bank; however, right whales continue to feed in Cape Cod Bay and the Great South Channel in spite of frequent disturbance from passing vessels. Based on this information and the high level of vessel traffic disturbance already present in the action area, it is likely that whales will habituate to or tolerate the occasional disturbance of the thrusters, and would return to the area even if some initial displacement occurred.

Masking

In addition to the behavioral effects discussed above, when exposed to loud anthropogenic noises that overlap with the frequency of their calls, whales may experience "masking." Here, we consider the potential for masking from all of the sound sources considered in this Opinion.

Masking, which refers to the reduction in an animals' ability to detect communication or other relevant sound signals due to elevated levels of background noise, is a natural phenomenon which marine mammals must cope with even in the absence of man-made noise (Richardson *et al*. 1995). Marine mammals demonstrate strategies for reducing the effects of masking, including changing the source level of calls, increasing the frequency or duration of calls, and changing the timing of calls (NRC 2003). Although these strategies are not necessarily without energetic costs, the consequences of temporary and localized increases in background noise level are impossible to determine from the available data (Richardson *et al*. 1995; NRC 2005). Some, if not all, of the whales exposed to increased underwater noise associated with the proposed activity may experience masking. However, in all instances this will be limited to the time it takes for the animal to swim away from the disturbing levels of noise, which is limited to a period of several minutes to several hours. These whales may make temporary shifts in calling behavior to reduce the effects of masking. The energy expended to adjust calls is expected to be minor. Richardson *et al*. (1995) concludes broadly that, although further data are needed, localized or temporary increases in masking probably cause few problems for marine mammals, with the possible exception of populations highly concentrated in an ensonified area. As evidenced by sightings data, right, humpback, fin, and sei whales typically occur in the action area as individuals or small groups. There are very few instances of aggregations of right whales in the action area and these species are not considered to be highly concentrated in the area where increased underwater noise will be experienced. Based on the temporary nature of any masking, masking effects to whales are expected to be insignificant.

Acoustically Induced Stress

Acoustically induced stress is a condition that whales can experience upon chronic exposure to anthropogenic noise. Here, we consider the potential for whales in the action area to experience acoustically induced stress due to noise associated with the proposed action.

Generally, stress is a normal, adaptive response, and the body returns to homeostasis with minimal biotic cost to the animal. However, stress can turn to “distress” or become pathological if the perturbation is frequent, outside of the normal physiological response range, or persistent (NRC 2003). In addition, an animal that is already in a compromised state may not have sufficient reserves to satisfy the biotic cost of a stress response, and then must divert resources away from other functions. Typical adaptive responses to stress include changes in heart rate, blood pressure, or gastrointestinal activity. Stress can also involve activation of the pituitary-adrenal axis, which stimulates the release of more adrenal corticoid hormones. Acute noise exposure may cause inhibited growth (in a young animal), or reproductive or immune responses. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg 1987, Rivest and Rivier 1995) and altered metabolism (Elasser *et al*. 2000), immune competence (Blecha 2000) and behavior.

There are very few studies on the effects of stress on marine mammals, and even fewer on noise-induced stress in particular. One controlled laboratory experiment on captive bottlenose dolphins showed cardiac responses to acoustic playbacks, but there were no changes in the blood chemistry parameters (Miksis et al. 2001 in NRC 2003). Beluga whales exposed to playbacks of drilling rig noise (30 minutes at 134-153 dB re 1μPa) exhibited no short term behavioral responses and no changes in catecholamine levels or other blood parameters (Thomas et al. 1990 in NRC 2003). However, techniques to identify the most reliable indicators of stress in natural marine mammal populations have not yet been fully developed, and as such it is difficult to draw conclusions about potential noise-induced stress from the limited number of studies conducted.

There have been some studies on terrestrial mammals, including humans, that may provide additional insight on the potential for noise exposure to cause stress. Jones and Broadbent (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper *et al*. (1998) reported on the physiological stress responses of osprey to low-level aircraft noise while Krausman *et al*. (2004) reported on the auditory and physiological stress responses of endangered Sonoran pronghorn to military overflights.

These studies on stress in terrestrial mammals lead us to believe that this type of stress is likely to result from chronic acoustic exposure. Because we do not expect any chronic acoustic exposure to any individuals from any of the sound sources associated with the NEG Port operations, we do not anticipate this type of stress response from these activities.

Particular whales might not respond to the vessels at all, while in other circumstances, whales are likely to change their vocalizations, surface time, swimming speed, swimming angle or direction, respiration rates, dive times, feeding behavior, and social interactions. For most individuals these behavioral modifications will be minor and short-term, but there is potential for individual whales to be exposed multiple times, and for varying durations, to the effects associated with operation activities. Repeated or prolonged exposure could result in delay of foraging, migratory, or other critical behaviors that could have a temporary adverse effect on the species. We, therefore, have determined that any listed whale exposed to noise levels in excess of 120 dB re 1µPa RMS may be harassed by the noise produced by the operation activities associated with the NEG Port and Algonquin Pipeline Lateral.

6.6.5.3 Synthesis of Effects

Maintenance and Repair Noise

Aside from the case of mass strandings of beaked whales in response to acoustic activities, no scientific studies have conclusively demonstrated a link between exposure to sound and adverse effects on a marine mammal population (NRC 2005). Any animals that are exposed to operation, maintenance, and repair noises may display behavioral reactions to the sounds by temporarily ceasing resting, migration, and foraging activities and moving away from the sound source. Behavioral responses are typically more extreme when a novel source is initiated. Since the operation, maintenance, and repair noise would continue steadily and predictably for several days, we expect the alterations in behavior to diminish or cease over time. The action area currently experiences a high volume of commercial, fishing, whale watching, and other recreational vessel traffic, increasing the likelihood that the animals present are already habituated to a degree to the presence of industrial noise in their environment. As discussed previously in this Opinion, the ambient noise level in the action area can range between 105 and 125 dB re l µPa (Tetra Tech 2011), and has previously been found in the nearby SBNMS to range between 50 and 140 dB re l µPa (Neptune 2005), which suggests the animals in the area are accustomed to fluctuations in background noise.

Animals exposed to elevated noise levels for a short duration would likely exhibit some startle responses and temporary avoidance behavior at the initiation of activities, but would habituate relatively quickly and resume their initial behaviors once the activity was no longer perceived as a potential threat. In addition, after the maintenance and repair activity has ceased, any animal temporarily displaced for the duration of the activity would likely return to the area without long term impairment of migrating, feeding, resting, or other behaviors. Permanent shifts in habitat use or distribution or foraging success are not expected. Based on what we know about their responses upon exposure to such sound sources in other instances, we expect that long-term adverse effects on individuals won’t occur, and as such would not reduce the overall reproductive success, feeding, or migration of any individual animal. However, repeated or prolonged exposure to elevated noise levels could potentially harass individual whales by significantly delaying foraging, migratory, or other critical behaviors. Although we anticipate harassment of whales exposed to excessive noise due to maintenance and repair activities, the effect is anticipated to be temporary and it will not result in death or injury of any individuals.

Operational Noise

The evidence presented above indicates that animals do respond and modify behavioral patterns in the presence of industrial noise, although adequate data do not yet exist to quantitatively assess or predict the significance of alterations in behavior and shifts in energy budgets or accumulation of stress responses to the health and viability of marine mammal populations. In many cases, it can be difficult to assess the energetic costs of a behavioral change, let alone the effect of that energetic cost on the likelihood that an individual will survive and reproduce. For example, studies have been able to show that the distribution of feeding baleen whales correlates with prey rather than with loud sonar or industrial activities, but were unable to test for potentially more subtle effects on feeding, such as reduced prey capture per unit effort and reduced time engaged in feeding due to the presence of noise in the environment (NRC 2005). Further, in order to move from energetic cost to potential deleterious effects on survival and reproduction, data regarding whether a change in feeding rate is within the range of normal variation would be needed (NRC 2005). A full predictive model for the effects of noise on marine mammal populations is at least a decade away from fruition due to lack of necessary data (NRC 2005).

The uncertainties in the available data make it difficult to predict the response and long term significance of masking and stress on right, humpback, fin, and sei whales affected by the NEG LNG port. However, based on observations of marine mammals exposed to other types of industrial activity, the moderate intensity and duration of sound generated by project components, and the levels of vessel noise and disturbance already present in the project area, we anticipate that the noise associated with the long term operation of the NEG facility is not likely to have a measurable adverse impact on the capacity of the animals to feed successfully, breed successfully, or complete their life histories. Nonetheless, we remain concerned about the potential for unknown or unanticipated long-term effects on the individuals present in the project area. As such, we believe that long-term monitoring of Port operations is necessary to verify that large scale abandonment of the habitat will not occur and that acoustic output from the Port is within the ranges predicted by modeling exercises.

If full operation of this facility is realized, monitoring through the passive acoustic archival array will be implemented as a condition of the IHA. This will assist in the detection of large-scale shifts in marine mammal use or distribution within the project area, which may indicate greater population level impacts than anticipated. In the meantime, short-term acoustic monitoring of operations, maintenance, and repairs at the LNG port will ensure that the noise estimates used to ascertain the affected area, as well as the number of affected individuals, are not exceeded. Monitoring of stress and the overall health of these populations would provide better information on the potential long-term effects of the Port; however, techniques for assessing stress in free-ranging marine mammals are not developed to the point where such monitoring studies would be considered feasible, nor does baseline data exist for the populations in the project area.

6.6.5.4 Estimation of the Number of Affected Whales

There is no danger of injury, death, or hearing impairment from the exposure to the noise levels associated with this project as analyzed above. The basis for NMFS PR's take (level B harassment) estimate under the MMPA is the number of marine mammals that would be exposed to sound levels in excess of 120 dB re 1 μPa RMS, which is the threshold used for non-pulse sounds. For the NEG LNG Port and Algonquin Pipeline Lateral operations and maintenance and repair activities, the MMPA take estimates are determined by multiplying the 120 dB RMS ensonified area by local marine mammal density estimates, and then multiplying by the estimated dates such activities would occur during a year-long period. For the NEG Port operations, the 120 dB re 1 μPa RMS ensonified area is 56.8 km^2 (based on a radius of 4.25 km) for a single visit during docking when running DP system (Table 5). For NEG Port and Algonquin Pipeline Lateral maintenance and repair activities, modeling based on the empirical measurements showed that the distance of the 120-dB re 1 μPa RMS radius is expected to be 3.6 km (Table 5), making a maximum 120-dB ZOI of approximately 40.7 km^2.

Although there has been no LNG delivery since February 2010 at the NEG LNG Port, NEG expects that when the Port is under full operation, it will receive up to 65 LNG shipments per year, and would require 14 days for NEG Port maintenance and up to 40 days for planned and unplanned Algonquin Pipeline Lateral maintenance and repair.

Although baleen whale species other than North Atlantic right whales have been sighted in the project area from May to November, the occurrence and abundance of fin and humpback whales is not well documented within the project area. Nonetheless, NMFS PR uses the data on cetacean distribution within Massachusetts Bay, such as those published by the National Centers for Coastal Ocean Science (NCCOS 2006), to estimate potential takes of marine mammal species in the vicinity of project area.

