FINAL

Programmatic Environmental Assessment

for

Fisheries Research Conducted and Funded by the Northeast Fisheries Science Center

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Appendix A

NEFSC Research Gear and Vessel Descriptions

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A trawl is a funnel-shaped net towed behind a boat to capture fish. The codend, or ‘bag,’ is the fine-meshed portion of the net most distant from the towing vessel where fish and other organisms larger than the mesh size are retained. In contrast to commercial fishery operations, which generally use larger mesh to capture marketable fish, research trawls often use smaller mesh to enable estimates of the size and age distributions of fish in a particular area. The body of a trawl net is generally constructed of relatively coarse mesh that functions to gather schooling fish so they can be collected in the codend. The opening of the net, called the ‘mouth’, is extended horizontally by large panels of wide mesh called ‘wings.’ The mouth of the net is held open by hydrodynamic force exerted on the trawl doors attached to the wings of the net. As the net is towed through the water, the force of the water spreads the trawl doors horizontally apart.

The trawl net is usually deployed over the stern of the vessel, and attached with two cables, or ‘warps,’ to winches on the deck of the vessel. The cables are played out until the net reaches the fishing depth. Commercial trawl vessels may travel at speeds between two and five knots while towing the net for up to several hours, whereas most NEFSC trawl surveys involve tow speeds from 1.4 to 4.0 knots, and tow durations from 15 to 60 minutes. The speed and duration of the tow depend on the purpose of the trawl, the catch rate, and the target species. At the end of the tow, the net is retrieved and the contents of the codend are emptied onto the deck. For research purposes, the speed and duration of the tow and the characteristics of the net must be standardized to allow meaningful comparisons of data collected at different times and locations. Active acoustic devices incorporated into the research vessel and the trawl gear monitor the position and status of the net, speed of the tow, and other variables important to the research design.

NEFSC research trawling activities use both ‘pelagic’ (surface or mid-water) trawls, which are designed to operate at various depths within the water column, as well as ‘bottom’ trawls, which are designed to capture target species at or near the seafloor (see Figure A-1). Marine mammals can become entangled by trawl gear when swimming with risks differing widely between species. Many species of marine mammals forage and swim at mid-water depths, putting them at risk of being captured or entangled in pelagic trawls. In the Northeast United States, pilot whales and white-sided dolphins are particularly susceptible to being caught in mid-water trawls in nearshore areas. Species that forage on or near the seafloor are at risk of being captured or entangled in bottom trawl netting or tow lines. Humpback whales in the southern Gulf of Maine commonly feed along the seafloor (Ware et al. 2013), making them vulnerable to entanglement in bottom trawl gear. There is also potential for marine mammals to interact with bottom trawl equipment near the surface of the water, as the gear is retrieved from fishing depth and brought aboard the vessel. Historically, the NEFSC has recorded marine mammal interactions with both bottom trawl and pelagic trawl nets (Section 4.2.4).

4-seam, 3-bridle bottom trawl: Several NEFSC research programs utilize a 4-seam, 3-bridle bottom trawl, manufactured using 12 centimeter and 6 cm mesh. The effective mouth opening of the 4-seam, 3-bridle bottom trawl is approximately 70 square meters (14 meter spread x 5 meters high), spread by a pair of trawl doors. The footrope of the trawl is 89 feet in length, and is ballasted with heavy rubber discs or roller gear. The head rope is approximately 79 feet in length and is supported by 60 Nokalon #508, eight inch center hole, orange trawl floats. For certain research activities, a liner may be sewn into the codend to minimize the loss of small fish.

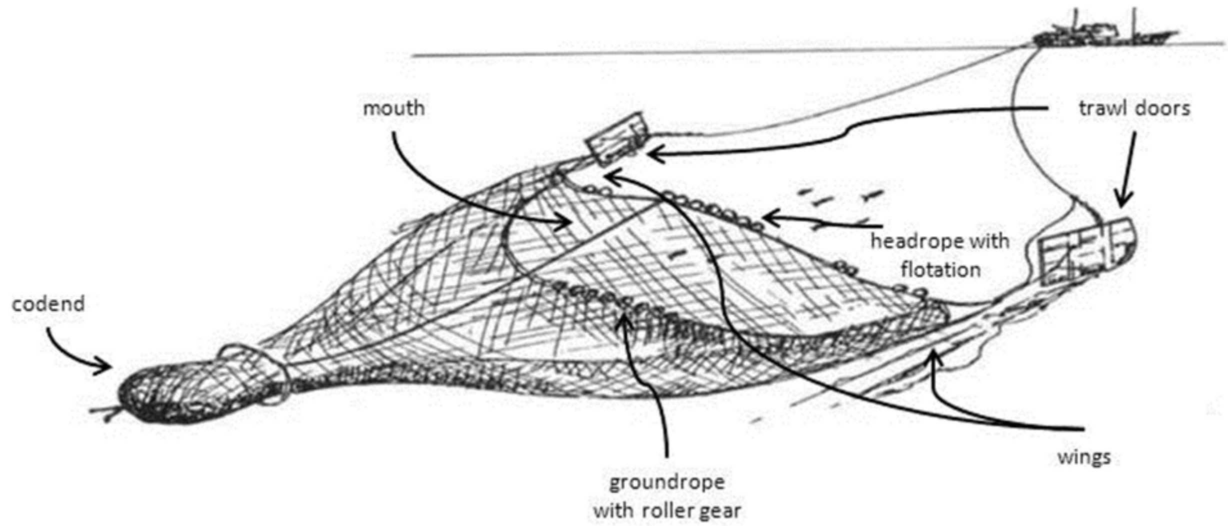

Figure A-1. Bottom trawl illustration

NEFSC uses the 4-seam, 3-bridle bottom trawl for a variety of research programs along the U.S. east coast. The objectives of these cruises include tracking mature animals, determination of juvenile abundance, assessment of habitat distribution, and collection of data on seasonal migrations. The trawl is fished at depth for 15 - 60 minutes at a time at speeds of 1.5 - 4 knots.

Midwater Rope Trawl: the High Speed Midwater Rope Trawl (Gourock HSMRT design R202825A) used for the NEFSC's fisheries acoustics surveys employs a four-seam box design with a 174 feet headrope, footrope, and breastlines (see Figure A-2). The mouth opening of the HSMRT is approximately 13.3 meters vertical and 27.5 meters horizontal. Once the net is deployed, changes in the position of the net in the water column are made by increasing or decreasing the speed of the vessel, or by bringing in or letting out trawl wire. Active acoustics are also deployed to monitor the ship and net positions and status. As with bottom trawl nets, protected species may interact with pelagic trawl nets during the deployment and retrieval of the net when the net is at or near the surface of the water. However, because pelagic nets are operated above the seafloor, impacts related to bottom habitat degradation and interactions with bottom-dwelling species are minimal. Because pelagic trawl nets are not designed to contact the seafloor, they do not have bobbins or roller gear, which are often used to protect the foot rope of a 'bottom' trawl net as it is dragged along the bottom.

Figure A-2. Emptying the codend of the High Speed Midwater Rope Trawl

Credit: NEFSC Photo Archives.

Figure A-3. The Isaacs-Kidd Midwater Trawl (IKMT) net

Credit: Joe Warren, Stony Brook University

Other Towed Nets: In addition to the nets described above, NEFSC uses various small, fine-mesh, towed nets designed to sample plankton, small fish, and pelagic invertebrates. The Isaacs-Kidd Midwater Trawl (IKMT), shown in Figure A-3, is used to collect deep water biological specimens larger than those taken by standard plankton nets. The mouth of the net is approximately 1.5 meters wide by 2 meters high, and is attached to a wide, V-shaped, rigid diving vane that keeps the mouth of the net open and maintains the net at depth for extended periods (Yasook et al. 2007). The IKMT is a long, round net approximately 6.5 meters long, with a series of hoops decreasing in size from the mouth of the net to the codend that maintain the shape of the net during towing (Yasook et al. 2007). While most trawls must be towed at speeds of 1 to 2 knots because of the high level of drag exerted by the net in the water, an IKMT can be towed at speeds as high as five knots. The MOCNESS, or Multiple Opening/Closing Net and Environmental Sensing System, uses a stepping motor to sequentially control the opening and closing of the net. The MOCNESS uses underwater and shipboard electronics to control the device. The electronics system continuously monitors the functioning of the nets, frame angle, horizontal velocity, vertical velocity, volume filtered, and selected environmental parameters, such as salinity and temperature. The MOCNESS is used for specialized zooplankton surveys. Similarly, the Tucker trawl is an opening and closing mid-water zooplankton trawl. It is typically equipped with a full suite of instruments, including inside and outside flow meters, CTD, pitch sensor and stepper motor. The Tucker trawl used for NEFSC research surveys uses 333 micron plankton nets with 1.0 meter by 1.4 meter openings. The nets operate at a 45 degree angle during fishing which results in an effective fishing area of 1.0 square meter. The Tucker trawl is designed for deep oblique tows where up to three replicate nets can be sequentially operated by a double release mechanism. There has never been an interaction with a protected species for any of the gear types described in this paragraph during NEFSC research activity.

A beam trawl is a type of bottom trawl that uses a wood or metal beam to hold the net open as it is towed along the sea floor (see Figure A-4). The beam holds open the mouth of the net so that no trawl doors are needed. Beam trawls are generally smaller than other types of bottom trawls. Commercial beam trawls have beam lengths of up to 12 meters, while beam trawls for research purposes typically use beams two to four meters in length.

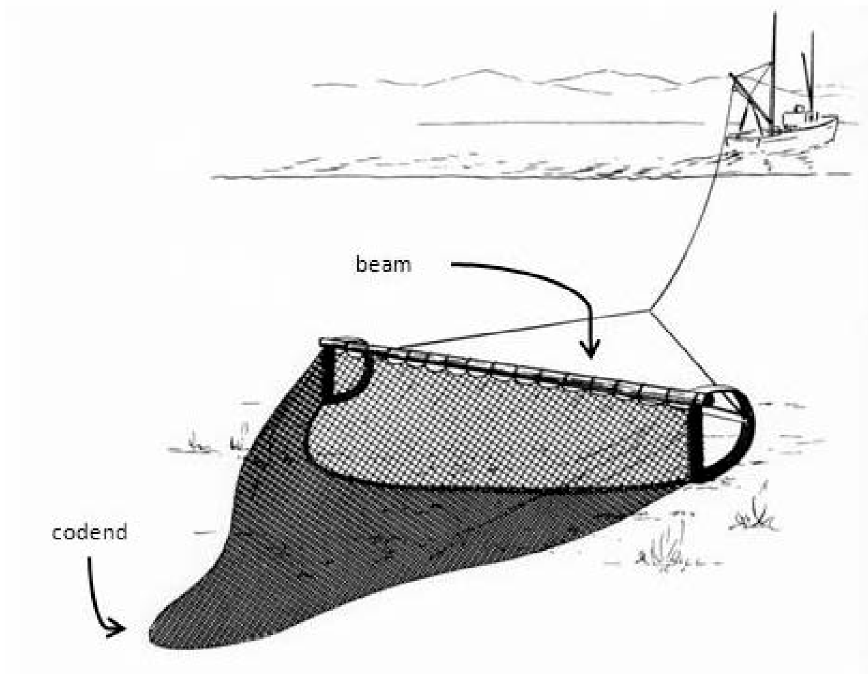

Figure A-4. Beam trawl illustration

Credit: FAO 2001

2. Fyke nets

Fyke nets are bag-shaped nets which are held open by frames or hoops. The fyke nets used in NEFSC survey activities are constructed of successively smaller plastic coated square metal tube frames that are covered with mesh net (0.6 centimeters for small, 1.9 centimeters for large). Two 9.1 meters wings extend from the opening of each fyke at an angle of approximately 30 degrees (Figure A-5). The wings have a weighted footrope and floats on the head-rope and are the same height (either 0.91 meters or 1.83 meters high) and comprised of the same net mesh as the fyke net itself. Each net has two throats tapering to a semi-rigid opening of 12.7 centimeters for the small net and 45.7 centimeters for the larger net. The fish pass through these throats before becoming trapped in the live box. For the large fyke, the final compartment of the net is configured with a rigid framed live box (2 x 2 x 3 meters) at the surface for removal of catch directly from above without having to retrieve the entire net.

A marine mammal excluder device is attached to the outer-most throat of the larger fyke to stop marine mammals from entering the net and becoming trapped. The exclusion device consists of a grate constructed of aluminum bars as shown in Figure A-6. The size of the openings is approximately 14 centimeters, which effectively prohibits marine mammals from entering the net. The dimensions of the grate openings were based on exclusion devices on Penobscot Hydroelectric fishway facilities that are four to six inches and allow for passage of numerous target species including river herring, eels, striped bass, and adult salmon.

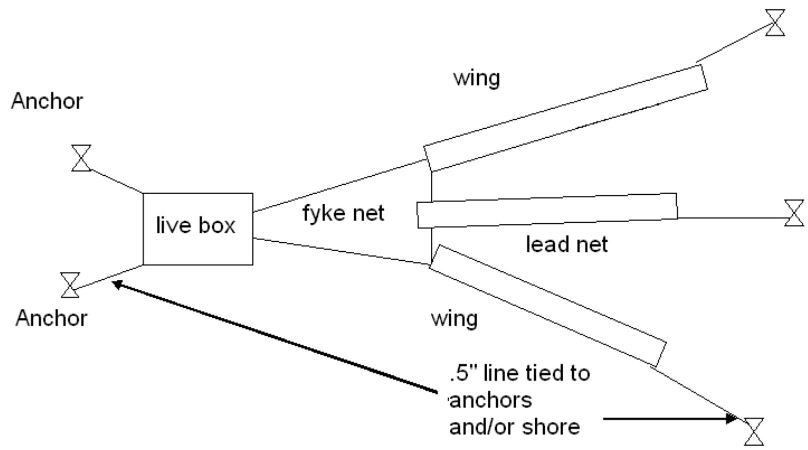

Figure A-5. Sketch of typical fyke net deployment

Orientation may be into, opposite, or perpendicular to flow as appropriate for site.

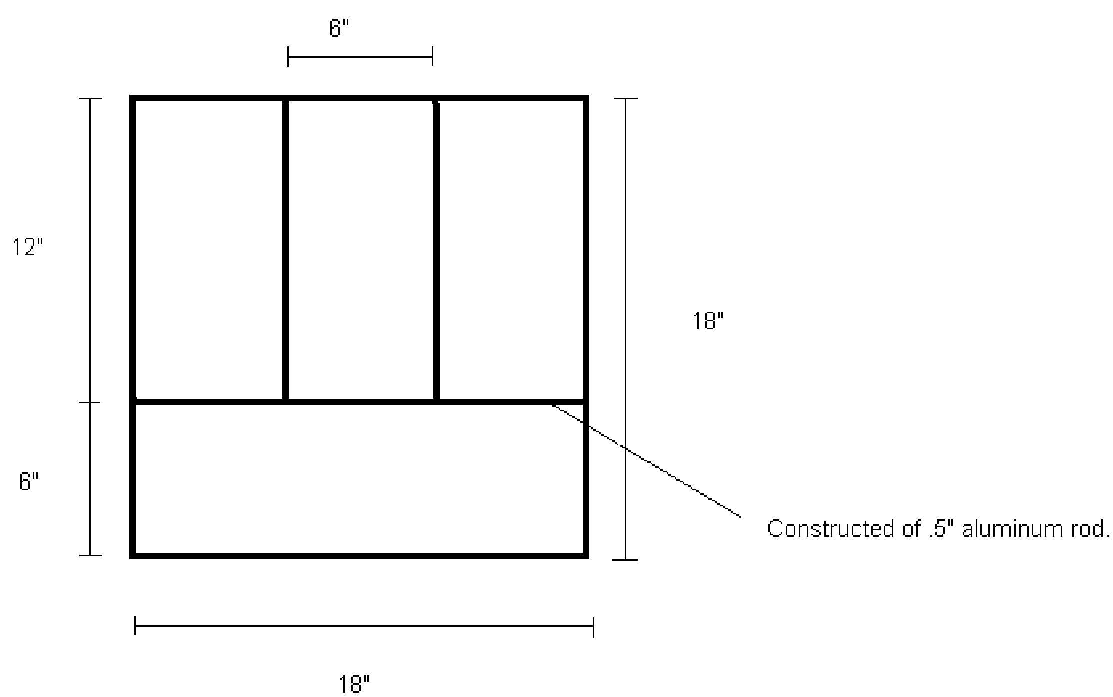

Figure A-6. Sketch of marine mammal excluder device used in the fyke net

The bottom of the grate is parallel to the net bottom as to not exclude small semi-benthic fish.

3. Gillnets

Gillnets consist of vertical netting held in place by floats and weights to selectively target fish of uniform size depending on the netting size (Walden 1996). Typical Gillnets are made of monofilament, multi-monofilament, or multifilament nylon constructed of single, double, or triple netting/paneling of varying mesh sizes, depending on their use and target species (Hovgård and Lassen 2000). A specific mesh size will catch a target species of a limited size range, allowing this gear type to be very selective.

The types of gillnets used in NEFSC survey activities are anchored sinking gillnets. Anchored sinking gillnets are fixed to the ocean floor or at a set distance above (typically in the lower one-third of the water column), held in place by anchors or ballasts with enough weight to counteract the buoyancy of the floats used to hold the net up (Nedelec and Prado 1990). Figure A-7 provides an example of an anchored sinking gillnet. NEFSC survey activities use gillnets that range from 50 to 325 feet in length, 8 to 10 feet in height, with mesh sizes from 6.5 to 12 inches. In some cases, gillnets may be configured in 10-panel strings totaling 3,000 feet long. All gillnets used in NEFSC research use weak links of particular strength and locations on the gear, as specified by the Large Whale Take Reduction Plan, in order to minimize the risk of large whales becoming entangled in the gear. Soak times for long-term surveys are typically 3 hours (Table 2.2-1) but short-term cooperative research projects have used soak times up to 96 hours (Table 2.2-2).

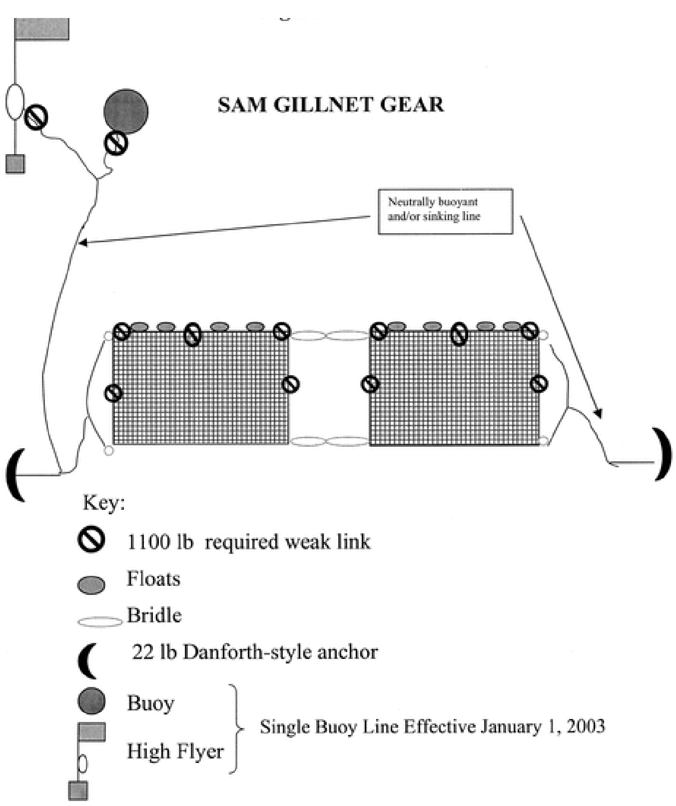

Figure A-7. Anchored sinking gillnet

Credit: 67 FR 1142

4. Pound nets

A pound net is a fixed fishing device that consists of poles or stakes secured into the bottom with netting attached. The structure includes a pound with a netting floor, a heart-shaped enclosure, and a straight wall or leader (Figure A-8). Pound nets are generally set close to shore and the leader is set perpendicular to the shore to guide migrating fish into the pound. The leader is a wall of mesh webbing that extends from the sea floor to approximately the sea surface and may be up to several hundred meters in length (Silva et al. 2011).

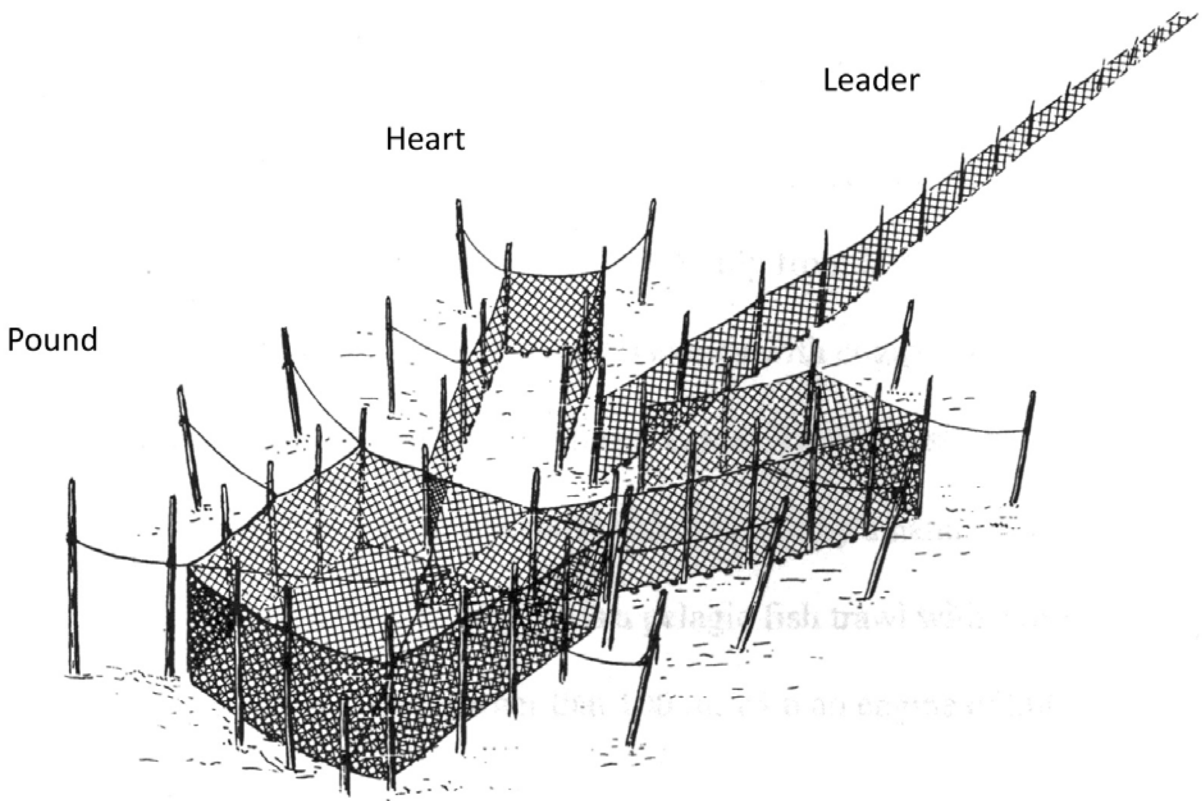

Figure A-8. Pound net diagram

Credit: Silva et al. 2011

Fish swimming laterally along the shoreline encounter the leader and generally turn towards deeper water to circumvent the obstruction (DeAlteris et al. 2005). The heart and pound portions of the net, located at the deep end of the leader, direct and trap the fish so they cannot escape. The pound is usually a rectangular enclosure 6 to 13 meters long constructed of small mesh (DeAlteris et al. 2005). Pound nets are relatively non-selective, and are used to capture several species of live fish (DeAlteris et al. 2005). NEFSC has previously conducted research focused on the relationships between pound net leader design and bycatch of sea turtles and other protected species (DeAlteris et al. 2005; Silva et al. 2011).

5. Longline

Longline vessels fish with baited hooks attached to a mainline or ‘groundline’(see Figure A-9). The length of the longline and the number of hooks depend on the species targeted, the size of the vessel, and the purpose of the fishing activity. Commercial longlines can be over 62 miles long and can have thousands of hooks attached, however longlines used for research purposes are usually shorter. The longline gear used for NEFSC research purposes typically uses 100-400 hooks attached to a line 2 to 10 miles in length, except for the small-scale Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) surveys that typically use 25-50 hooks attached to a 1,000 feet mainline. Hooks are attached to the longline by another thinner line called a ‘gangion’ The length of the gangion and the distance between gangions depends on the purpose of the fishing activity.

Depending on the fishery, longline gear can be deployed on the seafloor (bottom longline), in which case weights are attached to the mainline, or longline gear can be deployed near the surface of the water (pelagic longline), in which case buoys are attached to the mainline to provide flotation and keep the baited hooks suspended in the water. Radar reflectors, radio transmitters, and light sources are often used to help fishers determine the location of the longline gear prior to retrieval. Light sources may also be attached to the gangions to attract target species to the gear. Because pelagic longline gear is not anchored to the seafloor, it floats freely in the water, and may drift considerable distances between the time of deployment and the time of retrieval.

‘Yankee’ swordfish-style pelagic longline gear consists of 5/16 inches tarred nylon mainline, with 24-33 foot gangions composed of 13 feet of 3/16 inches nylon, 7 feet of 3/32 inches stainless steel leader, and a #40 Japanese tuna hook. For research purposes, the hooks are baited with whole Atlantic mackerel, and attached at 170 feet intervals. Floats are attached at five hook intervals on 40 feet float lines. Flag buoys, or ‘high flyers,’ are located at each end of the gear.

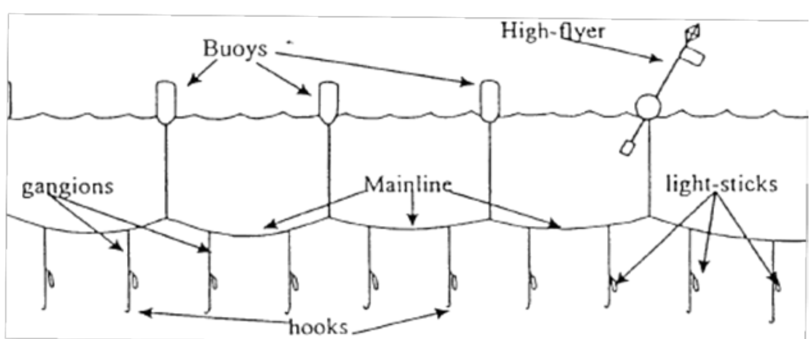

Figure A-9. Pelagic longline gear diagram

‘Florida’ commercial-style bottom longline gear consists of 940-pound test monofilament mainline with 12 feet gangions made of 730-pound test monofilament with a longline clip at one end and a 3/0 shark hook at the other. Hooks are baited with chunks of spiny dogfish and are attached to the mainline at roughly 60 feet intervals. Five-pound weights are attached at 15 hook intervals, and 15-pound weights and small buoys are attached at 50 hook intervals. To ensure that the gear fishes on the bottom, 20-pound weights are placed at the beginning and end of the mainline after a length of line two to three times the water depth is deployed. A 20 feet flag buoy (‘high flyer’) equipped with radar reflectors and flashing lights is attached to each end of the mainline. The flag buoys used for bottom longline gear use long buoy lines to allow the weighted groundline to rest on the seafloor while the attached buoys float on the surface to enable retrieval of the gear.

The small-scale COASTSPAN surveys use two types of anchored bottom longline gear: one for targeting small juvenile sharks and the other targets large juveniles and adult sharks. The juvenile gear consists of 1000 feet of 1/4 inches braided nylon mainline with at least 200 feet of additional line on each side for scope, and 50 gangions attached at 20 feet intervals, comprised of 12/0 Mustad circle hooks with barbs depressed, 20 inches 1/16 stainless cable, and 40 inches of 1/4 inch braided nylon line with 4/0 longline snaps. The large juvenile/adult survey uses the same type and length of mainline as the juvenile gear with 25 gangions attached at 40 feet intervals, comprised of 16/0 Mustad circle hooks with barbs depressed, 20 inches of 3/32 stainless cable, and 80 inches of 3 mm clear monofilament with 4/0 longline snaps. Previously frozen Atlantic mackerel or herring are purchased and used as bait for both juvenile and large juvenile/adult shark longline gear

The time between deployment and retrieval of the longline gear is the ‘soak time.’ Soak time is an important parameter for calculating fishing effort. For commercial fisheries the goal is to optimize the soak time to maximize catch of the target species while minimizing the bycatch rate, and minimizing damage to target species caught on the hooks that may result from predation by sharks or other predators. Soak time can also be an important factor for controlling longline interactions with protected species. Marine mammals, turtles, and other protected species may be attracted to bait, or to fish caught on the longline hooks. Protected species may become caught on longline hooks or entangled in the longline while attempting to feed on the catch before the longline is retrieved.

Birds may be attracted to the baited longline hooks, particularly while the longline gear is being deployed from the vessel. Birds may get caught on the hooks, or entangled in the gangions while trying to feed on the bait. Birds may also interact with longline gear as the gear is retrieved.

6. Hydraulic dredge

Hydraulic dredges are used to harvest Atlantic Surfclams (*Spisula solidissima*) and Ocean Quahogs (*Arctica islandica*) using pressurized water jets to wash clams out of the seafloor. The water jets penetrate the sediment in front of the dredge and help to propel the dredge forward. A blade on the front of the dredge then lifts the clams that have been separated from the sediment, and guides them into the body, or “cage,” of the dredge. The hydraulic dredges used for the NEFSC surfclam/ocean quahog survey employ a 12.5 feet blade and are towed at a rate of 1.5 knots. During survey tows, the dredge is deployed at depth for a duration of five minutes. As they are towed along the seafloor, hydraulic dredges may interact with sea turtles, and considerable effort has been made to develop devices and modify dredge design in order to minimize interactions between hydraulic dredges and sea turtles. Turtle mats and excluder devices (described below) may reduce the severity of some turtle interactions by preventing turtles from entering the dredge (Murray 2011).

7. New Bedford-type dredge

The New Bedford-type dredge is primarily used to harvest sea scallops in the Georges Bank and Mid-Atlantic scallop fisheries. The forward edge of the New Bedford-type dredge uses a cutting bar to create turbulence that drives scallops from the sediment into the bag of the dredge (see Figure A-10). The bag is made of metal rings and drags on the seafloor. Towing times for commercial scallop dredges are highly variable, depending on the size of the bag and the density of sea scallops at the fishing location. New Bedford-type dredges may interact with sea turtles, and NEFSC surveys use a turtle mat to minimize the impacts of dredge sampling on turtles.

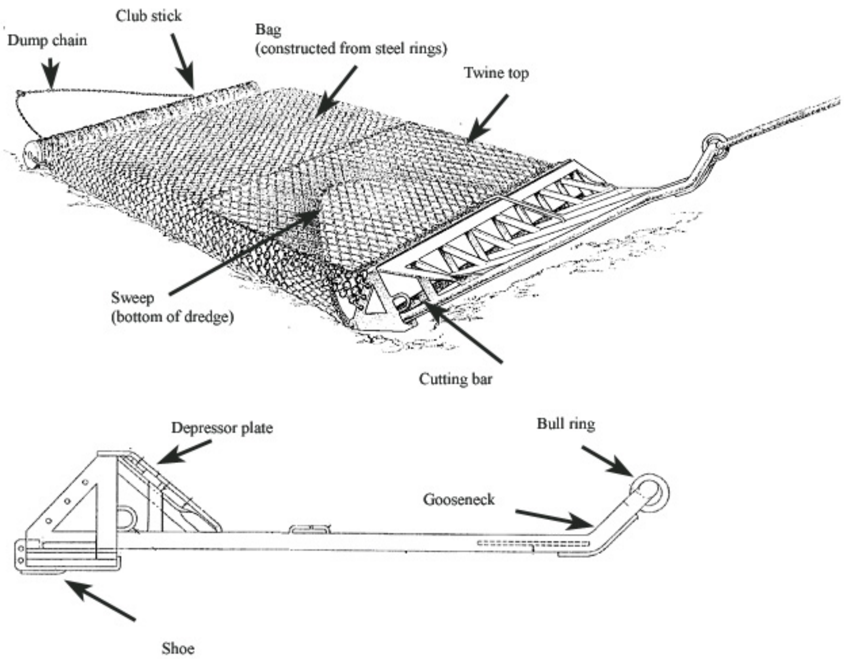

Figure A-10. Standard New Bedford sea scallop dredge

In response to the observed capture of sea turtles in scallop dredge gear, including serious injuries and mortality as a result of capture, NMFS proposed a modification to scallop dredge gear (70 FR 30660, May 27, 2005). The rule, finalized as proposed (71 FR 50361, August 25, 2006), required federally permitted scallop vessels fishing with dredge gear in Mid-Atlantic waters south of 41 °9'N from the shoreline to the outer boundary of the EEZ between May and November to modify their gear by adding an arrangement of horizontal and vertical chains (hereafter referred to as a "chain mat" or "turtle mat") between the sweep and the cutting bar (see Figure A-11). The requirement was subsequently modified by emergency rule on November 15, 2006 (71 FR 66466), and by a final rule published on April 8, 2008 (73 FR 18984). On May 5, 2009, NMFS proposed additional minor modifications to the regulations on how chain mats are configured (74 FR 20667). Chain mats consist of vertical and horizontal chains hung between the sweep and cutting bar and are intended to reduce the severity of some turtle interactions by preventing turtles from entering the dredge bag (Murray 2011). Monitoring the effectiveness of chain mats is difficult because interactions could still be occurring, but the chain mat prevents the turtle from being captured and observed (Murray 2011). However, chain mats are not expected to reduce the overall number of sea turtle interactions with scallop dredge gear.

Figure A-11. Turtle chain mat on traditional scallop dredge frame

Additional design modifications to a traditional New Bedford style scallop dredge were evaluated by NEFSC in cooperation with the Coonamesset Farm Foundation to prevent loggerhead sea turtles from snagging on top of the dredge frame or becoming trapped under the dredge bale, while maintaining efficiency for dredging sea scallops (Smolowitz *et al.* 2008). The final design, the Coonamesset Farm turtle excluder dredge (see Figure A-12), proved effective at guiding turtles over the top of the dredge by eliminating most of the bale bars and forming a ramp with a forward positioned cutting bar and closely spaced struts leading back at a forty-five degree angle (Smolowitz *et al.* 2008).

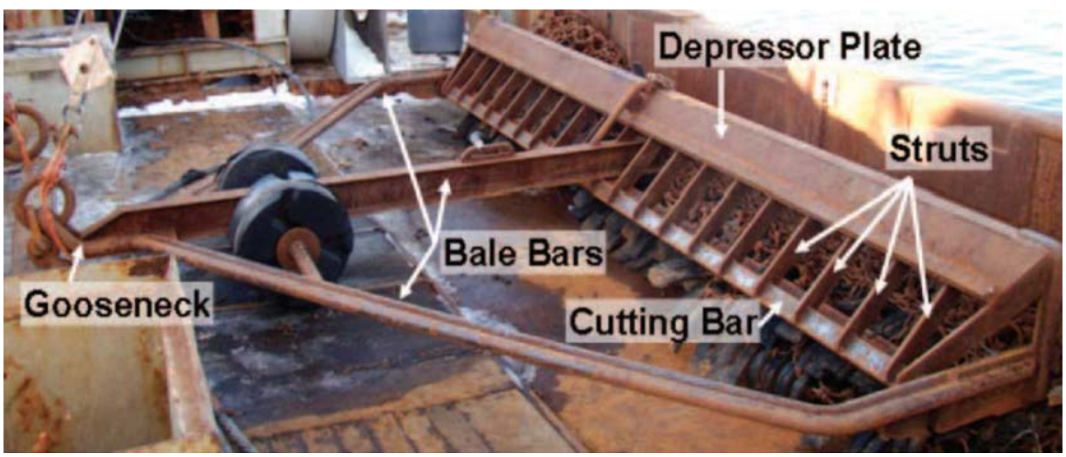

Figure A-12. Coonamessett Farm turtle deflector dredge

8. Naturalist dredge

The Naturalist dredge, shown in Figure A-13, is primarily used to obtain samples of megafaunal species, such as oysters, crabs, mussels and whelks. The Naturalist dredge is typically small (1 meter wide) and towed along the seafloor over a relatively short distance (30 to 200 feet) in order avoid overfilling the dredge and losing part of the sample. All megafauna from the dredge samples are picked out by hand and processed on deck after retrieval of the dredge. Due to the small size of the Naturalist dredge and the limited periods of time over which it is deployed, interactions with protected species are expected to be minimal. However, dredges do disturb bottom habitats, and may potentially interact with sea turtles.

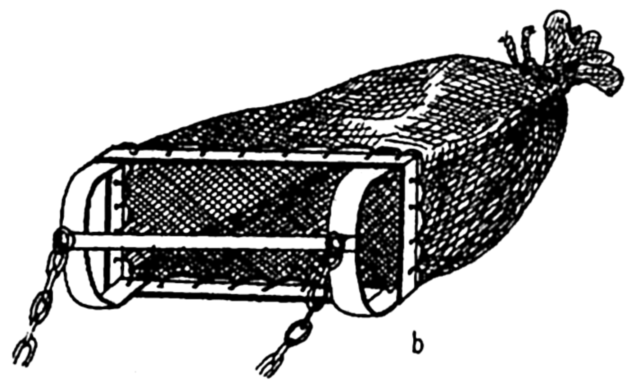

Figure A-13. Naturalist dredge

9. Fish / Lobster Pots

Several NEFSC and cooperative research surveys use fish or lobster pots to selectively capture species for research, tagging studies, and sample collection. Fish pots can be designed to select for particular species by configuring the entrances, mesh, and escape tunnels (or "vents") to allow retention of the target species, while excluding larger animals, and allowing smaller animals to escape from the pot before retrieval. In many instances, animals remain alive in the pot until it is pulled, making pots a preferred method for collecting some species for tagging or mark / recapture studies.

The NEFSC research set aside program targeting black sea bass in southern New England (SNE) and Mid-Atlantic waters uses unvented pots 43½ inches long, 23 inches wide, and 16 inches high made with 1½ inches by 1½ inches coated wire mesh, a single mesh entry head, and a single mesh inverted parlor nozzle (see Figure A-14).

Figure A-14. Retrieval of a pot targeting black sea bass

Other NEFSC research activities targeting various finfish and shellfish species use different pot configurations, depending on the species of interest. Figure A-15 shows examples of different types of pots.