The NCCOS study used cetacean sightings from two sources: (1) the North Atlantic Right Whale Consortium (NARWC) sightings database held at the University of Rhode Island (Kenney 2001); and (2) the Manomet Bird Observatory (MBO) database, held at NMFS Northeast Fisheries Science Center (NEFSC). The NARWC data contained survey efforts and sightings data from ship and aerial surveys and opportunistic sources between 1970 and 2005. The main data contributors included: Cetacean and Turtles Assessment Program (CETAP), Canadian Department of Fisheries and Oceans, PCCS, International Fund for Animal Welfare, NOAA's NEFSC, New England Aquarium, Woods Hole Oceanographic Institution, and the University of Rhode Island. A total of 653,725 kilometers (406,293 miles) of survey track and 34,589 cetacean observations were provisionally selected for the NCCOS study in order to minimize bias from uneven allocation of survey effort in both time and space. The sightings-per-unit-effort (SPUE) was calculated for all cetacean species by month covering the southern Gulf of Maine study area, which also includes the project area (NCCOS 2006).

The MBO's Cetacean and Seabird Assessment Program (CSAP) was contracted from 1980 to 1988 by NMFS NEFSC to provide an assessment of the relative abundance and distribution of cetaceans, seabirds, and marine turtles in the shelf waters of the northeastern United States (MBO 1987). The CSAP program was designed to be completely compatible with NMFS NEFSC databases so that marine mammal data could be compared directly with fisheries data throughout the time series during which both types of information were gathered.
A total of 5,210 km (8,383 mi) of survey distance and 636 cetacean observations from the MBO data were included in the NCCOS analysis. Combined valid survey effort for the NCCOS studies included 567,955 km (913,840 mi) of survey track for small cetaceans (dolphins and porpoises)

and 658,935 km (1,060,226 mi) for large cetaceans (whales) in the southern Gulf of Maine. The NCCOS study then combined these two data sets by extracting cetacean sighting records, updating database field names to match the NAR WC database, creating geometry to represent survey tracklines and applying a set of data selection criteria designed to minimize uncertainty and bias in the data used.

Owing to the comprehensiveness and total coverage of the NCCOS cetacean distribution and abundance study, NMFS PR calculated the estimated take number of marine mammals based on the most recent NCCOS report published in December 2006. A summary of seasonal cetacean distribution and abundance in the project area is provided above, in the "Description of Marine Mammals in the Area of the Specified Activities" section. For a detailed description and calculation of the cetacean abundance data and SPUE, please refer to the NCCOS study (NCCOS 2006). These data show that the relative abundance of North Atlantic right, fin, humpback, and sei whales for all seasons, as calculated by SPUE in number of animals per square kilometer, is 0.0082, 0.0097, 0.0118, and 0.0084, respectively.

In calculating the area density of these species from these linear density data, NMFS PR used 0.5 miles (0.825 km) as the hypothetical strip width (W). This strip width is based on the distance of visibility used in the NARWC data that was part of the NCCOS (2006) study. However, those surveys used a strip transect instead of a line transect methodology. Therefore, in order to obtain a strip width, one must divide the visibility or transect value in half. Since the visibility value used in the NARWC data was 2.3 miles (3.7 km), it thus gives a strip width of 1.15 mi (1.85 km). The hypothetical strip width used in the analysis is less than half of that derived from the NAR WC data, therefore, the analysis provided here is more protective in calculating marine mammal densities in the area. Based on this information, the area density (D) of these species in the project area can be obtained by the following formula:

$D = SPUE/2W$

where D is marine mammal density in the area, and W is the strip width. Based on this calculation method, the estimated take (by harassment) numbers per year for North Atlantic right, fin, humpback, and sei whales by the NEG Port facility operations (maximum 65 visits per year), NEG Port maintenance and repair (up to 14 days per year), and Algonquin Pipeline Lateral operation and maintenance (up to 40 days per year), are 29, 35, 42, and 30, respectively. These numbers represent approximately 6.59%, 1 %, 5.12%, and 8.4% of the populations for these species based on the latest NMFS Atlantic marine mammal stock assessment reports (Waring *et al.* 2014), respectively. Since it is very likely that individual animals could be behaviorally disturbed multiple times, these percentages are the upper boundary of the animal population that could be affected. Therefore, the actual number of individual animals being exposed to behaviorally disturbing levels of sound could be less.

7.0 CUMULATIVE EFFECTS

Cumulative effects, as defined in the ESA, are those effects of future state or private activities, not involving federal activities that are reasonably certain to occur within the action area of the federal action subject to consultation. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Sources of human-induced adverse effects of cetaceans in the action area include incidental takes in state-regulated fishing activities, vessel collisions, ingestion of plastic debris, and pollution. The combination of these activities may affect populations of ESA-listed species, preventing or slowing a species' recovery.

Future commercial fishing activities in state waters may take several protected species. However, it is not clear to what extent these future activities would affect listed species differently than the current state fishery activities described in the Environmental Baseline section. We expect these state water fisheries to continue in the future, and as such, the potential for interactions with listed species will also continue.

As noted in the Environmental Baseline section, private and commercial vessel activities in the action area may adversely affect listed species in a number of ways, including entanglement, boat strike, or harassment. Boston, Massachusetts is one of the Atlantic seaboard's busiest ports. A vessel transit analysis through Massachusetts Bay was conducted in 2006 that included an independent risk assessment conducted for the USCG in relation to both the NEG and Neptune Deepwater Port Projects. The NEG traffic analyses estimated approximately 3,131 (Section 3.9.3 of the NEG final EIS/EIR) large commercial vessel transits were made per year in Massachusetts Bay. The independent risk assessment for the USCG estimated an additional 54,914 transits from medium size ships, whale watch vessels, commercial fishing vessels, and dredging vessels (USCG 2006). A recent study conducted by Hatch *et al.* (2008) estimated the number of large vessel transits through the greater Stellwagen Bank National Marine Sanctuary in 2006 to be 3,413 transits.

Increasing vessel traffic in the action area also raises concerns about the potential effects of noise pollution on marine mammals. The effects of increased noise levels are not yet completely understood, and can range widely depending on the context of the disturbance. Acoustic impacts can include auditory trauma, temporary or permanent loss of hearing sensitivity, habitat exclusion, habituation, and disruption of other normal behavior patterns such as feeding, migration, and communication. We are working to develop policy guidelines for monitoring and managing acoustic impacts on marine mammals from anthropogenic sound sources in the marine environment.

Nutrient loading from land-based sources such as coastal community discharges is known to stimulate plankton blooms in closed or semi-closed estuarine systems. The effect to larger embayments is unknown. Pollutant loads are usually lower in baleen whales than in toothed whales and dolphins. However, a number of organochlorine pesticides were found in the blubber of North Atlantic right whales with PCB's and DDT found in the highest concentrations (Woodley *et al.* 1991). Contaminants could indirectly degrade habitat if pollution and other factors reduce the food available to marine animals.

8.0 INTEGRATION AND SYNTHESIS OF EFFECTS

The effects of the NEG Port operations include: habitat disturbance resulting in potential impacts to water quality and prey; exposure to increased underwater noise; and exposure to increased vessel traffic. We have determined that the only stressor that is likely to result in adverse effects to listed species is noise. The source levels associated with the operation, maintenance, and repair activities at the NEG LNG may result in large areas with noise levels that are potentially disturbing for right, humpback, fin, and sei whales. We expect these animals to alter their behavior from foraging, rearing, migrating, and resting to make evasive movements away from the area with disturbing levels of noise. Although short term exposure might lead to minor effects, individuals that are exposed repeatedly, or for a longer duration could be more severely affected. Such exposure may result in stress to these animals and may come at a metabolic and energetic cost. However, because this response is limited to only a few hours, the stress will resolve and not result in injury and any disruption to essential behaviors will be temporary. We do not anticipate any injury or mortality immediately or in the future and do not anticipate any reduction in fitness. We have determined that this behavioral disturbance is considered “harassment” under the ESA definition of take.

The ESA does not define the term “harass,” nor have we defined this term pursuant to the ESA through regulation; however, it is commonly understood to mean to annoy or bother. Legislative history helps elucidate Congress' intent: "[take] includes harassment, whether intentional or not. This would allow, for example, the Secretary to regulate or prohibit the activities of birdwatchers where the effect of those activities might disturb the birds and make it difficult for them to hatch or raise their young" (HR Rep. 93-412, 1973). In contrast, the MMPA expressly defines harassment as any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [16 U.S.C. 1362(18)(A)]. As the MMPA considers harassment to mean the “potential for injury,” rather than the “likelihood of injury,” it is a more conservative interpretation of the term. However, due to the difficulty in detecting the probability of effects in individual whales, consistent with the legislative history discussed above, we will accept the estimates proposed in the IHA as the best available information of the number of whales that may be adversely affected by the proposed activities.

Harassment will occur in the form of avoidance or displacement from habitats and behavioral and/or metabolic/energetic compensation to deal with short term (hours) of stress resulting from exposure to disturbing levels of noise, which modify or degrade habitat used by whales. While these individuals may experience temporary disruption of behavior patterns, we do not anticipate that the behavioral modification caused by noise will actually kill or injure listed whales by significantly impairing essential behavioral patterns. Rather, we expect that individuals will resume pre-disruption behaviors once the disturbance has ceased. In the effects of the action section of this Opinion, we determined that up to 29 right whales, 42 humpback whales, 35 fin whales, and 30 sei whales are likely to be exposed to disturbing levels of noise per year due to the operation, maintenance, and repair of the NEG LNG Port and the associated Algonquin Pipeline Lateral. We have determined that all other effects to listed species, including benthic disturbance and increased vessel traffic, will be insignificant and discountable.

In the discussion below, we consider whether the effects of the proposed action reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of any listed species. The purpose of this analysis is to determine whether the NEG Port operations, in the context established by the status of the species, environmental baseline, and cumulative effects, would jeopardize the continued existence of any listed species. In the NMFS/USFWS Section 7 Handbook, for the purposes of determining jeopardy, survival is defined as, "the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter." Recovery is defined as, "Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in Section 4(a)(1) of the Act." Below, for the listed species that may be affected by the proposed action, we consider whether the proposed action will result in reductions in reproduction, numbers or distribution of that species and then consider whether any reductions in reproduction, numbers or distribution resulting from the NEG Port operations would reduce appreciably the likelihood of both the survival and recovery of that species, as those terms are defined for purposes of the federal Endangered Species Act.

North Atlantic Right Whales

The area in which the NEG LNG Port will be operated and maintained will continue to be used by fishing vessels, recreational boaters, and the maritime industry. It will also continue to be subject to noise pollution, contaminants, increased turbidity, and benthic habitat disturbance. While the effects of operation and construction associated with repair and maintenance will be added to the baseline conditions that will exist over the course of the action, we do not anticipate that the effects of the action and baseline conditions will combine synergistically to produce effects greater than the sum of the parts. As explained in the Opinion, we do not anticipate any injury or mortality of any right whales to result from the proposed action itself. As explained below, we do not expect the effects of the action, even when added to baseline conditions over the course of the action, will result in injury or mortality of any right whales.

Any project-caused benthic habitat disturbance, prey loss, turbidity, and release of contaminants, are anticipated to be so small in area, low in severity, and temporary, that they will not have a perceptible effect on baseline conditions. Given the relatively small number of EBRV transits (65 annually), we expect project-related vessel strikes to be extremely unlikely to occur and the additional project-related vessels will have an insignificant effect on the baseline risk of vessel strikes over the course of the action.

Behavioral effects, such as disruption of feeding, resting, or other activities or alterations in breathing, vocalizing, or diving rates, are likely during exposure to underwater noise above 120 dB re 1uPa RMS resulting from the maintenance, repair, and operation activities associated with the NEG Port. The anticipated project-related acoustic effects will be temporary, short-term, and geographically limited to a very small portion of the overall species' range. Even when added to the existing acoustic baseline, these time and space limited project-related acoustic effects will not significantly impair any essential behaviors or affect an individual's health, survival or reproductive success. Specifically, the combined effects of ambient noise plus an introduced sound signal, the overall sound level in the affected environment can be determined by the following expression: L_{x+y} (in dB) =10 Log ($10^{x/10} + 10^{y/10}$); where, L_{x+y}= the overall sound level; x= ambient noise level (in dB) and y =the introduced sound signal (Richardson et al. 1995). This expression demonstrates that, due to the logarithmic nature of the decibel scale, the summation of two sound sources does not result in simply a doubling of sound energy. Instead, when considered together, ambient noise has little to no effect on the overall sound level produced and in fact, is "over taken" by the introduced sound signal. That is, ambient noise is non-detectable in the presence of the sound source. As a result, the total sound produced is reflective of the introduced sound source. For instance, if we consider ambient conditions to be 100 dB and the introduced sound signal to be 180 dB, the overall/total sound in the affected area is 180 dB. Based on this information, project related sound levels, when considered in combination with ambient noise, will not result in overall sound levels that differ from those project specific source levels considered on their own. As such, the behavioral effects, and the extent that they will be experienced, will remain as described for each sound source.

Based on the information provided above, when added to baseline conditions, the proposed action, including the behavioral disturbance of no more than 29 right whales due to exposure to disturbing levels of noise will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of right whales; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; and (3) the action will have only a minor and temporary effect on the distribution of individual right whales in the action area (related to the temporary avoidance of temporarily ensonified areas) and no effect on the distribution of the species throughout its range.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the NEG Port operations will not appreciably reduce the likelihood that the species will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. Recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the proposed action will affect the potential for the species to rebuild to a point where listing is no longer appropriate.

The goal of the 2005 revised Recovery Plan for North Atlantic Right Whale is to recover North Atlantic right whales to a level sufficient to warrant their removal from the List of Endangered and Threatened Wildlife and Plants under the ESA. The recovery plan includes demographic recovery criteria as well as a list of tasks that must be accomplished. Demographic recovery criteria are included for the western North Atlantic right whale population. These criteria focus on sustained increases in the number of individuals in each basin, an increase in the abundance of prey, and a reduction in anthropogenic threats. The recovery tasks focus on evaluating the species population status, protecting habitats, and minimizing anthropogenic effects associated with fishing gear entanglements, vessel collision, and anthropogenic noise. As discussed in this Opinion, we do not anticipate noise and ship strike effects to injure or kill any right whales, although there is potential for harassment due to repeated or prolonged exposure to elevated noise levels associated with the maintenance, repair, and operation of the LNG Port.

Since the NEG Port operations, maintenance, and repair activities will not result in injury or mortality of any individuals, it will not reduce fitness or future reproduction of any individual and, therefore, will not affect the persistence of the species. Furthermore, the proposed action will not appreciably reduce the likelihood that right whales can be brought to the point at which they are no longer listed as endangered or threatened . Based on the analysis presented herein, the NEG Port operations will not appreciably reduce the survival and recovery of North Atlantic right whales.

Humpback Whales

The area in which the NEG LNG Port will be operated and maintained will continue to be used by fishing vessels, recreational boaters, and the maritime industry. It will also continue to be subject to noise pollution, contaminants, increased turbidity, and benthic habitat disturbance. While the effects of operation and construction associated with repair and maintenance will be added to the baseline conditions that will exist over the course of the action, we do not anticipate that the effects of the action and baseline conditions will combine synergistically to produce effects greater than the sum of the parts. As explained in the Opinion, we do not anticipate any injury or mortality of any humpback whales to result from the NEG port operations itself. As explained below, we do not expect the effects of the action, even when added to baseline conditions over the course of the action, will result in injury or mortality of any humpback whales.

Any project-caused benthic habitat disturbance, prey loss, turbidity, and release of contaminants, are anticipated to be so small in area, low in severity, and temporary, that they will not have a perceptible effect on baseline conditions. Given the relatively small number of EBRV transits (65 annually), we expect project-related vessel strikes to be extremely unlikely to occur and the additional project-related vessels will have an insignificant effect on the baseline risk of vessel strikes over the course of the action.

Behavioral effects, such as disruption of feeding, resting, or other activities or alterations in breathing, vocalizing, or diving rates, are likely during exposure to underwater noise greater than 120 dB re 1uPa RMS resulting from the maintenance, repair, and operation activities associated with the NEG Port. The anticipated project-related acoustic effects will be temporary, short-term, and geographically limited to a very small portion of the overall species' range. Even when added to the existing acoustic baseline, these time and space limited project-related acoustic effects will not significantly impair any essential behaviors or affect an individual's health, survival or reproductive success. Specifically, the combined effects of ambient noise plus an introduced sound signal, the overall sound level in the affected environment can be determined by the following expression: L_{x+y} (in dB) =10 Log ($10^{x/10} + 10^{y/10}$); where, L_{x+y}= the overall sound level; x= ambient noise level (in dB) and y =the introduced sound signal (Richardson et al. 1995). This expression demonstrates that, due to the logarithmic nature of the decibel scale, the summation of two sound sources does not result in simply a doubling of sound energy. Instead, when considered together, ambient noise has little to no effect on the overall sound level produced and in fact, is “over taken” by the introduced sound signal. That is, ambient noise is non-detectable in the presence of the sound source. As a result, the total sound produced is reflective of the introduced sound source. For instance, if we consider ambient conditions to be 100 dB and the introduced sound signal to be 180 dB, the overall/total sound in the affected area is 180 dB. Based on this information, project related sound levels, when considered in combination with ambient noise, will not result in overall sound levels that differ from those project specific source levels considered on their own. As such, the behavioral effects, and the extent that they will be experienced, will remain as described for each sound source.

Based on the information provided above, when added to baseline conditions, the NEG Port operations, including the behavioral disturbance of no more than 42 humpback whales due to exposure to disturbing levels of noise will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of humpback whales; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; and (3) the action will have only a minor and temporary effect on the distribution of individual humpback whales in the action area (related to the temporary avoidance of temporarily ensonified areas) and no effect on the distribution of the species throughout its range.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the NEG Port operations will not appreciably reduce the likelihood that the species will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. Recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the NEG Port operations will affect the potential for the species to rebuild to a point where listing is no longer appropriate.

In 1991, we issued a recovery plan for the humpback whale (NMFS 1991a). The plan includes demographic recovery criteria as well as a list of tasks that must be accomplished. Demographic recovery criteria are included for both the North Atlantic and North Pacific populations. These criteria focus on sustained increases in the number of individuals in each basin, an increase in the abundance of prey, and a reduction in anthropogenic threats. The recovery tasks focus on evaluating the species population status, protecting habitats, and minimizing anthropogenic effects associated with fishing gear entanglements, vessel collision, and anthropogenic noise. As discussed in this Opinion, we do not anticipate noise and ship strike effects to injure or kill any humpback whales, although there is potential for harassment due to repeated or prolonged exposure to elevated noise levels associated with the maintenance, repair, and operation of the LNG Port.

Since the NEG Port operations, maintenance, and repair activities will not result in injury or mortality of any individuals, it will not reduce fitness or future reproduction of any individual and, therefore, will not affect the persistence of the species. Therefore, the effects of the proposed action will not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Based on the analysis presented herein, the NEG Port operations will not appreciably reduce the survival and recovery of humpback whales.

Fin Whales

The area in which the NEG LNG Port will be operated and maintained will continue to be used by fishing vessels, recreational boaters, and the maritime industry. It will also continue to be subject to noise pollution, contaminants, increased turbidity, and benthic habitat disturbance. While the effects of operation and construction associated with repair and maintenance will be added to the baseline conditions that will exist over the course of the action, we do not anticipate that the effects of the action and baseline conditions will combine synergistically to produce effects greater than the sum of the parts. As explained in the Opinion, we do not anticipate any injury or mortality of any fin whales to result from the NEG port operations itself. As explained below, we do not expect the effects of the action, even when added to baseline conditions over the course of the action, will result in injury or mortality of any fin whales.

Any project-caused benthic habitat disturbance, prey loss, turbidity, and release of contaminants, are anticipated to be so small in area, low in severity, and temporary, that they will not have a perceptible effect on baseline conditions. Given the relatively small number of EBRV transits (65 annually), we expect project-related vessel strikes to be extremely unlikely to occur and the additional project-related vessels will have an insignificant effect on the baseline risk of vessel strikes over the course of the action.

Behavioral effects, such as disruption of feeding, resting, or other activities or alterations in breathing, vocalizing, or diving rates, are likely during exposure to underwater noise greater than 120 dB re 1uPa RMS resulting from the maintenance, repair, and operation activities associated with the NEG Port. The anticipated project-related acoustic effects will be temporary, short-term, and geographically limited to a very small portion of the overall species' range. Even when added to the existing acoustic baseline, these time and space limited project-related acoustic effects will not significantly impair any essential behaviors or affect an individual's health, survival or reproductive success. Specifically, the combined effects of ambient noise plus an introduced sound signal, the overall sound level in the affected environment can be determined by the following expression: L_{x+y} (in dB) =10 Log ($10^{x/10} + 10^{y/10}$); where, L_{x+y}= the overall sound level; x= ambient noise level (in dB) and y =the introduced sound signal (Richardson et al. 1995). This expression demonstrates that, due to the logarithmic nature of the decibel scale, the summation of two sound sources does not result in simply a doubling of sound energy. Instead, when considered together, ambient noise has little to no effect on the overall sound level produced and in fact, is "over taken" by the introduced sound signal. That is, ambient noise is non-detectable in the presence of the sound source. As a result, the total sound produced is reflective of the introduced sound source. For instance, if we consider ambient conditions to be 100 dB and the introduced sound signal to be 180 dB, the overall/total sound in the affected area is 180 dB. Based on this information, project related sound levels, when considered in combination with ambient noise, will not result in overall sound levels that differ from those project specific source levels considered on their own. As such, the behavioral effects, and the extent that they will be experienced, will remain as described for each sound source.

Based on the information provided above, when added to baseline conditions, the NEG Port operations, including the behavioral disturbance of no more than 35 fin whales due to exposure to disturbing levels of noise will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of fin whales; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; and (3) the action will have only a minor and temporary effect on the distribution of individual fin whales in the action area (related to the temporary avoidance of temporarily ensonified areas) and no effect on the distribution of the species throughout its range.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur. As explained above, we have determined that the NEG Port operations will not appreciably reduce the likelihood that the species will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. Recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the NEG Port operations will affect the potential for the species to rebuild to a point where listing is no longer appropriate.

In 2010, we issued a recovery plan for the fin whale (NMFS 2010). The plan includes demographic recovery criteria as well as a list of tasks that must be accomplished. Demographic recovery criteria are included for each of the three ocean basins where the species occurs. These criteria focus on sustained increases in the number of individuals in each basin, an increase in the abundance of prey, and a reduction in anthropogenic threats. The recovery tasks focus on evaluating the species population status, protecting habitats, and minimizing anthropogenic effects associated with fishing gear entanglements, vessel collision, and anthropogenic noise. As discussed in this Opinion, we do not anticipate noise and ship strike effects to injure or kill any fin whales, although there is potential for harassment due to repeated or prolonged exposure to elevated noise levels associated with the maintenance, repair, and operation of the LNG Port.