Figure A-15. Examples of pot equipment

10. Rotary Screw Trap

Rotary screw traps (RSTs) enable live capture of smolts emigrating from several coastal rivers, including the Narraguagus, Penobscot, Pleasant, and Sheepscot Rivers. RSTs are used to estimate smolt populations, enumerate and sample smolts (and other co-occurring species), and to better understand factors that limit smolt production and migration success. Figure A-16 shows a RST that was used on the Sheepscot River to capture Atlantic salmon smolts. RSTs are also platforms for telemetry studies that provide valuable data on smolt behavior and migratory success. RSTs are positioned in the water channels to maximize fish capture. Fish enter the trap through the large end of a revolving and half-submerged screen cone suspended between two pontoons. The NEFSC uses RSTs with different size openings (4 ft, 5 ft, and 8 ft models). As the river current turns the cone, the fish are guided downstream into a live car, where they are held in river water until retrieved for sampling. Traps are tended daily, so fish spend as little time as possible in the live car. As smolts tend to move downstream at night, they often confined for less than 12 hours.

RSTs require adequate water depth and current to rotate the cone for most effective "fishing." Although RSTs can be used in high flow conditions, they sometimes become jammed with debris. River conditions are monitored closely to prevent fish injury. RSTs are equipped with a hubodometer that records the number of revolutions of the cone, allowing for an estimation of catch per unit of effort.

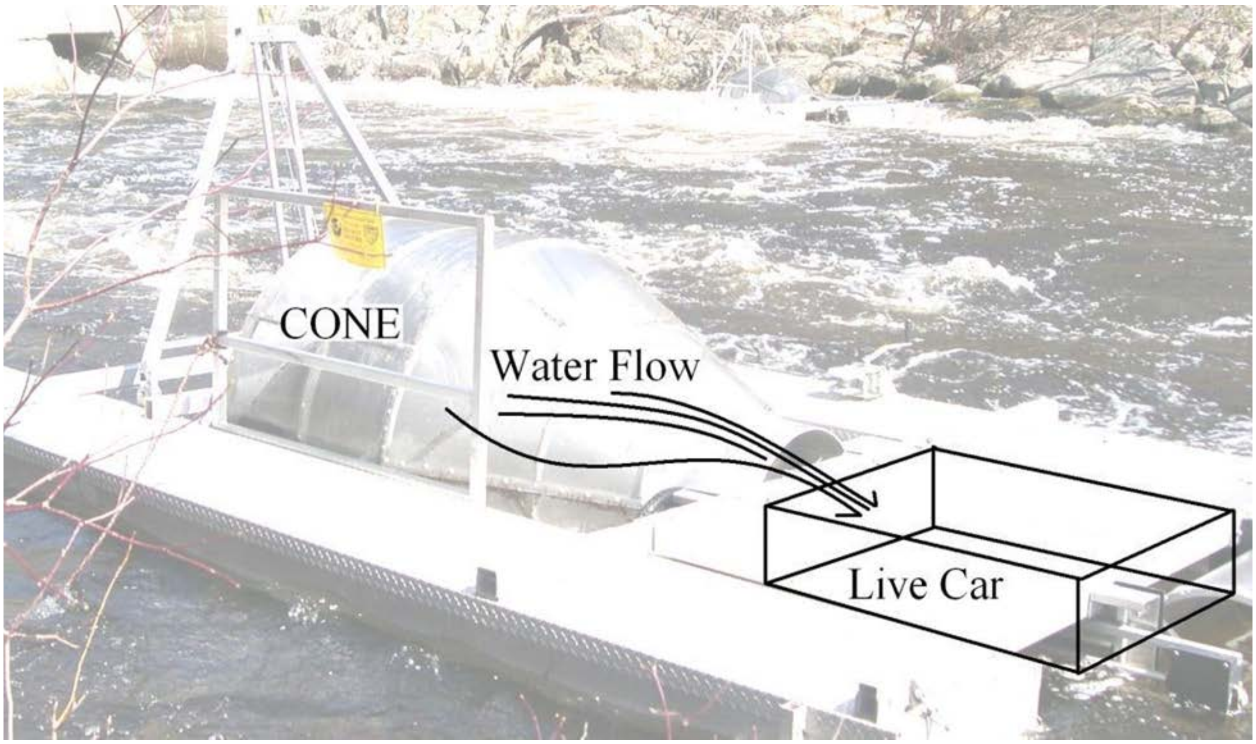

Figure A-16. Rotary screw trap

Credit: NOAA archives

11. Various plankton nets (Bongo Nets)

NEFSC research activities include the use of several plankton sampling nets that employ very small mesh to sample plankton and fish eggs from various parts of the water column. Plankton sampling nets usually consist of fine mesh attached to a weighted frame. The frame spreads the mouth of the net to cover a known surface area. The Bongo nets used for NEFSC surveys typically have openings 61 centimeters in diameter and employ either 333 micrometer or 505 micrometer mesh. The nets are 3 meters in length with a 1.5 meters cylindrical section coupled to a 1.5 meters conical portion that tapers to a detachable codend constructed of 333 micrometers or 0.505 micrometer nylon mesh (Figure A-17).

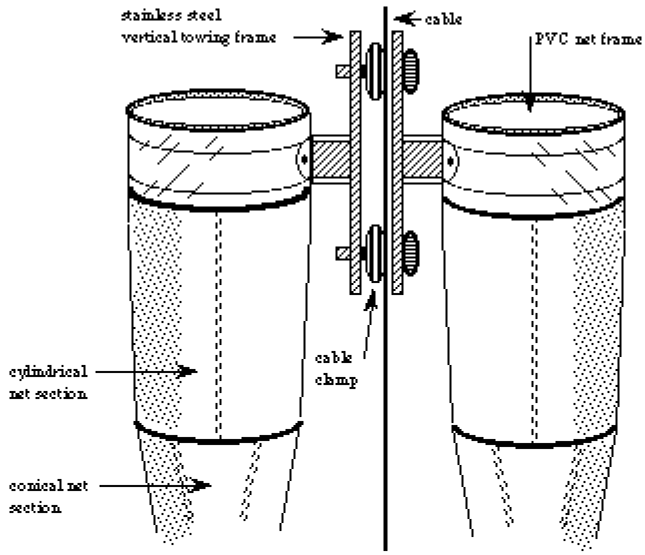

Figure A-17. Bongo net diagram

Credit: Aquatic Research Instruments (2011)

The bongo nets are towed through the water at an oblique angle to sample plankton over a range of depths. During each plankton tow, the bongo nets are deployed to a depth of approximately 210 meters and are then retrieved at a controlled rate so that the volume of water sampled is uniform across the range of depths. In shallow areas, sampling protocol is adjusted to prevent contact between the bongo nets and the seafloor. A collecting bucket, attached to the codend of the net, is used to contain the plankton sample. When the net is retrieved, the collecting bucket can be detached and easily transported to a laboratory. Some bongo nets can be opened and closed using remote control to enable the collection of samples from particular depth ranges. A group of depth-specific bongo net samples can be used to establish the vertical distribution of zooplankton species in the water column at a site. Bongo nets are generally used to collect zooplankton for research purposes, and are not used for commercial harvest.

12. Van Veen sediment grab sampler

Sediment grab samplers are used to collect sediments and assess populations of benthic fauna from the seafloor. The Van Veen grab sampler is comprised of a hinged pair of scoops that can be deployed over the side of the vessel and lowered to the seafloor on a cable (see Figure A-18). The scoops are approximately 31 centimeters wide to allow sampling of a 0.1 square meter area of the seafloor. Sharp cutting edges on the bottoms of the scoops enable them to penetrate up to about 40 centimeters into the sediment. The grab sampler may be galvanized, stainless steel, or Teflon-coated.

Prior to deployment, the sampler is cocked with the safety key in place. The sampler is then deployed over the side of the vessel, the safety key is removed, and the sampler is slowly lowered to the bottom. After bottom contact has been made (indicated by slack in the cable), the tension on the cable is slowly increased, causing the scoops to close. Once the sampler is back on board, the top doors are opened for inspection of the sediment sample (Stubbs et al. 1987).

The Van Veen sediment grab sampler is designed to collect sediments and invertebrates from the seafloor and potential interactions with marine mammals, turtles, or birds are believed to be negligible.

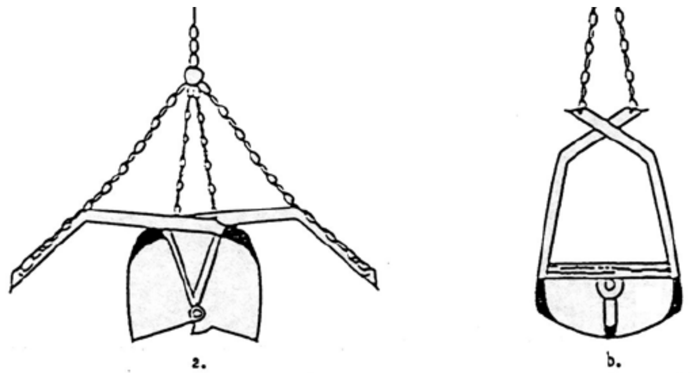

Figure A-18. Van Veen grab sampler: a) cocked position b) closed position

Credit: modified from Stubbs et al. (1987)

13. ADCP

An Acoustic Doppler Current Profiler, or ADCP, is a type of sonar used for measuring water current velocities simultaneously at a range of depths. In the past, current depth profile measurements required the use of long strings of current meters. ADCP enables measurements of current velocities across an entire water column, replacing the long strings of current meters. An ADCP anchored to the seafloor can measure current speed not just at the bottom, but also at equal intervals all the way up to the surface (WHOI 2011). An ADCP instrument can also be mounted to a mooring, or to the bottom of a boat.

The ADCP measures water currents with sound, using the Doppler Effect. A sound wave has a higher frequency when it moves towards the sensor (blue shift) than when it moves away (red shift). The ADCP works by transmitting "pings" of sound at a constant frequency into the water. As the sound waves travel, they ricochet off particles suspended in the moving water, and reflect back to the instrument (WHOI 2011). Due to the Doppler Effect, sound waves bounced back from a particle moving away from the profiler have a slightly lowered frequency when they return. Particles moving toward the instrument send back higher frequency waves. The difference in frequency between the waves the profiler sends out and the waves it receives is called the Doppler shift. The instrument uses this shift to calculate how fast the particle and the water around it are moving. Sound waves that hit particles far from the profiler take longer to come back than waves that strike close by. By measuring the time it takes for the waves to return to the sensor, and the Doppler shift, the profiler can measure current speed at many different depths with each series of pings (WHOI 2011).

ADCPs operate at frequencies between 75 and 600 kilohertz. High frequency pings yield more precise data, but low frequency pings travel farther in the water. Thus, a compromise must be made between the distance that the profiler can measure and the precision of the measurements (WHOI 2011).

ADCPs that are bottom-mounted need an anchor to keep them on the bottom, batteries, and a data logger. Vessel-mounted instruments need a vessel with power, a shipboard computer to receive the data, and a GPS navigation system so the ship's movements can be subtracted from the current velocity data (WHOI 2011).

14. CTD profiler

'CTD' is an acronym for Conductivity, Temperature, and Depth. A CTD profiler measures these parameters, and is the primary research tool for determining chemical and physical properties of seawater. A shipboard CTD is made up of a set of small probes attached to a large (1 to 2 meters in diameter) metal rosette wheel (see Figure A-19). The rosette is lowered through the water column on a cable, and CTD data are observed in real time via a conducting cable connecting the CTD to a computer on the ship. The rosette also holds a series of sampling bottles that can be triggered to close at different depths in order to collect a suite of water samples that can be used to determine additional properties of the water over the depth of the CTD cast. A standard CTD cast, depending on water depth, requires 2 to 5 hours to complete (WHOI 2011). The data from a suite of samples collected at different depths are often called a depth profile, and are plotted with the value of the variable of interest on the x-axis and the water depth on the y-axis. Depth profiles for different variables can be compared in order to glean information about physical, chemical, and biological processes occurring in the water column.

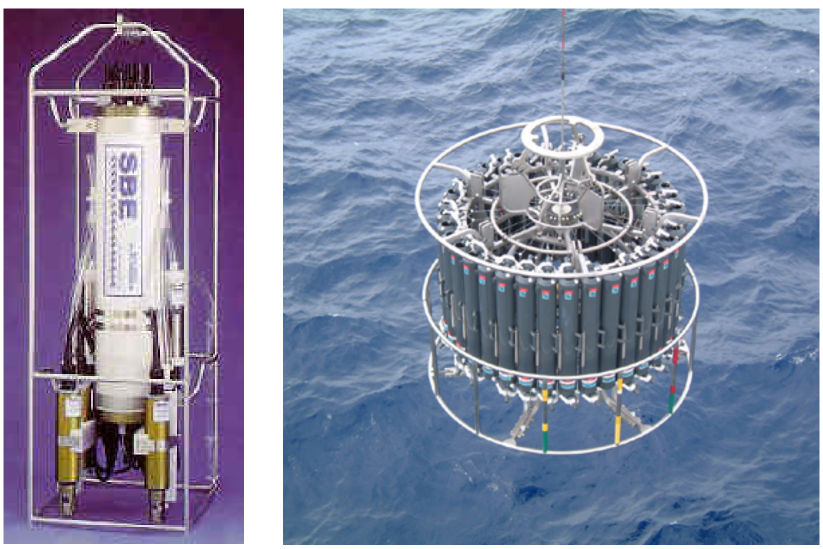

Figure A-19. Sea-Bird 911*plus* CTD profiler and deployment on a sampling rosette

Credit: Sea-Bird Electronics, Bellevue, WA

Conductivity is measured as a proxy for salinity, or the concentration of salts dissolved in the seawater. Salinity is expressed in 'practical salinity units' (psu) which represent the sum of the concentrations of several different ions. Salinity is calculated from measurements of conductivity. Salinity influences the types of organisms that live in a body of water, as well as physical properties of the water. For instance, salinity influences the density and freezing point of seawater.

Temperature is generally measured using a high-sensitivity thermistor protected inside a thin walled stainless steel tube. The resistance across the thermistor is measured as the CTD profiler is lowered through the water column to give a continuous profile of the water temperature at all water depths.

The depth of the CTD sensor array is continuously monitored using a very sensitive electronic pressure sensor. Salinity, temperature, and depth data measured by the CTD instrument are essential for characterization of seawater properties.

15. Still and video camera images taken from an ROV

The NEFSC maintains and deploys remotely operated vehicles (ROVs)(See Figure A-20). The ROVs are used to quantify fish and shellfish, photograph fish for identification, and provide information for habitat-type classification studies. Still and video camera images are also used to monitor the operation of bycatch reduction devices. Precise geo-referenced data from ROV platforms also enables SCUBA divers to use bottom time more effectively for collection of brood stock and other specimens.

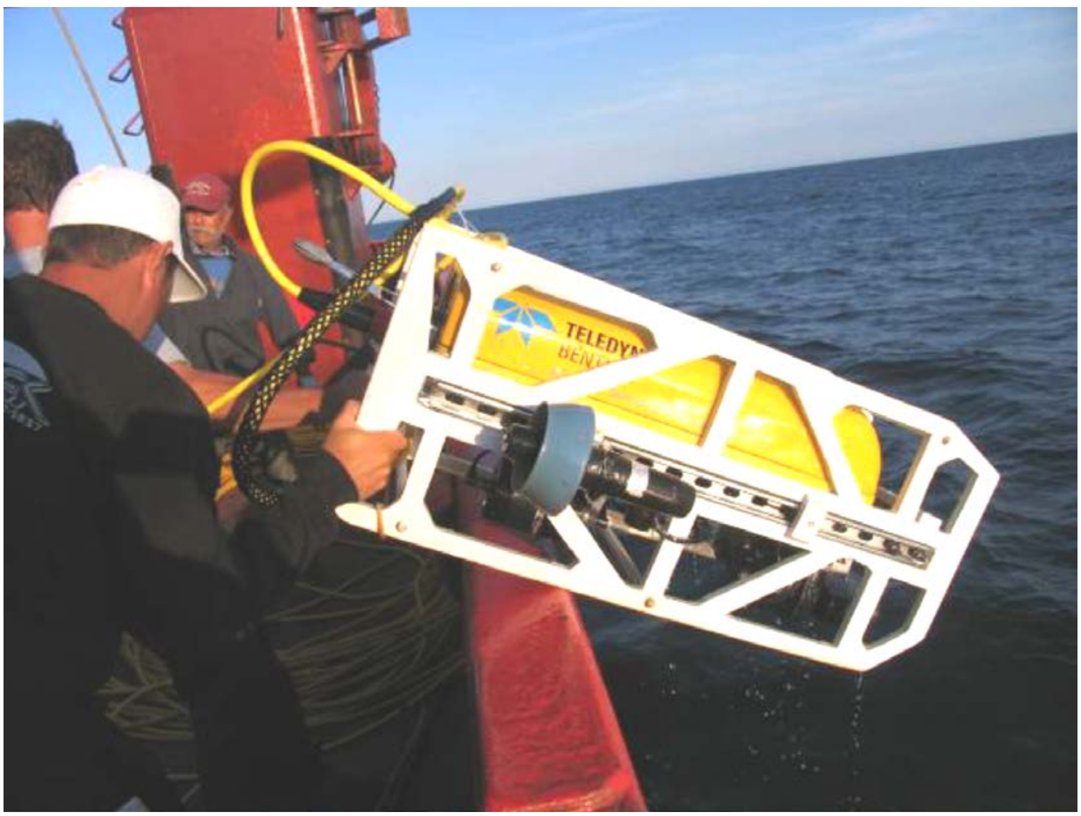

Figure A-20. ROV being deployed from scallop vessel

The Seabed Observation and Sampling System (SEABOSS) was designed for rapid, inexpensive, and effective collection of seabed images and sediment samples in coastal/inner-continental shelf regions. The observations from video and still cameras, along with sediments collected in the sampler, are used in conjunction geophysical mapping surveys to provide more comprehensive interpretations of seabed character.

The SEABOSS incorporates two video cameras, a still camera, a depth sensor, light sources, and a modified Van Veen sediment sampler (see Figure A-21). These components are attached to a stainless steel frame that is deployed through an A-frame, using a power winch, as the SEABOSS weighs 300 pounds. The SEABOSS frame has both a stabilizing fin capable of orienting the system while it drifts, and base plates that prevent over-penetration when the system rests on the sea floor. Undisturbed samples are taken with the modified Van Veen sampler. The system begins imaging the sea floor with a 35-millimeter camera before touching bottom, at 30 inches height above bottom. Scale, time, and exposure number are annotated on each image. These images are later scanned into a digital format. A downward-looking video camera overlaps the field of view of the still camera. The second video camera is mounted in a forward-looking orientation, providing an oblique sea floor view and enables a shipboard operator to monitor for proper tow-depth and for obstacles to the SEABOSS while operations are underway. (Blackwood *et al.* 2000).

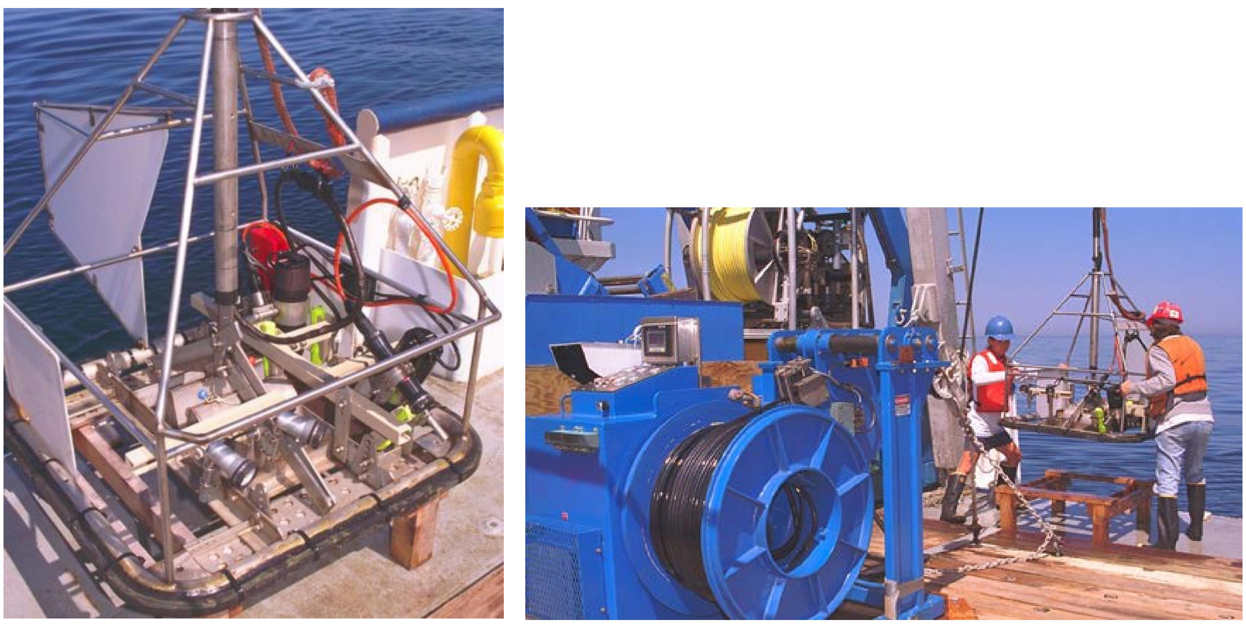

Figure A-21. The SEABOSS benthic observation system

16. Active Acoustic Sources used in NEFSC Fisheries Surveys

A wide range of active acoustic sources are used in NEFSC fisheries surveys for remotely sensing bathymetric, oceanographic, and biological features of the environment. Most of these sources involve relatively high frequency, directional, and brief repeated signals tuned to provide sufficient focus and resolution on specific objects. Important characteristics of the nine predominant NEFSC acoustic sources are provided below in Tables A-1, followed by descriptions of some of the primary sources.

Table A-1 Output characteristics for the seven predominant NEFSC active acoustic sources.

Active Acoustic System (product name and #)	Operating frequencies (kHz)	Maximum source level (dB re 1 µPa at 1 m)	Single ping duration	Nominal beam width (degrees)
Simrad EK60 Narrow Beam Scientific Echo Sounder	18, 38, 70, 120, 200, & 333	224	1 millisecond	11° at 18 kHz; 7° at 38, 120, 200 & 333 kHz
Simrad ME70 Multi-Beam Echo Sounder	70-120	205	150 microsecond	140°
Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP), Ocean Surveyor	75	224		30°
Simrad SX90 Narrow Beam Sonar (conservative assumption--pointed horizontally)	20-30	219		7°
Raymarine SS260 (DSM300 sounder)	50, 200	217		19° at 50 kHz; 6° at 200 kHz
NetMind	30, 200	190		50°
Simrad EQ50	50, 200	210		16° at 50 kHz; 7° at 200 kHz

17. Multi-frequency Narrow Beam Scientific Echo Sounders (Simrad EK60 - 18, 38, 70, 120, 200, 333 kilohertz)

Similar to multibeam echosounders, multi-frequency split-beam sensors are deployed from NOAA survey vessels to acoustically map the distributions and estimate the abundances and biomasses of many types of fish; characterize their biotic and abiotic environments; investigate ecological linkages; and gather information about their schooling behavior, migration patterns, and avoidance reactions to the survey vessel. The use of multiple frequencies allows coverage of a broad range of marine acoustic survey activity, ranging from studies of small plankton to large fish schools in a variety of environments from shallow coastal waters to deep ocean basins. Simultaneous use of several discrete echosounder frequencies facilitates accurate estimates of the size of individual fish, and can also be used for species identification based on differences in frequency-dependent acoustic backscattering between species. The NEFSC uses devices that transmit and receive at six frequencies ranging from 18 to 333 kilohertz.

18. Single Frequency Omnidirectional Sonars (Simrad SX-90)

Low frequency, high-resolution, long range fishery sonars including the SX-90 operate with user selectable frequencies between 20 and 30 kilohertz providing longer range and prevent interference from other vessels. These sources provide an omnidirectional imaging around the source with three different vertical beamwidths, single or dual vertical view and 180° tiltable vertical views are available. At 30 kilohertz operating frequency, the vertical beamwidth is less than seven degrees. This beam can be electronically tilted from +10 to -80 degrees, which results in differential transmitting beam patterns. The cylindrical multi-element transducer allows the omnidirectional sonar beam to be electronically tilted down to -60 degrees, allowing automatic tracking of schools of fish within the whole water volume around the vessel. The signal processing and beamforming is performed in a fast digital signal processing system using the full dynamic range of the signals.

19. Multi-beam echosounder (Simrad ME70)

Multibeam echosounders and sonars work by transmitting acoustic pulses into the water then measuring the time required for the pulses to reflect and return to the receiver and the angle of the reflected signal (see Figure A-22). The depth and position of the reflecting surface can be determined from this information, provided that the speed of sound in water can be accurately calculated for the entire signal path.

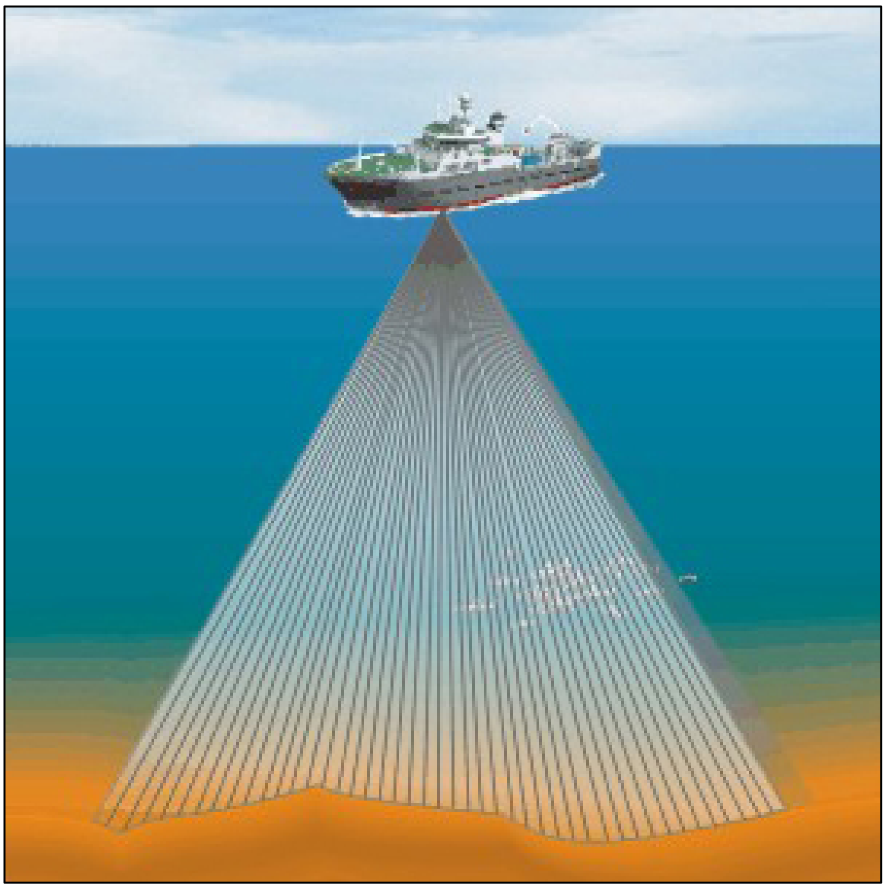

Figure A-22. Multi-beam echosounder

Credit: Simrad – www.simrad.com

The use of multiple acoustic 'beams' allows coverage of a greater area compared to single beam sonar. The sensor arrays for multibeam echosounders and sonars are usually mounted on the keel of the vessel and have the ability to look horizontally in the water column as well as straight down. Multibeam echosounders and sonars are used for mapping seafloor bathymetry, estimating fish biomass, characterizing fish schools, and studying fish behavior. The multibeam echosounders used by NEFSC are mounted to the hull of the research vessels and emit frequencies in the 70-120 kilohertz range.

20. NEFSC Vessels used for Survey Activities

NMFS employs NOAA-operated research vessels, chartered vessels, and vessels operated by cooperating agencies and institutions to conduct research, depending on the survey and type of research.

Figure A-23. R/V *Delaware II*

The NOAA research vessel (R/V) *Delaware II* was used for trawl surveys for many years during the Status Quo period considered in this DPEA. It was retired from NOAA service in 2012 and sold so it is not anticipated to be one of the vessels used in the future. The R/V *Delaware II* was a 155 foot steel-hulled, purpose-built research vessel powered by two General Motors diesel engines with a total of 1,230 horsepower (Figure A-23). The R/V *Delaware II* used a single propeller to achieve a sustained cruising speed of 10.0 knots. The deck equipment featured six winches, one deck crane, two A-frames, and a moveable stern gantry. Each of the winches served a specialized function ranging from trawling to hydrographic surveys. The ship had a beam of 30.2 feet and a draft of 14.8 feet, and could accommodate a crew of 32 people including up to 14 scientists for voyages of up to 16 days. The ship's normal operating area was the Gulf of Maine, Georges Bank, and the continental shelf and slope from Southern New England to Cape Hatteras, NC.

Figure A-24. R/V *Henry B. Bigelow*

The NOAA research vessel *Henry B. Bigelow*, shown in Figure A-24, was launched in 2005 to replace the *Albatross IV*. The 209 feet steel-hulled *Henry B. Bigelow* uses an integrated diesel electric drive system, with two 1,542 horsepower propulsion motors, and a single 14.1 feet propeller to achieve a sustained cruising speed of up to 12 knots. The ship has a beam of 49.2 feet and a draft of 19.4 feet and can accommodate up to 39 crew, including 15 scientists, for voyages of up to 40 days. The deck equipment features five winches, one deck crane, two A-frames, and a moveable stern gantry. The ship's primary operating area is offshore waters of the Northeast Continental Shelf LME. The *Henry B. Bigelow* has a number of features engineered specifically to reduce transmission of ship noise into the ocean, which enhances its utility for research because fish and marine mammals are less likely to react to ship noise.

Figure A-25. R/V *Hugh R. Sharp*

The R/V *Hugh R. Sharp*, shown in Figure A-25, is a 146 feet acoustically quiet research vessel operated by the University of Delaware Marine and Earth Studies program, as a member of the University-National Oceanographic Laboratory System (UNOLS). The vessel is powered by a diesel-electric propulsion system with twin Z-drives and a tunnel-style bow thruster. The vessel has a dynamic positioning system, enabling it to maintain a precise location 'on-station' during research activities. It has a nominal cruising speed of 11 knots, and can carry 14 to 20 scientists on cruises up to 18 days in duration. It typically operates in the coastal waters from Long Island, New York, to Cape Hatteras, North Carolina, as well as the Delaware and Chesapeake Bays. Projects occasionally require the vessel to work as far north as the Gulf of Maine, as far south as Florida, and as far offshore as Bermuda. Operational support for the R/V *Hugh R. Sharp* is provided primarily by the National Science Foundation (NSF), the Office of Naval Research (ONR), and the National Oceanic and Atmospheric Administration (NOAA). The R/V *Hugh R. Sharp* is a purpose-built research vessel designed with special attention to controlling underwater radiated noise to minimize effects on the marine environment.

Figure A-26. R/V *Gloria Michelle*

The R/V *Gloria Michelle* is a 72 feet steel–hulled stern trawler operated by NOAA and used for Gulf of Maine shrimp trawl surveys (Figure A-26). The vessel is powered by a Caterpillar 3406 producing 365 horsepower, driven through a single fixed-pitch 64 inches four-blade propeller. The R/V *Gloria Michelle* has a beam of 20 feet, a draft of 9.5 feet, and can accommodate a crew of two officers and eight scientists for voyages up to five days in length.

In addition to NOAA-operated research vessels, research activities may be conducted from chartered or cooperative vessels. A wide range of commercial fishing vessels participate in such cooperative research, ranging from small open boats to modern trawlers and longliners. The sizes of the vessels used for cooperative research, engine types, cruising speeds, etc. vary depending upon the location and requirements of the research for which the vessel is used.

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FINAL
Programmatic Environmental Assessment

for

Fisheries Research Conducted and Funded by the Northeast Fisheries Science Center

July 2016

Appendix B

Spatial and Temporal Distribution of NEFSC Fisheries Research Effort

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Appendix B

Spatial and Temporal Distribution of NEFSC Fisheries Research Effort

This Appendix provides an analysis of the spatial and temporal distributions of NEFSC fisheries research effort, by season and by LME subarea, through figures and detailed tables.

List of Tables

List of Figures

Spatial and Temporal Distribution of NEFSC Research Activity

The amount of research effort exerted in particular seasons and in particular areas impacts the potential effects resulting from that research, i.e. to what extent are research activities concentrated in time and space. Many of the large surveys have consistent levels of effort every year but are stratified random designs so the specific location of sample sites is different every year. Other research activities, especially short-term cooperative research projects, may not have consistent levels of effort with different gear types or occur in the same general areas each year. The information in this appendix is therefore an approximation of a "typical" year of NEFSC fisheries research based on the average level of gear deployment for all surveys and projects from 2008 through 2012. Figures B-1 through B-4 break down this representative research effort by LME subarea and season, with individual tables summarizing activity by gear type and survey effort. This allows the reader to judge the concentration of research by gear type in different regions of the Northeast Continental Shelf LME. Tables B-1 through B-5 summarize the research effort in each LME subarea by season, with general descriptions of survey and gear types, along with effort levels. When combined with the figures referenced above, it provides a more complete understanding of the NEFSC research effort. See Table 2.2-1, Table 2.2-2, and Appendix A for more details on the gears used in NEFSC fisheries and ecosystem research.

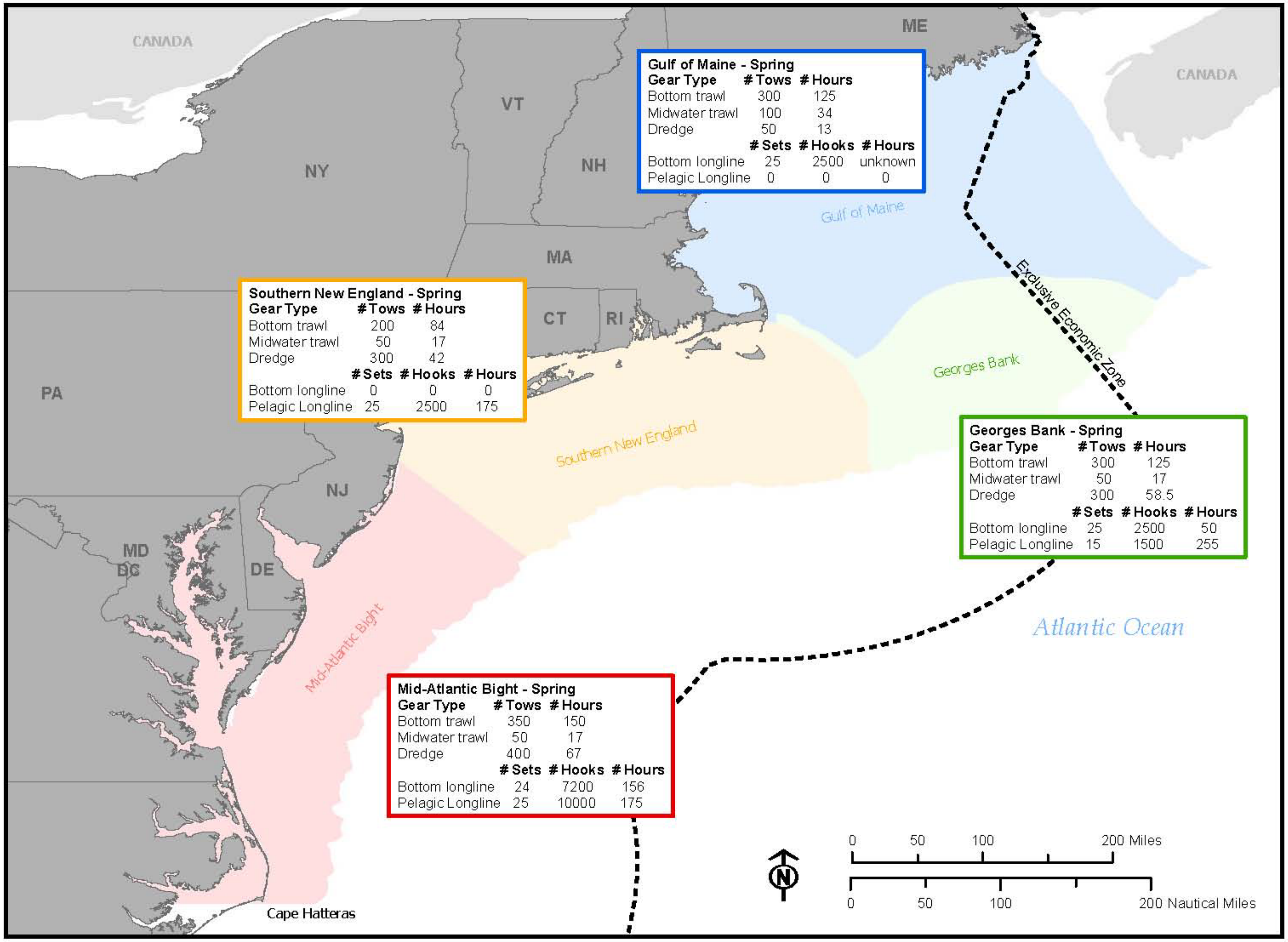

Figure B-1. **Distribution of NEFSC Fisheries Research by Gear Type in March-May.**

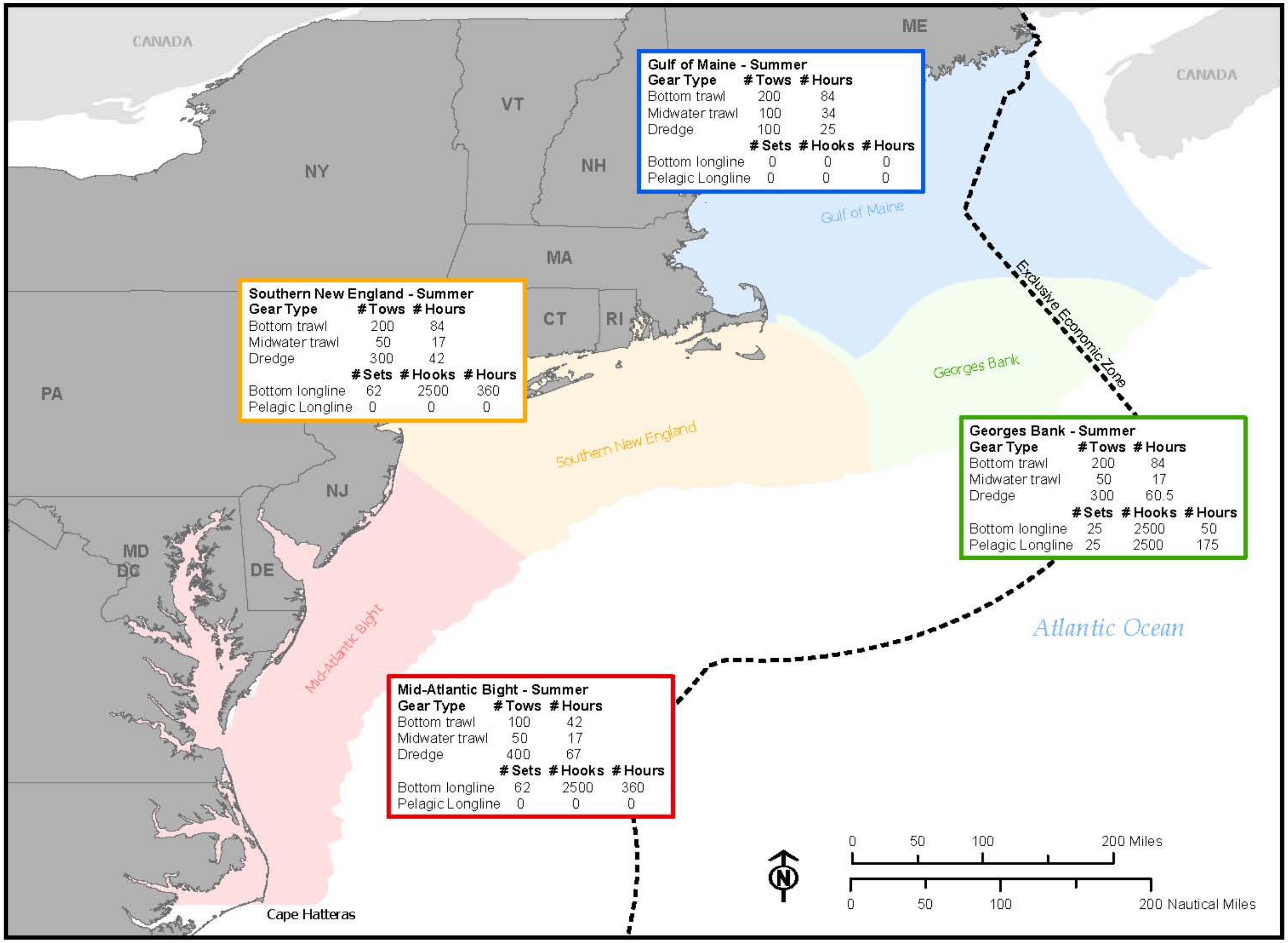

Figure B-2. Distribution of NEFSC Fisheries Research by Gear Type in June-August.