Since the NEG Port operations, maintenance, and repair activities will not result in injury or mortality of any individuals, it will not reduce fitness or future reproduction of any individual and, therefore, will not affect the persistence of the species. Therefore, the effects of the proposed action will not reduce the likelihood that the status of the species can improve to the point where it is recovered and could be delisted. Based on the analysis presented herein, the NEG Port operations will not appreciably reduce the survival and recovery of fin whales.

Sei Whale

The area in which the NEG LNG Port will be operated and maintained will continue to be used by fishing vessels, recreational boaters, and the maritime industry. It will also continue to be subject to noise pollution, contaminants, increased turbidity, and benthic habitat disturbance. While the effects of operation and construction associated with repair and maintenance will be added to the baseline conditions that will exist over the course of the action, we do not anticipate that the effects of the action and baseline conditions will combine synergistically to produce effects greater than the sum of the parts. As explained in the Opinion, we do not anticipate any injury or mortality of any sei whales to result from the NEG Port operations itself. As explained below, we do not expect the effects of the action, even when added to baseline conditions over the course of the action, will result in injury or mortality of any sei whales.

Any project-caused benthic habitat disturbance, prey loss, turbidity, and release of contaminants, are anticipated to be so small in area, low in severity, and temporary, that they will not have a perceptible effect on baseline conditions. Given the relatively small number of EBRV transits (65 annually), we expect project-related vessel strikes to be extremely unlikely to occur and the additional project-related vessels will have an insignificant effect on the baseline risk of vessel strikes over the course of the action.

Behavioral effects, such as disruption of feeding, resting, or other activities or alterations in breathing, vocalizing, or diving rates, are likely during exposure to underwater noise greater than 120 dB re 1uPa RMS resulting from the maintenance, repair, and operation activities associated with the NEG Port. The anticipated project-related acoustic effects will be temporary, short-term, and geographically limited to a very small portion of the overall species' range. Even when added to the existing acoustic baseline, these time and space limited project-related acoustic effects will not significantly impair any essential behaviors or affect an individual's health, survival or reproductive success. Specifically, the combined effects of ambient noise plus an introduced sound signal, the overall sound level in the affected environment can be determined by the following expression: L_{x+y} (in dB) =10 Log ($10^{x/10} + 10^{y/10}$); where, L_{x+y}= the overall sound level; x= ambient noise level (in dB) and y =the introduced sound signal (Richardson et al. 1995). This expression demonstrates that, due to the logarithmic nature of the decibel scale, the summation of two sound sources does not result in simply a doubling of sound energy. Instead, when considered together, ambient noise has little to no effect on the overall sound level produced and in fact, is "over taken" by the introduced sound signal. That is, ambient noise is non-detectable in the presence of the sound source. As a result, the total sound produced is reflective of the introduced sound source. For instance, if we consider ambient conditions to be 100 dB and the introduced sound signal to be 180 dB, the overall/total sound in the affected area is 180 dB. Based on this information, project related sound levels, when considered in combination with ambient noise, will not result in overall sound levels that differ from those project specific source levels considered on their own. As such, the behavioral effects, and the extent that they will be experienced, will remain as described for each sound source.

Based on the information provided above, when added to baseline conditions, the NEG Port operations, including the behavioral disturbance of no more than 30 sei whales due to exposure to disturbing levels of noise will not appreciably reduce the likelihood of survival of this species (i.e., it will not increase the risk of extinction faced by this species) given that: (1) there will be no mortality and therefore, no reduction in the numbers of sei whales; (2) there will be no effect to the fitness of any individuals and no effect on reproductive output of the species; and (3) the action will have only a minor and temporary effect on the distribution of individual sei whales in the action area (related to the temporary avoidance of temporarily ensonified areas) and no effect on the distribution of the species throughout its range.

In certain instances, an action that does not appreciably reduce the likelihood of a species' survival might affect its likelihood of recovery or the rate at which recovery is expected to occur.

As explained above, we have determined that the NEG Port operations will not appreciably reduce the likelihood that the species will survive in the wild. Here, we consider the potential for the action to reduce the likelihood of recovery. Recovery is defined as the improvement in status such that listing is no longer appropriate. Thus, we have considered whether the NEG Port operations will affect the potential for the species to rebuild to a point where listing is no longer appropriate.

In 2011, we issued a recovery plan for the sei whale (NMFS 2011). The plan includes demographic recovery criteria as well as a list of tasks that must be accomplished. Demographic recovery criteria are included for each of the three ocean basins where the species occurs. These criteria focus on sustained increases in the number of individuals in each basin, an increase in the abundance of prey, and a reduction in anthropogenic threats. The recovery tasks focus on evaluating the species population status, protecting habitats, and minimizing anthropogenic effects associated with fishing gear entanglements, vessel collision, and anthropogenic noise. As discussed in this Opinion, we do not anticipate noise and ship strike effects to injure or kill any sei whales, although there is potential for harassment due to repeated or prolonged exposure to elevated noise levels associated with the maintenance, repair, and operation of the LNG Port.

Since the NEG Port operations will not result in injury or mortality of any individuals, will not reduce fitness or future reproduction of any individual and, therefore, it will not affect the persistence of the species. Likewise, since the NEG Port operations will not result in injury or mortality and will not result in any reduction in numbers or reproduction, it will not delay the recovery timeline or otherwise decrease the likelihood of recovery. Based on the analysis presented herein, the NEG Port operations will not appreciably reduce the survival and recovery of sei whales.

9.0 CONCLUSION

After reviewing the best available information on the status of endangered and threatened species under our jurisdiction, the environmental baseline for the action area, the effects of the action, and the cumulative effects in the action area, it is our biological opinion that the operation of the NEG LNG Port, including required maintenance and repair work, is likely to adversely affect, but is not likely to jeopardize the continued existence of the North Atlantic right, humpback, fin, and sei whales. Additionally, we have concluded that the proposed action is not likely to adversely affect blue or sperm whales, or hawksbill, green, Kemp’s ridley, leatherback and loggerhead sea turtles or Atlantic sturgeon and, therefore, is not likely to jeopardize the continued existence of these species.

10.0 INCIDENTAL TAKE STATEMENT

Section 9 of the ESA prohibits the take of endangered species of fish and wildlife. “Fish and wildlife” is defined in the ESA “as any member of the animal kingdom, including without limitation any mammal, fish, bird (including any migratory, non-migratory, or endangered bird for which protection is also afforded by treaty or other international agreement), amphibian, reptile, mollusk, crustacean, arthropod or other invertebrate, and includes any part, product, egg, or offspring thereof, or the dead body or parts thereof.” 16 U.S.C. 1532(8). “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS to include any act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. “Otherwise lawful activities” are those actions that meet all State and Federal legal requirements except for the prohibition against taking in ESA Section 9 (51 FR 19936, June 3, 1986), which would include any State endangered species laws or regulations. Section 9(g) makes it unlawful for any person “to attempt to commit, solicit another to commit, or cause to be committed, any offense defined [in the ESA.]” 16 U.S.C. 1538(g). A “person” is defined in part as any entity subject to the jurisdiction of the United States, including an individual, corporation, officer, employee, department or instrument of the Federal government (see 16 U.S.C. 1532(13)). Under the terms of section 7(b)(4) and section 7(o)(2), taking that results from, but is not the purpose of the agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

We have concluded that the operation, maintenance, and repair of the NEG LNG Port is likely to result in take of North Atlantic right, humpback, fin, and sei whales in the form of harassment, where habitat conditions (i.e., sound levels above the 120 dB threshold for continuous noise used to determine harassment in the proposed IHA) will temporarily impair normal behavior patterns. This harassment will occur in the form of avoidance or displacement from preferred habitat and behavioral and/or metabolic compensations to deal with short-term masking or stress. While whales may experience temporary impairment of behavior patterns, no significant impairment resulting in injury is likely due to the moderate sound output of project components (i.e., sound levels below the thresholds for injury), the ability of whales to easily move to areas beyond the impact zone that also provide suitable prey, and the limited exposure time to disturbing levels of sound.

This Opinion does not include an ITS at this time. Upon issuance of the IHA under Section 101(a)(5) of the MMPA and/or its 1994 Amendments, we will amend this Opinion to include an incidental take statement(s) for the described action.

11.0 CONSERVATION RECOMMENDATIONS

In addition to section 7(a)(2), which requires agencies to ensure that proposed projects will not jeopardize the continued existence of listed species, section 7(a)(1) of the ESA places a responsibility on all federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species". Conservation Recommendations are discretionary activities designed to minimize or avoid adverse effects of a NEG Port operations on listed species or critical habitat, to help implement recovery plans, or to develop information. As the proposed IHA already includes all of the conservation measures that we would recommend, no conservation recommendations will be included as part of this Opinion.

12.0 REINITIATION OF CONSULTATION

This concludes formal consultation on the issuance of a IHA for the operation, maintenance, and repair of the NEG LNG Deepwater Port. As provided in 50 CFR §402.16, re-initiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may not have been previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, section 7 consultation must be reinitiated immediately.

13.0 LITERATURE CITED

AcuTech. 2006. Independent Risk Assessment for Neptune and Northeast Gateway Deepwater Ports. Prepared for US Coast Guard, G-PSO05, Deepwater Ports Standards Division. April 12, 2006.

Agler, B.A., R.L., Schooley, S.E. Frohock, S.K. Katona, and I.E. Seipt. 1993. Reproduction of photographically identified fin whales, *Balaenoptera physalus*, from the Gulf of Maine. J. Mamm. 74:577-587.

Aguilar, A. 2002. Fin whale, *Balaenoptera physalus*. Pages 435-438 *in* W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.). Encyclopedia of Marine Mammals. San Diego: Academic Press.

Aguilar, A. and C. Lockyer. 1987. Growth, physical maturity and mortality of fin whales (*Balaenoptera physalus*) inhabiting the temperate waters of the northeast Atlantic. Can. J. Zool. 65:253-264.

Allen, B. M., and R. P. Angliss. 2011. Alaska marine mammal stock assessments. 2010. U.S. Dep. Commer., NOAA Tech. Memo. NMFSAFSC-223, 292 p.

Allen, B.M., and R. P. Angliss. 2010. Alaska Marine Mammal Stock Assessments, 2009. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-206, 276 p.

Angliss, R.P. and R.B. Outlaw. 2007. Alaska Marine Mammal Stock Assessments, 2006. NOAA Technical Memorandum NOAA-TM-AFSC-168. 244 pp.

Angliss, R.P., D.P. DeMaster, and A.L. Lopez. 2001. Alaska marine mammal stock assessments, 2001. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-124, 203 p.

Atlantic States Marine Fisheries Commission (ASMFC). 1999. Amendment 3 to the Interstate Fishery Management Plan for American Lobster. Atlantic States Marine Fisheries Commission. December 1997.

Au, W.W.L., A.N. Popper, and R.R. Fay (eds.). 2000. Hearing by Whales and Dolphins. Springer-Verlag, New York, NY.

Baker, C. S. and Herman, L. M. 1989. Behavioral responses of summering humpback whales to vessel traffic: experimental and opportunistic observations. Final Report to the National Park Service, U. S. Department of the Interior, Anchorage, AK.

Baker, C.S. L.M. Herman, B.G. Bays and G.B. Bauer. 1983. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska: 1982 season. Report submitted to the National Marine Mammal Laboratory, Seattle, Washington.

Baker, C.S., L.M. Herman, B.G. Bays and W.F. Stifel. 1982. The impact of vessel traffic on the behavior of humpback whales in southeast Alaska. Report submitted to the National Marine Mammal Laboratory, Seattle, Washington

Barlow, J., and P. J. Clapham. 1997. A new birth-interval approach to estimating demographic parameters of humpback whales. Ecology, 78: 535-546.

Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. Fishery Bulletin 105:509-526.

Bass, A.H. and C.W. Clarke. 2003. The physical acoustics of underwater sound. In: A.M. Simmons, A.N. Popper and R.R. Fay (eds.) *Acoustic Communication*, pp. 15-64. New York: Springer Science and Business Media, LLC.

Bauer, G.B., and L.M. Herman. 1985. Effects of vessel traffic on the behavior of humpback whales in Hawaii. Report submitted to the National Marine Fisheries Service, Honolulu, Hawaii.

Baumgartner, M.F. and B.R. Mate. 2005. Summer and fall habitat of North Atlantic right whales inferred from satellite telemetry. *Canadian Journal of Fisheries and Aquatic Science* 62:527-543.

Baumgartner, M.F., N.S.J. Lysiak, C. Schuman, J. Urban-Rich, and F.W. Wenzel. 2011. Diel vertical migration behavior of *Calanus finmarchicus* and its influence on right and sei whale occurrence. Marine Ecology Progress Series 423:167-184.

Beale, C. M., and P. Monaghan. 2004. Human disturbance: people as predation-free predators? Journal of Applied Ecology 41:335-343.

Berube, M., A Aguilar, D. Dendanto, F. Larsen, G. Notarbatolo di Sciara, R. Sears, J. Sigurjohnsson, J. Urban-R, and P. Palsboll. 1998. Population genetic structure of North Atlantic, Mediterranean Sea and Sea of Cortez fin whales: Analysis of mitochondrial and nuclear loci. Molecular Ecology 7: 585-599.

Best, P.B., J. L. Bannister, R.L. Brownell, Jr., and G.P. Donovan (eds.). 2001. Right whales: worldwide status. *J. Cetacean Res. Manage.* (Special Issue). 2. 309pp.

Blecha F. 2000. Immune system response to stress. In: Moberg GP, Mench IA, eds. Biology of Animal Stress: Implications for Animal Welfare. Wallingford, Oxon, UK: CAB

Bowman, R., E. Lyman, D. Mattila, C. Mayo, M. Brown. 2003. Habitat Management Lessons From a Satellite-Tracked Right Whale. Presentation to the ARGOS Animal Tracking Symposium. March 24-26, 2003. Annapolis, MD.

Brown, M.W., O.C. Nichols, M.K. Marx, and J.N. Ciano. 2002. Surveillance, Monitoring, and Management of North Atlantic Right Whales in Cape Cod Bay and Adjacent Waters – 2002. Final report to the Division of Marine Fisheries, Commonwealth of Massachusetts. Center for Coastal Studies.

Brown, S.G. 1986. Twentieth-century records of right whales (*Eubalaena glacialis*) in the northeast Atlantic Ocean. *In*: R.L. Brownell Jr., P.B. Best, and J.H. Prescott (eds.) Right whales: Past and Present Status. IWC Special Issue No. 10. p. 121-128.

Brown, J.J. and G.W. Murphy. 2010. Atlantic sturgeon vessel strike mortalities in the Delaware River. Fisheries 35(2):72-83.

Bryant, P.J., Lafferty, C.M. and Lafferty, S.K. 1984. Reoccupation of Laguna Guerrero Negro, Baja California, Mexico, by gray whales. pp. 375-387. *In*: M.L. Jones, S.L. Swartz, S. Leatherwood (eds.). *The Gray Whale Eschrichtius robustus*. Academic Press, San Diego, California. xxiv+600pp.

Burton, W.H. 1993. Effects of bucket dredging on water quality in the Delaware River and the potential for effects on fisheries resources. Versar, Inc., 9200 Rumsey Road, Columbia, Maryland 21045.

Calambokidis, J., E. A. Falcone, T.J. Quinn., A.M. Burdin, P.J. Clapham, J.K.B. Ford, C.M. Cabriele, R. LeDuc, D. Matilla, L. Rojas-Bracho, J.M. Straley, B.L. Taylor, J. Urban, D. Weller, B.H. Witteveen, M.Yamaguchi, A. Bendlin, D. Camacho, K. Flynn, A. Havron, J. Huggins, and N. Maloney. 2008. SPLASH: Structure of Populations, Levels of Abundance and Status of Humpback Whales in the North Pacific. Final Report for Contract AB133F-03-RP-00078. 57pp.

Carretta, J.V., K.A. Forney, E. Oleson, K. Martien, M.M. Muto, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, D. Lynch, L. Carswell, R.L. Brownell Jr., J. Robbins, D.K. Mattila, K. Ralls, and Marie C. Hill. 2011. U.S. Pacific Marine Mammal Stock Assessments: 2010. U.S. Department of Commerce, NOAA Technical Memorandum, NMFS-SWFSC-476, 352 pp.

Caswell, H., M. Fujiwara, and S. Brault. 1999. Declining survival probability threatens the North Atlantic right whale. Proc. Nat. Acad. Sci. 96: 3308-3313.

Caulfield, R.A. 1993. Aboriginal subsistence whaling in Greenland: the case of Qeqertarsuaq municipality in West Greenland. Arctic 46:144-155.

Clapham, P.J. 1992. Age at attainment of sexual maturity in humpback whales, *Megaptera* *novaengliae*. Can. J. Zool. 70:1470-1472.

Clapham, P.J. (ed.). 2002. Report of the working group on survival estimation for the North Atlantic right whales. Available from the Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543.

Clapham, P.J. and C.A. Mayo. 1990. Reproduction of humpback whales (*Megaptera novaengliae*) observed in the Gulf of Maine. Rep. Int. Whal. Commn. Special Issue 12: 171-175.

Clapham, P.J., S.B. Young, and R.L. Brownell. 1999. Baleen whales: Conservation issues and the status of the most endangered populations. Mammal Rev. 29(1):35-60.

Clark, C.W. 1995. Application of U.S. Navy underwater hydrophone arrays for scientific research on whales. Rep. Int. Whal. Commn. 45: 210-212.

Cornell University, Bioacoustics Research Program. 2010. Marine Mammal Acoustic Monitoring and Analysis for the Operations of the Northeast Gateway Energy Bridge Deepwater Port and Pipeline Lateral 17 January – 31 December 2008. Prepared for Northeast Gateway Energy Bridge, L.P, Tetra Tech EC, Inc. and TRC Solutions by the Cornell Lab of Ornithology. Technical Report 09-08. 138 pp.

Cox, T.M, A.J. Read, A. Solow, and N. Tregenza. 2001. Will harbor porpoises (*Phocoena phocoena*) habituate to pingers? Journal of Cetacean Research Management 3:81-86.

Donovan, G.P. 1991. A review of IWC stock boundaries. Rep. Int. Whal. Comm., Spec. Iss. 13:39-63.

Dovel, W.L. and T.J. Berggren. 1983. Atlantic sturgeon of the Hudson River Estuary, New York. New York Fish and Game Journal 30: 140-172.

Dunton, K.J., A. Jordaan, K.A. McKown, D.O. Conover, and M.J. Frisk. 2010. Abundance and distribution of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) within the Northwest Atlantic Ocean, determined from five fishery-independent surveys. Fishery Bulletin 108:450-465.

Durbin, E, G. Teegarden, R. Campbell, A. Cembella, M.F. Baumgartner, B.R. Mate. 2002. North Atlantic right whales, *Eubalaena glacialis*, exposed to Paralytic Shellfish Poisoning (PSP) toxins via a zooplankton vector, *Calanus finmarchicus*. Harmful Algae. 1: 243-251.

Elasser, T.H., KC Klasing, N Flipov and F Thompson, 2000. The Metabolic consequences of stress: Targets for stress and priorities of nutrient use. In 'The Biology of Animal Stress', G P Moberg and J A Mench, pp77-110. CAB INTERNATIONAL.Wallingford.

Erickson, D. L., A. Kahnle, M. J. Millard, E. A. Mora, M. Bryja, A. Higgs, J. Mohler, M. DuFour, G. Kenney, J. Sweka, and E. K. Pikitch. 2011. Use of pop-up satellite archival tags to identify oceanic-migratory patterns for adult Atlantic Sturgeon, *Acipenser oxyrinchus oxyrinchus* Mitchell, 1815. J. Appl. Ichthyol. 27: 356–365.

Excelerate Energy, L.P and Tetra Tech EC. January 2013. Request for the Taking of Marine Mammals Incidental to the Operation of Northeast Gateway Deepwater Port and Algonquin Pipeline Lateral. IHA Application submitted to NMFS.

Excelerate Energy, L.P.. October 12, 2011. Supplemental Data Responses in support of Northeast Gateway Deepwater Port (NEG Port) Concerning Revised Seawater Usage Information Requests from the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Northeast Regional Office (NERO).

Federal Energy Regulatory Commission (FERC). 2001. Final Environmental Impact Statement—Volume I on Maritimes and Northeast Pipeline, LLC et al.'s Phase III/HubLine Project. Docket No. CP01-4 et al. November 2001.

Forney, K.A. 2007. Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC- 406. 27 pp.

Flinn, R. D., A. W. Trites and E. J. Gregr. 2002. Diets of fin, sei, and sperm whales in British Columbia: An analysis of commercial whaling records, 1963-1967.
Mar. Mamm. Sci. 18(3): 663-679.

Frasier, T.R., B.A. McLeod, R.M. Gillett, M.W. Brown and B.N. White. 2007.
Right Whales Past and Present as Revealed by Their Genes. Pages 200-231. In:
S.D. Kraus and R.M. Rolland (eds) The Urban Whale. Harvard University Press, Cambridge, Massachusetts, London, England. vii-xv + 543pp.

Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions. Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

Fujiwara, M. and H. Caswell. 2001. Demography of the endangered North Atlantic right whale. Nature. 414:537-541.

Gambell, R. 1993. International management of whales and whaling: an historical review of the regulation of commercial and aboriginal subsistence whaling. Arctic 46:97-107.

Gard, R. 1974. Aerial census of gray whales in Baja California Lagoons, 1970 and 1973, with notes on behavior, mortality, and conservation. Calif. Fish and Game. 60(3):132-143.

Geraci, J.R., D.M. Anderson, R.J. Timperi, D.J. St. Aubin, G.A. Early, J.H.Prescott, and C.A. Mayo. 1989. Humpback Whales (*Megaptera novaeangliae*) Fatally Poisoned by Dinoflagellate Toxin. Can. J. Fish. and Aquat. Sci. 46(11): 1895- 1898.

Glass, A. H., T.V.N. Cole, M. Garron, R.L. Merrick, and R.M. Pace III. 2008.

Mortality and Serious Injury Determinations for Baleen Whale Stocks Along the United States Eastern Seaboard and Adjacent Canadian Maritimes, 2002- 2006. Northeast Fisheries Science Center Document 08-04. 18 pp.

Glass A.H., T.V.N. Cole, and M. Garron. 2009. Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2003-2007 (2nd Edition). US Dep Commer, Northeast Fish Sci Cent Ref Doc. 09-04; 19 pp.