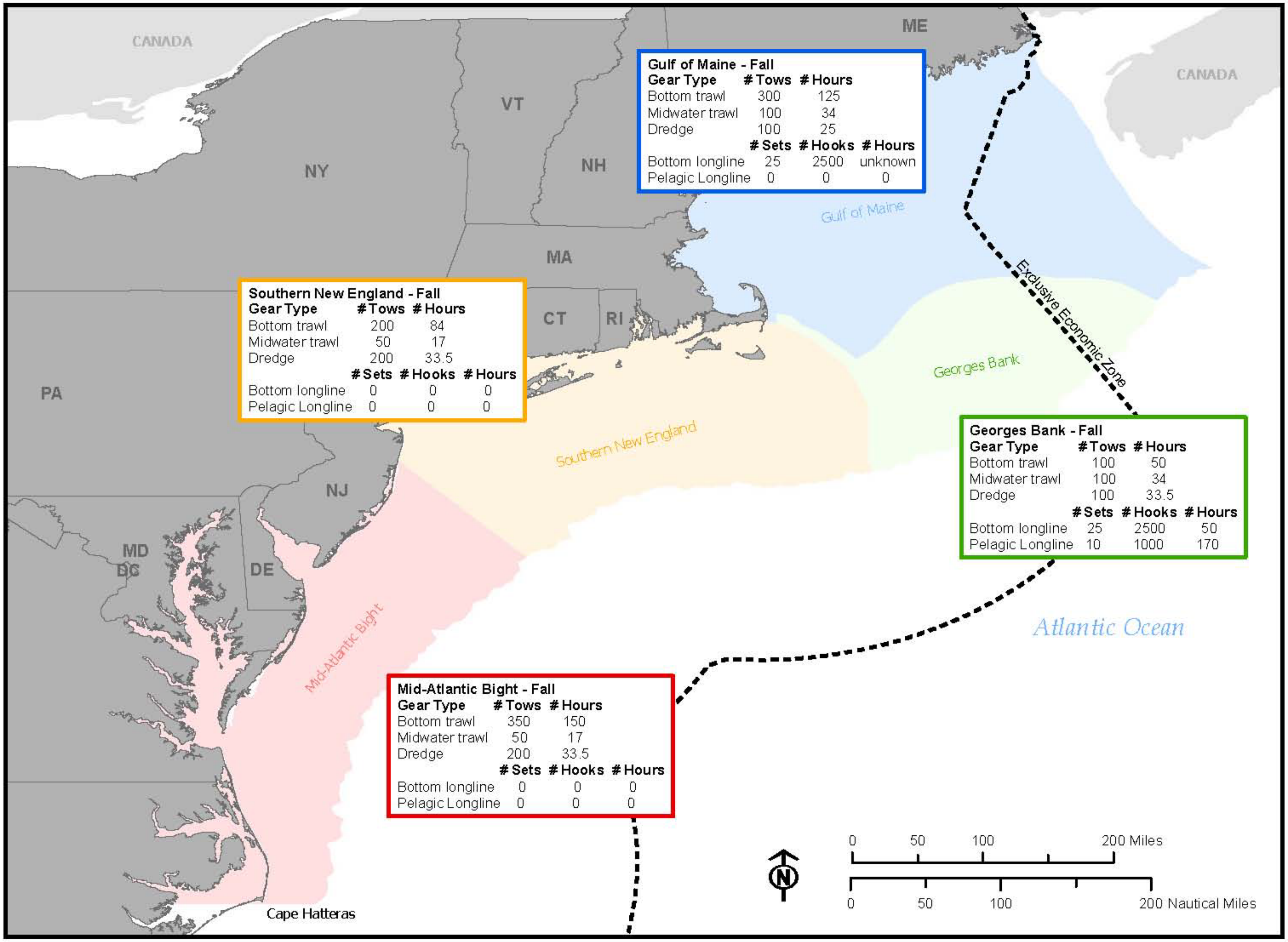

Figure B-3. Distribution of NEFSC Fisheries Research by Gear Type in September-November.

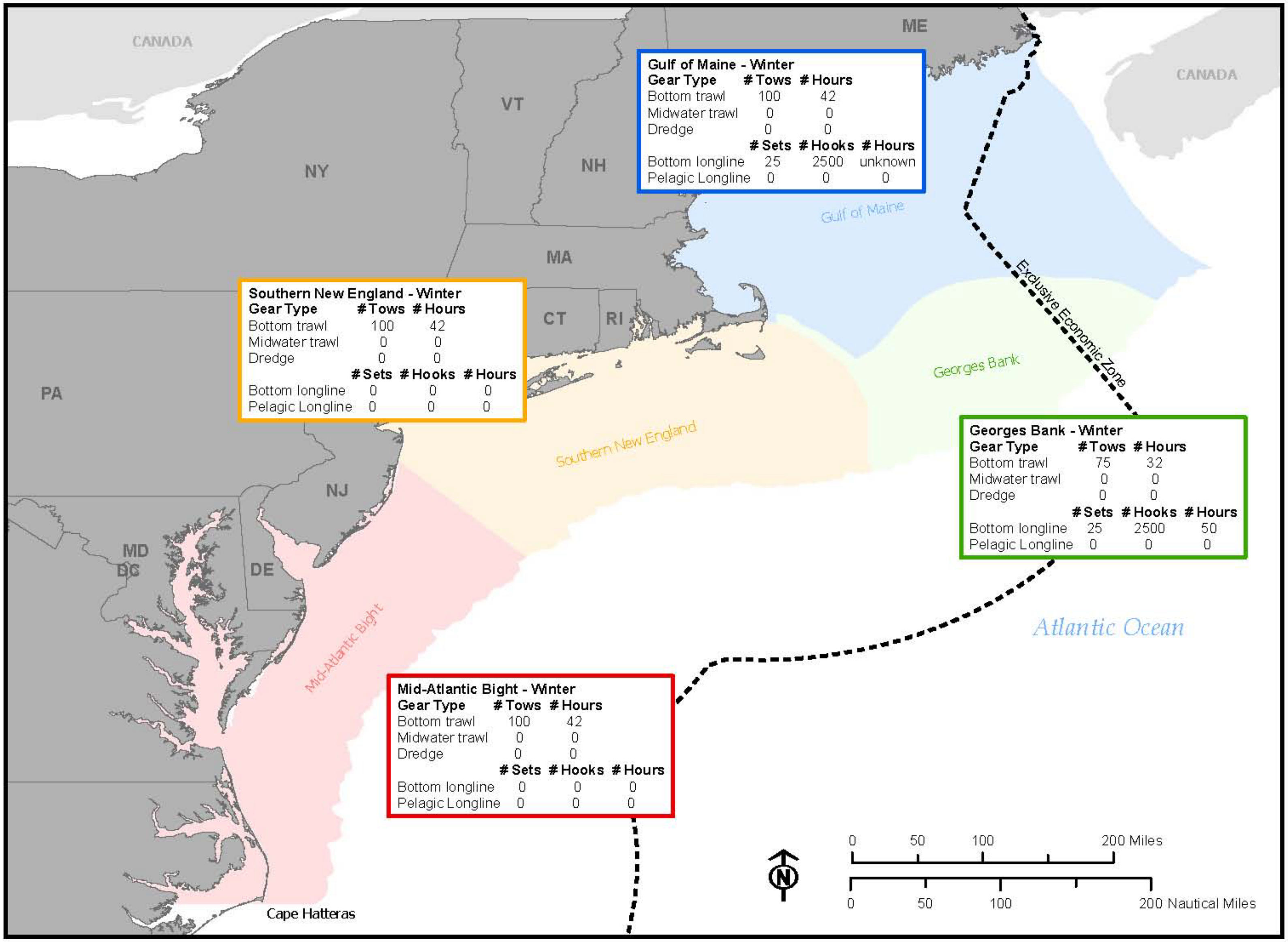

Figure B-4. Distribution of NEFSC Fisheries Research by Gear Type in December-February.

Table B-1. Distribution of research effort by gear type and season in the Gulf of Maine

Gear type	Surveys	Gear details	Sampling Events	Effort
Spring (March-May) Gulf of Maine				
Bottom Trawling	NEFSC Spring BTS NEFSC Gear Studies Maine-NH Spring BTS Integrated Benthic Surveys Cooperative Research Alosid Predation Studies MA Div of Marine Fisheries Bottom Trawl Surveys	400x12 4-Seam, Yankee 36, NEFSC Flatfish, Commercial, and Small Scientific Trawls	354 tows	20-30 min tows; ~ 142 hrs bottom time
Pelagic Trawling	Cooperative Research	Irish Midwater and Commercial Midwater Tows	100 tows	10-30 min tows; ~ 34 hrs fishing time
	Atlantic Salmon Trawl Survey	Modified mid-water trawl that fishes at the surface	130 tows	30-60 min tows, ~98 hrs
	Penobscot Estuarine Fish Community and Ecosystem Survey	Mamou shrimp trawl modified to fish at surface	50 tows	20 min tows, ~17 hrs
Net Sonde and Monitoring Gear	NEFSC Spring BTS NEFSC Gear Studies Maine-NH Spring BTS Integrated Benthic Surveys Cooperative Research Alosid Predation Studies	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	400 tows	~ 200 hrs in the water
Scallop Dredging	Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	50	10-15 min tows; ~13 hrs bottom time
Sediment Sampling Dredges	Integrated Benthic Surveys	Eckman Dredge Ponar Grab	50 dredge samples	10 m^3 of sediment
Bottom Longline	Cooperative Research	Commercial bottom longline	25 100-hook sets	5000 hook days
Split Beam Acoustics	NEFSC Spring BTS NEFSC Gear Studies Maine-NH Spring BTS Integrated Benthic Surveys Cooperative Research Alosid Predation Studies	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Multibeam Acoustics	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys	Simrad ME-70 EM-3002	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Sidescan Sonar	Integrated Benthic Surveys Survey	Edgetech Side Scan Sonar	Continuous Operations	500 hrs
Acoustic Telemetry	Inshore Telemetry Studies Cooperative Research	Vemco VR-2 Receivers	Up to 50 Moorings	Up to 1000 Mooring Days
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	500 hrs
CTD	NEFSC Spring BTS NEFSC Gear Studies Maine-NH Spring BTS Integrated Benthic Surveys Cooperative Research Alosid Predation Studies	Seabird CTD and Other CTD models	150 casts	75 hrs in water
Plankton Sampling	NEFSC Spring BTS NEFSC Gear Studies Maine-NH Spring BTS Integrated Benthic Surveys Cooperative Research Alosid Predation Studies	Bongo Nets Smaller Research Plankton Nets	150 samples	75 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Summer (June-August) Gulf of Maine				
Bottom Trawling	AFMSC Shrimp Integrated Benthic Surveys NEFSC Gear Studies Cooperative Research Alosid Predation Studies	NEFSC Shrimp, 400X12 4-Seam, Yankee 36, NEFSC Flatfish, Commercial and Small Scientific Trawls	200 tows	20-30 min tows; ~ 144 hrs bottom time
	Changes in the Community Structure of Benthic Fishes	16 ft trawl	176 tows	
	Deep-sea Coral Survey	2-m beam trawl	8 tows	
Pelagic Trawling	Cooperative Research	Irish Midwater and Commercial Midwater Tows	100 tows	10-30 min tows; ~ 51 hrs fishing time
	Penobscot Estuarine Fish Community and Ecosystem Survey	Mamou shrimp trawl modified to fish at surface	50 tows	
Net Sonde and Monitoring Gear	AFMSC Shrimp Integrated Benthic Surveys NEFSC Gear Studies Cooperative Research Alosid Predation Studies	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, I32	300 tows	~ 150 hrs in the water
Beach Seine	Beach Seine Survey	45 m beach seine, 5mm nylon mesh	100 sets	Variable
Fyke Net	Fyke Net Survey	2m fyke:- 2x2m – 1.9 cm main/0.6cm mesh 1m fyke:- 1x1m – 0.6cm mesh	100 sets	Variable
Scallop Dredging	NEFSC Sea Scallop Cooperative Research	8’ NEFSC Survey and/or 15’ Commercial Dredge	100 tows	10-15 min tows; ~25 hrs bottom time
Sediment Sampling Dredges	Integrated Benthic Surveys	Eckman Dredge Ponar Grab	50 dredge samples	10 m3 of sediment
Bottom Longline	Cooperative Research	Commercial bottom longline	25 100-hook sets	5000 hook days
Split Beam Acoustics	AFMSC Shrimp Integrated Benthic Surveys NEFSC Gear Studies Cooperative Research Alosid Predation Studies	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Multibeam Acoustics	AFMSC Shrimp Integrated Benthic Surveys NEFSC Gear Studies Alosid Predation Studies	Simrad ME-70 EM-3002	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	Integrated Benthic Surveys NEFSC Gear Studies	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Acoustic Telemetry	Inshore Telemetry Studies Cooperative Research	Vemco VR-2 Receivers	Up to 50 Moorings	Up to 1000 Mooring Days
Sidescan Sonar	Integrated Benthic Surveys Survey	Edgetech Side Scan Sonar	Continuous Operations	500 hrs
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	500 hrs
CTD	AFMSC Shrimp Integrated Benthic Surveys NEFSC Gear Studies Cooperative Research Alosid Predation Studies	Seabird CTD and Other CTD models	150 casts	75 hrs in water
Plankton Sampling	AFMSC Shrimp Integrated Benthic Surveys NEFSC Gear Studies Cooperative Research Alosid Predation Studies	Bongo Nets and Smaller Research Plankton Nets	150 samples	75 hrs
Fall (September-November) Gulf of Maine				
Bottom Trawling	NEFSC Autumn BTS NEFSC Gear Studies Maine-NH Autumn BTS Alosid Predation Studies MA Div of Marine Fisheries Bottom Trawl Surveys	400x12 4-Seam, Yankee 36, NEFSC Flatfish, Commercial, and Small Scientific Trawls	354 tows	20-30 min tows; ~ 142 hrs bottom time

Gear type	Surveys	Gear details	Sampling Events	Effort
Pelagic Trawling	NEFSC Herring Acoustic Survey Cooperative Research Penobscot Estuarine Fish Community and Ecosystem Survey	Irish Midwater, High Speed Rope and Commercial Midwater Trawls Mamou shrimp trawl modified to fish at surface	100 tows 50 tows	10-30 min tows; ~ 51 hrs fishing time
Net Sonde and Monitoring Gear	NEFSC Autumn BTS NEFSC Gear Studies Maine-NH Autumn BTS NEFSC Herring Acoustic Survey Integrated Benthic Surveys Cooperative Research Alosid Predation Studies	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	400 tows	~ 200 hrs in the water
Scallop Dredging	Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	100	10-15 min tows; ~25 hrs bottom time
Sediment Sampling Dredges	Integrated Benthic Surveys	Eckman Dredge Ponar Grab	50 dredge samples	10 m3 of sediment
Bottom Longline	Cooperative Research	Commercial bottom longline	25 100-hook sets	5000 hook days
Split Beam Acoustics	NEFSC Autumn BTS NEFSC Gear Studies Maine-NH Autumn BTS Alosid Predation Studies NEFSC Herring Acoustic Survey Cooperative Research	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam Acoustics	NEFSC Autumn BTS NEFSC Gear Studies NEFSC Herring Acoustic Survey	Simrad ME-70 EM-3002	Continuous Operations	500 hrs
Acoustic Telemetry	Inshore Telemetry Studies Cooperative Research	Vemco VR-2 Receivers	Up to 50 Moorings	Up to 1000 Mooring Days
Sidescan Sonar	Integrated Benthic Surveys Survey	Edgetech Side Scan Sonar	Continuous Operations	500 hrs
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	500 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Acoustic Doppler Current Profiler	NEFSC Autumn BTS NEFSC Gear Studies NEFSC Herring Acoustic Survey	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	1500 hrs
CTD	NEFSC Autumn BTS NEFSC Gear Studies Maine-NH Autumn BTS Alosid Predation Studies NEFSC Herring Acoustic Survey Cooperative Research	Seabird CTD and Other CTD models	150 casts	75 hrs in water
Plankton Sampling	NEFSC Autumn BTS NEFSC Gear Studies Maine-NH Autumn BTS Alosid Predation Studies NEFSC Herring Acoustic Survey Cooperative Research	Bongo Nets and Smaller Research Plankton Nets	150 samples	75 hrs
Winter (December-February) Gulf of Maine				
Bottom Trawling	Cooperative Research LMRCSC Survey NEFSC Gear Studies	400X12 4-Seam and Commercial Trawls	100 tows	20-30 min tows; ~ 42 hrs bottom time
Pelagic	Penobscot Estuarine Fish Community and Ecosystem Survey	Mamou shrimp trawl modified to fish at surface	50 tows	20 min tows, 17 hrs
Net Sonde and Monitoring Gear	Cooperative Research LMRCSC Survey NEFSC Gear Studies	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, I32	100 tows	~ 60 hrs in the water
Bottom Longline	Cooperative Research	Commercial bottom longline	25 100-hook sets	5000 hook days
Split Beam Acoustics	Cooperative Research LMRCSC Survey NEFSC Gear Studies	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam Acoustics	LMRCSC Survey	Simrad ME-70 EM-3002	Continuous Operations	500 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Acoustic Doppler Current Profiler	Cooperative Research LMRCSC Survey NEFSC Gear Studies	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	1500 hrs
CTD	Cooperative Research LMRCSC Survey NEFSC Gear Studies	Seabird CTD and Other CTD models	150 casts	75 hrs in water
Plankton Sampling	Cooperative Research LMRCSC Survey	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs

Table B-2. Distribution of research effort by gear type and season in Georges Bank

Gear type	Surveys	Gear details	Sampling Events	Effort
Spring (March-May) Georges Bank				
Bottom Trawling	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research	400X12 4-Seam, Yankee 36, NEFSC Flatfish and Commercial Trawls	300 tows	20-30 min tows; ~ 125 hrs bottom time
Pelagic Trawling	Cooperative Research	Irish Midwater and Commercial Midwater	50 tows	10-30 min tows; ~ 17 hrs fishing time
Net Sonde and Monitoring Gear	NEFSC Spring BTS NEFSC Gear Studies Maine-NH Spring BTS Integrated Benthic Surveys Cooperative Research Alosid Predation Studies	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	350 tows	~ 180 hrs in the water
Scallop Dredging	Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	200	10-15 min tows; ~50 hrs bottom time
Clam Dredging	NEFSC Surfclam and Ocean Quahog Dredge Cooperative Research	NEFSC Clam and/or Commercial Dredge	100	5 min tows; ~ 8.5 hrs bottom time
Bottom Longline	Cooperative Research	Commercial bottom longline	25 100-hook sets	5000 hook days
Sediment Sampling Dredges	Integrated Benthic Surveys Surveys	Eckman Dredge Ponar Grab	50 dredge samples	10 m^3 of sediment
Split Beam Acoustics	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research NEFSC Surfclam and Ocean Quahog Dredge NEFSC Apex Predator	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam Acoustics	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys	Simrad ME-70 EM-3002	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Sidescan Sonar	Integrated Benthic Surveys Survey	Edgetech Side Scan Sonar	Continuous Operations	500 hrs
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	500 hrs
CTD	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research NEFSC Surfclam and Ocean Quahog Dredge NEFSC Apex Predator	Seabird CTD and Other CTD models	150 casts	75 hrs in water
Plankton Sampling	NEFSC Spring BTS Integrated Benthic Surveys Cooperative Research NEFSC Surfclam and Ocean Quahog Dredge NEFSC Apex Predator	Bongo Nets and Smaller Research Plankton Nets	150 samples	75 hrs
Summer (June-August) Georges Bank				
Bottom Trawling	NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research Deep-sea Coral Survey	400X12 4-Seam, Yankee 36, NEFSC Flatfish and Commercial Trawls 2 m beam trawl	208 tows	20-30 min tows; ~ 87 hrs bottom time
Pelagic Trawling	Cooperative Research	Irish Midwater and Commercial Midwater Trawls	50 tows	10-30 min tows; ~ 17 hrs fishing time
Net Sonde and Monitoring Gear	NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research Alosid Predation Studies	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32	250 tows	~ 130 hrs in the water
Scallop Dredging	NEFSC Sea Scallop Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	200	10-15 min tows; ~52 hrs bottom time
Clam Dredging	NEFSC Surfclam and Ocean Quahog Dredge Cooperative Research	NEFSC Clam and/or Commercial Dredge	100	5 min tows; ~ 8.5 hrs bottom time
Sediment Sampling Dredges	Integrated Benthic Surveys Surveys	Eckman Dredge Ponar Grab	50 dredge samples	10 m^3 of sediment
Bottom Longline	Cooperative Research	Commercial bottom longline	25 100-hook sets	5000 hook days

Gear type	Surveys	Gear details	Sampling Events	Effort
Split Beam Acoustics	NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Dredge	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam Acoustics	NEFSC Gear Studies Integrated Benthic Surveys	Simrad ME-70 EM-3002	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	NEFSC Gear Studies Integrated Benthic Surveys NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Dredge	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Sidescan Sonar	Integrated Benthic Surveys Survey	Edgetech Side Scan Sonar	Continuous Operations	500 hrs
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	500 hrs
CTD	NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Dredge	Seabird CTD and Other CTD models	100 casts	100 hrs in water
Plankton Sampling	NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Dredge	Bongo Nets and Smaller Research Plankton Nets	150 samples	75 hrs
Fall (September-November) Georges Bank				
Bottom Trawling	NEFSC Autumn BTS NEFSC Gear Studies Autumn	400X12 4-Seam, Yankee 36 , NEFSC Flatfish, and Commercial Trawls	100 tows	20-30 min tows; ~ 50 hrs bottom time
Pelagic Trawling	NEFSC Herring Acoustic Cooperative Research	Irish Midwater, High Speed Rope, and/or Commercial Midwater Trawls	100 tows	10-30 min tows; ~ 34 hrs fishing time
Net Sonde and Monitoring	NEFSC Autumn BTS	Scanmar Scanmate 6 & Scanbass	200 tows	~ 110 hrs in the water

Gear type	Surveys	Gear details	Sampling Events	Effort
Gear	NEFSC Gear Studies Maine-NH Autumn BTS Integrated Benthic Surveys Cooperative Research Alosid Predation Studies	Netmind Simrad ITI, PI32 & FS900		
Scallop Dredging	Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	100	10-15 min tows; ~25 hrs bottom time
Clam Dredging	Cooperative Research	NEFSC Clam and/or Commercial Dredge	100	5 min tows; ~ 8.5 hrs bottom time
Bottom Longline	Cooperative Research	Commercial bottom longline	25 100-hook sets	5000 hook days
Pelagic Longline	Apex Predators Pelagic Nursery Grounds Shark	Commercial Pelagic Longline 1020 hooks	10 sets	~17 hrs in the water/set ~170 hrs in the water
Split Beam Acoustics	NEFSC Autumn BTS NEFSC Gear Studies Autumn NEFSC Herring Acoustic Cooperative Research	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam Acoustics	NEFSC Autumn BTS NEFSC Gear Studies NEFSC Herring Acoustic	Simrad ME-70 EM-3002	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	NEFSC Autumn BTS NEFSC Gear Studies Autumn NEFSC Herring Acoustic	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Sidescan Sonar	Integrated Benthic Surveys Survey	Edgetech Side Scan Sonar	Continuous Operations	500 hrs
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	500 hrs
CTD	NEFSC Autumn BTS NEFSC Gear Studies Autumn NEFSC Herring Acoustic Cooperative Research	Seabird CTD and Other CTD models	100 casts	100 hrs in water
Plankton Sampling	NEFSC Autumn BTS NEFSC Gear Studies Autumn NEFSC Herring Acoustic	Bongo Nets and Smaller Research Plankton Nets	150 samples	75 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Winter (December-February) Georges Bank				
Bottom Trawling	Cooperative Research LMRCSC Survey NEFSC Gear Studies Integrated Benthic Surveys	400X12 4-Seam, Commercial and Small Scientific Trawls	75 tows	20-30 min tows; ~ 32 hrs bottom time
Net Sonde and Monitoring Gear	Cooperative Research LMRCSC Survey NEFSC Gear Studies Integrated Benthic Surveys	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	75 tows	~ 50 hrs in the water
Bottom Longline	Cooperative Research	Commercial bottom longline	25 100-hook sets	5000 hook days
Split Beam Acoustics	Cooperative Research LMRCSC Survey NEFSC Gear Studies Integrated Benthic Surveys	Simrad EK-60 Simrad EK-500	Continuous Operations	200 hrs
Multibeam Acoustics	LMRCSC Survey Integrated Benthic Surveys	Simrad ME-70	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	Cooperative Research LMRCSC Survey NEFSC Gear Studies	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
CTD	Cooperative Research LMRCSC Survey NEFSC Gear Studies	Seabird CTD and Other CTD models	150 casts	75 hrs in water
Plankton Sampling	Cooperative Research LMRCSC Survey	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs

Table B-3. Distribution of research effort by gear type and season in Southern New England

Gear type	Surveys	Gear details	Sampling Events	Effort
Spring (March-May) Southern New England				
Bottom Trawling	NEFSC Spring BTS NEFSC Gear Studies NEAMAP Spring BTS Integrated Benthic Surveys Cooperative Research MA Div of Marine Fisheries Bottom Trawl Surveys	400X12 4-Seam, Yankee 36, NEFSC Flatfish and Commercial Trawls Otter trawls	254 tows	20-30 min tows; ~ 101 hrs bottom time
Pelagic Trawling	Cooperative Research	Irish Midwater and Commercial Midwater Trawls	50 tows	10-30 min tows; ~ 17 hrs fishing time
Net Sonde and Monitoring Gear	NEFSC Spring BTS NEFSC Gear Studies NEAMAP Spring BTS Integrated Benthic Surveys Cooperative Research	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	250 tows	~ 110 hrs in the water
Gillnet	Inshore Telemetry	Variable mesh experimental gillnets	10 100-foot gillnets	2 hour soak time/set; 600 hrs total soak time
Scallop Dredging	NEFSC Sea Scallop Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	100 tows	10-15 min tows; ~25 hrs bottom time
Clam Dredging	NEFSC Surfclam and Ocean Quahog Dredge Cooperative Research	NEFSC Clam Dredge and/or Commercial Dredge	200 tows	5 min tows; ~ 17 hrs bottom time
Sediment Sampling Dredges	NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Integrated Benthic Surveys Survey	Eckman Dredge Ponar Grab	50 dredge samples	10m^3 of sediment
Split Beam Acoustics	NEFSC Spring BTS NEFSC Gear Studies NEAMAP Spring BTS NEFSC Surfclam and Ocean Quahog Dredge NEFSC Sea Scallop Integrated Benthic Surveys	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Multibeam Acoustics	NEFSC Spring BTS NEFSC Gear Studies	Simrad ME-70	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	NEFSC Spring BTS NEFSC Gear Studies	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Sidescan Sonar	Integrated Benthic Surveys Survey	Edgetech Side Scan Sonar	Continuous Operations	500 hrs
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	500 hrs
CTD	NEFSC Spring BTS NEFSC Gear Studies NEAMAP Spring BTS NEFSC Surfclam and Ocean Quahog Dredge NEFSC Sea Scallop Integrated Benthic Surveys	Seabird CTD and Other CTD models	150 casts	75 hrs in water
Plankton Sampling	NEFSC Spring BTS NEFSC Surfclam and Ocean Quahog Dredge NEFSC Sea Scallop Integrated Benthic Surveys Survey	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs
Summer (June-August) Southern New England				
Bottom Trawling	Integrated Benthic Surveys NEFSC Gear Studies Cooperative Research Deep-sea Coral Survey	400X12 4-Seam, Yankee 36, NEFSC Flatfish and Commercial Trawls 2-m beam trawl	200 tows 8 tows	20-30 min tows; ~ 87 hrs bottom time
Pelagic Trawling	Cooperative Research	Irish Midwater Trawl and/or Commercial Midwater Trawls	50 tows	10-30 min tows; ~ 17 hrs fishing time
Net Sonde and Monitoring Gear	Integrated Benthic Surveys NEFSC Gear Studies Cooperative Research	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	250 tows	~ 110 hrs in the water
Gillnet	Inshore Telemetry Studies	Variable Mesh Experimental Gillnets	10 100-foot gillnets	2 hour soak time; 600 total net hrs
Beach Seine	Beach Seine Survey	45 m beach seine, 5mm nylon mesh	90 sets	Variable

Gear type	Surveys	Gear details	Sampling Events	Effort
Scallop Dredging	NEFSC Sea Scallop Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	100	10-15 min tows; ~25 hrs bottom time
Clam Dredging	NEFSC Surfclam and Ocean Quahog Dredge Cooperative Research	NEFSC Clam Dredge Commercial Dredge	200	5 min tows; ~ 17 hrs bottom time
Sediment Sampling Dredges	NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Dredge Integrated Benthic Surveys	Eckman Dredge Ponar Grab	50 dredge samples	10 m^3 of sediment
Bottom Longline	Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Longline Surveys	Small juvenile and large juvenile/adult shark rigs	50 sets at 25-50 hooks each	0.5 hour soak juvenile gear, ~1.5 hrs in the water per set 2 hour soak large juvenile/adult gear, ~4 hrs in the water per set
Split Beam Acoustics	Integrated Benthic Surveys NEFSC Gear Studies	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam **Acoustics**	Integrated Benthic Surveys NEFSC Gear Studies Cooperative Research	Simrad ME-70 EM-3002	Continuous Operations	500 hrs
Acoustic Doppler **Current** **Profiler**	Integrated Benthic Surveys NEFSC Gear Studies NEFSC Sea Scallop Cooperative Research	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Sidescan Sonar	Integrated Benthic Surveys Survey	Edgetech Sidescan Sonar	Continuous Operations	200 hrs
Acoustic Telemetry Studies	Inshore Telemetry Studies Cooperative Research	Vemco VR-2 Receivers	Up to 50 Moorings	Up to 1000 Mooring Days
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	500 hrs
CTD	Integrated Benthic Surveys NEFSC Gear Studies NEFSC Sea Scallop Cooperative Research	Seabird CTD and Other CTD models	100 casts	50 hrs in water
Plankton Sampling	Integrated Benthic Surveys NEFSC Sea Scallop	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Fall (September-November) Southern New England				
Bottom Trawling	NEFSC Autumn BTS NEFSC Gear Studies NEAMAP Autumn BTS Integrated Benthic Surveys MA Div of Marine Fisheries Bottom Trawl Surveys	400X12 4-Seam, Yankee 36, NEFSC Flatfish and Commercial Trawls Otter trawls	254 tows	20-30 min tows; ~ 101 hrs bottom time
Pelagic Trawling	Cooperative Research	Irish Midwater and/or Commercial Midwater Trawls	50 tows	10-30 min tows; ~ 17 hrs fishing time
Net Sonde and Monitoring Gear	NEFSC Autumn BTS NEFSC Gear Studies NEAMAP Autumn BTS Integrated Benthic Surveys	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	250 tows	~ 110 hrs in the water
Gillnet	Inshore Telemetry Studies	Variable mesh experimental nets	10 100-foot gillnets	2 hour soak time 600 total net hrs
Scallop Dredging	Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	100	10-15 min tows; ~25 hrs bottom time
Clam Dredging	Cooperative Research	NEFSC Clam Dredge Commercial Dredge	100	5 min tows; ~ 8.5 hrs bottom time
Split Beam Acoustics	NEFSC Autumn BTS NEFSC Gear Studies Integrated Benthic Surveys	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam Acoustics	NEFSC Autumn BTS NEFSC Gear Studies	Simrad ME-70 EM-3002	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	NEFSC Autumn BTS NEFSC Gear Studies Integrated Benthic Surveys	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Sidescan Sonar	Integrated Benthic Surveys	Edgetech Sidescan Sonar	Continuous Operations	200 hrs
Acoustic Telemetry Studies	Inshore Telemetry Studies Cooperative Research	Vemco VR-2 Receivers	Up to 50 Moorings	Up to 1000 Mooring Days

Gear type	Surveys	Gear details	Sampling Events	Effort
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	300 hrs
CTD	NEFSC Autumn BTS NEFSC Gear Studies NEAMAP Autumn BTS Integrated Benthic Surveys Inshore Telemetry Studies Cooperative Research	Seabird CTD and Other CTD models	100 casts	50 hrs in water
Plankton Sampling	NEFSC Autumn BTS Integrated Benthic Surveys Cooperative Research	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs
Winter (December-February) Southern New England				
Bottom Trawling	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	400X12 4-Seam and Commercial Trawls	100 tows	20-30 min tows; ~ 42 hrs bottom time
Net Sonde and Monitoring Gear	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	100 tows	~ 60 hrs in the water
Split Beam Acoustics	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Simrad EK-60 Simrad EK-500	Continuous Operations	300 hrs
Multibeam Acoustics	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Simrad ME-70	Continuous Operations	300 hrs
Acoustic Doppler Current Profiler	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	300 hrs
CTD	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Seabird CTD and Other CTD models	100 casts	50 hrs in water

Gear type	Surveys	Gear details	Sampling Events	Effort
Plankton Sampling	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs

Table B-4. Distribution of research effort by gear type and season in the Mid-Atlantic Bight

Gear type	Surveys	Gear details	Sampling Events	Effort
Spring (March-May) Mid-Atlantic Bight				
Bottom Trawling	NEFSC Spring BTS NEFSC Gear Studies NEAMAP Spring BTS Integrated Benthic Surveys Cooperative Research	400X12 4-Seam, Yankee 36, NEFSC Flatfish and Commercial Trawls	350 tows	20-30 min tows; ~ 150 hrs bottom time
Pelagic Trawling	Cooperative Research	Irish Midwater and Commercial Midwater Trawls	50 tows	10-30 min tows; ~ 17 hrs fishing time
Net Sonde and Monitoring Gear	NEFSC Spring BTS NEFSC Gear Studies NEAMAP Spring BTS Integrated Benthic Surveys Cooperative Research	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	450 tows	~ 210 hrs in the water
Gillnet	Inshore Telemetry Studies	Variable Mesh Experimental Gillnets	10 100-foot gillnets	2 hour soak time 600 hrs total soak time
Scallop Dredging	NEFSC Sea Scallop Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	200 tows	10-15 min tows; ~50 hrs bottom time
Clam Dredging	NEFSC Surfclam and Ocean Quahog Dredge Cooperative Research	NEFSC Clam Dredge Commercial Dredge	200 tows	5 min tows; ~ 17 hrs bottom time
Sediment Sampling Dredges	NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Dredge Integrated Benthic Surveys	Eckman Dredge Ponar Grab	50 dredge samples	10 m^3 of sediment
Bottom Longline	Apex Predator Coastal Shark Surveys	300 hooks of traditional Florida style monofilament	24 sets	3 hour soak ~6.4 hrs/set ~156 hrs in the water
Split Beam Acoustics	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys NEFSC Surfclam and Ocean Quahog Dredge	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam Acoustics	NEFSC Spring BTS NEFSC Gear Studies	Simrad ME-70	Continuous Operations	500 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Acoustic Doppler Current Profiler	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys NEFSC Surfclam and Ocean Quahog Dredge	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Sidescan Sonar	Ecology of Coastal Ocean Seascapes Integrated Benthic Surveys	Edgetech Sidescan Sonar	Continuous Operations	400 hrs
Acoustic Telemetry Studies	Inshore Telemetry Studies	Vemco VR-2 Receivers	Up to 50 Moorings	Up to 1000 Mooring Days
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	300 hrs
CTD	NEFSC Spring BTS NEFSC Gear Studies Integrated Benthic Surveys NEFSC Surfclam and Ocean Quahog Dredge NEFSC Apex Predator Ecology of Coastal Ocean Seascapes Cooperative Research	Seabird CTD and Other CTD models	100 casts	50 hrs in water
Plankton Sampling	NEFSC Spring BTS Integrated Benthic Surveys NEFSC Surfclam and Ocean Quahog Dredge Ecology of Coastal Ocean Seascapes Cooperative Research	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs
Summer (June-August) Mid-Atlantic Bight				
Bottom Trawling	NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research Habitat Mapping Survey Deep-sea Coral Survey	400X12 4-Seam, Yankee 36, NEFSC Flatfish and Commercial Trawls 2-m beam trawl	100 tows 54 tows	20-30 min tows; ~ 72 hrs bottom time
Pelagic Trawling	Cooperative Research	Irish Midwater and/or Commercial Midwater Trawl	50 tows	10-30 min tows; ~ 17 hrs fishing time
Net Sonde and Monitoring Gear	NEFSC Gear Studies Integrated Benthic Surveys Cooperative Research	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	150 tows	~ 80 hrs in the water