Goddard, P.C., and D.J. Rugh. 1998. A group of right whales seen in the Bering Sea in July 1996. Mar. Mamm. Sci. 14(2): 344-349.

Greene, C.H., A.J. Pershing, R.D. Kenney, and J.W. Jossi. 2003. Impact of climate variability on the recovery of endangered North Atlantic right whales.
Oceanography. 16: 96-101.

Greene, C.H and A.J. Pershing. 2004. Climate and the conservation biology of North Atlantic right whales: the right whale at the wrong time? Frontiers in Ecology and the Environment. 2(1):29-34.

Greene CH, Pershing AJ, Cronin TM and Ceci N. 2008. Arctic climate change and its impacts on the ecology of the North Atlantic. Ecology 89:S24-S38.

Hain, J.H.W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The fin whale, *Balaenoptera physalus*, in waters of the northeastern United States continental shelf. Rep. Int. Whal. Comm. 42: 653-669.

Hamilton, P.K., M.K. Marx, and S.D. Kraus. 1998. Scarification analysis of North Atlantic right whales (*Eubalaena glacialis*) as a method of assessing human impacts. Final report to the Northeast Fisheries Science Center, NMFS, Contract No. 4EANF-6-0004.

Hamilton, P.K., and C.A. Mayo. 1990. Population characteristics of right whales (*Eubalaena glacialis*) observed in Cape Cod and Massachusetts Bays, 1978-1986. Reports of the International Whaling Commission, Special Issue No. 12: 203-208.

Hammond P.S., G. Bearzi, A. Bjørge, K. Forney, L. Karczmarski, T. Kasuya, W.F. Perrin, M.D. Scott, J.Y. Wang, R.S. Wells, and B. Wilson. 2008. *Lagenorhynchus acutus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Hammond, P.S., K.MacLeod, L. Burt, A. Cañadas, S. Lens, B.Mikkelsen, E. Rogan, B. Santos, A. Uriarte, O.Van Canneyt, and J.A Vázquez. 2011. Abundance of baleen whales in the European Atlantic. Paper SC/63/RMP24 presented to the IWC. Scientific Committee, June 2011, Tromsø, Norway (unpublished). 22pp.

Hatch, L.T., Clark, C.W., Merrick, R., Van Parijs, S., Ponirakis, D., Schwehr, K., Thompson, M. and Wiley, D. 2008. Characterizing the relative contributions of large vessels to total ocean noise fields: a case study using the Gerry E. Studds Stellwagen Bank National Marine Sanctuary.

Environmental Management.

Henry A.G., T.V.N. Cole, M. Garron, and L. Hall. 2011. Mortality and Serious Injury Determinations for Baleen Whale Stocks along the Gulf of Mexico, United States and Canadian Eastern Seaboards, 2005-2009. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-18. 24 pp.

Henry, A.G., T.V.N. Cole, M. Garron, L. Hall, W. Ledwell and A. Reid. 2012. Mortality and serious injury determinations for baleen whale stocks along the Gulf of Mexico, United States East Coast and Atlantic Canadian Provinces, 2006–2010, NEFSC Reference Document 12-11. 24 pp.

Hightower, M. et al. 2004. Threat and Breach Analysis of an LNG Ship Spill Over Water. U.S. DOE and Sandia National Laboratories, Albuquerque, NM.

Hildebrand, H. 1982. A historical review of the status of sea turtle populations in the western Gulf of Mexico, P. 447-453. In K.A. Bjorndal (ed.), Biology and conservation of sea turtles. Smithsonian Institution Press, Washington, D.C.

Hulme, P.E. 2005. Adapting to climate change: Is there scope for ecological management in the face of global threat? Journal of Applied Ecology 43: 617-627.

Intergovernmental Panel on Climate Change (IPCC). 2006. IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

Intergovernmental Panel on Climate Change (IPCC). 2007a. Summary for Policymakers. *In* Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (editors). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, New York, USA.

Intergovernmental Panel on Climate Change (IPCC). 2007b. Fourth Assessment Report. Valencia, Spain.

International Whaling Commission (IWC). 1979. Report of the sub-committee on protected species. Annex G., Appendix I. Rep. Int. Whal. Comm. 29: 84-86.

International Whaling Commission (IWC). 1986. Right whales: past and present status. Reports of the International Whaling Commission. Special Issue No. 10: Cambridge, England.

International Whaling Commission (IWC). 1992. Report of the comprehensive assessment special meeting on North Atlantic fin whales. Reports of the International Whaling Commission 42:595-644.

International Whaling Commission (IWC). 1995. Report of the Scientific Committee, Annex E.

Rep. Int. Whal. Comm. 45:121-138.

International Whaling Commission (IWC). 1997. Report of the IWC workshop on climate change and cetaceans. *Report of the International Whaling Commission* 47: 293-313.

Jahoda, M., C. L. Lafortuna, N. Biassoni, C. Almirante, A. Azzelino, S. Panigada, M. Zanardelli et al. 2003. Mediterranean fin whale's (*Balaenoptera physalus*) response to small vessels and biopsy sampling assessed through passive tracking and timing of respiration. Marine Mammal Science 19:15.

Jansen, G. 1998. Chapter 25. Physiological effects of noise. Pages 25.21 - 25.19 in C. M. Harris, editor. Handbook of acoustical measurements and noise control. Acoustical Society of America, Woodbury, New York.

Jefferson, T.A., M.A. Webber, and R.L. Pitman. (2008). Marine Mammals of the World, A Comprehensive Guide to their Identification. Amsterdam, Elsevier. Pp. 47-50.

Jensen AS and GK Silber. 2003. Large whale ship strike database. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-F/OPR 25, 37 p.

Johnson, M. P. and P.L. Tyack. 2003. A digital acoustic recording tag for measuring the response of wild marine mammals to sound. *IEEE J. Oceanic Engng* **28**, 3–12.

Jones, D. M., and D. E. Broadbent. 1998. Chapter 24. Human peformance and noise. Pages 24.21 - 24.24 in C. M. Harris, editor. Handbook of acoustical measurements and noise control. Acoustical Society of America, Woodbury, New York.

Kenney, R.D. 2001. Anomalous 1992 spring and summer right whale (*Eubalaena glacialis*) distribution in the Gulf of Maine. Journal of Cetacean Research and Management (special Issue) 2: 209-23.

Kenney, R.D. 2002. North Atlantic, North Pacific and Southern right whales, *Eubalaena glacialis, E. japonica and E. australis*. Pp 806-813 in Perrin et al., editors, Encyclopedia of Marine Mammals.

Kenney, R.D., M.A.M. Hyman, and H.E. Winn. 1985. Calculation of Standing Stocks and Energetic Requirements of the Cetaceans of the Northeast United States Outer Continental Shelf. NOAA Technical Memorandum NMFS-F/NEC-41. Woods Hole, MA: National Marine Fisheries Service. iv + 99 pp.

Kenney, R.D., M.A.M. Hyman, R.E. Owen, G.P. Scott, and H.E. Winn. 1986. Estimation of prey densities required by Western North Atlantic right whales. Mar. Mamm. Sci. 2(1): 1-13.

Kenney, R.D., H.E. Winn, and M.C. Macaulay. 1995. Cetaceans in the Great South Channel, 1979-1989: right whale (*Eubalaena glacialis*). Cont. Shelf. Res. 15: 385-414.

Ketten, D.R. 1998. Marine mammal auditory systems: a summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA Technical Memorandum NMFS: NOAA-TM-NMFS-SWFSC-256.

Khan, C., T.V.N. Cole, P. Duley, A. Glass, M. Niemeyer, and C. Christman. 2009. North Atlantic Right Whale Sighting Survey (NARWSS) and Right Whale Sighting Advisory System (RWSAS) 2008 Results Summary. NEFSC Reference Document 09-05. 7 pp.

Khan, C., T. Cole, P. Duley, A. Glass, and J. Gatzke. 2010. North Atlantic Right Whale Sighting Survey (NARWSS) and Right Whale Sighting Advisory System (RWSAS) 2009 Results Summary. NEFSC Reference Document 10-07. 7 pp.

Khan, C., T. Cole, P. Duley, A. Glass, and J. Gatzke. 2011. North Atlantic Right Whale Sighting Survey (NARWSS) and Right Whale Sighting Advisory System (RWSAS) 2010 Results Summary. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 11-05. 6 pp.

Khan C., T. Cole, P. Duley, A. Glass, and J. Gatzke, J. Corkeron. 2012. North Atlantic Right Whale Sighting Survey (NARWSS) and Right Whale Sighting Advisory System (RWSAS) 2011 Results Summary. US Dept Commer, Northeast Fish Sci Cent Ref Doc. 12-09; 6 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026, or online at http://nefsc.noaa.gov/publications/

Knowlton, A. R., J. Sigurjonsson, J.N. Ciano, and S.D. Kraus. 1992. Long-distance movements of North Atlantic right whales (*Eubalaena glacialis*). Mar. Mamm. Sci. 8(4): 397-405.

Knowlton, A.R., S.D. Kraus, and R.D. Kenney. 1994. Reproduction in North Atlantic right whales (*Eubalaena glacialis*). Can. J. Zool. 72: 1297-1305.

Knowlton, A.R., L. A. Cooper, P. K. Hamilton, M. K. Marx, H. M. Pettis, and S. D. Kraus. 2008. Analysis of scarring on North Atlantic right whales *(Eubalaena glacialis)*: Monitoring rate of entanglement interaction- 1980 – 2004. Final report to the Northeast Fisheries Science Center, NMFS, Contract No. EA133F- 03-SE-0323. New England Aquarium: 25pp.

Kraus S.D., R. M. Pace III and T.R. Frasier. 2007. High Investment, Low Return: The Strange Case of Reproduction in *Eubalaena Glacialis*. Pp 172-199. In: S.D. Kraus and R.M. Rolland (eds.) The Urban Whale. Harvard University Press, Cambridge, Massachusetts, London, England. vii-xv + 543pp.

Kraus, S.D., J. H. Prescott, and A. R. Knowlton. 1986. Wintering right whales (*Eubalaena glacialis*) along the Southeastern coast of the United, 1984-1986. New England Aquarium: 15pp.

Kraus, S.D., P.K. Hamilton, R.D. Kenney, A.R. Knowlton, and C.K. Slay. 2001. Reproductive parameters of the North Atlantic right whale. J. Cetacean Res. Manage. 2: 231-236.

Kraus, S.D., M.W. Brown, H. Caswell, C.W. Clark, M. Fujiwara, P.K. Hamilton, R.D. Kenney, A.R. Knowlton, S. Landry, C.A. Mayo, W.A. McLellan, M.J. Moore, D.P. Nowacek, D.A. Pabst, A.J. Read, R.M. Rolland. 2005. North Atlantic Right Whales in Crisis. *Science*, 309:561-562.

Krausman, P. R., L. K. Harris, C. L. Blasch, K. K. G. Koenen, and J. Francine. 2004. Effects of military operations on behavior and hearing of endangered Sonoran pronghorn. Wildlife Monographs:1-41.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, M. Podesta. 2001. Collisions between ships and whales. Marine Mammal Science 17(1):35-75.