Gear type	Surveys	Gear details	Sampling Events	Effort
Gillnet	Inshore Telemetry Studies	Variable Mesh Experimental Gillnets	10 100-foot gillnets	2 hour soak time 600 hrs total soak time
Scallop Dredging	NEFSC Sea Scallop Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	200	10-15 min tows; ~50 hrs bottom time
Clam Dredging	NEFSC Surfclam and Ocean Quahog Dredge Cooperative Research	NEFSC Clam Dredge Commercial Dredge	200	5 min tows; ~ 17 hrs bottom time
Sediment Sampling Dredges	NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Dredge Integrated Benthic Surveys	Eckman Dredge Ponar Grab	50 dredge samples	10 m^3 of sediment
Bottom Longline	COASTSPAN Longline Surveys	Small juvenile and large juvenile/adult shark rigs	210 sets at 25-50 hooks each	0.5 hour soak small juvenile gear, ~1.5 hrs in the water per set, ~20 hrs in the water total 2 hour soak large juvenile/adult gear, ~4 hrs in the water per set,
Anchored Sinking Gillnet	COASTSPAN Gillnet Surveys	Anchored sinking gillnet	12 325 ft x 10 ft gillnet sets	3 hour soak time with continuous monitoring ~ 4.5 hrs in the water per set
Split Beam Acoustics	NEFSC Gear Studies Integrated Benthic Surveys NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam **Acoustics**	NEFSC Gear Studies Integrated Benthic Surveys	Simrad ME-70	Continuous Operations	500 hrs
Acoustic Doppler **Current** **Profiler**	NEFSC Gear Studies Integrated Benthic Surveys NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Sidescan Sonar	Ecology of Coastal Ocean Seascapes Integrated Benthic Surveys	Edgetech Sidescan Sonar	Continuous Operations	400 hrs
Acoustic Telemetry Studies	Inshore Telemetry Studies	Vemco VR-2 Receivers	Up to 50 Moorings	Up to 1000 Mooring Days
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	300 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
CTD	NEFSC Gear Studies NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Ecosystem Monitoring Survey Integrated Benthic Surveys Surveys Ecology of Coastal Ocean Seascapes Cooperative Research	Seabird CTD and Other CTD models	100 casts	50 hrs in water
Plankton Sampling	NEFSC Sea Scallop NEFSC Surfclam and Ocean Quahog Ecosystem Monitoring Survey Integrated Benthic Surveys Ecology of Coastal Ocean Seascapes Cooperative Research	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs
Fall (September-November) Mid-Atlantic Bight				
Bottom Trawling	NEFSC Autumn BTS NEFSC Gear Studies NEAMAP Autumn BTS Cooperative Research	400X12 4-Seam, Yankee 36, NEFSC Flatfish, Commercial and Small Scientific Trawls	350 tows	20-30 min tows; ~ 150 hrs bottom time
Pelagic Trawling	Cooperative Research	Irish Midwater and/or Commercial Midwater Trawls	50 tows	10-30 min tows; ~ 17 hrs fishing time
Net Sonde and Monitoring Gear	NEFSC Autumn BTS NEFSC Gear Studies NEAMAP Autumn BTS Cooperative Research	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	400 tows	~ 210 hrs in the water
Gillnet	Inshore Telemetry Studies	Variable Mesh Experimental Gillnets	10 100-foot gillnets	2 hour soak time 600 hrs total soak time
Scallop Dredging	Cooperative Research	8' NEFSC Survey and/or 15' Commercial Dredge	100	10-15 min tows; ~25 hrs bottom time
Clam Dredging	Cooperative Research	NEFSC Clam Dredge Commercial Dredge	100	5 min tows; ~ 8.5 hrs bottom time

Gear type	Surveys	Gear details	Sampling Events	Effort
Sediment Sampling Dredges	Integrated Benthic Surveys	Eckman Dredge Ponar Grab	50 dredge samples	10 m^3 of sediment
Split Beam Acoustics	NEFSC Autumn BTS NEFSC Gear Studies Integrated Benthic Surveys	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam Acoustics	NEFSC Autumn BTS NEFSC Gear Studies Integrated Benthic Surveys	Simrad ME-70	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	NEFSC Autumn BTS NEFSC Gear Studies Integrated Benthic Surveys	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
Sidescan Sonar	Ecology of Coastal Ocean Seascapes Integrated Benthic Surveys	Edgetech Sidescan Sonar	Continuous Operations	400 hrs
Acoustic Telemetry Studies	Inshore Telemetry Studies	Vemco VR-2 Receivers	Up to 50 Moorings	Up to 1000 Mooring Days
Suspended and Towed Underwater Video Systems	Integrated Benthic Surveys Scallop RSA Studies	HabCam System SMAST Tripod Camera	Continuous Operations	300 hrs
CTD	NEFSC Autumn BTS NEAMAP Autumn BTS NEFSC Gear Studies Ecosystem Monitoring Survey Integrated Benthic Surveys Surveys Ecology of Coastal Ocean Seascapes Cooperative Research	Seabird CTD and Other CTD models	100 casts	50 hrs in water
Plankton Sampling	NEFSC Autumn BTS NEFSC Gear Studies Ecosystem Monitoring Survey Integrated Benthic Surveys Surveys Ecology of Coastal Ocean Seascapes Cooperative Research	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs

Gear type	Surveys	Gear details	Sampling Events	Effort
Winter (December-February) Mid-Atlantic Bight				
Bottom Trawling	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	400X12 4-Seam, Yankee 36 , NEFSC Flatfish and Commercial Trawls	100 tows	20-30 min tows; ~ 42 hrs bottom time
Net Sonde and Monitoring Gear	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Scanmar Scanmate 6 & Scanbass Netmind Simrad ITI, PI32 & FS900	100 tows	~ 60 hrs in the water
Split Beam Acoustics	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Simrad EK-60 Simrad EK-500	Continuous Operations	500 hrs
Multibeam Acoustics	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Simrad ME-70	Continuous Operations	500 hrs
Acoustic Doppler Current Profiler	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Teledyne Workhorse Mariner RD Instruments OS 75	Continuous Operations	500 hrs
CTD	NEFSC Spring BTS NEFSC Gear Studies LMRCSC Survey	Seabird CTD and Other CTD models	100 casts	50 hrs in water
Plankton Sampling	NEFSC Spring BTS LMRCSC Survey	Bongo Nets and Smaller Research Plankton Nets	100 samples	50 hrs

Table B-5. Distribution of research effort by gear type and season in the Southeast U.S. Continental Shelf LME

Gear type	Surveys	Gear details	Sampling Events	Effort
Spring (March - May) Southeast Atlantic				
Bottom Longline	Apex Predator Coastal Shark Surveys	Florida style monofilament	71 sets at 300 hooks each	~6.5 hrs/set, ~462 hrs in the water
Summer (June - August) Southeast Atlantic				
Bottom Longline	COASTSPANLongline Surveys	Small juvenile and large juvenile/adult shark rigs	450 sets at 25-50 hooks each	0.5 hour soak juvenile gear, ~1.5 hrs in the water per set 2 hour soak large juvenile/adult gear, ~4 hrs in the water per set
Anchored Sinking Gillnet	COASTSPAN Gillnet Surveys	Anchored sinking gillnet	40 325 ft x 10 ft gillnet sets	3 hour soak time with continuous monitoring ~ 4.5 hrs in the water per set

Final
Programmatic Environmental Assessment

for

Fisheries Research Conducted and Funded by the Northeast Fisheries Science Center

July 2016

Appendix C

Request for Rulemaking and Letters of Authorization

Prepared for the National Marine Fisheries Service by:

URS Group

700 G Street, Suite 500

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Request for Rulemaking and Letters of Authorization

Under Section 101(A)(5)(A) of the Marine Mammal Protection Act

for the Take of Marine Mammals
Incidental to Fisheries Research Activities
conducted by
NOAA Fisheries Northeast Fisheries Science Center within the Northeast and Southeast U.S. Continental Shelf Large Marine Ecosystems and Offshore Regions

December 2014

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1.0 DETAILED DESCRIPTION OF THE SPECIFIC ACTIVITY OR CLASS OF ACTIVITIES THAT CAN BE EXPECTED TO RESULT IN INCIDENTAL TAKING OF MARINE MAMMALS

This application, submitted to the National Marine Fisheries Service (NMFS) Office of Protected Resources, requests rulemaking and subsequent Letters of Authorization under the Marine Mammal Protection Act (MMPA) of 1972, as amended,[1] for the incidental take of marine mammals during fisheries surveys and related research activities conducted by the Northeast Fisheries Science Center (NEFSC), National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA). Management of certain protected species falls under the jurisdiction of the NMFS under the MMPA and Endangered Species Act (ESA) of 1973.[2] Mechanisms exist under both the ESA and MMPA to assess the effect of incidental takings and to authorize appropriate levels of take.

The federal government has a trust responsibility to protect living marine resources in waters of the United States (U.S.), also referred to as federal waters. These waters generally lie 3-to-200 nautical miles (nm) from the shoreline [those waters 3-12 nm offshore comprise territorial waters and those 12-to-200 nm offshore comprise the Exclusive Economic Zone (EEZ)]. The U.S. government has also entered into a number of international agreements and treaties related to the management of living marine resources in international waters outside of the U.S. EEZ (i.e., the high seas). To carry out its responsibilities over federal and international waters, Congress has enacted several statutes authorizing certain federal agencies to administer programs to manage and protect living marine resources. Among these federal agencies, NOAA has the primary responsibility for protecting marine finfish and shellfish species and their habitats. Within NOAA, the NMFS has been delegated primary responsibility for the science-based management, conservation, and protection of living marine resources.

Within the area covered by this MMPA application to incidentally take marine mammals, NMFS manages finfish and shellfish harvest under the provisions of several major statutes, including the Magnuson-Stevens Fishery Conservation and Management Act (MSA),[3] the Atlantic Coastal Fisheries Cooperative Management Act (ACA),[4] and the Atlantic Striped Bass Conservation Act.[5] Accomplishing the requirements of these statutes requires the close interaction of numerous entities in a sometimes complex fishery management process. In the Northeast, the entities involved are a NMFS Regional Fisheries Science Center, NMFS Regional Office, NMFS Headquarters, two Fisheries Management Councils, and a Fisheries Commission. The following sections briefly summarize each entity and their missions

1.1 Fisheries Science Centers

Six Regional Fisheries Science Centers direct and coordinate the collection of scientific information needed to make informed decisions.[6] Each Fisheries Science Center is a distinct entity and is the scientific focal point for a particular region (Figure 1.1-1). The Northeast Fisheries Science Center (NEFSC) fisheries research activities are conducted off the Atlantic coast of the United States (U.S.), primarily within 200 miles of the shoreline from Cape Hatteras, North Carolina to the U.S.-Canada border. This

[1] 16 U.S.C 1631 *et seq*., (MMPA 2007)

[2] 16 U.S.C. 1531 et seq (ESA 1973)

[3] 16 U.S.C. §§ 1801-1884, (MSA 2007).

[4] 16 U.S.C. 5101-5109, (ACFCMA 1993).

[5] 16 U.S.C. 5151-5158, (ASBCA1984).

[6] The six Regional Fisheries Science Centers are: 1) Northeast, 2) Southeast, 3) Southwest, 4) Northwest, 5) Alaska, and 6) Pacific Islands.

primary research area is known as the Northeast U.S. Continental Shelf Large Marine Ecosystem (Northeast LME). In addition, a small number of NEFSC survey activities extend south into the Southeast U.S. Continental Shelf LME (Southeast LME) and occasionally north into the Scotian Shelf LME. However, the majority of NEFSC research activities occur within the Northeast LME. The Northeast LME is subdivided into four major subareas: the Gulf of Maine (GOM), Georges Bank (GB), Southern New England (SNE), and the Mid-Atlantic Bight (MAB) (Figure 1.1-2). The NEFSC, primarily based in Woods Hole, Massachusetts, also includes the Orono Field Station (Maine) and four laboratories: the NEFSC Headquarters Laboratory in Woods Hole; Narragansett, Rhode Island Laboratory; Milford, Connecticut Laboratory; James J. Howard Marine Sciences Laboratory in Sandy Hook, New Jersey; and the National Systematics Laboratory, located in Washington, D.C., which is administered by the NEFSC and serves as the taxonomic research arm of NMFS.

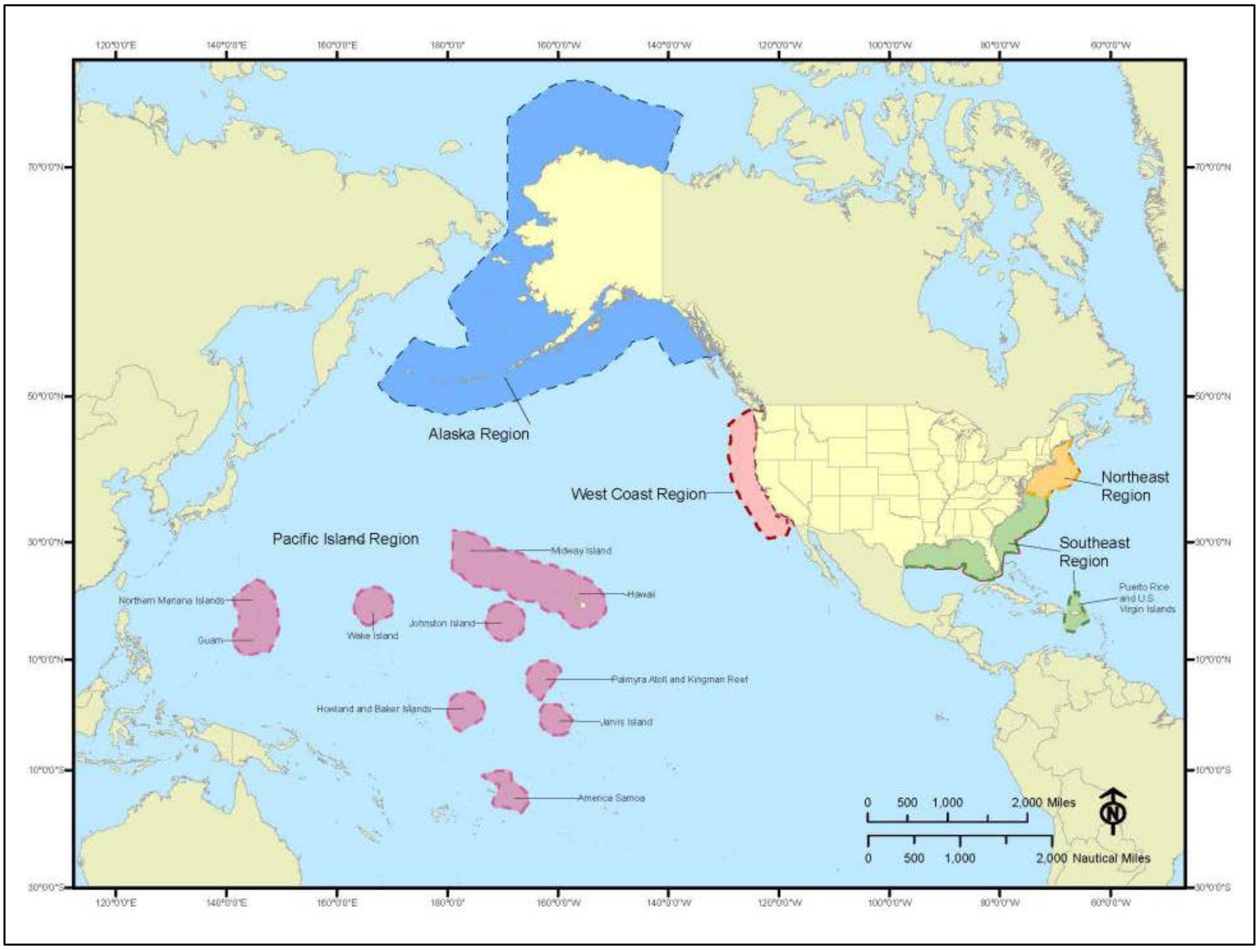

Figure 1.1-1 NMFS's Fisheries Science Center Regions

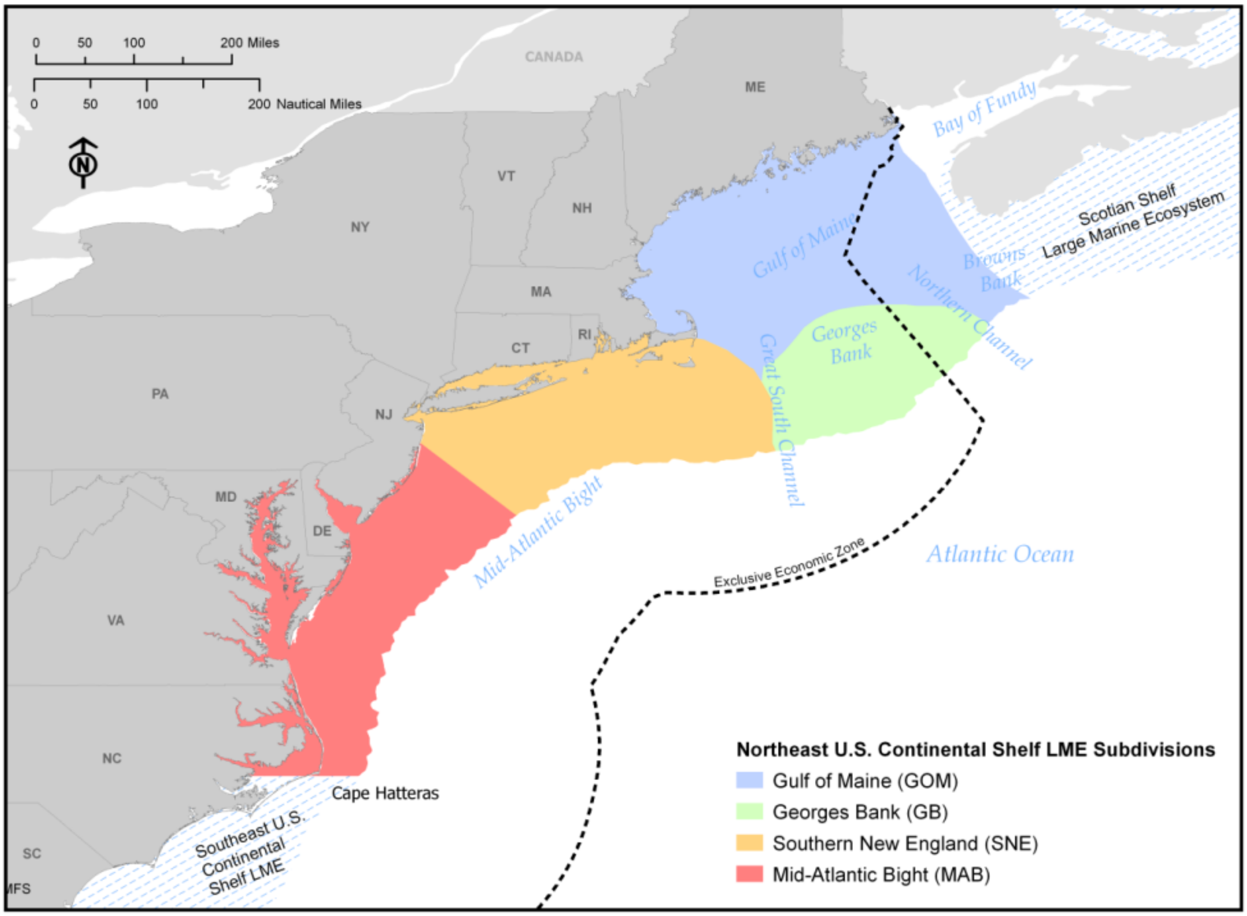

Figure 1.1-2 Primary NEFSC research areas

1.2 Role of fisheries research in federal fisheries management

The NEFSC provides scientific information and advice used by fisheries managers to assist with development of Fishery Management Plans (FMPs) prepared by the New England Fishery Management Council (NEFMC), the Mid-Atlantic Fishery Management Council (MAFMC), and the Atlantic States Marine Fisheries Commission (ASMFC). Fisheries managers use a variety of techniques to manage trust resources, a principal one being the development of FMPs. FMPs articulate fishery goals as well as the methods used to achieve those goals and their development is specifically mandated under the MSA. The councils, which include fishing industry representatives, fishers, scientists, government agency representatives, federal appointees, and others, are designed to provide all resource users and managers a voice in the fisheries management process. Under the MSA, the councils are charged with developing FMPs and management measures for the fisheries occurring within the EEZ adjacent to their constituent states. Data collected by Fisheries Science Centers are often used to inform FMPs, as well as to inform other policies and decisions promulgated by the Fishery Management Councils. Such policies and decisions sometimes affect areas that span the jurisdictions of several Fishery Management Councils, and make use of data provided by multiple Fisheries Science Centers.

The NEFSC works with fisheries managers to help develop FMPs for fin and shellfish species from Maine through North Carolina. To date, NEFMC and MAFMC have developed 16 FMPs that affect over 20 species of finfish and shellfish, and the ASMFC has developed 24 FMPs for the 24 species that they manage

Through its Regional Fisheries Science Centers, NMFS conducts both fisheries-dependent and fisheries-independent research on the status of the species and the habitats that support them, which aids in the development of FMPs. Fisheries-dependent research is carried out in partnership with commercial fishing vessels. The vessel activity is not directed by NEFSC, but researchers collect data on the commercial catch.

Fisheries-independent research is designed and conducted independent of commercial fishing activity to meet specific research goals. Depending on the research, NMFS' role in these activities varies and includes the following:

- Fishery-independent research directed by NEFSC scientists and conducted on board NOAA-owned and operated vessels (white ships) or NOAA-chartered vessels.
- Fishery-independent research directed by cooperating scientists (other agencies, academic institutions, and independent researchers) conducted on board non-NOAA vessels.
- Fishery-dependent research conducted on board commercial fishing vessels, with or without NOAA scientists on board.

1.3 NEFSC Research Programs

The NEFSC, the research arm of NMFS in the Northeast Region, plans, develops, and manages a multidisciplinary program of basic and applied research to inform management of the marine and anadromous fish and invertebrate populations of the Northeast LME from the Gulf of Maine to Cape Hatteras, NC, to ensure they remain at sustainable and healthy levels and the habitat quality essential for their existence and the habitat quality essential for their existence and continued productivity. Responsibilities include maintaining healthy fish stocks for commercial and recreational fishing, sustaining ecosystem services, and coordinating with domestic and international organizations to implement fishery agreements and treaties.

The NEFSC carries out these functions through the coordinated efforts of research facilities located in Massachusetts, Maine, Rhode Island, Connecticut, New Jersey, and Washington, DC. Since 1963, the NEFSC has conducted research surveys from the Gulf of Maine (GOM) south to Cape Hatteras, North Carolina. The NEFSC conducts these surveys to monitor for important indicators of the overall health and status of the Region's fisheries resources. This includes:

Monitoring Recruitment. To predict future landings and stock sizes, the survival of fish already large enough to be retained by harvesting gear must be estimated as well as the incoming recruitment to the fishery each year. Depending on the species, research vessel surveys can allow extrapolation of the strength of incoming age groups up to several years before they are allowed to be landed in commercial fisheries.

Monitoring Abundance and Survival of Harvestable Sizes. The catch-at-age data collected from the surveys are one important source of information used to estimate survival rates from one year to the next. Research vessel samples generally span the full size and age range of a population in the Northeast LME. Although recruitment prediction is one important element of fishery forecasts, it is equally important to calculate the survival rate of the portion of the stock already subjected to fishing. In practice, fishery scientists usually combine catch-at-age data from the surveys with similar data from the commercial fishery catch to improve estimates of fishing mortality and stock sizes. These combined estimates allow calculation of the population that must have existed to yield the catch levels observed during the recent history of the fishery.

Monitoring the Geographic Distribution of Species. Some species show high site fidelity while others are highly migratory. Research vessel surveys conducted over multiple seasons are a major source of data on the movement patterns and geographic extent of stocks. Distribution data are important not only for fishery management, but also for evaluating the population level effects of pollution and environmental change.

Monitoring Ecosystem Changes. With few exceptions, surveys conducted by the NEFSC are multi-purpose. Bottom trawl surveys are not directed at one species, but rather generate data on over 600 species of fish and invertebrates in the NCS waters. Many of these species are relatively rare, and have little or no commercial or recreational value. However, when evaluating the effect of intensive harvesting on selected species, the response of the entire animal community can be observed. The dramatic changes in the system reflect the depletion of several important commercial fishery species, such as haddock, yellowtail flounder, pollock, Atlantic cod, and American plaice, and an increase in winter skate, spiny dogfish, and other commercial fish. These data suggest ecosystem-level responses to intensive harvesting, which may have important implications for developing harvesting strategies for the community of species, rather than the individual stocks. A multi-species surveying approach thus provides an important research opportunity in the emerging field of ecosystem-based management.

Monitoring Biological Rates of Stocks. Apart from basic information on the abundance and distribution of species, research vessel survey data are collected on a range of biological rates for stocks. These processes include growth rates, sexual maturity rates, and feeding rates. Changes in growth and maturity directly influence assessment calculations related to spawning stock biomass, yield-per-recruit, and percent of maximum spawning potential. Over the past four decades, these parameters have changed dramatically for some species. Faster growth and earlier onset of maturity have been observed for haddock and cod. It is important to monitor these rates continuously if stock status is to be accurately determined. Likewise, diet data, collected via examination of stomach contents at sea, will be increasingly important as scientists try to evaluate how harvesting affects species linked by predator-prey relationships.

Collecting Environmental Data and Support Other Research. Research vessel surveys are generally conducted 24-hours a day when the vessels are at sea. This presents an excellent opportunity to collect environmental information (temperature, salinity, pollution levels, etc.) and to allow other researchers to piggyback on surveys to collect a host of environmental data not directly related to the stock assessment. All research vessel surveys conducted by the NEFSC collect and archive an extensive array of environmental measurements and usually have a “shopping list” of samples to be obtained for researchers at academic institutions, other government agencies, and the private sector. On every survey there are scientific berths allocated to cooperating scientists and students in order to foster this cooperative approach to marine science.

1.4 NEFSC Fisheries Research Activities

Following is a summary of activities conducted by the NEFSC that have the potential to take marine mammals incidental to fisheries and ecosystem research activities. The NEFSC is requesting rulemaking and subsequent Letters of Authorization for the proposed activities. The descriptions below include the location, time of year the surveys occur and gear used. Additional information and detail for each survey and its associated mitigation measures for marine mammals are in Table 1.1 and Appendix A. In general, all NEFSC surveys are set in an ecological context. That is, the NEFSC conducts concurrent hydrographic, oceanographic, and meteorologic sampling in addition to the marine resource surveys. Table 1-1 provides a summary of long-term surveys and research activities conducted by the NEFSC and its research partners. The NEFSC anticipates that these long-term surveys are likely to continue during the next five years, although not necessarily every year.

1.4.1 Summary of Long-term Research Surveys and Activities in the Northeast LME

Benthic Habitat Survey

The benthic habitat survey occurs annually during the summer (July) or fall (October) in an area that extends from the Hudson Canyon to the Georges Bank. It assesses seafloor disturbance by commercial fishing and changes as the benthic ecosystem recovers from chronic fishing impacts and collects data on seasonal migration, bottom data for mapping and indication of climate change through species shifts. Survey operations are on a 24-hour (hr) schedule.

The protocol for the July Hudson Canyon survey includes deploying a 4-seam, 3-bridle bottom trawl at approximately 2.5 knots (kts) for 30-minute tows at a target depth. The survey averages 54 tows per year and requires about 20 DAS using the R/V *H.B. Bigelow,* R/V *Gordon Gunter,* or R/V *Pisces* (Table 1.1).

The 4-seam, 3-bridle bottom trawl gear includes a net (31 meters [m] long by 19 m wide by 5 m high) that retains the sampled animals, a headrope with floats and trawl doors/vanes to keep the net open while trawling; and a footrope with rollers to maintain contact with the seafloor).

Sampling protocols include the use of conductivity temperature depth (CTD) profiler and rosette water sampler, Brooke Ocean moving vessel CTD, plankton light trap, Van Veen sediment grab, beam trawl, naturalists dredge, and SeaBoss benthic camera vehicle.

Additional protocols include the use of use of multi-frequency active acoustics (output frequencies: 18, 38, 120, 200, 400, and 450 kilohertz (KHz).

Changes in the Community Structure of Benthic Fishes

This survey occurs annually during the summer (July) in the Hudson River Estuary, New York. It quantifies the abundance and distribution of benthic associated fishes of the Hudson River Estuary ecosystem. Survey operations are on a 24-hour schedule.

The protocol for the survey includes deploying a 16-foot (ft) bottom trawl net towed at approximately 2.5 kts for 5 min. The survey averages 176 trawls annually and requires approximately 20 DAS using the R/V *Nauvoo*.

Protocols also include the deployment of a Yellow Spring YSI 6000 water quality meter and Kemmerer water sampling bottles. Additional protocols include the use of use of multi-frequency active acoustics: (output frequencies: 38 and 120 kHz).

Fish Collection for Laboratory Experiments

This survey occurs annually, as needed throughout the year in the New York Bight, Sandy Hook Bay, New Jersey. Survey operations are on a 24-hour schedule. It catches high quality fish for laboratory experiments.

Protocols include deployment of a 16-ft or 30-ft bottom trawl nets towed at approximately 2.5 kts for 10 min, or hook and line fishing. The number of tows varies depending on scientific need, typically enough trawls to capture 10-60 specimens. The survey requires approximately 10 DAS on the R/V *Nauvoo,* R/V *Harvey, or* R/V *Chemist*. Additional protocols include the deployment of a Sea Cam video sled, CTD, Tucker plankton net, an Acoustic Doppler Current Profiler (ADCP): 38, 120 kHz, Ponar grab, and Kemmerer water sampling bottles.

Habitat Characterization

This survey occurs annually throughout the year in Sandy Hook Bay, Barnegat Bay, and offshore New York and New Jersey. Survey operations are on a 24-hour schedule. It characterizes and maps coastal marine habitats and living marine resources in waters and wetlands around New York and New Jersey.

It is conducted under the terms of a Memorandum of Understanding with the New Jersey Sea Grant Consortium. The protocol for the survey includes deploying a 16-ft or 30-ft bottom trawl net (simple Memphis net and twine "shrimp trawl) towed at approximately 2.5 kts for 10 min. The survey requires about 60 tows per year and approximately 30 DAS on the R/V *Nauvoo* or R/V *Resolute.*

Protocols may include deployment of a Sea Cam 5000 12v video cam, CTDs, YSI 6000 water quality meter, Tucker plankton net, Kemmerer bottle, and Ponar grab. Additional protocols include the use of multi-frequency active acoustics (38 and 120 kHz) and an ADCP (600 kHz).

Habitat Mapping Survey

This survey occurs annually during the summer in the ocean shelf off the Maryland coast. It maps shallow reef habitats of fisheries resource species, including warm season habitats of black sea bass, and to locate sensitive habitats (e.g. shallow temperate coral habitats) for habitat conservation. Survey operations are on a 24-hour schedule.

The protocol includes deploying a 4-seam, 3-bridle bottom trawls (31 m long x 19 m wide x 5 m high) towed at 3.0 kts for 30 minutes at target depth. The survey requires about 54 tows per year and approximately 11 DAS using the R/V *Hassler*. Additional protocols include deployment of a CTD Profiler, Brooke Ocean Moving Vessel CTD profiler, split beam sonar, plankton light trap, beam trawl (tow speed 2.0 kts for 20 minutes), a naturalists dredge (tow speed 2.0-3.0 kts for 1 minute at depth), SeaBoss benthic camera vehicle, and continuous use of four multi-frequency acoustic devices: (output frequencies: 18, 38, 120, 200, 400, and 450) (Table 1.1).

Living Marine Resources Center Survey

The survey is conducted annually in January from Cape Hatteras to New Jersey. It determines distribution, abundance, and recruitment patterns for multiple species. The survey operates on 24-hour schedule.

Protocols include deployment of a 4-seam, 3-bridle bottom trawl (31 m long x 19 m wide x 5 m high) towed at 3.0 kts for 30 min. The survey averages 25 tows per year and requires about 11 DAS using the R/V *Henry B. Bigelow* or a similar vessel type. Protocols also include the use of a 2 m wide beam trawl at 2.0 kts for 20 minutes at depth, Van Veen sediment grab, and CTD profiler.

Additional protocols include the continuous use of multi-frequency active acoustics (output frequencies: 18, 38, and 120 kHz).

Massachusetts Division of Marine Fisheries (MADMF) Bottom Trawl Surveys

The MADMF spring (May) and fall (September) annual bottom trawl surveys have been conducted since 1978 during daylight hours within 5 nm of the Massachusetts coast, thus includes some federal waters, from the Rhode Island to New Hampshire borders. It tracks abundance of mature and juvenile fishes.

The protocol includes deploying an otter trawl at approximately 2.5 kts for 20-min. The surveys average 206 tows per year and requires about 30-36 DAS using the R/V *Gloria Michelle*.

The trawl has a 39 ft headrope and 51 ft footrope, rigged with a 3.5 inch (in) rubber disc sweep and has a ½ in stretched nylon liner at the cod end to retain small fish. The net is spread by 72 in x 40 in 325 pound (lb) wooden trawl doors connected to the net via 63 ft 3/8 in chain bottom legs and 60 ft 3/8 in wire top legs.

Northeast Area Monitoring and Assessment Program (NEAMAP) Near Shore Trawl Program

The survey is conducted annually from April-June and October-December in two segments during daylight hours. The northern segment extends from the U.S.-Canada border to New Hampshire-

Massachusetts from shore to the 300 ft depth, whereas the southern segment extends from Montauk, New York to Capte Hatteras from 20 to 90 ft depth. This program collects data in support of single and multispecies stock assessments in the mid-Atlantic.

The protocol in the northern segment includes deploying a modified Gulf of Maine shrimp trawl, typically used by commercial vessels in Maine and New Hampshire, at approximately 2.2 kt for 20 min. The survey averages 200 tows per year and requires approximately 30-50 DAS using the F/V *Robert Michael*. In the southern segment a 4-seam, 3-bridle bottom trawl is deployed at approximately 3.0 kts for 20 min. The survey averages 300 tows per years and requires approximately 30-50 DAS using the F/V *Darana R*. The net has a 58 ft headrope, 70 ft footrope, 24 ft siderope, with 1 in poly stretch mesh, and #7.5 Bison doors.

Northeast Observer Program (NEFOP) Observer Bottom and Mid-water Trawl Training Trips

This is a certification training program for new NEFOP Observers. It occurs from Maine to North Carolina annually, using one-day trips throughout the year as needed, totaling about 18 DAS on contracted commercial fishing vessels.

The protocol includes deployment of a commercial fishing net (net size, tow speed, and other details vary depending on the vessel and gear used). No active acoustic gear is used as part of the training. About 108 tows may occur per year.

Northern Shrimp Survey

This survey is conducted annually in July in the Gulf of Maine during daylight hours. It determines the distribution and abundance of northern shrimp and collects related data.

The protocol includes deployment of a 4-seam modified commercial shrimp bottom trawl (25 m length by 17 m width by 3 m high) at approximately 2-3 kts for 15 min. The surveys average 82 tows per year and require 22 DAS using the R/V *G. Michelle*.

NEFSC Standard Bottom Trawl Surveys (BTS)

This survey has been conducted annually in spring (March to May, occasionally to June) and fall (September to November) from Cape Hatteras to the western Scotian Shelf. The survey operates on a 24-hour schedule. It tracks mature fish species and juvenile abundance over their range of distribution.

Protocols include deployment of a 4-seam, 3-bridle bottom trawl at 3 kts for 20 min. The combined surveys average 800 tows and require 120 DAS using the R/V *H.B. Bigelow*, or a similar size vessel. The net size is 31 m long, 19 m wide and 5 m high.

Additional protocols include the use of CTD profiler, bongo net equipped with CTD, ADCP (150 or 300 kHz), and the use of split beam and multibeam active acoustics (output frequencies: 18, 38, 70, 120, and 200 kHz).

Atlantic Herring Survey

This survey is conducted in September and October, as funding allows, on Geroges Bank and in the Gulf of Maine. Survey operations occur on a 24-hr schedule. The survey collects fisheries independent herring spawning biomass data and also includes survey equipment calibration and performance tests.

Protocols included deployment of the Gourock high speed midwater rope trawl at 4 kts for 5-30 minutes. Approximately, 70 tows are made, which require about 34 DAS using the R/V *H.B. Bigelow* or similar size vessel. The net size is 15 m high and 30 m wide. Trawling protocols also include 20 deployments of the 4-seam, 3-bridle bottom trawl at 3 kts for 10-20 minutes using the R/V *H.B. Bigelow*, R/V *Pisces*, or similar size vessel. The net size is 31 m long, 19 m wide, and 5 m high. Additional protocols include the continuous use of split beam and multibeam active acoustics (output frequencies: 18, 38, 70, 120, and 200 kHz).

Atlantic Salmon Trawl Survey

This survey is conducted annually in May, as funding allows, in inshore waters of Gulf of Maine and Penobscot Bay during daylight hours. It is intended to evaluate the marine ecology of Atlantic salmon.

Protocols include deployment of a modified mid-water trawl that fishes at the surface via pair trawling at 2-6 kts for 30-60 min. Approximately 130 tows are made, which require approximately 21 DAS using contracted commercial vessels.

Deepwater Biodiversity Survey

This survey is conducted annually in summer, as funding allows, in deep-water from Cape Hatteras to the mid-Atlantic Ridge (international waters). Survey operations are on a 24-hour schedule. It is intended to collect fish, cephalopod and crustacean specimens from 1,000 to 2,000 m for tissue samples, specimen photos, and documentation of systematic characterization.

Protocols include deployment of the 4-seam, 3-bridle bottom trawl with roller gear and the International Young Gadoid pelagic trawl. Tow speeds are typically 1.5-2.5 kts with duration of 180 minutes (in deep water each operation setting, fishing, and haulback requires 60 minutes). The surveys average 18 tows per year and require about 16 DAS *(*R/V *H.B. Bigelow,* R/V *Pices* or equivalent).

Additional protocols include the use of multi-frequency active acoustics (output frequencies: 18, 38, 70, 120, and 200 kHz).

Penobscot Estuarine Fish Community and Ecosystem Survey

This survey is conducted annually year round during daylight hours in Penobscot Estuary and Bay using a contracted commercial vessel. It is intended to survey and collect fish and invertebrates samples for biometric and population analysis of estuarine and coastal species.