Laney, R.W., J.E. Hightower, B.R. Versak, M.F. Mangold, W.W. Cole Jr., and S.E. Winslow 2007. Distribution, habitat use, and size of Atlantic sturgeon captured during cooperative winter tagging cruises, 1988–2006. Pages 167-182. In: J. Munro, D. Hatin, J. E. Hightower, K. McKown, K. J. Sulak, A. W. Kahnle, and F. Caron, (editors), Anadromous sturgeons: Habitats, threats, and management. Am. Fish. Soc. Symp. 56, Bethesda, MD.

Learmonth J.A., C.D. MacLeod, M.B. Santos, G.J. Pierce, H.Q.P. Crick, R.A. Robinson. 2006. Potential effects of climate change on marine mammals. Oceanogr Mar Biol Annu Rev 44:431-464.

MacLeod, C.D. 2009. Global climate change, range changes and potential implications for the conservation of marine cetaceans: A review and synthesis. Endang Species Res 7:125-136.

Malik, S., M. W. Brown, S.D. Kraus and B. N. White. 2000. Analysis of mitochondrial DNA diversity within and between North and South Atlantic right whales. Mar. Mammal Sci. 16:545-558.

Malme, C.I. et al. 1983. Investigation of the potential effects of acoustic stimuli associated with oil and gas exploration and development on the behavior of migrating gray whales. Final Report No. 5366: Bolt Beranek and Newman, Inc.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J. E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 586. Rep. from Bolt, Beranek, & Newman, Inc. Cambridge, Massachusetts, for U.S. Minerals Management Service, Anchorage, Alaska.

Mate, B.M., S.L. Nieukirk, R. Mescar, and T. Martin. 1992. Application of remote sensing methods for tracking large cetaceans: North Atlantic right whales (*Eubalaena glacialis*). Final Report to the Minerals Management Service, Contract No. 14-12-0001-30411, 167 pp.

Mate, B.M., S.L. Nieukirk, and S.D. Kraus. 1997. Satellite monitored movements of the North Atlantic right whale. J. Wildl. Manage. 61:1393-1405.

Mayo, C.A. and M.K. Marx. 1990. Surface foraging behavior of the North Atlantic right whale, *Eubalaena glacialis*, and associated zooplankton characteristics. Can. J. Zool. 68: 2214-2220.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M-N Jenner, J.D. Penrose, R.I.T. Prince, A.

Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Report R99-15. Centre for Marine Science and Technology, Curtin University of Technology, Western Australia.

Mellinger, D.K. 2004. A comparison of methods for detecting right whale calls. *Canadian Acoustics,* 32:55-65.

Merrick, R.L. 2005. Seasonal management areas to reduce ship strikes of northern right whales in the Gulf of Maine. U.S. Dep. Commer., Northeast Fish. Sci. Cent. Ref. Doc. 05-19; 18 p.

Miller C.A., D. Reeb, P.B. Best, A.R. Knowlton, M.W. Brown, M.J. Moore. 2011. Blubber thickness in right whales Eubalaena glacialis and Eubalaena australis related with reproduction, life history status and prey abundance. Mar Ecol Prog Ser 438:267-283.

Minton, G., Collins, T., Pomilla, C., Findlay, K.P., Rosenbaum, H., Baldwin, R. & Brownell Jr., R.L. 2008. *Megaptera novaeangliae (Arabian Sea subpopulation)*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.2. <www.iucnredlist.org>. Downloaded on 12 August 2010.

Mitchell, E., V.M. Kozicki, and R.R. Reeves. 1986. Sightings of right whales, *Eubalaena glacialis*, on the Scotian Shelf, 1966-1972. Reports of the International Whaling Commission (Special issue). 10: 83-107.

Mizroch, S.A. and A.E. York. 1984. Have pregnancy rates of Southern Hemisphere fin whales, *Balaenoptera physalus*, increased? Reports of the International Whaling Commission, Special Issue No. 6:401-410.

Moberg, GP. 1987. Influence of the adrenal axis upon the gonads. Oxford Reviews of Reproductive Biology. **9** 456–496.

Moore, JC and E. Clark. 1963. Discovery of Right Whales in the Gulf of Mexico. Science 141: 269.

Moore, M.J., W.A. McLellan, P.Daous, R.K. Bonde and A.R. Knowlton. 2007. Right Whale Mortality: A Message from the Dead to the Living. Pp 358-379. *In*: S.D. Kraus and R.M. Rolland (eds). The Urban Whale. Harvard University Press, Cambridge, Massachusetts, London, England. vii-xv + 543pp.

Moore M.J., A.R., Knowlton, S.D. Kraus, W.A. McLellan, R.K. Bonde. 2004. Morphometry, gross morphology and available histopathology in North Atlantic right whale (*Eubalaena glacialis*) mortalities (1970–2002). Journal of Cetacean Research and Management. 6(3):199-214.

Murawski, S.A. and A.L. Pacheco. 1977. Biological and fisheries data on Atlantic sturgeon, *Acipenser oxyrhynchus* (Mitchill). National Marine Fisheries Service Technical Series Report 10:1-69.

Murdoch, P.S., J.S. Baron, and T.L. Miller. 2000. Potential effects of climate change on surface-water quality in North America. JAWRA Journal of the American Water Resources Association, 36: 347–366.

National Assessment Synthesis Team (NAST). 2000. Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change, US Global Change Research Program, Washington DC, 2000.

National Research Council (NRC). 2003. Ocean noise and marine mammals. National Academy Press; Washington, D.C.

National Marine Fisheries Service (NMFS). 1991a. Final recovery plan for the humpback whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the national Marine Fisheries Service, Silver Spring, Maryland. 105 pp.

National Marine Fisheries Service (NMFS). 1991b. Final recovery plan for the northern right whale (*Eubalaena glacialis*). Prepared by the Right Whale Recovery Team for the National Marine Fisheries Service. 86 pp.

National Marine Fisheries Service (NMFS). 1995. Endangered Species Act Section 7 consultation on United States Coast Guard vessel and aircraft activities along the Atlantic coast. Biological Opinion. September 15, 1995.

National Marine Fisheries Service (NMFS). 1998a. Final recovery plan for the shortnose sturgeon (*Acipenser brevirostrum*). National Marine Fisheries Service, Silver Spring, Maryland. October 1998.

National Marine Fisheries Service (NMFS). 1998b. Draft recovery plans for the fin whale (*Balaenoptera physalus*) and sei whale (*Balaenoptera borealis*). Prepared by R.R. Reeves, G.K. Silber, and P.M. Payne for the National Marine Fisheries Service, Silver Spring, Maryland. July 1998.

National Marine Fisheries Service (NMFS). 1998c. Recovery plan for the blue whale (*Balaenoptera nusculus*). Prepared by R.R. Reeves, P. Clapham, R.L. Brownell, G.K. Silber for the National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service (NMFS). 2005. Recovery Plan for the North Atlantic Right Whale (*Eubalaena glacialis*). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service (NMFS). 2005a. Endangered Species Act Section 7 consultation on the Continued operation of the Oyster Creek Nuclear Generating Station on the Forked River and Oyster Creek, Barnegat Bay, New Jersey. Biological Opinion, September 22.

National Marine Fisheries Service (NMFS). 2006. Draft Environmental Impact Statement (DEIS) to Implement the Operational Measures of the North Atlantic Right Whale Ship Strike

Reduction Strategy. National Marine Fisheries Service. July 2006.

National Marine Fisheries Service (NMFS). 2007. Endangered Species Act Section 7 consultation for the construction and operation of the Northeast Gateway LNG Port in Massachusetts Bay. Biological Opinion, November 30.

National Marine Fisheries Service. 2005. Recovery Plan for the North Atlantic Right Whale (Eubalaena glacialis). National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service. 2010. Recovery plan for the fin whale (Balaenoptera physalus). National Marine Fisheries Service, Silver Spring, MD. 121pp.

National Marine Fisheries Service. 2011. Final Recovery Plan for the Sei Whale (Balaenoptera borealis). National Marine Fisheries Service, Office of Protected Resources, Silver Spring, MD. 108 pp

Northeast Fisheries Science Center. 2014. "Interactive North Atlantic Right Whale Sightings Map". Web. http://www.nefsc.noaa.gov/psb/surveys/. Accessed on November 6, 2014.

Parks, S.E, P.K. Hamilton, S.D. Kraus, and P.L. Tyack. 2005. The gunshot sound produced by male North Atlantic right whales (*Eubalaena glacialis*) and its potential function in reproductive advertisement. Mar Mamm Sci 21:458-475.

Parks, S.E. and P.L. Tyack. 2005. Sound production by North Atlantic right whales (*Eubalaena glacialis*) in surface active groups. J. Acoust. Soc. Am. 117(5): 3297-3306.

Payne, K. and R.S. Payne. 1985. Large-scale changes over 17 years in songs of humpbackwhales in Bermuda. Z. Tierpsychol. 68: 89-114.

Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. The Great Whales: History and status of six species listed as endangered under the US Endangered Species Act of 1973. Special issue of the Marine Fisheries Review 61(1), 74 pp.

Pike, D.G., Gunnlaugsson, T., Vikingsson, G.A., and B. Mikkelsen. 2008. Estimates of the abundance of fin whales (Balaenoptera physalus) from the T-NASS Icelandic and Faroese ship surveys conducted in 2007. Paper SC/60/PFI13 presented to the IWC Scientific Committee, 16pp.

Pritchard, P.C.H. 1982. Nesting of the leatherback turtle, *Dermochelys coriacea*, in Pacific, Mexico, with a new estimate of the world population status. Copeia 1982:741-747.

Reeves, R.R. 1977. The problem of gray whale (Eschrichtus robustus) harassment: at the breeding lagoons and during migration. Final report to the US Marine Mammal Commission.

Reilly, S.B., Bannister, J.L., Best, P.B., Brown, M., Brownell Jr., R.L., Butterworth, D.S., Clapham, P.J., Cooke, J., Donovan, G.P., Urbán, J. & Zerbini, A.N. 2008. *Megaptera novaeangliae*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.2.

<www.iucnredlist.org>. Downloaded on 12 August 2010.

Richardson, W. J., Würsig, B. & Greene, C. R., Jr. 1986. Reactions of bowhead whales, Balaena mysticetus, to seismic exploration in the Canadian Beaufort Sea. J. Acoust. Soc. Am. 79, 1117–1128.

Richardson, W.J., C.R. Greene, Jr., W.R. Koski, C.I. Maime, G.W. Miller, M.A. Smultea, and B. Wiirsig. 1990. Acoustic Effects of Oil Production Activities on Bowhead and White Whales Visible During Spring Migration Near Pt. Barrow, Alaska – 1989 Phase: Sound Propagation and Whale Responses to Playbacks of Continuous Drilling Noise From an Ice Platform, as Studied in Pack Ice Conditions. OCS Study MMS 90-0017. LGL Report TA848-4. July 1990. LGL Ltd., Environmental Research Associates, Ontario, Canada

Richardson, W.J., M.A. Fraker, B. Wursig, and R.S. Wells. 1985. Behavior of bowhead whales *Balaena mysticetus* summering in the Beaufort Sea: Reactions to industrial activities. Biol. Conserv. 32: 195-230.

Richardson W.J., C.R. Greene Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press; San Diego, California.

Ridgway, S.H., E.G. Weaver, J.G. McCormick, J. Palin, and J.H. Anderson. 1969. Hearing in the Giant Sea Turtle, *Chelonia mydas*. Proceedings of the National Academy of Sciences 64(3): 884-890.

Rivest S. and Rivier C., 1995. The role of corticotropin-releasing factor and interleukin-1 in the regulation of neurons controlling reproductive functions. Endocr. Rev. 16, 177-99.