The protocol for the survey is to deploy a Mamou shrimp trawl modified to sample at the surface and it is towed at 2-4 kts. The trawl has a mouth opening 12 x 6 m as is towed for 20 min; approximately 200 trawl tows are conducted per year and require about 12 DAS.

Northeast Integrated Pelagic Survey

This survey is conducted annually each quarter (e.g., February, May/June, August, and November) in an area that expends from Cape Hatteras to the western Scotian Shelf. It assesses the pelagic components of the ecosystem including: water currents, water properties, phytoplankton, micro-zooplankton, meso-zooplankton, pelagic fish and invertebrates, sea turtles, marine mammals, and sea birds. Survey operations are on a 24-hour schedule.

Protocols include deploying a variety of fishing trawls:

1. Hydroacoustic midwater rope trawl- The net is 15 m high, 30 m wide and towed at 4 kts for 5-30 minutes at depth; approximately 80 tows are conducted per year.
2. Isaacs-Kidd midwater trawl- The net is 3 m and 4.5 m wide, and towed at 2.5 kts for a maximum of 30 min; approximately 160 tows are conducted per year.
3. Mid-water trawl- The trawl is for use in shallow water (>15 m depth). The net has an 8 m x 8 m opening and is towed at 2.5 kts for a maximum of 30 min; approximately 80 tows are conducted per year.

Surveys require about 80 DAS and are conducted on one of several vessels including: R/V *H.B. Bigelow*, R/V *Pisces*, and R/V *G. Gunter*.

Protocols also include the use of CTD, rosette water sampler, bongo net equipped with CTD. Additional protocols include the use of continuous use of split beam and multibeam active acoustics (output frequencies: 18, 38, 70, 120, 200 kHz), and ADCP (300 or 150 kHz).

Apex Predators Bottom Longline Coastal Shark

This survey is conducted bi-annually in April-May, contingent upon funding, in an area extending from Florida to Delaware. It assesses shark populations shark populations that are in sharp decline, including monitoring of distribution, abundance, and species composition, and tagging sharks. Survey operations are on a 24-hour schedule.

Protocol for the survey includes deploying a Florida style bottom longline. 'Florida' commercial-style bottom longline gear consists of 940 lb test monofilament mainline with 3.6 m gangions made of 730 lb test monofilament with a longline clip at one end and a 3/0 shark hook at the other. Hooks are baited with chunks of spiny dogfish and are attached to the mainline at roughly 20 m intervals. Five lb weights are attached at 15 hook intervals, and 15 lb weights and small buoys are attached at 50 hook intervals. To ensure that the gear fishes on the bottom, 20 lb weights are placed at the beginning and end of the mainline after a length of line 2-3 times the water depth is deployed. A 6 m flag buoy ('high flyer') equipped with radar reflectors and flashing lights is attached to each end of the mainline. The gear is set at night without lightsticks, soak time is 3 hours, and the gear is hauled during daylight. There are about 56 sets per survey, which require 47 DAS using charter vessels.

Apex Predators Pelagic Nursery Grounds Shark

This research is conducted aboard commercial swordfish vessels in October on Georges Bank and the Grand Banks off Newfoundland. This collaborative work offers NEFSC researchers the opportunity to sample and tag by caught sharks. Further, it offers a unique opportunity to sample and tag blue sharks and shortfin makos in a potential nursery area on the Grand Banks. Sharks are released after tagging.

Protocol for this research is based on commercial fishing operations. The commercial swordfish longline gear is set at night, with lightsticks, and hauled in the morning – vessels operations are on a 24-hour schedule. Commercial trips require 21-55 DAS using the F/V *Eagle Eye II*.

Cooperative Atlantic States Shark Pupping and Nursery Survey (COASTSPAN)

This survey is conducted annually from June-August in coastal Delaware, New Jersey, and Rhode Island waters. It assesses shark nursery grounds and the species composition and habitat preferences of sharks that occur on these grounds. Survey operations are conducted during daylight hours.

Protocols include using small juvenile/ large juvenile-adult shark longline gear, depending on the survey target. The gear characteristics for each target size are: mainline length: 1000 ft/ 1000 ft; gangion length: 5 ft/ 8 ft; gangion spacing: 20 ft/ 40 ft; hook size and type: 12/0 / 16/0 mustad circle hooks; hooks per set: 50/ 75; bait: mackerel or herring; soak time: 30 minutes /2 hours. The NEFSC conducted surveys require 25 DAS, whereas the cooperating institutions surveys require about 40 DAS using the R/V *C.E. Stillwell* and partner vessels.

NEFOP Observer Bottom Longline Training Trips

As with the NEFOP Observer bottom and mid-water trawl training trips discussed earlier, these trips are certification training for NEFOP observers. However, this training has not been implemented to date, but is expected to occur when funding becomes available. The trips will occur from Maine to North Carolina annually for 5 DAS on contracted commercial fishing vessels using commercial bottom longline gear.

The mainline length is approximately 3,000 ft with 600 hooks per set 2-3 sets per trip. Lightsticks are not used in training trip finshing operations.

Annual Assessments of Sea Scallop Abundance and Distribution in Selected Closed/Rotational Areas

The Atlantic Sea Scallop Research Set Aside rotational surveys occur at various times within the April-September period, depending on the area studied (see Table 1-1 for specific sampling dates and ships used). The survey region includes: large areas in Georges Bank, Closed Areas I & II, Hudson Canyon, DelMarVa, Nantucket, Gulf of Maine Mid-Atlantic areas, and other scallop fishing grounds. It monitors scallop biomass to derive estimates of Total Allowable Catch (TAC) for annual scallop catch specifications. Additionally, the surveys monitor recruitment, growth, and other biological parameters such as meat weight, shell height and gonadal somatic indices.

The protocol includes commercial and standardized NMFS scallop dredges, towed simultaneously. Survey operations are on a 24-hour schedule. The NMFS survey dredge is 8 ft wide, has 2-in rings, 4-in diamond twine top, and 1.5 in diamond mesh liner. The commercial gear used consists of a 15 ft Coonamessett Farm Turtle Deflector Dredge (CFTDD) with 4-in rings, 10-in diamond mesh twine top and no liner. Turtle chains are used in configurations as dictated by the area surveyed and current commercial fishing regulations under the MSA. Tow speed: 3.8-4.0 kts for 15 minutes. About 100 dredge tows per year are completed in each rotational area when sampled using that method. Average number of dredge tows per year is about 200 in all areas.

Additional protocols include the use of a towed photographic and sonar hydroacoustic imaging system (HABCAM) and a drop camera, and underwater video system. The HABCAM photographic system has 1 m field of view in each photograph, 5–10 frames per second with >50% overlap at 5 kts towing speed. Photo system coupled with two Imagenix side scan sonars or Teledyne Benthos C3D side scan sonars. Between 350 and 690 nm of transects using digital photography by HABCAM each year. Drop camera typically samples over 400 stations on a 1.57 km sampling grid.

NEFOP Observer Scallop Dredge Training Trips

As above, these trips are certification training for NEFOP observers and occur from Maine to North Carolina annually, one-day trips (daylight tows) throughout the year as needed. About 6 DAS on contracted commercial fishing vessels using commercial scallop gear such as a turtle deflector dredge (4 to 5 m wide). Tow duration is about 1 hr with 2-3 tows per trip and 12-18 tows total.

Sea Scallop Survey

The sea scallop occurs annually during May-July in an area that extends from Cape Hatteras, North Carolina to the Scotian Shelf, Canada. It assesses distribution and abundance of sea scallops and collects related data. Survey operations are on a 24-hour schedule.

The protocol, since 2008, is to use the chartered vessel R/V *Hugh R. Sharp* from the University of Delaware to conduct the standardized survey. The vessel deploys a NEFSC 8-ft scallop dredge equipped with a 2-in ring chain bag and lined with 1.5 in mesh webbing liner to retain small scallops. The dredge is towed at 3.8 kts for 15-minute tow intervals with a 3.5:1 tow wire to depth ratio (scope). Approximately 450 stations are sampled each year and require about 36 DAS.

Additional protocols may include deploying a stereo-optic towed camera array to count and measure sea scallops and associated fauna utilizing automated digital imagery. The camera system was towed during the 2012 standard survey for half of the sea days. The non-invasive vehicle is towed by a 2 in fiber optic cable that keeps the vehicle about 1.5 m off the sea floor.

Surf Clam and Ocean Quahog Dredge Survey

The NEFSC standard surf clam and quahog survey occurs every three years during June-August in an area that extends from southern Virginia to Georges Bank. It assesses distribution and abundance of surf clams and quahogs and collects related data. Survey operations are on a 24-hour schedule. Until 2012 the surveys were conducted using the F/RV *Delaware II*. The protocol is to use commercial vessels to conduct the survey. The contract vessel will deploy a standard commercially sized hydraulic-jet clam dredge (13 ft blade width). The dredge will be towed at 1.5 kts for 5 minutes with a 2:1 tow wire to depth ratio (scope). The survey averages 150 tows per survey and requires 15 DAS.

Beach Seine Survey, Maine

The Maine beach seine survey occurs annually during April to November in the Penobscot River estuary. It monitors the salmon community within the estuary. Survey operations are during daylight hours.

The protocol is to set the seine biweekly. Seines are deployed with one end held on shore by a crew member and the net slowly deployed by boat in an arc and then retrieved by pulling both ends onto shore. The seine is 45 m in length with 5 mm nylon mesh. Typical seine heals are less than 15 minutes with the resultant catch sampled and released. The survey averages 5 sets per day and 100 sets per year and requires approximately 20 DAS.

Beach Seine Survey, New Jersey

The New Jersey beach seine survey occurs in summer (June to August) in Sandy Hook Bay and in the Navesink River, New Jersey. It monitors the fish community at fixed locations, and survey operations are conducted from shore during daylight hours. The protocol is to set seines in close proximity to shore by small boat crews. Seines are deployed with one end held on shore by a crew member and the net slowly deployed by boat in an arc and then retrieved by pulling both ends onto shore. The seine is 45 m in length with 5 mm nylon mesh. Typical seine heals are less than 15 minutes with the resultant, catch sampled and released. The survey averages 90 sets per year.

Coastal Maine Telemetry Network

This research is conducted year round in the Gulf of Maine and April to November in the Penobscot River, estuary and bay. The survey operates on a 24-hour schedule. This project monitors tagged fish (e.g., Atlantic salmon, Atlantic sturgeon, and short-nose sturgeon) entering the Penobscot Bay System and exiting the system into the Gulf of Maine. A contracted commercial vessel is used to service the array, and requires 10 DAS.

The protocol relies on fixed position acoustic telemetry array receivers on 30 to 120 moorings attached to 10 to 100 m vertical lines (600 lb test with weak links) spaced 250-400 m apart to scan the 69 kHz frequency. Data acquisition is obtained by hauling each buoy and downloading the data.

Deep-sea Coral Survey

The deep-sea coral survey occurs annually between April-August in deep water (greater than 500 meters) from Cape Hatteras to the eastern Scotain Shelf. It assesses the species diversity, community composition, distribution and extent of deep sea coral and sponge habitats along the continental shelf margin, slope, and submarine canyons. Survey operations are on a 24-hour schedule. The survey averages 16 DAS, using the R/V *H.B. Bigelow*.

Protocols include deploying a 2-m beam trawl (optional) which is 2 m wide and towed at 2 kts for 20 minutes at depth with a maximum of 30 tows; towing a tethered ROV (10 dives) at 3 kts; a towed camera system at 0.25 kt for 8 hours (18 dives); and CTD profiler with Niskin 12-bottle rosette water sampler.

Additional protocols include the use of ADCP (300 or 150 kHz) and split beam and multi-beam acoustics (output frequencies: 18, 38, 70, 120, and 200 kHz).

DelMarVa Habitat Characterization

This survey occurred one time in August, 2013 in coastal waters off Delaware, Maryland, and Virginia (DelMarVa). The purpose was to characterize and determine fish use of bottom habitats in coastal waters off the DelMarVa Peninsula, as an adjunct to the DelMarVa Reef Survey – see next description. Survey operations were during daylight hours aboard the R/V *Resolute* and required 5 DAS.

The protocol was to perform water column acoustic surveys using a single beam, dual frequency (38 and 120 kHz) sonar system. Acoustic transects were performed for periods of 4-6 hours at speeds of 2-4 kt, interrupted periodically to obtain vertical CTD casts recording profiles for temperature, conductivity, chlorophyll *a*, and turbidity.

DelMarVa Reefs Survey

This survey occurs annually during August in coastal waters off Delaware, Maryland, and Virginia. The objective is to determine the extent and distribution of rock outcrops and coral habitats and their use by black sea bass and other reef fishes. The survey is conducted using the R/V *Sharp* and requires 5 DAS.

The protocol is to deploy and continuously tow a HabCam towed camera vehicle at 5 kts. Additional protocol is to deploy a CTD.

Diving Operations

Daylight diving operations are conducted on a year-round basis in Long Island Sound. It collects growth data on hard clams, oysters and bay scallops. The survey is conducted, using the R/V *Loosanoff*, R/V *Milford 17*, or R/V *Milford 22*) and requires 20 DAS.

The protocol is to deploy wire mesh cages (1.5 in square mesh cages 60 in x 24 in x 18 in) that are staked to the substrate, and lantern nets (18 in diameter x 72 in long) that are anchored to the seabed with 4 four cinder blocks with the net oriented vertically.

Ecology of Coastal Ocean Seascapes

This survey is conducted annually in spring, summer, and fall within the New York Bight. It provides information required for a next generation spatially and temporally explicit population simulation model for commercially important stocks such as summer flounder. Approximately 80 tows are conducted using the R/V *Nauvoo* or R/V *Resolute* and the survey requires 35 DAS.

The protocol is to deploy a video sled containing a Sea Cam 5000 12 v video cam towed at 1 kt for 300 m. Additional protocols include deployment of CTD, YSI, (1.4 m x 1 m Tucker trawl), plankton net, multi-nutrient analyzer (EcoLAB 2) and Kemmerer bottle. Active acoustics include: ADCP (600 kHz) and multi-frequency echosounder (output frequencies: 38 and 120 kHz).

Finfish Nursery Habitat Study

This survey is conducted from May through October in Long Island Sound during daylight hours within two hours of high tide. It collects fish eggs, larvae, and juvenile fish from the seabed to identify essential habitats, and to track movements of juvenile fish. The survey is conducted using the R/V *Loosanoff*, R/V *Milford 17, or Milford 22* and requires 10 DAS.

The protocol is to deploy: 1) an epibenthic sled (1 m x 333 cm opening) towed on the seabed at 1.5 kts for 5 min; 2) bongo net tow at 0.5 kts at varying depths between the surface and bottom; and 3) Neuston plankton net (1 m x 0.5 m opening a 1 kt at the surface). An additional protocol is to implant 30 acoustic (70 kHz) tags on juvenile fish. The tags have a 14 month battery life.

Gear Effects on Amphipod Tubes

This survey occurs annually in July and August in Sandy Hook, Barnegat, and Great South Bay, New Jersey. It assesses the abundance of amphipod tubes and the effects of bull raking and crab dredging. Sampling is conducted during day and night using the R/V *Nauvoo*, R/V *Resolute*, and R/V *Harvey* and requires 20 DAS.

The protocol is to deploy a Ponar sediment grab, YSI, 1 m x 1 m Tucker trawl, and a plankton net. The number of samples varies.

Gulf of Maine Ocean Observing System Mooring Cruise

This survey occurs annually during May and October in the Gulf of Maine and northern portion of Georges Bank. It services oceanographic moorings operated by the University of Maine. The vessels used are: R/V *H.B. Bigelow*, R/V/*Pices*, and R/V *G. Gunther*, and require 12 DAS. The vessels operate on a 24-hour schedule.

The protocol is to operate the ADCP (300 kHz) during vessel transects to moorings and service ADCP (300 and 75 kHz) on moorings.

Hydroacoustic Surveys

This survey occurs from spring to autumn (April to November) in Penobscot Bay and estuary. The purpose of the hydroacoustic component of the estuary surveys is to describe the spatial and temporal patterns of fish distribution in the estuary with a focus on diadromous species. The objective is to inform abundance and habitat-use data gaps through systematic sampling using a variety of gears. The surveys operate during daylight hours. The survey is conducted using the R/V *Silver Smolt* or similar size charter vessel, and requires 25 DAS.

The protocol is to operate active multi-frequency acoustics: split-beam (38 and 120 kHz) and DIDSON sonars (1.1 megahertz [MHz]).

Maine Estuaries Diadromous Survey

This survey occurs annually (April-November) in the Penobscot River estuary. It assesses the fish community. Survey operations are on a 24-hour schedule.

Protocols include setting a 2 m (2 m x 2 m; 1.9 cm mesh) or 1 m (1m x 1 m; 0.6 cm mesh) inshore by small boat crews during daylight at low tide. The fyke net soaks overnight and is hauled the next day. A marine mammal excluder device is incorporated into the 2 m net (but not the 1 m net). The marine mammal excluder device is a grate of metal bars with 14 centimeter spacing between the bars. The 1 m net has a throat opening of only 12.7 centimeters, which is too small for marine mammals to enter the net. From April to May the nets are set weekly, then twice per month through November. The survey averages 100 sets per year which requires about 100 days to complete.

Miscellaneous Fish Collections and Experimental Survey Gear Trials

These small scale and opportunistic projects are conducted in all seasons in New York Bight estuary waters.

The survey protocol is dependent on the sampling or gear trial protocols. Potential gear are: 1) combination bottom trawl – net size: 23 ft head rope, 32 ft sweep, 7 ft rise, tow speed 2.5 kts for 20 minutes; 2) lobster pots – 18 in x 24 in x 136 in wire pot connected by 3/8 in rope with 7 in x 14 in surface float. One to 60 posts are set for 24-96 hr between retrievals; three fish pots – 9 in x 9 in x 18 in wire pots with 1/8 in mesh liner, connected by 3/8 in rope with 7 in x 14 in surface floats. One to 60 pots are set for 24-96 hours between retrievals; 4) 2 m beam trawl towed at 2 kts for 15 minutes, up to 5 tows per year; 5) seine net; and 6) trammel nets – multi trammel net, 12 in walling, 3 in mesh, 6 ft deep x 25 ft long. The research activities are conducted on either the R/V *Nauvoo*, R/V *Resolute*, R/V *Harvey*, or R/V *Chemist.*

NEFOP Observer Gillnet Training Trips

As described earlier, these one day trips are certification training for NEFOP observers and occur from Maine to North Carolina annually for 6 10 DAS on contracted commercial fishing vessels using the contracted vessels gillnet gear. The nets are strings of 3-5 panels each soaked for 12-24 hours with 4 sets per trip, 40 sets total. There are no standard dimensions for commercial gillnets, but panels generally measure 3 m high and 91 m long.

Nutrients and Frontal Boundaries

This study is conducted quarterly in February, May-June, August, and November in the mid-Atlantic Bight (i.e., coastal New Jersey and Long Island waters). The survey is conducted using the R/V *Resolute* and requires 10 DAS. Sampling occurs day and night.

The survey protocol requires ADCP (600 kHz), multi-frequency active acoustic devices (38 and 120 kHz), and deployment of CTD.

Ocean Acidification

These studies are conducted quarterly in the Hudson River and adjacent coastal waters. The purpose is to develop baseline pH measurements in the Hudson River water. This is conducted using the R/V *Resolute* and requires 10 DAS. Sampling occurs day and night.

The protocol is to deploy a YSI 6000, CTD, Kemmerer bottle, and EcoLAB2 multi-nutrient analyzer.

Pilot Studies

This project is conducted annually in June in Massachusetts coastal waters or on Georges Bank.

The survey protocol is to deploy an AUV (Remus 100) during daylight hours to test equipment. The AUV is deployed from the R/V *G. Michelle* and requires 5 DAS.

Rotary Screw Trap (RSTs) Survey

Rotary screw trap sampling is conducted annually from April to June, daily (mornings) in the Penobscot River estuary. It assesses the fish community within the estuary. This project requires 60 DAS.

The protocol is to deploy 1-3 traps depending on the sampling site. Trap dimensions are 1.2 m x 1.5 m x 2.4 m and tending schedules are adjusted according to conditions of the river/estuary and potential for interactions with protected species. Sampling can be modified (period fishing), delayed, or concluded according to the potential for interactions with Atlantic salmon or other protected species.

Sea Bed Habitat Classification Survey

This survey is conducted year round in Long Island Sound during daylight hours within two hours of high tide. It determines the composition of the surface layer of the seabed utilizing hydroacoustic equipment. The survey requires 20 DAS using the R/V *Loosanoff*, R/V *Milford 17*, or R/V *Milford 22*.

The protocol is to connect a Quester Tangent seabed classification system to the 50/200 kHz hull-mounted transducer while transects are made at 4.5 kts. In addition, a drop camera (24 in x 24 in x 24 in) in a water filled box is deployed 2 m or less above the seabed directly below the support vessel

Trawling to Support Finfish Aquaculture Research

This work is conducted annually from May through August in Long Island Sound. It collects finfish broodstock for laboratory spawning and rearing and experimental studies.

The protocol is to deploy a combination bottom trawl with a net size (40 ft x 40 ft x 7 ft at 2.5 kts for a maximum duration of 30 min; or shrimp trawl (16 ft x 16 ft x 2ft) at 1.5 kts for a maximum of 30 min. Additional protocols include rod and reel (I/O circle and J hooks, and gill net which is 150 ft long 8 ft high, with 4 in stretched mesh. The combination and shrimp trawls require 50 tows, the rod and reel 12 hooks fished for 1000 hr and 15 gillnet sets. The survey requires 30 DAS using the R/V *V. Loosanoff*, R/V *Milford 17*, or R/V *Milford* 22.

U.S. Army Corps of Engineers Bottom Sampling

Bottom grab samples are collected every two years in Woods Hole Harbor for habitat assessment monitoring.

The protocol is to deploy a Peterson grab to collect 6 random samples. This is conducted by the R/V *G. Michelle* during daylight hours and requires 1 DAS.

1.4.2 Summary of Long-term Research Surveys and Activities in the Southeast LME

Apex Predators Bottom Longline Coastal Shark

This survey is conducted bi-annually in April-May, contingent upon funding, in an area extending from Florida to Delaware. It accesses shark populations shark populations that are in sharp decline, including monitoring of distribution, abundance, and species composition, and tagging sharks. Survey operations are on a 24-hour schedule.

The protocol for the survey includes deploying a Florida style bottom longline. 'Florida' commercial-style bottom longline gear consists of 940 lb test monofilament mainline with 3.6 m gangions made of 730 lb test monofilament with a longline clip at one end and a 3/0 shark hook at the other. Hooks are baited with chunks of spiny dogfish (*Squalus acanthias*) and are attached to the mainline at roughly 20 m intervals. Five-pound weights are attached at 15 hook intervals, and 15 lb weights and small buoys are attached at 50 hook intervals. To ensure that the gear fishes on the bottom, 20 lb weights are placed at the beginning and end of the mainline after a length of line 2-3 times the water depth is deployed. A 6 m flag buoy ('high flyer') equipped with radar reflectors and flashing lights is attached to each end of the mainline. The gear is set a night without lightsticks, soak time is 3 hours, and the gear is hauled during daylight. There are about 56 sets per survey, which require 47 DAS.

COASTSPAN Longline and Gillnet Surveys

The purpose of this survey is to determine the location of shark nurseries, their species composition, relative abundance, distribution, and migration patterns. It is used to identify and refine essential fish habitat and provides standardized indices of abundance by species used in multiple species specific stock assessments. This component of COASTSPAN is conducted by cooperating institutions and agencies (South Carolina Department of Natural Resources, Georgia Department of Natural Resources, and University of North Florida). It occurs from Florida to Rhode Island annually during summer using 85 DAS on cooperating institution and agency vessels.

The protocol for the survey includes deployment of bottom longline gear or anchored sinking gillnet. There are two categories of longline gear characteristics based on the size of sharks targeted; small juvenile sharks and large juvenile/adult sharks. The mainline length is 1000 ft for both categories. Gangion length is 5 ft for small sharks and 8 ft for large sharks. Gangion spacing is 20 ft for small sharks and 40 ft for large sharks. Mustad circle hooks of size 12/0 are used for small sharks and size 16/0 for large sharks. Sets for small sharks use 50 hooks per set while large shark sets have 25 hooks. The bait is finfish (mackerel or herring) for both types of sets. Soak time is 30 minutes for small sharks and 2 hours for large sharks. Approximately 150 total sets are made per survey (see Table 1-1).

The single panel anchored gillnet is 325 ft long x 10 ft high with 4 in stretch mesh made of #177 (20 lb test) nylon monofilament. The soak time is 3 hr, but the net is continuously checked to retrieve, tag and release target species and release all bycatch.

Opportunistic Hydrographic Sampling

This program consists of opportunistic plankton and hydrographic sampling during summer transits on the R/V Okenos Explorer in waters less than 300 m deep. The protocol is to deploy small plankton nets (1 m x 2 m) to a depth of 25 m and to record hydrographic data from expendable bathythermographs.

Table 1-1 Summary description of long-term NEFSC-affiliated surveys conducted or funded in the proposed action.

See Appendix A for descriptions of the different gear types and vessels used. Appendix B in the NEFSC Draft Programmatic Environmental Assessment (DPEA) includes figures showing the spatial/temporal distribution of fishing gears used during NEFSC research. Mitigation measures are described in Section 2.2.1 in the DPEA and in section 11 of this application. Abbreviations used in the table: ADCP = Acoustic Doppler Current Profiler; CTD = Conductivity Temperature Depth; DAS = days at sea; cm^2 = square centimeter; freq = frequency; ft = feet; GB = Georges Bank; GOM = Gulf of Maine; hrs = hours; in = inch; kHz = kilohertz; km = kilometer; kts = knots; L = liter; m = meter; m^3 = cubic meter; MAB = Mid-Atlantic Bight; max = maximum; MHz = megahertz; mi = miles; min = minutes; mm = millimeter; NA = Not Available or Not Applicable; nm = nautical miles; SNE = Southern New England; TBD = to be determined; v = volt; yr = year; ~ = approximately.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Northeast US Continental Shelf LME								
Projects using bottom trawl gear								
Benthic Habitat Survey	The objective of this project is to assess habitat distribution and condition, including disturbance by commercial fishing and changes as the benthic ecosystem recovers from chronic fishing impacts. Also serves to collect data on seasonal migration of benthic species, collect bottom data for mapping, and provide indications of climate change through species shifts.	GB	Summer or Fall, Annually 20 DAS	R/V *H.B. Bigelow*, R/V *Gordon Gunter*, or R/V *Pisces*	4-seam, 3-bridle bottom trawl	Net size: 31 m long x 19 m wide x 5 m high Tow speed: 3.0 kts Duration: 30 min at target depth	54 tows (maximum)	**Standard Avoidance:** Vessel captains and crew watch for marine mammals and sea turtles while underway, especially where concentrations of protected species are observed, and take action to avoid collisions if possible (see Section 11.2). **Move-on Rule:** Vessel captains and Chief Scientists take action to avoid setting gear at times and places where concentrations of protected species are observed to avoid potential interactions with gear (see Section 11.2).
					Conductivity Temperature Depth (CTD) profiler and rosette water sampler	Tow Speed: 0 Duration: 5-15 min	217 casts (maximum)	
					Brooke Ocean Moving Vessel CTD Profiler	Tow speed: 10 kts	Continuous	
					Van Veen Sediment Grab aboard SeaBoss	Samples a 100 cm^2 area Tow speed: 0 Duration: 1 min	128 casts (maximum)	
					Plankton Light Trap	Size: 0.027 m^3 Tow speed: 0 Duration: 30 min	10 casts (maximum)	
					Beam trawl	Net size: 2 m wide Tow speed : 2.0 kts Duration: 20 min at depth	50 tows	
					Naturalists dredge	1 m wide Tow speed: 2-3 kts Duration: 1 min at depth	3 casts	
					SeaBoss Benthic Camera Vehicle	Still and video cameras, strobe & continuous lighting, CTD Tow Speed: 0.5 kt Duration: 30 min	128 tows (maximum)	
					Reson 7125 swath sonar	Output freq: 200 and 400 kHz	Continuous	
					Klein 5500 side scan sonar	Output freq: 450 kHz	Continuous	
					Odum CV200 Single beam sonar	Output freq: 200 kHz	Continuous	
					Split Beam Sonar	Output freq: 18, 38, 120 kHz	Continuous	
Changes in the Community Structure of Benthic Fishes	The objective of this project is to quantify the abundance and distribution of benthic associated fishes of the Hudson River Estuary ecosystem.	Hudson River Estuary, New York.	Summer 20 DAS	R/V *Nauvoo*	16 ft bottom trawl	Net size: 16 ft wide bottom trawl Tow speed: 2.5 kts Duration: 5 min	176 trawls	Standard Avoidance and Move-on Rule
					YSI (electronic water chemistry sensor)	YSI 6000		

Table 1-1 Summary description of long-term NEFSC-affiliated surveys conducted or funded in the proposed action.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Hydroacoustic instrument	38 and 120 kHz split-beam		
					Kemmerer bottle	2.2 L		
Fish Collection for Laboratory Experiments	Trawling/hook and line collection operations undertake to capture high quality fish for laboratory experiments.	New York Bight, Sandy Hook Bay, New Jersey	Annually, as needed throughout year 10 DAS	R/V *Nauvoo*, R/V *Harvey*, R/V *Chemist*	Simple Memphis net and twine shrimp trawl	Net size: 16 ft wide bottom trawl Tow speed: 2.5 kts Duration: 10 min	Varies depending on scientific need, typically enough trawls to capture 10-60 specimens	Standard Avoidance and Move-on Rule
					Simple Memphis net and twine shrimp trawl	Net size: 30 ft wide bottom trawl Tow speed: 2.5 kts Duration: 10 min		
					Fishing poles	Fishing poles		
Habitat Characterization	The key objective of this project is to characterize and map coastal marine habitats and living marine resources, particularly in waters and wetlands of New York and New Jersey. The research is conducted under the terms of a Memorandum of Understanding with the NJ Sea Grant Consortium.	Sandy Hook Bay Barnegat Bay, New York and New Jersey	Annually 30 DAS	R/V *Nauvoo*, R/V *Resolute*	Simple Memphis net and twine shrimp trawl	Net size: 16 ft wide bottom trawl Tow speed: 2.5 kts Duration: 10 min	Max. 60 trawls per year with 16 ft net and 20 trawls per year with 30 ft net	Standard Avoidance and Move-on Rule
					Simple Memphis net and twine shrimp trawl	Net size: 30 ft wide bottom trawl Tow speed: 2.5 kts Duration: 10 min		
					Video Sled	Sea Cam 5000 12v video cam		
					CTD	Sea Bird CTD		
					YSI	YSI 6000		
					Tucker plankton net	1.4 m x 1 m trawl		
					Acoustic Doppler Current Profiler (ADCP)	Output freq. 600 kHz		
					Hydroacoustic instrument	38 and 120 kHz split-beam		
					Ponar grab	6 in x 6 in		
					Kemmerer bottle	2.2 L		
Habitat Mapping Survey	This project maps shallow reef habitats of fisheries resource species, including warm season habitats of black sea bass, and locate sensitive habitats (e.g. shallow temperate coral habitats) for habitat conservation.	Ocean shelf off Maryland Coast	Summer, Annually 11 DAS	R/V *F.R. Hassler*	4-seam, 3-bridle bottom trawl	Net size: 31 m x 19 m x 5 m Tow speed: 3.0 kts Duration: 30 min at target depth	54 tows (max)	Standard Avoidance and Move-on Rule
					CTD Profiler	Tow Speed: 0 Duration: 5-15 min	217 casts (max)	
					Brooke Ocean Moving Vessel CTD Profiler	Tow speed 10 kts	Continuous	
					Van Veen Sediment Grab aboard SeaBoss	Samples 100 cm^2 area Tow speed: 0 Duration: 1 min	128 casts (max)	
					Plankton Light Trap (optional)	Size: 0.027 m^3 Tow speed: 0 Duration: 30 min	10 casts (max)	
					Beam trawl,	Net size: 2 m wide Tow speed: 2.0 kts Duration: 20 min at depth	50 tows	

Table 1-1 Summary description of long-term NEFSC-affiliated surveys conducted or funded in the proposed action.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
					Naturalists dredge	1 m wide Tow speed: 2-3 kts Duration: 1 min at depth	3 casts	
					SeaBoss Benthic Camera Vehicle	Still and video cameras, strobe & continuous lighting, CTD Tow Speed: 0.5 kt Duration: 30 min	128 tows (max)	
					Reson 7125 swath sonar	Output freq: 200/400 kHz	Continuous	
					Klein 5500 side scan sonar	Output freq: 450 kHz	Continuous	
					Odum CV200 Single beam sonar	Output freq: 200 kHz	Continuous	
					Split Beam Sonar	Output freq: 18, 38, 120 kHz	Continuous	
Living Marine Resources Center Survey	This project undertakes to determine the distribution, abundance, and recruitment patterns for multiple species.	Cape Hatteras to New Jersey	Winter, Annually 11 DAS	R/V *H.B. Bigelow*, R/V *Gordon Gunter*, or R/V *Pisces*	4-seam, 3-bridle bottom trawl	Net size: 31 m x 19 m x 5 m Tow speed: 3.8 kts Duration: 30 min at depth	25 tows	Standard Avoidance and Move-on Rule
					Beam trawl	Net size: 2 m wide Tow speed: 2.0 kts Duration: 20 min at depth	30 tows	
					Van Veen sediment grab	Samples 100 cm^2 area Duration: 1 min	29 casts	
					CTD Profiler	Tow Speed: 0 Duration: 15-120 min	30 casts	
					Split Beam Sonar	Output freq: 18, 38, 120 kHz	Continuous	
Massachusetts Division of Marine Fisheries Bottom Trawl Surveys	The objective of this project is to track mature animals and determine juvenile abundance.	Territorial waters from Rhode Island to New Hampshire borders	Spring and Fall 30-36 DAS	R/V *G. Michelle*	Otter Trawl	Net size: 39 ft headrope, 51 ft footrope Tow speed: 2.5 kts Duration: 20 min	In Gulf of Maine (GOM), 56 tows in spring and 56 tows in fall. In Southern New England (SNE), 47 tows in spring and 47 tows in fall. 206 tows total/yr	Standard Avoidance and Move-on Rule
Northeast Area Monitoring and Assessment Program (NEAMAP) Near Shore Trawl Program	This project provides data collection and analysis in support of single and multispecies stock assessments in the Mid-Atlantic. It includes the Maine/New Hampshire inshore trawl program, conducted by Maine Department of Marine Resources (MDMR) in the northern segment, and the NEAMAP Mid-Atlantic to Southern New England survey, conducted by Virginia Institute of Marine Science, College of William and Mary (VIMS) in the southern segment.	Near shore Maine to North. Carolina Northern segment: U.S.-Canada border to New Hampshire-Massachusetts border from shore to 300 ft depth. Southern segment: Montauk, New York to Cape Hatteras, North. Carolina from 20 to 90 ft depth.	Spring (Apr.–June) and Fall (Oct.–Dec.) approximately 30-50 DAS per season for each segment.	F/V *Robert Michael* from Maine to New Hampshire (northern segment) F/V *Darana R* from Massachusetts to North Carolina (southern segment)	Northern segment: modified GOM shrimp otter trawl net typically used by commercial otter trawlers in Maine and New Hampshire. Southern segment: 4-seam, 3-bridle bottom trawl (same net used by NEFSC Standard Bottom Trawl Survey).	Northern segment: Net size: 58 ft headrope, 70 ft footrope, 24 ft siderope, 1 in poly stretch mesh, with #7.5 Bison doors Tow speed: 2.2-2.5 kts Duration: 20 min at target depth Southern segment: Net size: 31 m x 19 m x 5 m Tow speed: 3 kts Duration: 20 min at target depth	Northern segment: 100 tows per season, 200 tows per year, approx. 1 station per 36 square nm. Southern segment: 150 tows per season, 300 tows per year, approx. 1 station per 30 square nm	Daytime tows only in both northern and southern NEAMAP segments. In northern segment, each tow station is surveyed for lobster gear prior to setting out mobile trawl gear, during which the bridge crew also observe for protected species. Move-on Rule.

Table 1-1 Summary description of long-term NEFSC-affiliated surveys conducted or funded in the proposed action.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Northeast Observer Program (NEFOP) Observer Bottom Trawl Training Trips	Certification training for new NEFOP Observers is provided by this operation.	Maine to North Carolina	Annually, one-day trips throughout year as needed. 18 DAS	Contracted commercial fishing vessels	Contracted vessels trawl gear	Net size: various Tow speed: various Duration: 20-45 min per tow	6 tows per trip 108 tows total	Continuous watch for marine mammals and sea turtles by vessel crew and NEFOP staff while underway and take action to avoid setting gear at times and places where concentrations of protected species are observed.
Northern Shrimp Survey	The objective of this project is to determine the distribution and abundance of northern shrimp and collect related data.	GOM	Annually 22 DAS	R/V *G. Michelle*	4-seam modified commercial shrimp bottom trawl. Positional sensors, mini-log, and CTD attached to net gear.	Net size: 25 m x 17 m x 3 m Tow speed: 2 kts Duration: 15 min	82 tows	Standard Avoidance and Move-on Rule
NEFSC Standard Bottom Trawl Surveys (BTS)	This project track mature animals and determines juvenile abundance over their range of distribution.	Cape Hatteras to Western Scotian Shelf	Spring & fall 120 DAS	R/V *H.B. Bigelow*	4-seam, 3-bridle bottom trawl	Net size: 31 m x 19 m x 5 m Tow speed: 3 kts Duration: 20 min at target depth	GOM: 110 tows each season (220 total) Georges Bank (GB): 90 tows each season (180 total) SNE: 90 tows each season (180 total) Mid-Atlantic Bight (MAB): 110 tows each season (220 total)	Standard Avoidance and Move-on Rule
					CTD Profiler	Tow speed: 0 Duration: 2-5 hr	800 tows	
					ADCP	150 and 300 kHz	Continuous	
					Bongo net equipped with CTD	61 cm diameter Tow type: oblique Tow speed: 1.5 kts Duration: max 20 min	240 tows	
					Split beam and multi-beam acoustics	Output freq: 18, 38, 70, 120, 200 kHz	Continuous	
Projects using pelagic trawl gear								
Atlantic Herring Survey	This operation collects fisheries-independent herring spawning biomass data and also includes survey equipment calibration and performance tests.	GOM and Northern GB	Fall 34 DAS	R/V *H.B. Bigelow*, R/V *Gordon Gunter*, or R/V *Pisces*	4-seam, 3-bridle bottom trawl	31 m x 19 m x 5 m Tow Speed: 3 kts Duration 10-20 min on bottom	20 tows	Standard Avoidance and Move-on Rule
					Hydroacoustic Midwater Rope Trawl	Net size: 15 m x 30 m Tow speed : 4 kts Duration: 5-30 min at depth	70 tows	
					Split beam and multi-beam acoustics	Output Freq: 18, 38, 70, 120, 200 kHz	Continuous	
Atlantic Salmon Trawl Survey	This is a targeted research effort to evaluate the marine ecology of Atlantic salmon.	Inshore and offshore GOM	Spring - annually as funding allows Approx. 21 DAS	Contracted commercial vessels	Modified mid-water trawl that fishes at the surface via pair trawling	Net size: 50 m from wing to wing, 10 m from headrope to footrope Tow speed: 2-6 kts Duration: 30-60 min	Approximately 130 tows	Standard Avoidance and Move-on Rule
Deepwater Biodiversity	This project collects fish, cephalopod and crustacean specimens from 500 to 2000 m for tissue samples, specimen photos, and documentation of	Western North Atlantic	Annually 16 DAS	R/V *H.B. Bigelow* or R/V *Pisces*	Superior Midwater trawl	Net size: 92 m x 35 m x 31 m Tow speed : 1.5-2.5 kts Duration: 60 min at depth	16 tows	Standard Avoidance and Move-on Rule

Table 1-1 Summary description of long-term NEFSC-affiliated surveys conducted or funded in the proposed action.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
	systematic characterization.				4-seam, 3-bridle bottom trawl	Net size: 31 m x 19 m x 5 m Tow speed : 1.5-2.5 kts Duration: 60 min at depth	9 tows	
					Split beam and multi-beam acoustics	Output Freq: 18, 38, 70, 120, 200 kHz	Continuous	
Northeast Fisheries Observer Program (NEFOP) Mid-Water Trawl Training Trip	This program provides certification training for NEFOP Observers.	Maine to North Carolina	Annually 5 DAS	Contracted commercial fishing vessels	Various commercial nets	Varies by gear supplied by chartered vessel	1-2 tows per trip 5-10 tows total	Standard Avoidance and Move-on Rule. All NEFOP Observer protocols followed as per current NEFOP Observer Manual.
Northeast Integrated Pelagic Survey	The objective of this project is to assess the pelagic components of the ecosystem including water currents, water properties, phytoplankton, microzooolankton, mesozooplankton, pelagic fish and invertebrates, sea turtles, marine mammals, and sea birds.	Cape Hatteras to Western Scotian Shelf	Quarterly 80 DAS	R/V *H.B. Bigelow*, R/V *Pisces*, R/V *G. Gunter*	Hydroacoustic Midwater Rope Trawl	Net size: 15 m x 30 m Tow speed: 4 kts Duration: 5-30 min at depth	80 tows	Standard Avoidance and Move-on Rule. Seabird/marine mammal observers provide additional monitoring capacity as they survey birds, mammals, and sea turtles from the flying bridge on transits between stations during daylight hours.
					Isaacs-Kidd midwater trawl	3 m and 4.5 m Tow type: oblique Tow speed: 2.5 kts Duration: 30 min (max)	160 tows	
					Midwater trawl for use in shallow water (>15 m depth)	8 m x 8 m opening Tow speed: 2.5 kts Duration: max 30 min	80 tows	
					Split beam and multi-beam acoustics	Output Freq: 18, 38, 70, 120, 200 kHz	Continuous	
					Bongo net equipped with CTD	61 cm diameter Tow type: oblique Tow speed: 1.5 kts Duration: max 20 min	600 tows	
					Baby bongo: added to subset of Bongo tows	20 cm diameter attached above standard Bongo	480 casts	
					CTD profiler and rosette water sampler	Tow speed: 0 Duration: 1 hr (max)	250 casts	
					ADCP on vessel	300 kHz or 150 kHz	Continuous	
Penobscot Estuarine Fish Community and Ecosystem Survey	The objective of this project is fish and invertebrate sampling for biometric and population analysis of estuarine and coastal species.	Penobscot Estuary and Bay, Maine	Year round, even coverage across seasons. 12 DAS	Contracted commercial vessels	Mamou shrimp trawl modified to fish at surface	Net size: 12 m x 6 m trawl mouth opening Tow speed: 2-4 kts Duration: 20 min	50 trawls per season (200 trawl total)	Standard Avoidance and Move-on Rule

Table 1-1 Summary description of long-term NEFSC-affiliated surveys conducted or funded in the proposed action.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Projects using longline gear								
Apex Predators Bottom Longline Coastal Shark	The NEFSC conducts a bi-annual fishery-independent survey of Atlantic large and small coastal sharks in U.S. waters from Florida to Delaware. The objectives are to: 1) monitor the species composition, distribution, and abundance of sharks in the coastal Atlantic; 2) tag sharks for migration and age validation studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; and 4) collect morphometric data for other studies. The time-series of abundance from this survey is critical to the evaluation of coastal Atlantic shark species.	Rhode Island to Florida within 40 fathoms	Biannual in spring 47 DAS	Charter Vessel	Florida style bottom longline	Mainline length: 4 mi Gangion length: 12 ft Gangion spacing: 60 ft Hook size and type: Mustad #349703 3/0 non-stainless J hook Hooks per set: 300 Bait: spiny dogfish Soak time: 3 hr	29 sets (max) in MAB	Move-on Rule (this survey uses a one nautical mile radius around the vessel to guide the decision on whether the animals are at risk of interactions). During the soak the line is run and if any sea turtles or marine mammals are sighted the line is pulled immediately. In addition, the Chief Scientist, at a minimum, is a NEFOP trained sampler and tagger for sea turtles for the NEFSC.
Apex Predators Pelagic Nursery Grounds Shark	This project is an opportunistic sampling on board a commercial swordfish longline vessel to: 1) monitor the species composition, distribution, and abundance of sharks in the coastal Atlantic; 2) tag sharks for migration and age validation studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; and 4) collect morphometric data for other studies. Data from this survey are critical to the evaluation of juvenile pelagic Atlantic shark species. The project determines the location of shark nurseries, species composition, relative abundance, distribution, and migration patterns.	GB to Grand Banks off Newfoundland, Canada	Annually, fall 21-55 DAS	F/V *Eagle Eye II*	Standard commercial pelagic longline gear. Configured according to NMFS HMS Regulations	Mainline length: 35 mi Gangion length: 33 ft Gangion spacing: 183 ft Hook size and type: Non-stainless 18/0 10 degree offset circle Hooks per set: 1008 Bait: spiny dogfish Soak time: 8 hr	Average 21 sets	Move-on Rule. As per required for commercial longline vessels, Captain is trained in NMFS/Highly Migratory Species Protected Species Safe Handling, Release, and Identification Workshops to review mitigation methods required by various take reduction plans as well as methods to release protected species safely.
Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) Longline and Gillnet Surveys	This project determines the location of shark nurseries, species composition, relative abundance, distribution, and migration patterns. It is used to identify and refine essential fish habitat and provides standardized indices of abundance by species used in multiple species specific stock assessments. NEFSC conducts surveys in Delaware, New Jersey, and Rhode Island estuarine and coastal waters. Other areas are surveyed by cooperating institutions and agencies. In the Northeast LME, cooperating partners are Stony Brook University (SBU) in NY and Virginia Institute of Marine Science (VIMS).	Florida to Rhode Island	Annually, summer. 25 DAS for NEFSC conducted surveys. 40 DAS for cooperating institutions and agencies. Daytime sets only	R/V *C.E. Stillwell* and cooperating partner vessels	Bottom longline gear	Small juvenile gear / Large juvenile-adult shark gear Mainline length: 1000 ft / 1000 ft Gangion length: 5 ft / 8 ft Gangion spacing: 20 ft / 40 ft Hook size and type: 12/0 / 16/0 Mustad circle hooks Hooks per set: 50 / 25 Bait: finfish (mackerel or herring) Soak time: 30 min / 2 hr	NEFSC: 20 sets off coast of RI (SNE), 110 sets off coasts of DE and NJ (MAB). SBU: 30 sets off coast of NY. VIMS: 100 sets off coast of VA.	Move-on Rule. The gear is monitored during the soak; if any sea turtles or marine mammals are sighted during the soak and is considered to be at risk of interacting with the gear then the line is pulled immediately.
					Anchored Sinking Gillnet	325 ft x 10 ft, single panel of 4 in stretch mesh made of #177 (20 lb test) nylon monofilament 3 hr soak time while continuously running the net to tag and release targeted species and release all other species.	12 sets (max) in Delaware Bay (NEFSC)	
NEFOP Observer Bottom Longline Training Trips	This program provides certification training for NEFOP observers.	Maine to North Carolina	Annually 5 DAS	Contracted commercial fishing vessels	Commercial bottom longline gear	Mainline length: Approximately 3,000 ft Circle hooks: 600 per set	2-3 sets per trip 10-15 sets total	Standard Avoidance and Move-on Rule. All NEFOP Observer protocols followed as per current NEFOP Observer Manual. All applicable TRP gear requirements for commercial fisheries under the MSA.

Table 1-1 Summary description of long-term NEFSC-affiliated surveys conducted or funded in the proposed action.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Projects using dredge gear								
Annual Assessments of Sea Scallop Abundance and Distribution in Selected Closed/Rotational Areas	These Atlantic Sea Scallop Research Set-Aside rotational area surveys endeavor to monitor scallop biomass and derive estimates of Total Allowable Catch (TAC) for annual scallop catch specifications. Additionally, the surveys monitor recruitment, growth, and other biological parameters such as meat weight, shell height and gonadal somatic indices.	Dredge and drop camera samples in GB, Closed Areas I & II, Hudson Canyon, DELMarVA, Nantucket, GOM and Mid-Atlantic areas. Drop camera also samples in GOM: Fippennies Ledge, Cashes Ledge, Platts Bank and Jeffreys Ledge	Dredge surveys conducted Apr. through Sept. HABCAM and drop camera surveys generally occur in Summer months (June – Sept.) Not all rotational areas are sampled each year. Typically, between 2 to 4 areas are selected for dredge surveys and 2-3 areas for HABCAM or drop camera surveys are selected each year.	Dredge surveys: F/V *Celtic*, F/V *Pursuit*, F/V *Nordic Pride*, F/V *Kathy Ann*, F/V *Stephanie B II*, F/V *Regulus*, F/V *Carolina Boy* HABCAM : F/V *Kathy Marie* SMAST Drop Camera: F/V *Endeavor*, F/V *Guidance*, F/V *Karen Nicole*, F/V *Kathryn Marie*, F/V *Resolution*, F/V *Liberty*, F/V *Ranger*, F/V *Incentive*	Commercial and standardized NMFS scallop dredges, towed simultaneously.	NMFS New Bedford survey dredge: 8 ft width, 2 in rings, 4 in diamond twine top, and 1.5 in diamond mesh liner. Commercial gear: 15 ft Coonamessett Farm Turtle Deflector Dredge (CFTDD) with 4 in rings, 10 in diamond mesh twine top and no liner. Turtle chains are used in configurations as dictated by the area surveyed and current regulations. Tow speed: 3.8-4.0 kts Duration: 15 min	100 dredge tows in each rotational area when sampled using that method. Average number of dredge tows per year is about 200 in all areas.	Standard Avoidance and Move-on Rule
					Both a towed photographic and sonar hydroacoustic imaging system (HABCAM) and a drop camera and underwater video system is used to conduct the SMAST Video Survey Pyramid deployed from commercial scallop vessels.	HABCAM photographic system has 1 m field of view in each photograph, 5–10 frames per second with >50% overlap at 5 kts towing speed. Photo system coupled with two Imagenix side scan sonars or Teledyne Benthos C3D side scan sonars.	Between 350 and 690 nm of transects using digital photography by HABCAM each year. Drop camera typically samples over 400 stations on a 1.57 km sampling grid.	
NEFOP Observer Scallop Dredge Training Trips	This program provides certification training for NEFOP observers.	Maine to North Carolina	Annually, one-day trips throughout year as needed. 6 DAS	Contracted commercial fishing vessels	Contracted vessels scallop gear	Dredge type: Turtle Deflector Dredge Duration: 1 hr	2-3 tows per trip 12-18 tows total	All gear compliant with current commercial fishing regulations under the MSA. Continuous watch for marine mammals and sea turtles by vessel crew and NEFOP staff while underway and take action to avoid setting gear at times and places where concentrations of protected species are observed. All NEFOP Observer protocols followed as per current NEFOP Observer Manual and NEFOP Biosampling Manual.
Sea Scallop Survey	The objective of this project is to determine distribution and abundance of sea scallops and collect related data for Ecosystem Management from concurrent stereo-optic images. It is conducted by the NEFSC.	North Carolina to GB	Summer, Annually 36 DAS	R/V *H. R. Sharp*	New Bedford type dredge	8 ft width, 2 in rings, 4 in diamond twine top, and 1.5 in diamond mesh liner. Tow speed: 3.8 kts Duration: 15 min at depth	225 dredge tows	Standard Avoidance and Move-on Rule.
					HabCam	2,500 lb towed metal frame 3 ft x 10 ft x 4 ft. Carries a payload of two digital cameras, 4 strobes, and two cylinders containing an array of oceanographic data towed with an electro-optic cable.	18 days of continuous stereo-optic camera towing	

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Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Surfclam and Ocean Quahog Dredge Survey	The objective of this project is to determine distribution and abundance of Surfclam/ocean quahog and collect related data.	Southern Virginia to GB	One third of resource sampled per year over three year period. 15 DAS	Commercially contracted vessel (varies annually)	Hydraulic-jet dredge	12.5 ft cutting blade Tow speed: 1.5 kts Duration: 5 min at depth	150 tows	Minimal bottom time and construction of gear mitigate interactions with sea turtles
Projects using other gears								
Beach Seine Survey, Maine	The project is a fish community survey at fixed locations.	Penobscot Bay and estuary, Maine	Annually, Apr.-Nov.	R/V *Silver Smolt*	45 m beach seine	5 mm nylon mesh	100 sets	Observe for mammals before and continuously during sampling. Scientists look as far as field of view permits from the beach in the general sampling area before the net is fished and do not deploy if marine mammals are present. Net is removed if marine mammals appear while net is in the water.
Beach Seine Survey, New Jersey	The project is a fish community survey at fixed locations.	Sandy Hook Bay and Navesink River, New Jersey	Summer	NA, conducted from shore	45 m beach seine	5 mm nylon mesh	90 sets	Observe for mammals before and continuously during sampling. Scientists look as far as field of view permits from the beach in the general sampling area before the net is fished and do not deploy if marine mammals are present. Net is removed if marine mammals appear while net is in the water.
Coastal Maine Telemetry Network	The objective of this project is to monitor tagged animals entering the Penobscot Bay System and exiting the system into the Gulf of Maine.	Penobscot River, estuary and bay, GOM	Deployed continuously year round in GOM and Apr.-Nov. in nearshore areas 10 DAS for maintenance.	Contract commercial Vessel	Fixed position acoustic telemetry array receivers on moorings spaced 250-400 m apart.	69 kHz	Continuous in GOM, continuous from Apr.–Nov. in nearshore areas	Follow Take Reduction Plan gear restrictions for Penobscot Bay (i.e., 600 lb weak links on moored equipment).
Deep-sea Coral Survey	The objective of this program is to determine the species diversity, community composition, distribution and extent of deep sea coral and sponge habitats.	Continental shelf margin, slope, and submarine canyons and deep basins: GOM to Virginia	Annually, summer 16 DAS	R/V *H.B. Bigelow*	ROV (tethered)	Continuous and strobe lights, cameras, CTD, manipulator arm for sampling Speed: 3 kts Duration: 24 hr	10 dives	Standard Avoidance and Move-on Rule
					Towed Camera system	Strobe lights, camera, CTD Speed: 0.25 kt Duration: 8 hr	18 dives	
					CTD Profiler with Niskin 12-bottle rosette water sampler	Tow speed: 0 Duration: 1-5 hr	30 casts; 360 water samples (maximum)	
					ADCP	300 or 150 kHz	Continuous	
					Split beam and multi-beam acoustics	Output frequency: 18, 38, 70, 120, 200 kHz	Intermittent	
DelMarVa Habitat Characterization	The objective of this project is to characterize and determine key hard bottom habitats in coastal ocean off the DelMarVa Peninsula as an adjunct to the	Coastal waters off DE, MD and VA	August, annual 5 DAS, daytime only	R/V *Resolute*	ADCP	600 kHz ADCP	Continuous	Standard Avoidance and Move-on Rule
					Single beam, dual frequency sonar	38 and 120 kHz, transects at 2-4 kts for 4-6 hrs.	20 transects	

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Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
	DelMarVa Reef Survey.				Video Sled	Sea Cam 5,000 12 volt video camera: tow speed 1 kt, 15 min transects (~500 m)	20 transects	
					CTD	Sea Bird CTD	20 casts	
					YSI	YSI 6000	20 drops	
					Plankton net	1.4 m x 1.0 m Tucker trawl	20 vertical tows	
					Ponar grab	152 m x 152 m	20 drops	
					Kemmerer bottle	2.2 L	20 casts: 20 water samples	
DelMarVa Reefs Survey	The objective of this project is determination of extent and distribution of rock outcrops and coral habitats and their use by black sea bass and other reef fishes	Coastal waters off DE, MD and VA	August, annual 5 DAS	R/V *Sharp*	HabCam towed camera vehicle	Still cameras w/strobe lighting, CTD, sidescan sonar (200 kHz) Towing speed: 5 kts	continuous	Standard Avoidance and Move-on Rule
					CTD Profiler	Tow speed: 0 Duration: 5-15 min	30 casts	
Diving Operations	The objective of this project is to collect growth data on hard clams, oysters and bay scallops.	Long Island Sound	Year round 20 DAS	R/V *V. Loosanoff*, R/V *Milford 17*, R/V *Milford 22*	Wire mesh cages, lantern nets	1.5 in square wire mesh cages 60 in x 24 in x 18 in staked to the seabed	30 cages deployed for 1-36 months	Standard Avoidance and Move-on Rule
						Lantern nets 18 in diameter x 72 in long anchored to the seabed with 4 cinder blocks with the net oriented vertically	30 nets deployed for 1-36 months	
Ecology of Coastal Ocean Seascapes	This project is designed to provide information required for a next generation spatially and temporally explicit population simulation model for commercially important stocks such as summer flounder.	New York Bight	Annually, spring, summer, and fall 35 DAS Daytime sampling only.	R/V *Nauvoo*, R/V *Resolute*	ADCP	600 kHz	80 tows	Standard Avoidance and Move-on Rule
					Hydroacoustic	38 and 120 kHz		
					Video sled	Sea Cam 5000 12v video cam towed at 1 kt for 300 m		
					CTD	Sea Bird CTD		
					YSI	1.4 m x 1 m Tucker trawl		
					Plankton net	YSI 6000		
					Multi-nutrient analyzer	EcoLAB 2		
					Kemmerer bottle	2.2 L		
Finfish Nursery Habitat Study	This project is designed to collect fish eggs, larvae, and juvenile fish from the seabed to identify essential habitats. The project tracks fish to determine habitat use.	Long Island Sound, New York	May-Oct.10 DAS	R/V *V. Loosanoff*, R/V *Milford 17*, *Milford 22*	Epibenthic Sled	1 m x 333 cm opening towed on the seabed Tow speed: 1.5 kts Duration: 5 min	20 tows	Standard Avoidance and Move-on Rule
					Bongo plankton net	Two 0.5 m diameter nets attached side by side towed at 0.5 kts at varying depths between the surface and bottom	20 tows	
					Neuston plankton net	1 m x 0.5 m opening towed at 1 kt at the surface	20 tows	
					Acoustic fish tags	70 kHz implanted tags	30 tags with 14-month life	

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Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Gear Effects on Amphipod Tubes	The purpose of this project was to survey the abundance of amphipod tubes and examine the effects of bull raking and crab dredging.	Sandy Hook Bay, Barnegat Bay, and Great South Bay, New Jersey	Annually, July and Aug. 20 DAS, Daytime sampling only.	R/V *Nauvoo*, R/V *Resolute*, R/V *Harvey*	Plankton net		Varies	Standard Avoidance and Move-on Rule
					YSI			
					Ponar sediment sampling grab (clam shell type)	Sample area: 152 mm x 152 mm Volume: 2.4 L		
Gulf of Maine Ocean Observing System Mooring Cruise	This project services oceanographic moorings operated by the University of Maine.	GOM and Northern GB	Spring 12 DAS	R/V *H.B. Bigelow*, R/V *Pisces*, R/V *G. Gunter*	ADCP on vessel	300 kHz	Continuous 600 km/year	Standard Avoidance and Move-on Rule
					ADCP on moorings	300 and 75 kHz	Continuous	
Hydroacoustic Surveys	This project consists of mobile transects conducted throughout estuary and bay.	Penobscot Bay and estuary	25 DAS	R/V *Silver Smolt* or charter vessel	Split-beam and DIDSON	38 and 120 kHz split-beam 1.1 and 1.1 MHz DIDSON	Continuous 50 km per survey	Standard Avoidance
Maine Estuaries Diadromous Survey	This project is a fish community survey at fixed locations.	Penobscot estuary and bay, Maine	Annually, Apr.–Nov. 100 DAS	R/V *Silver Smolt*	1 m and 2 m fyke nets	2 m fyke: 2 m x 2 m (1.9 cm main/0.6 cm mesh) 1 m fyke: 1 m x 1 m (0.6 cm mesh) Duration: 24 hr	100 sets	Mammal excluder on 2 m fyke net (14 cm gap opening) Small throat opening on 1 m fyke (12.7 cm round)
Miscellaneous Fish Collections and Experimental Survey Gear Trials	The James J. Howard Sandy Hook Marine Laboratory occasionally supports short-term research projects requiring small samples of fish for various purposes or to test alterations of survey gear. These small and sometimes opportunistic sampling efforts have used a variety of gear types other than those listed under Status Quo projects. The gears and effort levels listed here are representative of potential requests for future research support.	NY Bight Estuary waters	TBD	R/V *Nauvoo*, R/V *Resolute*, R/V *Harvey*, R/V *Chemist*	Combination bottom trawl	Net size: 23 ft head rope, 32 ft sweep, 7 ft rise Tow speed: 2.5 kts Duration: 20 min	5 trawls	Standard Avoidance and Move-on Rule
					Lobster pots	18 in x 24 in x 136 in wire pot Connected by 3/8 in rope With 7 in x 14 in surface float	1-60 pots set for 24-96 hr between retrievals	
					Fish pots	9 in x 9 in x 18 in wire pot With 1/8 in mesh liner Connected by 3/8 in rope With 7 in x 14 in surface float	1-60 pots set for 24-96 hr between retrievals	
					2 m beam trawl	1/4 in mesh liner, towed at 2 kts for 15 min	5 trawls	
					Seine net	25-200 ft net	5 sets	
					Trammel nets	Multi Trammel Net, 12 in walling, 3 in^2 mesh, 6 ft deep x 25 ft long	5 sets	
NEFOP Observer Gillnet Training Trips	This program provides certification training for NEFOP Observers.	Maine to North Carolina	Annually 10 DAS	Contracted commercial fishing vessels	Contracted vessels gillnet gear	String: 3-5 nets each Soak duration: 12-24 hr	4 sets per trip 40 sets total	Pingers used on all gillnet gear. Continuous watch for marine mammals and sea turtles by vessel crew and NEFOP staff while underway and take action to avoid setting gear at times and places where concentrations of protected species are observed All NEFOP Observer protocols followed as per current NEFOP Observer Manual and NEFOP Biosampling Manual.
Nutrients and Frontal Boundaries	The objective of this project is to characterize nutrient patterns associated with distinct water masses and their boundaries off of coastal New	MAB	Quarterly; Feb., May-June, Aug.,	R/V *Resolute*	ADCP	600 kHz	Varies	Standard Avoidance and Move-on Rule
					Hydroacoustic	38 and 120 kHz		

Table 1-1 Summary description of long-term NEFSC-affiliated surveys conducted or funded in the proposed action.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
	Jersey and Long Island in association with biological sampling.		and Nov. 10 DAS, sampling day and night		CTD	Sea Bird CTD		
Ocean Acidification	The objective of this project is to develop baseline pH measurements in the Hudson River water.	Hudson River Coastal waters	Quarterly 10 DAS, sampling day and night.	R/V *Resolute*	YSI	YSI 6000	Varies	Standard Avoidance and Move-on Rule
					Multi-nutrient analyzer	EcoLAB 2		
					Kemmerer bottle	2.2 L		
					CTD	Sea Bird CTD		
Pilot Studies	This program provides gear and platform testing.	Massachusetts state waters, GB	Annually (approximately) 5 DAS	R/V *G Michelle*	AUV	Remus 100	4-8 hr missions	Standard Avoidance and Move-on Rule
Rotary Screw Trap (RSTs) Survey	This project is designed to collect abundance estimates of Migrating Atlantic salmon smolts and other anadromous species.	Estuaries on coastal Maine rivers	Apr. 15-June 15 60 sampling days	NA	Rotary Screw Trap	4 ft, 5 ft and 8 ft traps – aluminum construction, current propelled sampling devices.	Continuous (Apr.–June)	Daily tends of sampling device; adjustments in frequency if protected species likely to occur. If protected species are observed in the sampling area, sampling is suspended temporarily. If capture occurs, animal is temporarily retained in live tank and released as soon as possible.
Sea Bed Habitat Classification Survey	The objective of this project is to determine the composition of the surface layer of the seabed utilizing hydroacoustic equipment.	Long Island Sound	Year round 20 DAS Sampling occurs during daylight hours within two hours of high tide.	R/V *V. Loosanoff*, R/V *Milford 17*, R/V *Milford 22*	Quester Tangent seabed classification equipment	50 and 200 kHz transducer, Transducer fixed to hull operated at 4.5 kts	100 hr	Standard Avoidance and Move-on Rule
					Drop camera	24 in x 24 in x 24 in water filled box with a 12v DC video camera inside and two 60 watt 12v DC lights. Deployed 2 m or less from the seabed directly below the support vessel.	20 20-min sessions	
Trawling to Support Finfish Aquaculture Research	The objective of this project is to collect broodstock for laboratory spawning and rearing and experimental studies.	Long Island Sound	May through Aug. 30 DAS	R/V *V. Loosanoff*, R/V *Milford 17*, R/V *Milford 22*	Combination bottom trawl	Net size: 40 ft head rope, 40 ft sweep, 7 ft rise Tow speed: 2.5 kts Duration: 30 min	~50 tows to collect 100 adult scup	Standard Avoidance and Move-on Rule
					Shrimp trawl	Net size: 16 ft head rope, 16 ft foot rope, 2 ft rise Tow speed: 1.5 kts Duration: 30 min	~50 tows to collect 400 young-of-year scup	
					Rod and Reel	I/O circle and J hooks	12 hooks fished for ~100 hr to collect 50 adult black sea bass	
					Gill net	150 ft x 8 ft tied down gill net with 4 in stretch mesh, 24 hr sets	15 sets	
U.S. Army Corps of Engineers Bottom Sampling	This program provides habitat assessments monitoring.	Woods Hole, Massachusetts	Every two years 1 DAS	R/V *G Michelle*	Grab sampler	Peterson Grab	6 grabs	Standard Avoidance and Move-on Rule

Table 1-1 Summary description of long-term NEFSC-affiliated surveys conducted or funded in the proposed action.

Project Name	Project Description	General Area of Operation	Season, Frequency, Annual Days at Sea (DAS)	Vessel Used	Gear Used	Gear Details	Number of Samples	Mitigation Measures
Southeast US Continental Shelf LME								
Projects using longline gear								
Apex Predators Bottom Longline Coastal Shark	The NEFSC conducts a bi-annual fishery-independent survey of Atlantic large and small coastal sharks in U.S. waters from Florida to Delaware to: 1) monitor the species composition, distribution, and abundance of sharks in the coastal Atlantic; 2) tag sharks for migration and age validation studies; 3) collect biological samples for age and growth, feeding ecology, and reproductive studies; and 4) collect morphometric data for other studies. The time-series of abundance indices (CPUE) from this survey is critical to the evaluation of coastal Atlantic shark species.	Florida to Rhode Island within 40 fathoms	Biannual, in spring 47 DAS	Charter Vessel	Florida style bottom longline	Mainline length: 4 mi Gangion length: 12 ft Gangion spacing: 60 ft Hook size and type: Mustad #349703 3/0 non stainless J hook Hooks per set: 300 Bait: spiny dogfish Soak time: 3 hr	71 sets (max.)	Move-on Rule. During the soak the line is run and if any sea turtles or marine mammals are sighted the line is pulled immediately. In addition, the Chief Scientist, at a minimum, is a NEFOP trained sampler and tagger for sea turtles for the NEFSC.
COASTSPAN Longline and Gillnet Surveys	This program determines location of shark nurseries, species composition, relative abundance, distribution, and migration patterns. Data are used to identify and refine essential fish habitat and provides standardized indices of abundance by species used in multiple species specific stock assessments. This component of COASTSPAN is conducted by cooperating institutions and agencies (South Carolina Department of Natural Resources [SCDNR], Georgia Department of Natural Resources [GDNR], and University of North Florida [UNF]).	Florida to Rhode Island.	Annually, summer. 85 DAS Daytime sets only	Cooperating institution and agency vessels	Bottom longline gear	Small juvenile gear / Large juvenile/adult shark gear Mainline length: 1000 ft / 1000 ft Gangion length: 5 ft / 8 ft Gangion spacing: 20 ft / 40 ft Hook size and type: 12/0 / 16/0 Mustad circle hooks Hooks per set: 50 / 25 Bait: finfish (mackerel or herring) Soak time: 30 min / 2 hr	SCDNR: 150 sets GDNR: 150 sets UNF: 150 sets	Move-on Rule.The gear is monitored during the soak; if any sea turtles or marine mammals are sighted during the soak and is considered to be at risk of interacting with the gear then the line is pulled immediately.
					Anchored sinking gillnet	325 ft x 10 ft Single panel of 4 in stretch mesh made of #177 (20 lb test) nylon monofilament 3 hr soak time while continuously running the net to tag and release targeted catch and release all bycatch	SCDNR: 20 sets UNF: 20 sets	
Projects using other gears								
Opportunistic Hydrographic Sampling	This program consists of opportunistic plankton and hydrographic sampling during ship transit.	Southeast LME at depths less than 300 m	Early summer—once per year	R/V *Okenos Explorer*	Plankton net	2 m x 1 m net deployed to 25 m, 330 micron mesh	50 samples	Standard Avoidance and Move-on Rule
					Expendable bathythermographs	Sippican	50 deployments	

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1.4.3 Summary of Short-term Cooperative Research Activities in the Northeast LME

In addition to the research activities summarized in Table 1-1, the Proposed Action includes a set of fisheries and ecosystem research activities which fall predominately within a category of activities known as Cooperative Research, which in the Northeast Region is made up of several major programs: Cooperative Research Partners Program, Northeast Consortium Cooperative Research Program, Commercial Fisheries Research Foundation, and the Research Set-Aside Program. The specific projects funded through these programs vary on an annual basis as needs arise for information to support particular fisheries or address emerging conservation concerns. Table 1-2 provides a summary of the collective scope of cooperative research projects that are anticipated to be funded in the next five years. All of these projects would be conducted within the Northeast LME. In order to provide a better sense of what these types of projects typically entail, Appendix B includes a more detailed description of the cooperative research projects that were supported by the NEFSC from 2008 through 2012.

Table 1-2 Collective scope of short-term, cooperative research activities considered in the proposed action

Gear Used	General Area of Operation	Season	Number of Samples
SURVEY PROJECTS			
Trawls Flatfish Surveys Monkfish, longfin squid and other catchability surveys	GOM, GB, SNE, MAB	Year round but primarily Summer-Fall	Flatfish surveys: 550 bottom tows per year, 20-30 min/tow at 3 kts Monkfish and catchability surveys: 630 pelagic tows per year, 20-30 min/tow at 3 kts
Hook and Line Eastern Maine hook and line/ jig survey in hard bottom areas Western-Central Gulf of Maine hard bottom longline survey	Downeast Maine coastal waters, western-central GOM, coastal waters and off-shore waters focused on sea mounts.	Spring and Fall	60 longline stations per year in eastern Maine, 90 longline stations per year in western-central GOM, up to 2,000 hooks per station depending on tide 48 stratified random jigging stations in eastern Maine, 5 lines per station, 3 hooks per line, 5 min soak time
Pots/traps Scup & black sea bass pot survey	SNE, Rhode Island Bight, Nantucket Sound, MAB waters from shore to shelf edge.	Spring and fall for black sea bass. Year round for scup.	Scup/ black sea bass: 2,650 pot sets per year
CONSERVATION ENGINEERING PROJECTS			
Bottom Trawl Gearnet conservation engineering work Selectivity studies in Acadian redfish fishery and other Small mesh fisheries Squid selectivity studies	GOM, GB, SNE, MAB	Year round sampling in various studies.	Estimated 500 tows per year under various protocols similar to commercial fishing conditions. Assume tow durations average 60 min per tow.
Dredge Scallop dredge finfish and turtle excluder research Hydrodynamic dredge development	GB, SNE, MAB	Annually Aug.-Jan.	Estimated over 1,700 dredge tows per year.
Hook and Line Utilization of electric rod and reel jig fishing targeting groundfish in the Gulf of Maine	Western GOM	Oct.-Jan.	20 DAS total, two vessels with 4 jigging machines (electric reels) each.

Gear Used	General Area of Operation	Season	Number of Samples
Gillnets Gillnet pinger exchange and research Raised foot rope gillnet selectivity study	GOM and GB Gillnet raised foot rope-Statistical area 513	Pinger exchange summer 2013, fishing year around. Raised foot-rope gillnet fishing monthly.	Raised foot rope: 69 sets of 24 hr soak time duration. 100 ft long nets, 4-net sets. Pinger-details not available.
Pots/traps Efficient cod harvesting using fish pots as an adjunct to otter trawl trips (TRAWLPOT)	Statistical areas: 525, 526, 537 (near Closed Area 1, western side of Great South Channel, and Block Island area)	5 sample periods, ideally in Spring	Newfoundland cod pots (2 m x 2 m x 1 m), 10 pots deployed at a time, 2-5 days soak, 100-250 pot soak days total
TAGGING PROJECTS			
Trawl Winter flounder migration patterns	Coastal waters in Gulf of Maine from New Hampshire to Stonington/Mt. Desert Island, Maine	Spring and Summer	10 otter trawl tows daily, up to 650 bottom trawls per year, 15-20 min per tow at 2.5 kts
Hook & Line and Gillnet Spiny dogfish tagging north and south of Cape Cod Cusk & NE multi-species tagging	GOM and GB waters adjacent to Cape Cod, MA	Spring, Summer, Fall sampling periods	Long line: 5 sets per trip, 15 sets total. Gillnet: 5 sets per trip, 15 sets total. (10 min sets)
Gillnets Monkfish tagging	GOM, SNE, MAB	Sept.–Jan.	18-20 DAS, 10 short-duration sets per day, 180-200 sets total
LIFE HISTORY PROJECTS			
Gillnets Monkfish population dynamics and climate change	MAB (work conducted by University of MD Eastern Shore under Research Set Aside Program)	Spring through Summer	Collecting fishery dependent data from monkfish collaborators. Number of gillnet sets dependent on commercial fishing operations, unknown at present.
HABITAT PROJECTS			
Pots/traps (artificial substrate settlement studies) Lobster settlement research Wolffish and cusk habitat studies	SNE, Rhode Island Bight Western GOM, Jeffery's Ledge Closed Area	Spring, Summer Fall All months	Total of 120 traps, 20 trawls (strings) grouped in 4 locations, 5 trawls per location, total of 40 vertical buoy lines. 32 pot sets, 3-4 per month.

2.0 THE DATE(S) AND DURATION OF SUCH ACTIVITY AND THE SPECIFIC GEOGRAPHICAL REGION WHERE IT WILL OCCUR

The dates and duration of the fisheries research activities that would be conducted by the NEFSC during the five year LOA authorization period are summarized in Section 1.6 and Tables 1-1 and 1-2. Actual short-term cooperative research projects that occur will depend on competitive grant processes and congressional funding levels for the NEFSC, which are inherently uncertain.

While some surveys are consistently conducted every year (Table 1.1), they are often based on randomized sampling designs so the exact location of survey effort varies year to year in the same general area.

Some surveys are only conducted every two or three years or when funding is available. Timing of the surveys is a key element of their design. Oceanic and atmospheric conditions, as well as ship contingencies, often dictate survey schedules even for routinely conducted surveys.

In addition, the cooperative research program is designed to provide flexibility on an annual basis in order to address issues as they arise.

Most cooperative research projects go through an annual competitive selection process to determine which projects should be funded based on proposals developed by many independent researchers and fishing industry participants. Because the need for different kinds of fisheries information changes over time and overall funding levels vary with annual congressional appropriations, the priorities for funding different kinds of projects change regularly, which makes it difficult to know what will be funded in the next several years

2.1 Specified Geographic Regions Where the Activities Will Occur

NEFSC fisheries research activities are conducted off the Atlantic coast of the United States (U.S.), primarily within 200 miles of the shoreline from Cape Hatteras, North Carolina to the U.S.-Canada border. This primary research area is known as the Northeast U.S. Continental Shelf Large Marine Ecosystem (Northeast LME), which is subdivided into four major subareas which are useful for describing where NEFSC-affiliated research occurs: the Gulf of Maine (GOM), Georges Bank (GB), Southern New England (SNE), and the Mid-Atlantic Bight (MAB). In addition, a small number of NEFSC survey activities extend east into deeper offshore waters and south into the Southeast U.S. Continental Shelf LME (Southeast LME) and, rarely, north into the Scotian Shelf LME. However, the great majority of NEFSC research activities occur within the Northeast LME.

2.1.1 Gulf of Maine

The GOM is an enclosed coastal sea characterized by relatively cold waters and deep basins. The GOM is bounded on the east by Browns Bank, on the north by Maine and Nova Scotia, on the west by Maine, New Hampshire, and Massachusetts, and on the south by Cape Cod and GB (Figure 2-1). Retreating glaciers (18000-14000 years ago) formed a complex system of deep basins, moraines, and rocky protrusions, leaving behind a variety of sediment types including silt, sand, clay, gravel, and boulders. These sediments are patchily distributed on the sea floor throughout the GOM, with occurrence largely related to the topography of the bottom.

Water patterns in the GOM exhibit a general counterclockwise current, influenced primarily by cold water masses moving in from the Scotian Shelf and offshore. Although large-scale water patterns are generally counterclockwise around the GOM, many small gyres and minor currents do occur. Freshwater runoff from the many rivers along the coast into the GOM influences coastal circulation as well. These water movements feed into and affect the circulation patterns on GB and in Southern New England (SNE), both of which are discussed below.