Robbins, J. and D. Mattila. 2004. Estimating humpback whale (*Megaptera novaeangliae*) entanglement rates on the basis of scar evidence: Report to the Northeast Fisheries Science Center, National Marine Fisheries Service. Order number 43EANF030121. 21 pp.

Rogers, P.H., and M. Cox. 1988. Underwater Sound as a Biological Stimulus. In: J. Atema, R.R. Fay, A.N. Popper, and W.N. Tavolga (eds.) *Sensory Biology of Aquatic Animals*, pp. 131-149. Springer-Verlag: New York.

Rolland, R.M, K.E. Hunt, G.J. Doucette, L.G. Rickard and S. K. Wasser. 2007. The Inner Whale: Hormones, Biotoxins, and Parasites. Pp 232-272. In: S.D. Kraus and R.M. Rolland (eds) *The Urban Whale*. Harvard University Press, Cambridge, Massachusetts, London, England. vii-xv + 543 pp.

Ruben, H.J, and S.J. Morreale. 1999. Draft Biological Assessment for Sea Turtles in New York and New Jersey Harbor Complex. Unpublished Biological Assessment submitted to National Marine Fisheries Service.

Savoy, T., and D. Pacileo. 2003. Movements and important habitats of subadult Atlantic sturgeon in Connecticut waters. Transactions of the American Fisheries Society. 132: 1-8.

Schaeff, C.M., Kraus, S.D., Brown, M.W., Perkins, J.S., Payne, R., and White, B.N. 1997. Comparison of genetic variability of North and South Atlantic right whales (Eubalaena), using DNA fingerprinting. Can. J. Zool. 75:1073-1080.

Schevill, W.E., W.A. Watkins, and K.E. Moore. 1986. Status of *Eubalaena glacialis* off Cape Cod. Reports of the International Whaling Commission, Special Issue No. 10: 79-82.

Schmidly, D.J., C.O. Martin, and G.F. Collins. 1972. First occurrence of a black right whale (Balaena glacialis) along the Texas coast. The Southwestern Naturalist.

Schick, R.S., P.N. Halpin, A.J. Read, C.K. Slay, S.D. Kraus, B.R. Mate, M.F. Baumgartner, J.J. Roberts, B.D. Best, C.P. Good, S.R. Loarie, and J.S. Clark. 2009. Striking the right balance in right whale conservation. NRC Research Press Web site at cjfas.nrc.ca. J21103.

Schulkin, M. and Mercer, J.A. 1985. "Colossus Revisited: A Review and Extension of the Marsh-Schulkin Shallow Water Transmission Loss Model," University of Washington Applied Physics Laborotory, APL-UW 8508.

Seipt, I., P.J. Clapham, C.A. Mayo, and M.P. Hawvermale. 1990. Population characteristics of individually identified fin whales, *Balaenoptera physalus*, in Massachusetts Bay. Fish. Bull. 88:271-278.

Smith, T.I.J. 1985. The fishery, biology, and management of Atlantic sturgeon, *Acipenser oxyrhynchus*, in North America. Environmental Biology of Fishes 14(1): 61-72.

Southall BL, AE Bowles, ,WT Ellison, JJ Finneran, RL Gentry, CR Greene Jr. , D Kastak, DR Ketten, JH Miller, PE Nachtigall, WJ Richardson, JA Thomas, and PL Tyack.. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals. 33(4): 427-436.

Stone, G.S., L. Flores-Gonzalez, and S. Cotton. 1990. Whale migration record. Nature. 346: 705.

Stein, A. B., K. D. Friedland, and M. Sutherland. 2004. Atlantic sturgeon marine distribution and habitat use along the northeastern coast of the United States. Transactions of the American Fisheries Society 133: 527-537.

Stevick P.T., J. Allen, P.J. Clapham, N. Friday, S.K. Katona, F. Larsen, J. Lien, D.K. Matilla, P.J. Palsboll, J. Sigurjonsson, T.D. Smith, N. Oien, P.S. Hammond. 2003. North Atlantic humpback whale abundance and rate of increase four decades after protection from whaling. Marine Ecology Progress Series. 258:263-273.

Stevick, P.T., J. Allen, P.J. Clapham, S.K. Katona, F. Larsen, J. Lien, D.K. Mattila, P.J. Palsboll, R. Sears, J. Sigurjonsson, T.D. Smith, G. Vikingsson, N. Oien, P.S. Hammond. 2006. Population spatial structuring on the feeding grounds in North Atlantic humpback whales (*Megaptera novaeangliae*). Journal of Zoology. 270(2006): 244-255.

Sumich, J.L. 1988. An Introduction to the Biology of Marine Life. 7th Edition. Dubuque, IA: Wm. C Brown Publishing.

Swingle, W.M., S.G. Barco, T.D. Pitchford, W.A. McLellan, and D.A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. Mar. Mamm. Sci. 9: 309-315.

Tetra Tech EC, Inc. 2011. Northeast Gateway Energy Bridge Energy Port and Pipeline Lateral Massachusetts Bay Area: Hydroacoustic surveys during construction, operations, and transit. Report submitted to NMFS Office of Protected Resources Permits.

Trimper, P. G., N. M. Standen, L. M. Lye, D. Lemon, T. E. Chubbs, and G. W. Humphries. 1998. Effects of low-level jet aircraft noise on the behaviour of nesting osprey. The Journal of Applied Ecology 35:9.

TEWG. 1998. An assessment of the Kemp's ridley (*Lepidochelys kempi*) and loggerhead (*Caretta caretta*) sea turtle populations in the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409. 96 pp.

Tyack, P. and C. Clark. 1998. "Quick Look - Playback of low frequency sound to gray whales migrating past the central California coast - January, 1998." Quick Look Report: 1-34.

Tynan, C.T. & DeMaster, D.P. 1997. Observations and predictions of Arctic climatic change: potential effects on marine mammals. Arctic 50, 308-322.

US Coast Guard (USCG). 2006a. Final Environmental Impact Statement and Environmental Impact Report, Northeast Gateway Deepwater Port.

US Coast Guard (USCG). 2006b. Final Environmental Impact Statement and Environmental Impact Report, Neptune LNG Deepwater Port License Application.

Vanderlaan, A.S.M. and C.T. Taggart. 2006. Vessel collisions with whales: The probability of lethal injury based on vessel speed. Mar. Mam. Sci. 22(3).

Vladykov, V.D. and J.R. Greeley. 1963. Order Acipenseroidei. In: Fishes of Western North Atlantic. Sears Foundation. Marine Research, Yale Univ. 1 630 pp.

Waluda, C.M., P.G. Rodhouse, G.P. Podestá, P.N. Trathan and G.J. Pierce. 2001. Surface oceanography of the inferred hatching grounds of *Illex argentinus* (Cephalopoda: Ommastrephidae) and influences on recruitment variability. *Marine Biology* 139, 671–679.

Waring, G.T., E. Josephson, C.P. Fairfield, and K. Maze-Foley (eds). 2005. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 2005. NOAA Technical Memorandum NMFS-NE-194.

Waring G.T., E. Josephson, C.P. Fairfield-Walsh, K. Maze-Foley, editors. 2009. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2008. NOAA Tech Memo NMFS NE 210. 440 pp.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel, editors. 2010. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments—2009. NOAA Tech Memo NMFS NE 219 pp.

Waring G.T. ,E. Josephson, K. Maze-Foley, P.E. Rosel, editors. 2011. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2010. NOAA Tech Memo NMFS NE 219. 598 p.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2012. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments—2011. NOAA Technical Memorandum NMFS-NE-221:1-319.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2014. U.S. Atlantic and Gulf of Mexico marine mammal stock assessments - 2013. NOAA Technical Memorandum

Wartzok, D., W.A. Watkins, B. Wursig, and C.I. Malme. 1989. Movements and behaviors of bowhead whales in response to repeated exposures to noise associated with industrial activities in the Beaufort Sea. Report to Amoco Production Company, Denver, CO. 228 pp.

Watkins, W.A. 1981. Activities and underwater sounds of fin whales. Scientific Reports of the International Whaling Commission 33: 83-117.

Watkins, W.A. 1986. Whale reactions to human activities in Cape Cod waters. Marine Mammal Science 2(4): 251-262.

Watkins, W.A., and W.E. Schevill. 1982. Observations of right whales (*Eubalaena glacialis*) in Cape Cod waters. Fish. Bull. 80(4): 875-880.

Watkins, W. A., K. E. Moore, D. Wartzok, and J. H. Johnson. 1981. Radio tracking of finback *(Balaenoptera physalu*s) and humpback *(Megaptera novaeangliae*) whales in Prince William Sound, Alaska. Deep-Sea Research 28A(6):577-588.

Watkins, W.A., K.E. Moore, J. Sigurjonsson, D. Wartzok, and G. Notarbartolo di Sciara. 1984. Fin whale (*Balaenoptera physalus*) tracked by radio in the Irminger Sea. Rit Fiskideildar 8(1): 1-14.

Weinrich, M., J. Tackaberry, and K Sardi. 2006. The distribution of endangered baleen whales in the waters surrounding the Neptune LNG proposed deepwater portsite: 1996-2005. Report prepared for Neptune LNG LLC by the Whale Center of New England, Gloucester, MA

Weisbrod, A.V., D. Shea, M.J. Moore, and J.J. Stegeman. 2000. Organochlorine exposure and bioaccumulation in the endangered Northwest Atlantic right whale (*Eubalaena glacialis*) population. Environmental Toxicology and Chemistry, 19(3):654-666.

Welsh, S. A., S. M. Eyler, M. F. Mangold, and A. J. Spells. 2002. Capture locations and growth rates of Atlantic sturgeon in the Chesapeake Bay. Pages 183-194. In: W. Van Winkle, P. J. Anders, D. H. Secor, and D. A. Dixon, (editors), Biology, management, and protection of North American sturgeon. American Fisheries Society Symposium 28, Bethesda, MD.

Wiley, D.N., R.A. Asmutis, T.D. Pitchford, and D.P. Gannon. 1995. Stranding and mortality of humpback whales, Megaptera novaeangliae, in the mid-Atlantic and southeast United States, 1985-1992. Fishery Bulletin 93(1):196-205.

Winn, H.E., C.A. Price, and P.W. Sorensen. 1986. The distributional biology of the right whale (*Eubalaena glacialis*) in the western North Atlantic. Reports of the International Whaling Commission (Special issue). 10: 129-138

Wirgin, I. and T.L. King. 2011. Mixed stock analysis of Atlantic sturgeon from coastal locales and a non-spawning river. Presentation of the 2011 Sturgeon Workshop, Alexandria, VA, February 8-10.

Wise, J.P, S.S. Wise, S. Kraus, R. Shaffley, M. Grau, T.L. Chen, C. Perkins, W.D. Thompson, T. Zhang, Y. Zhang, T. Romano and T. O'Hara. 2008. Hexavalent chromium is cytotoxic and genotoxic to the North Atlantic right whale (*Eubalaena glacialis*) lung and testes fibroblasts. Mutation Research—Genetic Toxicology and Environmental Mutagenesis. 650(1): 30-38.

Woodley, T.H., M.W. Brown, S.D. Kraus, and D.E. Gaskin. 1991. Organochlorine levels in North Atlantic right whale *(Eubalaena glacialis)* blubber. *Arch. Environ. Contam. Toxicol*. 21 (1): 141-145.