2.1.2 Georges Bank

Georges Bank is a shallow, elongate extension of the northeastern U.S. continental shelf, and it is characterized by a steep slope on its northern edge and a broad, flat, and gently sloping southern flank. The GOM lies to the north of GB, the Northeast Channel (between GB and Browns Bank) is to the east; the continental slope lies to the south, and the Great South Channel (GSC) separates GB and SNE to the west (Figure 2-1). Although the top of GB is predominantly characterized by sandy sediment, glacial retreat during the late Pleistocene era resulted in deposits of gravel along the northern edge of GB, and some patches of silt and clay can be found on the sea floor. The most dominant oceanographic features of GB include a weak but persistent clockwise gyre that circulates over the whole bank, strong tidal flows (predominantly northwest and southeast), and strong but intermittent storm-induced currents. The strong tidal currents result in vertically well-mixed waters over the bank. The clockwise GB gyre is in part driven by the southwestern flow of shelf and slope water that forms a countervailing current to the Gulf Stream.

2.1.3 Mid-Atlantic Bight

The MAB includes the continental shelf and slope waters from GB to Cape Hatteras (Figure 2-1). The basic morphology and sediments of the MAB were shaped during the retreat of the last ice sheet. The continental shelf south of New England is broad and flat, dominated by fine grained sediments (sand and silt). Patches of gravel can be found in places on the sea floor, such as on the western flank of the GSC.

The shelf slopes gently away from the shore out to 100-200 km offshore, where it transforms into the continental slope at the shelf break (at water depths of 100-200 m). Along the shelf break, numerous deep-water canyons incise the slope and shelf. The sediments and topography of the canyons are much more heterogeneous than the predominantly sandy top of the shelf, with steep walls and outcroppings of bedrock and deposits of clay.

The southwestern flow of cold shelf water feeding out of the GOM and off GB dominates the circulatory patterns in this area. The countervailing Gulf Stream provides a source of warmer water along the coast as warm-core rings and meanders break off from the Gulf Stream and move shoreward, mixing with the colder shelf and slope water. As the shelf plain narrows to the south (the extent of the continental shelf is narrowest at Cape Hatteras), the warmer Gulf Stream waters run closer to shore.

2.1.4 Southern New England

The SNE subarea extends from the Great South Channel in the east to the MAB in the west (Figure 2-1). The southwestern flow of cold shelf water feeding out of the GOM and off GB dominates the circulatory patterns in this area. The SNE continental shelf is a gently sloping region with smooth topography. The shelf is approximately 62 miles wide, and the shelf break occurs at depths of between 328 to 656 feet. The continental slope extends from the shelf break to a depth of 6,562 feet. This zone has a relatively steep gradient, and the relief is moderately smooth. The continental rise (6,500 feet to 19,700 feet) is similar to the slope in having only gradual changes in bathymetry. However, the overall gradient of the continental rise is less than that of the continental slope (Theroux and Wigley 1998).

Sediments of the SNE subarea are dominated by fine-grained sand and silt. Patches of gravel can be found in places on the sea floor, such as on the western flank of the Great South Channel. Water and sediment quality within the SNE may be influenced by current and historic disposal of dredged material. Within the SNE, there are seven sites that were or are currently used for disposal of dredged material. Those sites are the Rhode Island Sound, East Rockaway Inlet, Mud Dump, the Historic Area Remediation Site, Shark River, Axel Carlson Reef, and Manasquan Inlet disposal sites. In addition, the 12-Mile Site, which is located in the New York Bight, was historically used for barge-based disposal of municipal sewage sludge. Settled materials from offshore disposal have the potential to be impacted by research, due to the possibility of seafloor disturbance by bottom-contacting fishing gear. The U.S. Army Corp of Engineers maintains a publicly-available database that tracks disposal activity occurring at each of these sites.

2.1.5 Southeast U.S. Continental Shelf (Southeast LME)

The Southeast LME includes an area of the Atlantic Ocean extending approximately 930 miles from Cape Hatteras, North Carolina south to the Straits of Florida (Yoder 1991). The continental shelf in the region reaches up to approximately 120 miles off shore and the region is strongly influenced by the Gulf Stream Current with minor upwelling occurring along the Gulf Stream front.

The total area of the Southeast LME is approximately 115,000 square miles, including several protected areas and coral reefs (Aquarone 2008). The LME also includes numerous estuaries and bays, such as the Albemarle-Pamlico Sound, nearshore and barrier islands, and extensive coastal marshes that provide valuable ecosystem services and habitats for numerous marine and estuarine species. A six to 12 mile-wide coastal zone is characterized by high levels of primary production throughout the year, while offshore, on the middle and outer shelf, upwelling along the Gulf Stream front and intrusions from the Gulf Stream cause seasonal phytoplankton blooms. Because of its high productivity, the Southeast LME supports active commercial and recreational fisheries (Shertzer *et al*. 2009).

Within the Southeast LME, there are four sites that were or are currently used for disposal of dredged material. Those sites are the Morehead City I, Morehead City II, Wilmington Harbor I, and Wilmington Harbor II Disposal Sites. Settled materials from offshore disposal have the potential to be impacted by NEFSC research, due to the possibility of seafloor disturbance by bottom-contacting fishing gear. The U.S. Army Corp of Engineers maintains a publicly-available database that tracks disposal activity occurring at each of these sites.

2.1.6 Designated Critical Habitats

The Endangered Species Act (ESA) requires the federal government to designate critical habitat for any species identified as Threatened or Endangered. Critical habitat comprises those specific areas within the geographic area occupied by a federally listed species on which are found physical and biological features essential to the conservation of the species, and that may require special management. In the Northeast Region, research surveys occur in two areas that have been designated as critical habitat for the North Atlantic right whale (NOAA, 1994). These are the Cape Cod Bay (CCB) Critical Habitat Area and the Great South Channel GSC Critical Habitat Area (Figure 2-2). Critical habitat has also been designated for this species outside the action area in coastal Florida and Georgia (Figure 2-3). NEFSC does not conduct any surveys in any designated critical habitats for any other marine mammal species.

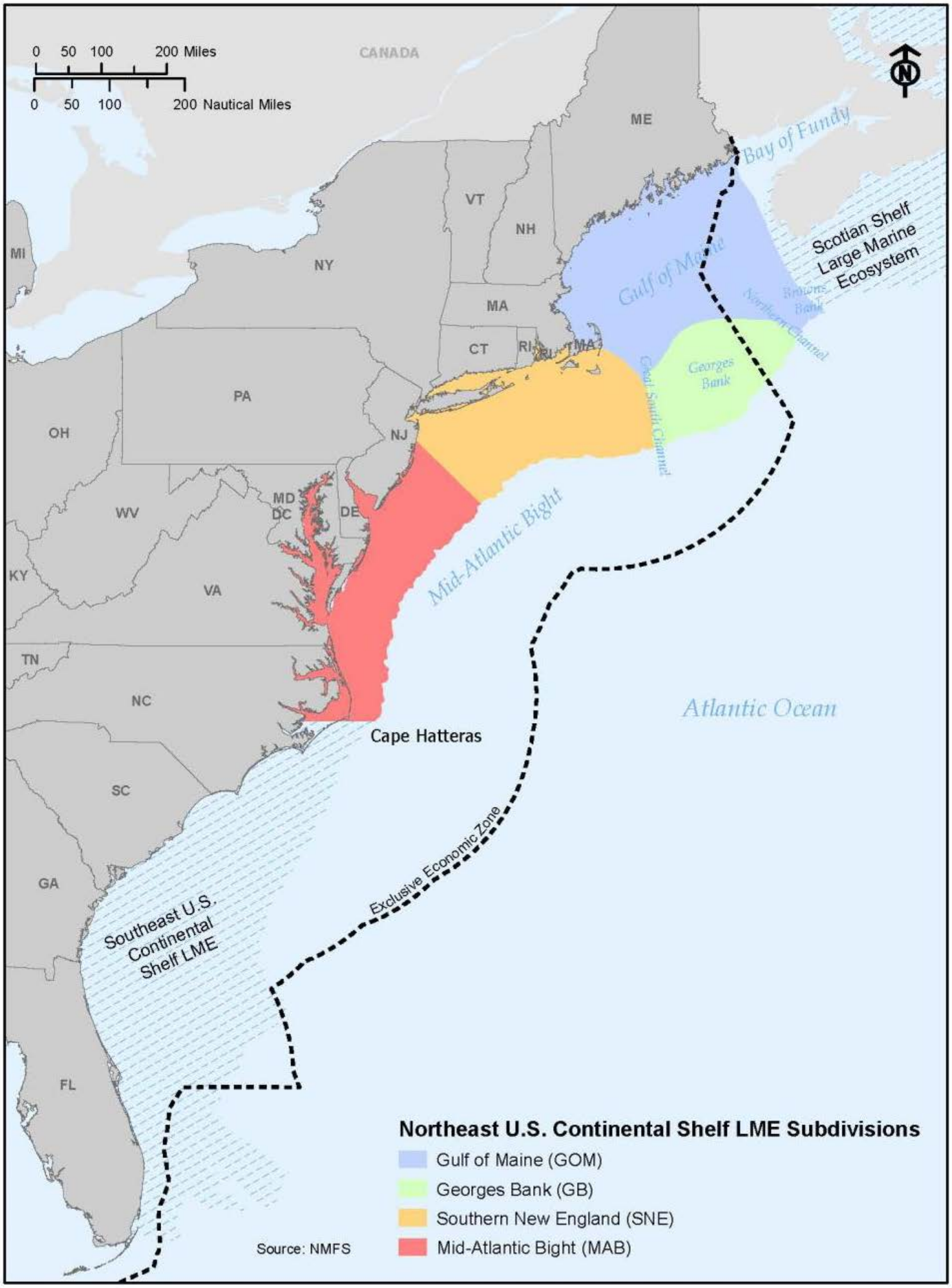

Figure 2-1 NEFSC-affiliated Fisheries Research Areas

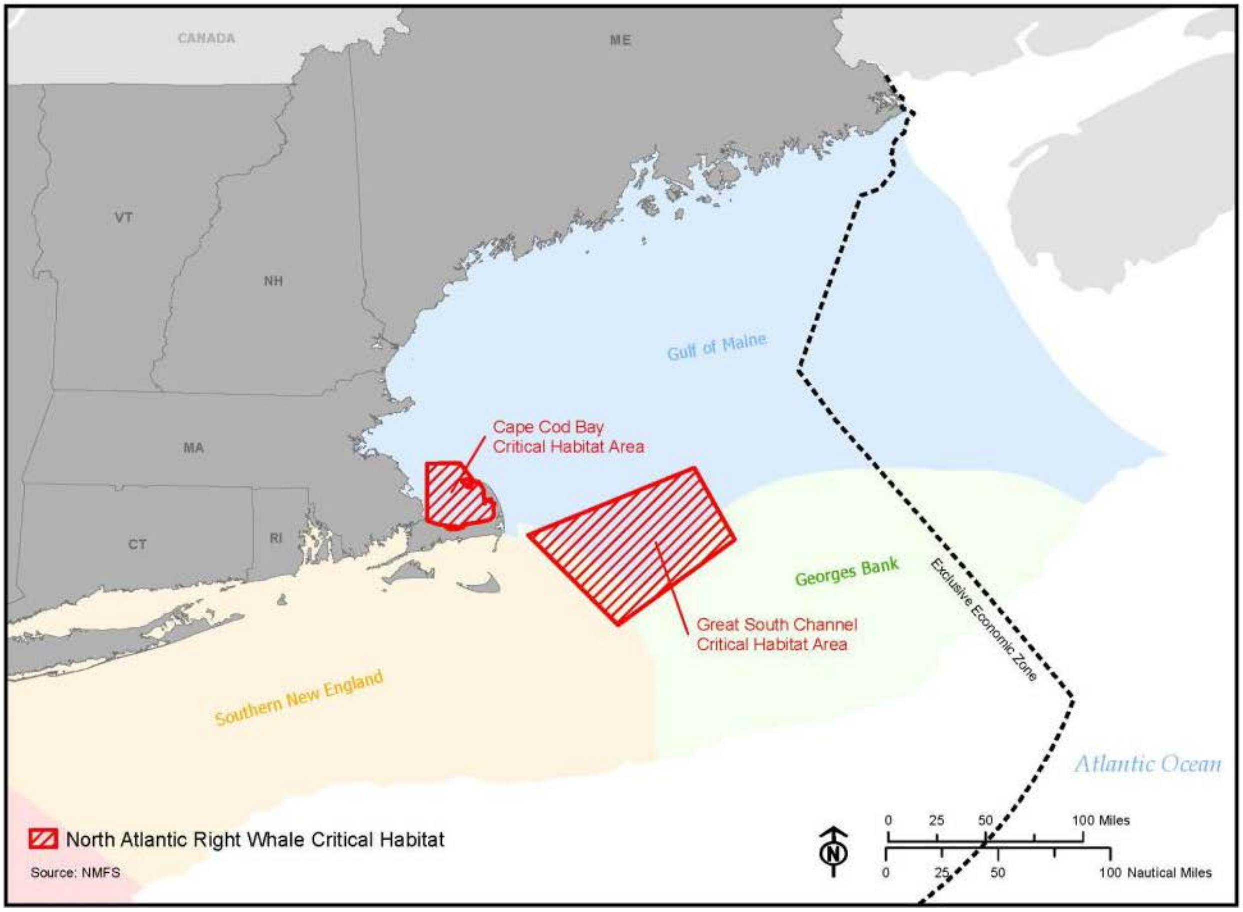

Figure 2-2 Designated Critical Habitat for the North Atlantic Right Whale in the Northeast LME

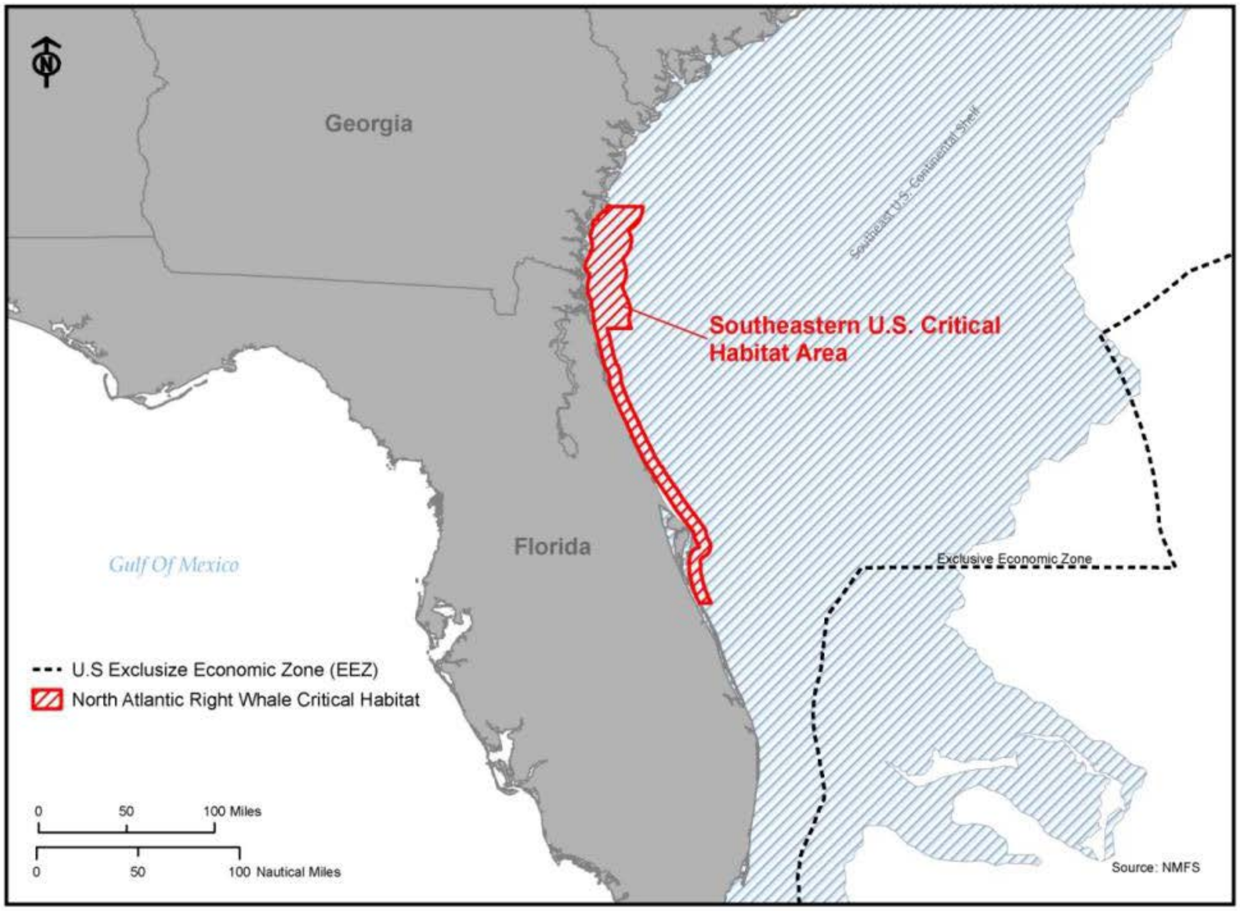

Figure 2-3 Designated Critical Habitat for the North Atlantic Right Whale in the Southeast LME

3.0 SPECIES AND NUMBERS OF MARINE MAMMALS LIKELY TO BE FOUND WITHIN THE ACTIVITY AREA

Marine mammal abundance estimates in this application represent the total number of individuals that make up a given stock or the total number estimated within a particular study area. NMFS stock abundance estimates for most species represent the total estimate of individuals within the geographic area, if known, that comprises that stock. For some species, this geographic area may extend beyond the U.S. EEZ. Survey abundance (as compared to stock or species abundance) is the total number of individuals estimated within the survey area, which may or may not align completely with a stock's geographic range as defined in the NMFS Stock Assessment Reports (SARs) (http://www.nmfs.noaa.gov/pr/sars/region.htm). These surveys may also extend beyond U.S. waters. Both stock abundance and survey abundance are used in this application when available to determine a density of marine mammal species within the survey area.

Off the northeast U.S. coast, over thirty cetacean and four pinniped species have been recorded. Seasonally, species are distributed throughout continental shelf and shelf break waters, with some species extending into deeper oceanic waters to the U.S. EEZ and beyond. The species and approximate numbers of marine mammals in the environment used by NEFSC fisheries research surveys are shown in Table 3-1. Extralimital species are not included. These are species that do not normally occur in the survey area for which there are one or more records that are considered beyond the normal range; these species that are not likely to be 'taken' pursuant to the MMPA during survey operations and are not included in the take request. Extralimital species within the NEFSC survey area includes Bryde's whales (*Balaenoptera edeni*), beluga whales (*Delphinapterus leucas*), bowhead whales (*Balaena mysticetus*), ringed seals (*Pusa hispida*), and bearded seals (*Erignathus barbatus*). Florida manatees (*Trichechus manatus latirostris*) and the Caribbean manatee (*Trichechus m. manatus*), an extralimital subspecies within the NEFSC survey areas, are under the jurisdiction of the U.S. Fish and Wildlife Service and will not be considered further in this application.

Table 3.1 lists the 33 cetacean species (of which *Mesoplodon* spp. includes four beaked whale species) and four pinniped species that occur frequently enough within the NEFSC research area that they could reasonably interact with NEFSC research activities. The list includes six cetacean species that are also listed as endangered under the ESA [North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), fin whale (*B. physalus*), sei whale (*B. borealis*), blue whale (*B. musculus*), and sperm whale (*Physeter macrocephalus*)] and one cetacean designated as depleted under the MMPA [coastal stocks of common bottlenose dolphins (*Tursiops truncatus*)]. Table 3-2 lists the 14 stocks of common bottlenose dolphins in the NEFSC research area. For completeness and to avoid redundancy, the required information about all marine mammal species and numbers of each (insofar as it is known), are included in Section 4.

The seasonal ebb and flow of marine mammals into this region results in significant changes in species composition and abundance across large fishery survey geographic regions (e.g., Northeast LME subareas). As examples, in the action area: 1) Baleen whales primarily use New England waters, but seasonally use near-shore waters that extend to the southern boundary (e.g., Cape Hatteras, NC) of the NEFSC survey region; 2) many delphinid species (e.g., long-finned pilot whales, short-beaked common dolphins, offshore common bottlenose dolphins, Atlantic spotted dolphins, etc.) are more prevalent during spring through autumn in waters off the New England coast as opposed to winter; 3) the distribution of both harbor porpoise and harbor seals extends into mid-Atlantic waters in autumn through spring, but they are more concentrated in the Gulf of Maine in summer; and 4) gray seals have established breeding colonies in both the Cape Cod region and mid-coast Maine, but seasonally utilized haul-out sites as far south as New Jersey.

Therefore, potential interactions between marine mammals and NEFSC fishery research operations have both spatial and temporal components. Further, most NEFSC fishery research activities are confined to continental shelf (<200 m), excluding pelagic longline and deep-water diversity surveys that operate in shelf-break or deeper oceanic waters. Our knowledge of marine mammal spatial and temporal habitat use, their general foraging ecology (e.g., target prey are zooplankton, small pelagic fish, ground fish or cephalopods), and interaction with commercial fisheries off the northeast U.S. means we are highly certain of which species may be encountered during various fishery survey operations. For example, during summer-autumn Atlantic herring pelagic trawling / acoustic surveys in the Gulf of Maine and Georges Bank the NEFSC is concerned with Atlantic white-sided dolphins, minke whales, harbor porpoise and seals that predate on herring and short-beaked common dolphins which have been incidentally caught in commercial fishery pelagic trawls.

To estimate marine mammal densities the NEFSC used methods similar to that described in Col *et al*., 2012 (estimates partitioned into the Northeast LME region) and Palka, 2006 (estimates partitioned into Navy exercise regions). First, two fishery research areas were defined: (1) a more coastal portion of the U.S. Northeast Continental Shelf LME (Figures. 3.1 and 3.2), and (2) an offshore fishery research area (Figure 3-1), where the approximate 200 m depth contour separated these two research areas. Second, the dedicated summer marine mammal abundance survey strata (shelf, shelf break, and offshore, Figure 2-1) were divided into the two fishery research areas (Table 3-3). Third, the summer density of each species within a fishery research area was calculated using only the sightings and track line lengths within that fishery research area and a pooled estimate of the detection function and g(0), the probability of detecting a group on the track line, where the pooled estimates use all data collected during that survey, thus resulting in more precise estimates. See Palka (2006) for a more complete description of these methods. To account for seasonal migration of species in and out of the fishery research areas and because only summer marine mammal surveys were conducted, the summer marine mammal density estimates (which are generally higher) were multiplied by a residence factor that accounts for the approximate percentage of animals present during each season. See Col *et al*., 2012 for a more complete description of the residence factor.

An annual average marine mammal density was estimated for the LME < 200 m depth fishery research area and the offshore > 200 m depth fishery research area (Table 3.4). Densities for species that were more likely found offshore and on the shelf break were estimated using the 2004 shipboard and aerial marine mammal abundance surveys (Figure 3-1), and for those species more likely found in the LME < 200 m depth fishery research area, the 2006 aerial marine mammal abundance survey was used (Figure 3-2). Note the 2006 aerial survey was conducted only in the northern half of the LME <200 m depth fish research area. Since species seen in this northern portion in summer are normally not seen in the southern half of the LME < 200 m fish research area in the summer, it was assumed there were no animals in the southern half during the summer.

The stock abundance of a few marine mammal species are not calculated using data from NMFS line transect marine mammal abundance surveys, so the density estimates within the fishery research areas for these species were calculated differently. The densities within the NEFSC fisheries research areas of northern right whales, blue whales, coastal bottlenose dolphins and harbor seals were calculated as the ratio of the abundance estimate as reported in a recent NMFS Stock Assessment Reports (SAR) (Waring et al. 2014) to the area of the fishery research area that the species is commonly found in.

Several other marine mammal species are rarely seen in these two fishery research areas. Consequently, there are no stock abundance or density estimates for these species within the fishery research areas. These species include killer whale, pygmy killer whale, melon-headed whale, northern bottlenose whale, Fraser's dolphin, Clymene dolphin, and spinner dolphin. As no abundance estimate is available for the gray seal, harp seal and hooded seal, no density estimate was calculated.

Table 3-1 Marine mammals that occur in the western North Atlantic Ocean, their status under the Endangered Species Act (ESA) and Marine Mammal Protection Act (MMPA), and estimated minimum numbers.

Density estimates for these species are shown in Table 3-4. Extralimital species are not included.

Common Name	Scientific Name	Federal ESA/MMPA Status[1]	Estimated Minimum Number (N_{min})[2]	Best Estimate[2]
CETACEANS				
North Atlantic right whale	*Eubalaena glacialis*	endangered	455	455
Humpback whale	*Megaptera novaeangliae*	endangered	823	823
Fin whale	*Balaenoptera physalus*	endangered	2,817	3,522
Sei whale	*Balaenoptera borealis*	endangered	236	357
Minke whale	*Balaenoptera acutorostrata acutorostrata*		16,199	20,741
Blue whale	*Balaenoptera musculus*	endangered	440	unknown
Sperm whale	*Physeter macrocephalus*	endangered	1,815	2,288
Dwarf sperm whale	*Kogia sima*		2,598[3]	3,785[3]
Pygmy sperm whale	*Kogia breviceps*		2,598[3]	3,785[3]
Killer Whale	*Orcinus orca*		unknown	unknown
Pygmy killer whale	*Feresa attenuata*		unknown	unknown
Northern bottlenose whale	*Hyperoodon ampullatus*		unknown	unknown
Cuvier's beaked whale	*Ziphius cavirostris*		5,021	6,532
Mesoplodon beaked whales	*Mesoplodon spp.*		4,632	7,092
Melon-headed whale	*Peponocephala electra*		unknown	unknown
Risso's dolphin	*Grampus griseus*		12,619	18,250
Long-finned pilot whale	*Globicephala melas melas*		19,930	26,535
Short-finned pilot whale	*Globicephala macrorhynchus*		15,913	21,515
Atlantic white-sided dolphin	*Lagenorhynchus acutus*		30,401	48,819
White-beaked dolphin	*Lagenorhynchus albirostris*		1,023	2,003
Short-beaked common dolphin	*Delphinus delphis delphinis*		112,531	173,486
Atlantic spotted dolphin	*Stenella frontalis*		31,610	44,715
Pantropical spotted dolphin	*Stenella attenuata*		1,733	3,333
Striped dolphin	*Stenella coeruleoalba*		42,804	54,807
Fraser's dolphin	*Lagenodelphis hosei*		unknown	unknown
Rough toothed dolphin	*Steno bredanensis*		134	271
Clymene dolphin	*Stenella clymene*		unknown	unknown
Spinner dolphin	*Stenella longirostris*		unknown	unknown
Common bottlenose dolphin[4]	*Tursiops truncatus truncatus*	See Table 3.2	Table 3.2	Table 3.2
Harbor Porpoise	*Phocoena phocoena*		61,415	79,833

Common Name	Scientific Name	Federal ESA/MMPA Status[1]	Estimated Minimum Number (N_{min})[2]	Best Estimate[2]
PINNIPEDS				
Harbor Seal	*Phoca vitulina concolor*		48,980	70,142
Gray Seal	*Halichoerus grypus*		unknown	unknown
Harp Seal	*Pagophilus groenlandica*		unknown	unknown
Hooded Seal	*Cystophora cristata*		unknown	unknown

1. Denotes ESA listing as either endangered or threatened, or MMPA listing as depleted. All marine mammal stocks are considered protected under the MMPA.
2. Waring et al 2007, 2009, 2010, 2011, 2012, 2013, 2014.
3. Estimate includes both the dwarf and pygmy sperm whales.
4. Numerous stocks for this species have been identified; please refer to Table 3-2.

Table 3-2 Stocks of common bottlenose dolphins (*Tursiops truncatus*) in the western North Atlantic Ocean that could interact with NEFSC fisheries research activities

Stock	MMPA Status	N_{min}	Best Estimate
Western North Atlantic Offshore		56,053	77,532
Coastal, Northern Migratory	Depleted	8,620	11,548
Coastal, Southern Migratory	Depleted	6,326	9,173
Coastal, South Carolina & Georgia	Depleted	3,097	4,377
Coastal, Northern Florida	Depleted	730	1,219
Coastal, Central Florida	Depleted	2,851	4,895
Northern North Carolina Estuarine System	Strategic	785	950
Southern North Carolina Estuarine System	Strategic	160	188
Northern South Carolina Estuarine System	Strategic	unknown	unknown
Charleston Estuarine System	Strategic	281	289
Northern Georgia/Southern South Carolina Estuarine System	Strategic	unknown	unknown
Southern Georgia Estuarine System	Strategic	185	194
Jacksonville Estuarine System	Strategic	unknown	unknown
Indian River Lagoon Estuarine System	Strategic	unknown	unknown

Source: Waring et al. 2014.

Table 3-3 Relationships between the two fishery research areas and three marine mammal survey strata from the 2004 marine mammal abundance survey

The platform used to survey and area of each strata are also listed

Fishery research area	2004 marine mammal survey strata	Area (km^2)	Survey method
Northeast LME (< 200 m depth)	shelf	226,476	airplane
	shelf break	20,186	ship
	TOTAL	246,662	
Offshore (> 200 m depth)	shelf break	27,927	ship
	offshore	144,005	ship
	TOTAL	171,932	

Table 3-4 Estimated density (animals/km^2) of marine mammals within the Northeast LME and offshore NEFSC fisheries research areas

Common Name	Scientific Name	Survey year	Density estimate LME < 200 m	Density estimate Offshore > 200 m
CETACEANS				
Northern right whale	*Eubalaena glacialis*	2012	0.0018	0
Humpback whale	*Megaptera novaeangliae*	2004, 2006	0.0009	0.0006
Fin whale	*Balaenoptera physalus*	2004	0.0036	0.0007
Sei whale	*Balaenoptera borealis*	2004	0.0027	0.00004
Minke whale	*Balaenoptera acutorostrata acutorostrata*	2006	0.0066	0
Blue whale	*Balaenoptera musculus*	2009	0	0.0026
Sperm whale	*Physeter macrocephalus*	2004	0.00001	0.0152
Dwarf sperm whale	*Kogia sima*	2004	0.00002	0.0020
Pygmy sperm whale	*Kogia breviceps*			
Killer Whale	*Orcinus orca*	unknown		
Pygmy killer whale	*Feresa attenuata*	unknown		
Northern bottlenose whale	*Hyperoodon ampullatus*	2004	0	0.0017
Cuvier's beaked whale	*Ziphius cavirostris*	2004	0.0021	0.0156
Mesoplodon beaked whales	*Mesoplodon spp.*			
Melon-headed whale	*Peponocephala electra*	unknown		
Risso's dolphin	*Grampus griseus*	2004	0.0022	0.0844
Long-finned pilot whale	*Globicephala melas melas*	2004	0.0345	0.0256
Short-finned pilot whale	*Globicephala macrorhynchus*			

Common Name	Scientific Name	Survey year	Density estimate	
			LME < 200 m	Offshore > 200 m
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	2006	0.0244	0
White-beaked dolphin	*Lagenorhynchus albirostris*	2006	0.0081	0
Short-beaked common dolphin	*Delphinus delphis delphinis*	2004	0.2115	0.1875
Atlantic spotted dolphin	*Stenella frontalis*	2004	0	0.0208
Pantropical spotted dolphin	*Stenella attenuata*	2011	0	0
Striped dolphin	*Stenella coeruleoalba*	2004	0	0.3028
Fraser's dolphin	*Lagenodelphis hosei*	unknown		
Rough toothed dolphin	*Steno bredanensis*	1998	0	0.0016
Clymene dolphin	*Stenella clymene*	unknown		
Spinner dolphin	*Stenella longirostris*	unknown		
Common bottlenose dophin (offshore)	*Tursiops truncatus truncatus*	2004	0.0060	0.0526
Common bottlenose dolphin (coastal)	*Tursiops truncatus truncatus*	2002	0.1033	0
Harbor Porpoise	*Phocoena phocoena*	2006	0.0193	0
PINNIPEDS				
Harbor Seal	*Phoca vitulina concolor*	2012	0.2844	0
Gray Seal	*Halichoerus grypus*	unknown		
Harp Seal	*Pagophilus groenlandica*	unknown		
Hooded Seal	*Cystophora cristata*	unknown		

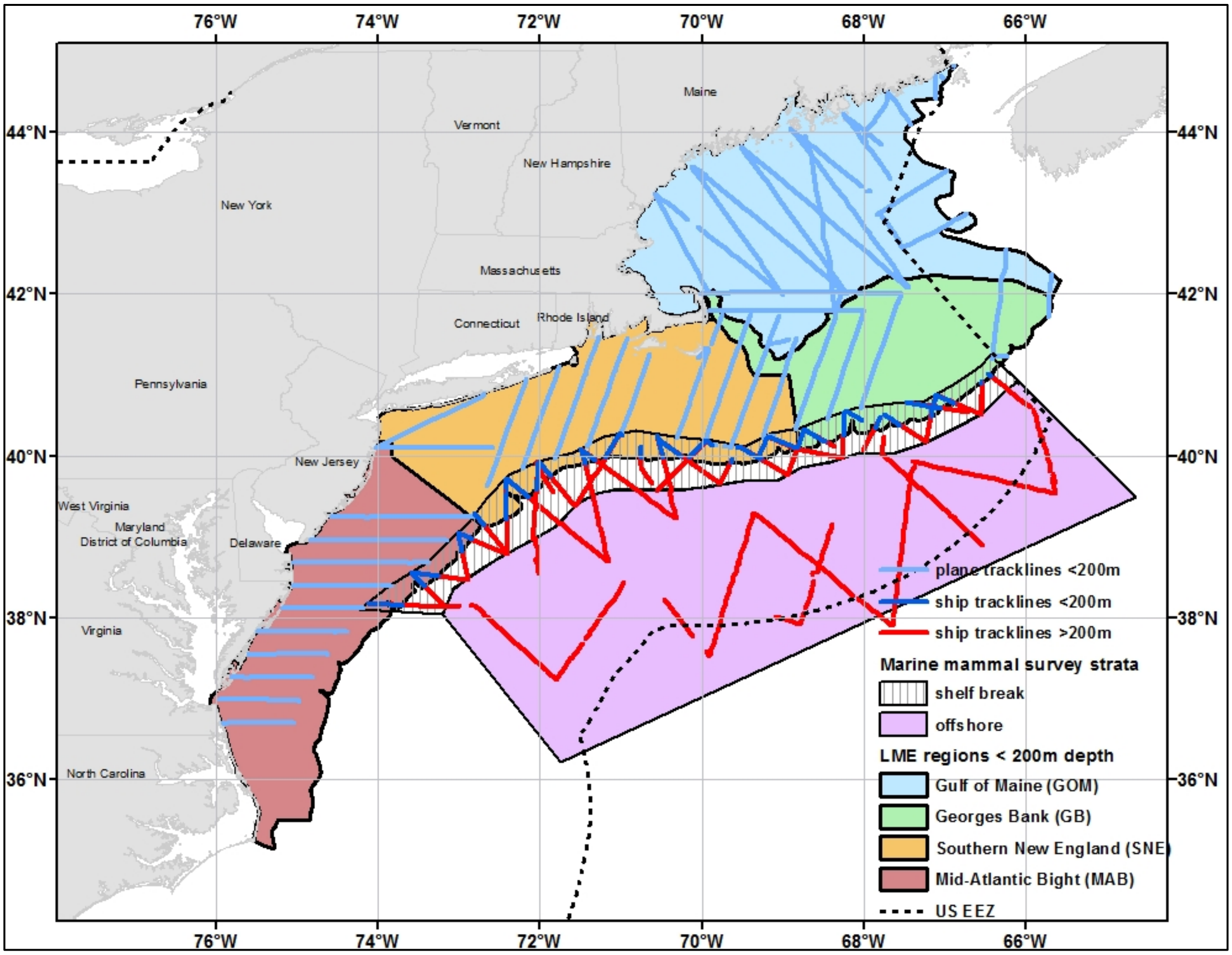

Figure 3-1 Spatial strata used in the 2004 marine mammal abundance survey.

Figure shows the shelf, shelf break and offshore strata and associated track lines conducted by airplane (in light blue) and ship (dark blue and red). The coastal fishery research area, Northeast LME was covered by the light and dark blue track lines. The offshore fishery research area, which is in waters deeper than the 200 m depth contour, was covered by the red track lines and spans part of the shelf break marine mammal shipboard stratum and the entire offshore marine mammal shipboard stratum.

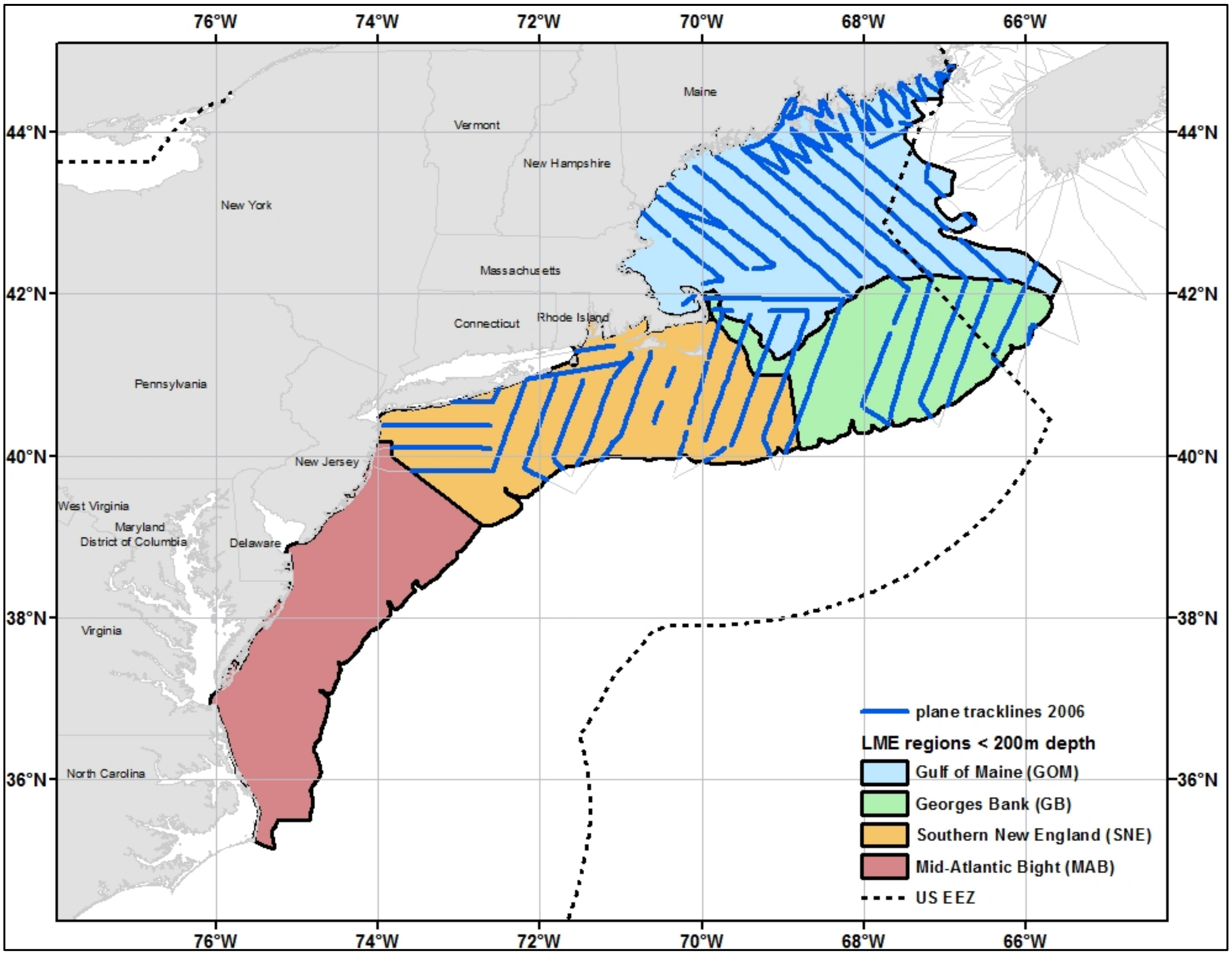

Figure 3-2 Track lines flown during the 2006 marine mammal abundance survey.

Dark blue lines are those in the Northeast LME and light gray lines are those flown outside the Northeast LME strata and not used in the analysis to estimate marine mammal density.

4.0 DESCRIPTION OF THE STATUS, DISTRIBUTION AND SEASONAL DISTRIBUTION (WHERE APPLICABLE) OF THE AFFECTED SPECIES OR STOCKS OF MARINE MAMMALS LIKELY TO BE AFFECTED BY SUCH ACTIVITIES

The following information summarizes data on the affected species, status and trends, distribution and habitat preferences, behavior and life history, and auditory capabilities, as available in published literature and reports, including marine mammal stock assessment reports.

Marine Mammal Acoustics and Hearing

Marine mammals rely on sound production and reception for social interactions (e.g., reproduction, communication), to find food, to navigate, and to respond to predators. General reviews of cetacean and pinniped sound production and hearing may be found in Richardson et al. (1995), Edds-Walton (1997), Wartzok and Ketten (1999), and Au and Hastings (2008). Several recent studies on hearing in individual species or species groups of odontocetes and pinnipeds also exist (e.g., Kastelein et al. 2009, Kastelein et al. 2013, Ruser et al. 2014). Interfering with these functions through anthropogenic noise could result in potential adverse impacts.

Southall et al. (2007) provided a comprehensive review of marine mammal acoustics including designating functional hearing groups. Assignment was based on behavioral psychophysics (the relationship between stimuli and responses to stimuli), evoked potential audiometry, auditory morphology, and, for pinnipeds, whether they were hearing through air or water. Because no direct measurements of hearing exist for baleen whales, hearing sensitivity was estimated from behavioral responses (or lack thereof) to sounds, commonly used vocalization frequencies, body size, ambient noise levels at common vocalization frequencies, and cochlear measurements. NOAA modified the functional hearing groups of Southall et al. (2007) to extend the upper range of low-frequency cetaceans and to divide the pinniped hearing group into Phocid and Otariid hearing groups (NOAA 2013). Detailed descriptions of marine mammal auditory weighting functions and functional hearing groups are available in NOAA (2013). Table 4-1 presents the functional hearing groups and representative species or taxonomic groups for each; most species found in the NEFSC project areas are in the first two groups, low frequency cetaceans (baleen whales) and mid frequency cetaceans (odontocetes).

Table 4-1 Summary of the five functional hearing groups of marine mammals

Functional Hearing Group	Estimated Auditory Bandwidth	Species or Taxonomic Groups
Low Frequency Cetaceans (Mysticetes–Baleen whales)	7 Hertz (Hz) to30 kilohertz (kHz) (best hearing is generally below 1000 Hz, higher frequencies for humpback whales)	All baleen whales
Mid- Frequency Cetaceans (Odontocetes—Toothed whales)	150 Hz to 160 kHz (best hearing is from approximately 10-120kHz)	Includes species in the following genera: *Steno*, *Tursiops*, *Stenella*, *Delphinus*, *Lagenodelphis*, *Lagenorhynchus*, *Grampus*, *Peponocephala*, *Feresa*, *Orcinus*, *Globicephala*, *Physeter*, *Hyperoodon*, *Ziphius*, *Mesoplodon*
High-frequency Cetaceans (Odontocetes)	200 Hz to 180 kHz (best hearing is from approximately 10-150 kHz)	Includes species in the following genera: *Kogia* and *Phocoena*
Phocid pinnipeds (true seals)	75 Hz to 100 kHz (best hearing is from approximately 1-30 kHz)	All seals

Functional Hearing Group	Estimated Auditory Bandwidth	Species or Taxonomic Groups
Otariid pinnipeds (sea lions and fur seals)	100 Hz to 40 kHz (best hearing is from approximately 1-16 kHz)	None occur in NEFSC research area

4.1 North Atlantic Right Whale (*Eubalaena glacialis*): Western Atlantic Stock

Abundance, Density, and Stock Status: The North Atlantic right whale is considered one of the most critically endangered large whales in the world (Clapham *et al.* 1999; Perry *et al*. 1999; Kenney 2009). A Recovery Plan, originally published in 1991 and most recently revised in 2005, is currently in effect for this species (NMFS 2005). The western population of North Atlantic right whales remains at very low levels, leaving it vulnerable to anthropogenic impacts throughout much of its range (NMFS 2006b).

The western North Atlantic right whale population was estimated to include at least 396 individuals in 2005. This is a minimum value, based on individual whales identified using photo-identification techniques, as matching of photos from 2006 and 2007 is not complete. The number of right whales presently estimated to occur in the project area includes a minimum estimate of 455 whales (Waring et al. 2014). The minimum number alive may increase slightly with analysis of the backlog of unmatched, but high-quality, photographs (Waring *et al*. 2011).

The density estimate for North Atlantic right whales in the LME <200 m was 0.0018 whales per km^2 and was estimated as the ratio of the minimum population size of 455 whales to the area of the Scotian Shelf and GOM/GB (Table 3.4).

The population appeared to be showing signs of slow recovery, with an estimated growth rate of 2.5 percent for the period 1986-1992 (Knowlton *et al.* 1994). Subsequently, additional analyses showed a decline in survival probability in the 1990s (Caswell *et al*. 1999; Clapham 2002). The decline appeared to be particularly marked in adult females. Recent mortalities also suggest an increased annual mortality rate that could reduce population growth by approximately 10%/year (Kraus *et al.* 2005).

Distribution and Habitat: The western North Atlantic right whale population ranges from wintering and calving grounds in the coastal waters of the southeastern U.S. to summer feeding and nursery grounds in New England waters and the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence (Cetacean and Turtle Assessment Program [CETAP] 1982; Waring *et al*. 2011). The six major habitats or congregation areas are: coastal waters of the southeastern U.S.; the GSC; GOM/GB; CCB and Massachusetts Bays; the Bay of Fundy; and the Scotian Shelf (Waring *et al.* 2009). Movements within and between habitats are extensive. Critical habitat for right whales was designated for CCB and GSC.

Right whales have been sighted from the MAB to the GOM during all months of the year (NMFS 2005). Peak abundance of right whales in CCB begins in late winter. In early spring (May), abundance shifts to Wilkinson Basin and to the Great South Channel (Kenney *et al.* 1995). During late June and July, distribution gradually shifts to the northern edge of GB, then, in late summer and fall, the population is centered in waters of the Bay of Fundy and around Roseway Basin (Winn *et al.* 1986; Kenny *et al.* 1995; Kenny *et al.* 2001). Right whales are found in New England waters throughout the winter months, as well as off Florida and Georgia, yet the location of much of the population during winter remains unknown (NMFS 2005).

New England waters constitute important feeding habitat for right whales, which feed primarily on zooplankton, specifically copepods of the genera *Calanus* and *Pseudocalanus* in this area. These dense zooplankton patches are likely key attributes of spring, summer, and fall right whale habitats (Kenney *et al*. 1986, 1995). Feeding has been well documented in the coastal waters off Massachusetts. Right whales have also been observed feeding along the margins of GB, in the GSC, in the GOM, in the Bay of Fundy, and over the Scotian Shelf. NMFS and Provincetown Center for Coastal Studies aerial surveys during springs of 1999-2006 found right whales along the Northern Edge of GB, in the GSC, in Georges Basin, and in various locations in the GOM, including Cashes Ledge, Platts Bank, and Wilkinson Basin. The consistency of right whales occurrence at these locations is relatively high; these studies also highlight the high interannual variability in right whale use of some habitats (Waring *et al.* 2009). Fluctuations in pattern of prey abundance will alter general patterns of right whale habitat use (Kenny 2001).

Acoustics and Hearing: Parks *et al.* (2007) recently developed a preliminary model of the frequency range of hearing for North Atlantic right whales using morphometric analyses of inner ears of stranded whales and a previously established model for marine mammal hearing. The predicted total hearing range was 10 Hz to 22 kHz (Parks *et al.* 2007). North Atlantic right whales are, thus, in the low-frequency functional hearing group of Southall *et al.* (2007). Their vocalizations range from 20 Hz to 15 kHz (Department of the Navy [DON] 2008) (Table 4.1).

4.2 Humpback Whale (*Megaptera novaeangliae*): Gulf of Maine Stock

Abundance, Density, and Stock Status: As summarized in Waring *et al.* (2009, and citations therein) an International Whaling Commission (IWC) Comprehensive Assessment addressed the status of the North Atlantic humpback whale population in June 2001 and in May 2002 (IWC 2002). Recent abundance estimates indicate continued population growth, but the size of the humpback whale stock off the U.S. east coast may still be below its optimum sustainable population (OSP). A Recovery Plan was published and is currently in effect (NMFS 1991). The average annual rate of increase for the North Atlantic population was estimated at 3.1 percent. An analysis of demographic parameters for the GOM suggested a lower rate of increase in that region than previously reported. Results, however, may have been confounded by distribution shifts that coincided with the period of declining survival rates (1992-1995). Calf survival and, presumably, population growth, appear to have increased since 1996 (Waring *et al.* 2009).

The best and minimum estimate of abundance for GOM humpback whales is 823 animals (Waring et al. 2014). The GOM stock appears to be steadily increasing. In 2004-2005, a large-scale assessment of humpback whales occurred in the GOM/Scotian Shelf region and principal wintering ground on Silver Bank, Dominican Republic. Data from the More of North Atlantic Humpbacks (MoNAH) project are being analyzed along with additional data from the U.S. mid-Atlantic. The intent is to update the previous Years of the North Atlantic Humpback (YONAH) population assessment in preparation for a possible status review under the ESA (Waring *et al.* 2011).

The density estimates calculated for humpback whales were 0.0009 for the LME <200 m and 0.0006 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: As summarized in Waring *et al.* (2007 and 2009, and citations therein) humpback whales in the western North Atlantic feed during spring, summer, and fall over a range which encompasses the eastern coast of the U.S. (including the GOM), the Gulf of St. Lawrence, Newfoundland/Labrador, and western Greenland. Additional feeding areas are off Iceland and northern Norway. These areas represent six relatively discrete subpopulations. Based on genetic analyses, the GOM feeding stock is treated as a separate management stock (IWC 2002).

Most North Atlantic humpback whales, including the GOM stock, migrate to the West Indies during the winter to mate and calve (Clapham *et al.* 1993). Not all migrate south, however, as significant numbers occur in mid- and high-latitude regions in winter (Clapham *et al.* 1993; Swingle *et al.* 1993). An increased number of sightings of humpback whales in the vicinity of the Chesapeake and Delaware Bays occurred in 1992 (Swingle *et al.* 1993). Wiley *et al.* (1995) reported 38 humpback whale strandings during 1985-1992 in the U.S. mid-Atlantic and southeastern states, particularly along the Virginia and North Carolina coasts. Most stranded animals were sexually immature and some may have only recently separated from their mothers. The question of population identity of humpbacks sighted off the coasts of the southeastern and mid-Atlantic States was addressed using fluke photographs of both living and dead whales (Barco *et al.* 2002). Most of the identified whales were from the GOM, but there were photographic matches to whales from Newfoundland and the Gulf of St. Lawrence. The mid-Atlantic region primarily represents a supplemental winter feeding ground for humpbacks whales (Barco *et al.* 2002). Wiley *et al.* (1995) concluded that these areas were becoming increasingly important habitats for juvenile humpback whales and that anthropogenic factors may negatively impact whales in this area.

Feeding is the principal activity of humpback whales in New England waters, and their distribution in this region has been largely correlated to prey species and abundance (Payne et al. 1986, 1990). Humpback whale habitat shifts in response to prey availability, but, overall, the important foraging habitats are: sandy shoals in the southwestern GOM, offshore waters of Cultivator Shoal, the Northeast Peak of GB, Jeffreys Ledge, and northern GOM (Payne *et al.* 1986; Paquet *et al.* 1997). Humpback whales are frequently piscivorous in these waters, feeding on Atlantic herring (*Clupea harengus*), sand lance (*Ammodytes* spp.), and other small fishes. In the northern GOM, euphausiids are also frequently taken (Paquet *et al.* 1997). Commercial depletion of herring and Atlantic mackerel (*Scomer scombrus*) led to an increase in sand lance in the southwestern GOM in the mid-1970s, with a concurrent decrease in humpback whale abundance in the northern GOM. Humpback whales were densest over the sandy shoals in the southwestern GOM, favored by the sand lance during much of the late 1970s and early 1980s, humpback distribution appeared to have shifted to this area (Payne et al. 1986). An apparent reversal began in the mid 1980s, and herring and mackerel increased as sand lance again decreased (Fogarty *et al.* 1991). Humpback whale abundance in the northern GOM increased dramatically during 1992-1993, along with a major influx of herring. Humpback whales were few in nearshore Massachusetts waters in the 1992-1993 summer seasons. They were more abundant in the offshore waters of Cultivator Shoal and the Northeast Peak on GB, and on Jeffreys Ledge; these latter areas are more traditional locations of herring occurrence. In 1996 and 1997, sand lance, and therefore humpback whales were once again abundant in the Stellwagen Bank area. However, unlike previous cycles, when an increase in sand lance corresponded to a decrease in herring, herring remained relatively abundant in the northern GOM, and humpbacks correspondingly continued to occupy this portion of the habitat, where they also fed on euphausiids (unpublished data, Provincetown Center for Coastal Studies and College of the Atlantic).

Acoustics and Hearing: Humpback whales are in the low-frequency functional hearing group, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall *et al.* 2007). Their vocal repertoire ranges from 20 Hz to greater than 10 kHz (DON 2008) (Table 4.1).

4.3 Fin Whale (*Balaenoptera physalus*): Western North Atlantic Stock

Abundance, Density, and Stock Status: The fin whale is listed as endangered under the ESA, yet the status of the stock off the U.S. Atlantic coast, relative to OSP is unknown and data are inadequate to determine the population trend for fin whales. A Draft Recovery Plan for fin whales is available for review (NMFS 2006a). The best abundance estimate for western North Atlantic fin whales is 3,522 with a minimum population estimate of 2,817 whales (Waring et al. 2014). The density estimates calculated for fin whales were 0.0036 for the LME <200 m and 0.0007 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Fin whales are common in waters off the U.S. east coast, principally from Cape Hatteras northward. Fin whales accounted for 46 percent of the large whales and 24 percent of all cetaceans sighted over the continental shelf during aerial surveys (CETAP 1982) between Cape Hatteras and Nova Scotia during 1978-82. While much remains unknown, the magnitude of the ecological role of the fin whale is impressive. In this region, fin whales are probably the dominant large cetacean species in all seasons, with the largest standing stock, the largest food requirements, and therefore the largest impact on the ecosystem of any cetacean species (Kenney et al. 1997; Hain *et al.* 1992).

New England waters represent a major feeding area for fin whales (Hain *et al.* 1992; Kenney *et al.* 1997), with key feeding grounds in the western GOM, from Stellwagen Bank to Jeffreys Ledge, and the GSC. These are areas associated with sand lance Kenney and Winn 1986; Hain *et al*. 1992). Secondary seasonal areas of importance are off eastern Long Island, along the northern edge of GB and in the northern GOM (CETAP 1982; Waring and Finn 1995). There is evidence of site fidelity by females, and possibly, sexual, maturational or reproductive class segregation in the feeding area (Agler *et al.* 1993). Clapham and Seipt (1991) showed maternally directed site fidelity for fin whales in the Gulf of Maine. Calving, mating, or wintering areas are unknown for most of the population, although Hain *et al.* (1992) suggested calving takes place during October to January off the U.S. mid-Atlantic region. Fin whales off the U.S. Atlantic coast may migrate into Canadian waters, open-ocean areas, or even subtropical or tropical regions. It is, however, unlikely that fin whales undergo distinct annual migrations (Waring *et al.* 2011).

Fin whale habitat preference along the Mid-Atlantic Ridge (MAR), based on a summer 2004 vessel survey from the Reykjanes Ridge to north of the Azores, was associated with foraging on krill patches (Waring *et al.* 2008). This includes areas north of the Charlie-Gibbs Fracture Zone and the southern portion of the MAR. Water depths in these regions varied between 1,760 m to 4,470 m.

Acoustics and Hearing: Fin whales are in the low-frequency functional hearing group, with an estimated auditory range of 7 Hz to 22 kHz (Southall *et al.* 2007). They also vocalize at low frequencies of 15-30 Hz (DON 2008) (Table 4.1).

4.4 Sei Whale (*Balaenoptera borealis*): Nova Scotia Stock

Abundance, Density, and Stock Status: Sei whales in the NEFSC survey area are part of the Nova Scotia stock, the range of which includes continental shelf waters of the northeastern U.S., and extends northeastward to south of Newfoundland (Waring *et al.* 2011). Sei whales are listed as endangered under the ESA, but stock status is unknown and data are insufficient for assessing population trends. A Recovery Plan for sei whales was written and is awaiting legal clearance (Waring *et al.* 2011).

The best population estimate for the Nova Scotia stock of sei whales (357) is the most recent with a minimum estimate is 236 sei whales. The 2004/2006 estimate should be viewed as very conservative considering the range of sei whales in the entire western North Atlantic, and uncertainties about population structure and whale movements between surveyed and unsurveyed areas (Waring *et al.* 2011). The density estimates calculated for Sei whales were 0.0027 for the LME <200 m and 0.00004 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: At least during the feeding season, most of the Nova Scotia sei whale stock appears to concentrate in northerly waters, including the Scotian Shelf (Mitchell and Chapman 1977. The southern portion of the species' range during spring and summer includes the GOMand GB. Abundance in U.S. waters is highest in spring, with sightings concentrated along the eastern margin of GB and into the Northeast Channel area, and along the southwestern edge of GB in the area of Hydrographer Canyon (CETAP 1982). NMFS aerial surveys in 1999, 2000 and 2001 found concentrations of sei and right whales along the northern edge of GB in the spring. Sei whales often occur in the deeper waters of the continental shelf edge region (Hain et al. 1985), where NMFS aerial surveys found substantial numbers, particularly south of Nantucket, in the spring of 2001. Similarly, Mitchell (1975a) reported that sei whales off Nova Scotia were often distributed closer to the 2000-m depth contour than were fin whales.

This general offshore pattern of sei whale distribution is disrupted during episodic incursions into more shallow and inshore waters. Although known to take piscine (fish) prey, sei whales (like right whales) are largely planktivorous, feeding primarily on euphausiids and copepods. In years of reduced predation on copepods by other predators, and thus greater abundance of this prey source, sei whales are reported in more inshore locations, such as the GSC (in 1987 and 1989) and Stellwagen Bank (in 1986) areas (Payne *et al.* 1990). Mitchell (1975) speculated that sei whales migrate from south of Cape Cod and along the coast of eastern Canada in June and July, and return south again in September and October. This remains unverified (Waring *et al.* 2011).

Sei whale habitat preference along the Mid-Atlantic Ridge, based on a summer 2004 vessel survey from the Reykjanes Ridge to north of the Azores, was near the frontal area just north and southwest of the Charlie-Gibbs Fracture Zone (Waring *et al.* 2008). This area was a local zone of maximum surface temperature and salinity. In general, sei whales were associated with the slopes of seamounts and rises and were in waters varying from 1,160 m to 4,500 m deep. The whales were often observed feeding and in areas where zooplankton (calanoid copepods) were sampled.

Acoustics and Hearing: Sei whales are in the low-frequency hearing group, along with other baleen whales, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall *et al.* 2007). There are few recordings of sei whale vocalizations in the North Atlantic, where the sweep frequency ranged from 1.5 to 3.5 kHz (DON 2008) (Table 4.1). This differed greatly from the low-frequency (average 433±192 Hz) sounds recorded in the Antarctic (McDonald *et al.* 2005).

4.5 Minke Whale (*Balaenoptera acutorostrata*): Canadian East Coast Stock

Abundance, Density, and Stock Status: Minke whales off the eastern coast of the U.S. are considered to be part of the Canadian East Coast stock, which inhabits the area from the eastern half of the Davis Strait (45º W) to the Gulf of Mexico (Waring *et al.* 2011). The number of minke whales comprising the Canadian East Coast stock is unknown and data are insufficient to calculate population trends. The best available current abundance estimate for the stock (20,741) was derived from a summer 2007 aerial Trans North Atlantic Sighting Survey (TNASS) (Lawson and Gosselin 2009). The minimum estimate is 16,199 animals (Waring et al. 2014). Minke whales are not listed as either threatened or endangered under the ESA. The density estimates calculated for minke whales were 0.0066 for the LME <200 m and 0.0 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Minke whales are common and widely distributed off the northeast U.S. coast, particularly in the GOM/GB regions (CETAP 1982; Waring *et al.* 2011). There appears to be a strong seasonal component to minke whale distribution. They are most abundant, widespread, and common in New England waters in spring and summer (CETAP 1982; Waring *et al.* 2007). Numbers diminish during fall and, during winter, minke whales are largely absent from the area (Mitchell 1991; Waring *et al.* 2011). Minke whales generally occupy the continental shelf proper, including bays and estuaries rather than shelf-edge waters (Mitchell and Kozicki 1975; Hamazaki 2002; Waring *et al.* 2007). Minke whales are largely piscivorous, and consume a variety of forage fishes (e.g., Atlantic herring, mackerel, and sand lance). Their dietary composition on the U.S. OCS was estimated as 95% fish and 5% euphausiids (Kenney *et al.* 1997).

Acoustics and Hearing: Minke whales are in the low-frequency functional hearing group with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall *et al.* 2007). Vocalizations range from 60 Hz to 20 kHz (DON 2008) (Table 4.1).

4.6 Blue Whale (*Balaenoptera musculus*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Blue whales are listed as endangered under the ESA, although the status of this stock is unknown and data are insufficient to determine population trends (Waring *et al.* 2010). A Recovery Plan has been published (Reeves et al. 1998) and is in effect.

Little is known about the population size of blue whales except for in the Gulf of St. Lawrence area. The 440 individually identified blue whales from the Gulf of St. Lawrence catalogued by Sears *et al.* (1987) are considered a minimum population estimate for the western North Atlantic stock (Waring *et al.* 2010). The density estimates calculated for blue whales were 0.0 for the LME <200 m and 0.0026 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Blue whale distribution in the western North Atlantic generally extends from the Arctic to at least mid-latitude waters. Most sightings are in the waters off eastern Canada, particularly the Gulf of St. Lawrence (Sears *et al.* 1987). The current Canadian distribution is, in general, spring, summer, and fall in the Gulf of St. Lawrence, especially along the north shore from the St. Lawrence River estuary to the Strait of Belle Isle and off eastern Nova Scotia. A blue whale photographed by a NMFS large whale survey in August 1999 had previously been observed in the Gulf of St. Lawrence in 1985 (R. Sears and P. Clapham, unpublished data cited in Waring *et al.* 2007). The blue whale is best considered as an occasional visitor in U.S. Atlantic waters, which may represent the current southern limit of its feeding range (CETAP 1982, Wenzel *et al.* 1988). Four of the 5 sightings described in the aforementioned references were in August; one was in October.

Acoustics and Hearing: Blue whales, along with other mysticetes (baleen whales), are in the low-frequency functional hearing group, with an estimated auditory range of 7 Hz to 22 kHz (Southall *et al.* 2007). Their vocalizations range from 12 Hz to 400 Hz, with a dominant range of 12-25 Hz (DON 2008) (Table 4.1).

4.7 Sperm Whale (*Physeter macrocephalus*): North Atlantic Stock

Abundance, Density, and Stock Status: Sperm whales are listed as endangered under the ESA. Data are insufficient to assess population trends, and the current abundance estimate was based on only a fraction of the known stock range (Waring *et al.* 2007). A Draft Recovery Plan for sperm whales was written and is available for review (NMFS 2006c).

Total numbers of sperm whales off the U.S. or Canadian Atlantic coasts are unknown. The best recent abundance estimate for sperm whales is the sum of the estimates from the two 2011 U.S. Atlantic surveys 2,288 (CV=0.28) where the estimate from the northern U.S. Atlantic is 1,593, and from the southern U.S. Atlantic is 695 sperm whales. The minimum population estimate for the western North Atlantic sperm whale is 1,815 (Waring et al. 2014). The density estimates calculated for sperm whales were 0.00001 for the LME <200 m and 0.0152 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Sperm whales are principally distributed along the continental shelf edge, over the continental slope, and into mid-ocean regions (CETAP 1982; Hamazaki 2002; Waring *et al.* 2001; Waring *et al.* 2007). Waring *et al.* (2007) suggest that this offshore distribution is more commonly associated with the Gulf Stream edge and other features. Off the Northeast U.S. coast there appears to be a distinct seasonal cycle (CETAP 1982; Scott and Sadove 1997). In winter, sperm whales concentrate east and northeast of Cape Hatteras. In spring, distribution shifts northward to east of Delaware and Virginia, and is widespread throughout the central MAB and the southern part of GB. Summer distribution includes the area east and north of GB and into the Northeast Channel region, as well as the continental shelf (inshore of the 100 m isobath) south of New England (Scott and Sadove 1997). In the fall, sperm whale occurrence on the continental shelf south of New England reaches peak levels, and there remains a continental shelf edge occurrence in the MAB (Waring *et al.* 2007). Similar inshore (< 200 m) observations have been made on the southwestern and eastern Scotian Shelf, particularly in the region of "the Gully" (Whitehead *et al.* 1991). CETAP and NMFS/NEFSC sightings in shelf-edge and off-shelf waters included many social groups with calves/juveniles (CETAP 1982).

Sperm whales occupied the entire length of the Mid-Atlantic Ridge during a summer 2004 vessel survey from the Reykjanes Ridge to north of the Azores (Waring *et al.* 2008). Some animals were concentrated north of the Charlie-Gibbs Fracture Zone (CGFZ) and in the southern region. The area at the CGFZ coincided with a frontal region with local maximum surface temperature and salinity gradients. Sperm whales were usually seen at the tops of the seamounts and rises and did not generally occur over the slopes. Sperm whales were recorded over depths varying from 800 m to 3500 m.

Acoustics and Hearing: As summarized in DON (2008a, and citations therein), sperm whales typically produce short-duration (less than 30 ms), repetitive broadband clicks used for communication and echolocation. These clicks range in frequency from 0.1 to 30 kHz, with dominant frequencies between the 2 to 4 kHz and 10 to 16 kHz ranges. When sperm whales are socializing, they tend to repeat series of group-distinctive clicks (codas), which follow a precise rhythm and may last for hours (Whitehead 2009). Codas are shared between individuals of a social unit and are considered to be primarily for intra-group communication. Neonatal clicks are of low directionality, long duration (2 to 12 ms), low frequency (dominant frequencies around 0.5 kHz) with estimated source levels between 140 and 162 dB re 1 μPa-m rms. Source levels from adult sperm whales' highly directional (possible echolocation), short (100 μs) clicks have been estimated up to 236 dB re 1 μPa-m rms. Creaks (rapid sets of clicks) are heard most frequently when sperm whales are engaged in foraging behavior in the deepest portion of their dives with intervals between clicks and source levels being altered during these behaviors. In summary, sperm whales are in the mid-frequency functional hearing group, with an estimated auditory range of 150 Hz to 160 kHz (Southall *et al.* 2007). Vocalizations, including echolocation clicks, range from 100 Hz to 30 kHz (DON 2008a) (Table 4.1).

4.8 Pygmy Sperm Whales (*Kogia sima*): Western North Atlantic Stocks and

4.9 Dwarf Sperm Whales (*Kogia breviceps*): Western North Atlantic Stocks

Abundance, Density, and Stock Status: Neither species is listed as either endangered or threatened under the ESA. Dwarf sperm whales (*K. sima*) and pygmy sperm whales (*K. breviceps*) are difficult to distinguish at sea (Jefferson *et al.* 1994). Sightings are, therefore, generally listed as *Kogia* spp. and abundance estimates are similarly grouped. Distinct morphological characteristics, as well as data obtained from blood and muscle tissues, enable species determination of stranded animals.

Total numbers of dwarf and pygmy sperm whales off the U.S. Atlantic coast is unknown. The best available abundance estimate for *Kogia* spp. is 3,785 (CV=0.47), derived by combining estimates from two 2011 surveys (Waring et al. 2014). The minimum population estimate for t *Kogia* spp. is 2,598 (Waring et al. 2014). The density estimates calculated for *Kogia* sp. were 0.00002 for the LME <200 m and 0.0020 for the offshore research area >200 m (Table 3.4).

Data are insufficient to estimate population trends. *Kogia* spp. are not listed as either threatened or endangered.

Distribution and Habitat: Both species occupy temperate to tropical waters (Caldwell and Caldwell 1989; McAlpine 2002). Off the Northeast U.S. they utilize shelf-edge and deeper oceanic regions (Waring *et al.* 2007).

Acoustics and Hearing: Kogia spp. are in the high-frequency functional hearing group, with an estimated auditory bandwidth of 200 Hz to 180 kHz (Southall *et al.* 2007). Vocalizations frequencies range from 13 to 200 kHz (Table 4.1). Recordings of clicks emitted by free-ranging *K. sima* (dwarf sperm whales) in the Lesser Antilles were in the lower end of the range (13-30 kHz). Recordings of stranded *K. breviceps* (pygmy sperm whales) were in the 60 to 200 kHz range (DON 2008).

4.10 Killer Whale (*Orcinus orca*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Killer whales are not listed as either threatened or endangered under the ESA. As summarized in Waring *et al.* (2011, and citations therein), killer whales are characterized as uncommon or rare in waters of the U.S. Atlantic EEZ. The 12 killer whale sightings constituted 0.1% of the 11,156 cetacean sightings in the 1978-81 CETAP surveys (CETAP 1982). The same is true for eastern Canadian waters, where the species has been described as relatively uncommon and numerically few (Mitchell and Reeves 1988). Their distribution, however, extends from the Arctic ice-edge to the West Indies. They are normally found in small groups, although 40 animals were reported from the southern Gulf of Maine in September 1979, and 29 animals were reported in Massachusetts Bay in August 1986 (Katona *et al.* 1988). In the U.S. Atlantic EEZ, while their occurrence is unpredictable, they do occur in fishing areas, perhaps coincident with tuna, in warm seasons (Katona *et al*. 1988). In an extensive analysis of historical whaling records, Reeves and Mitchell (1988) plotted the distribution of killer whales in offshore and mid-ocean areas. Their results suggest that the offshore areas need to be considered in present-day distribution, movements, and stock relationships.

Unlike the killer whales in the Pacific Northwest where three killer whale ecotypes are recognized, stock definition in the western Atlantic is unknown. Results from other areas (e.g., the Pacific Northwest and Norway) suggest that social structure and territoriality may be important.

The total number of killer whale off the eastern U.S. coast is unknown. Present data are insufficient to calculate a minimum population estimate and there are insufficient data to determine the population trends for this species.

Distribution and Habitat: Killer whales are found in all oceans and are second only to humans as the most widely spread of all mammals (Ford 2009). They are most commonly found in coastal and temperate waters of high productivity. Killer whales are very social and the basic social unit is based on matriline relationship and linked by maternal decent. A typical matriline is composed of a female, her sons and daughters, and the offspring of her daughters (Ford 2009). Females may live to 80-90 years so a female's line may contain four generations. The pod is the next level of organization that is a group of related matrilines that shared a common maternal ancestor. The next level of social structure is the clan, followed by a resident society.

Births may occur in any month but most are in October-March. Females give birth when between 11 and 16 years of age with a 5 year interval between births. Gestation is 15-18 months and weaning is about 1-2 years after birth. Males attain sexual maturity at about 15 years of age. Life expectancy for females is about 50 years with a maximum of 80-90; males typically live to about 29 years of age (Ford 2009).

Acoustics and Hearing: Killer whales, like most cetaceans, are highly vocal and use sound for social communication and to find and capture prey. The sounds include a variety of clicks, whistles, and pulsed calls (Ford 2009). As summarized in DON (2008b, and citations therein), the peak to peak source levels of echolocation signals range between 195 and 224 dB re 1 μPa-m. The source level of social vocalizations ranges between 137 to 157 dB re 1 μPa-m. Acoustic studies of resident killer whales in British Columbia have found that there are dialects, in their highly stereotyped, repetitive discrete calls, which are group-specific and shared by all group members (Ford 2009). These dialects likely are used to maintain group identity and cohesion, and may serve as indicators of relatedness that help in the avoidance of inbreeding between closely related whales (Ford 2009). The killer whale has the lowest frequency of maximum sensitivity and one of the lowest high frequency hearing limits known among toothed whales. The upper limit of hearing is 100 kHz for this species.

4.11 Pygmy Killer Whale (*Feresa attenuata*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Pygmy killer whales are not listed as either endangered or threatened under the ESA. They are assumed to be part of the cetacean fauna of the tropical western North Atlantic. The paucity of sightings is probably due to a naturally low number of groups compared to other cetacean species Waring *et al.* 2011, and citations therein). Sightings in the more extensively surveyed northern Gulf of Mexico occur in oceanic waters (Mullin *et al.* 1994; Mullin and Fulling 2004). The western North Atlantic population is provisionally being considered one stock for management purposes.

The numbers of pygmy killer whales off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen in any surveys (Waring *et al.* 2011, and citations therein). A group of 6 pygmy killer whale was sighted during a 1992 vessel survey of the western North Atlantic off of Cape Hatteras, North Carolina, in waters >1,500 m deep, but this species was not sighted during subsequent surveys (ibid). Abundance was not estimated for pygmy killer whales from the 1992 vessel survey because the sighting was not made during line-transect sampling effort; therefore, the population size of pygmy killer whales is unknown. Present data are insufficient to calculate density or a minimum population estimate for this stock and there are insufficient data to determine population trends.

Distribution and Habitat: Pygmy killer whales occur in tropical and subtropical waters worldwide, and are regularly sighted in the Eastern Tropical Pacific (Donahue and Perryman 2009). Sightings are more common in warmer coastal waters than offshore (Wade and Gerrodette 1993). The feeding behavior of pygmy killer whales is not well known. Remains of cephalopods and small fish have been found in stomachs of stranded and incidentally caught individuals. They may be one of the species of small whales that attack and sometimes eat smaller dolphins caught in the tuna purse-seine fishery (Donahue and Perryman 2009).

Pygmy killer whales are generally in small schools of 12-50 animals, although larger schools have been observed. They are known to bow ride. Pygmy killer whale life history is poorly understood.

Acoustics and Hearing: Pygmy killer whales are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall *et al.* 2007) (Table 4.1).

4.12 Northern Bottlenose Whale (*Hyperoodon ampullatus*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Northern bottlenose whales are not listed as either endangered or threatened under the ESA. They are characterized as extremely uncommon or rare in waters of the U.S. Atlantic EEZ. The two sightings of three individuals constituted less than 0.1% of the 11,156 cetacean sightings in the 1978-82 CETAP surveys. Both sightings were in the spring, along the 2,000-m isobath (CETAP 1982). In 1993 and 1996, two sightings of single animals, and in 1996, a single sighting of six animals (one juvenile), were made during summer shipboard surveys conducted along the southern edge of Georges Bank.

As summarized by Waring *et al.* (2011, and citations therein), there are two main centers of bottlenose whale distribution in the western north Atlantic, one in the area called "The Gully" just north of Sable Island, Nova Scotia, and the other in Davis Strait off northern Labrador. Studies at the entrance to the Gully from 1988-1995 identified 237 individuals and estimated the local population size at about 230 animals (95% C.I.). Wimmer and Whitehead (2004) identified individuals moving between several Scotian Shelf canyons more than 100 km from the Gully. Whitehead and Wimmer (2005) estimated a population of 163 animals (95% confidence interval 119-214), with no statistical significant population trend. These individuals are believed to be year-round residents and all age and sex classes are present. Stranding records document northern bottlenose whales in the Bay of Fundy and as far south as Rhode Island and three stranded individuals were documented on Sable Island, Nova Scotia, Canada.

Stock definition is currently unknown for those individuals inhabiting/visiting U.S. waters. The total number of northern bottlenose whales off the eastern U.S. coast is unknown. The density estimates calculated for northern bottlenose whales were 0.0 for the LME <200 m and 0.0017 for the offshore research area >200 m (Table 3.4). Present data are insufficient to calculate a minimum population estimate and there are insufficient data to determine the population trends for this species.

Distribution and Habitat: Bottlenose whales are typically found in small groups of 1-4 individuals but groups up to 20 have been observed. Northern bottlenose whales are distributed in the North Atlantic from Nova Scotia to about 70º in the Davis Strait to 77º and from England to the west coast of Spitzbergen. It is largely a deep-water species and is very seldom found in waters less than 2,000 m deep (Mead 1989). There is no information on the life history of northern bottlenose whales. They are believed to be deep divers feeding primarily on squid, with fish and benthic invertebrates infrequently consumed (Gowans 2009). Northern bottlenose whales have been recorded to dive to 1,400 m (ibid).

Acoustics and Hearing: There is no information on acoustics for this species. However, DON (2008b) reviewed the literature on beaked whale acoustics and reported that beaked whales use frequencies of between 300 Hz and 129 kHz for echolocation, and between 2 and 10 kHz, and possibly up to 16 kHz, for social communication. There is no information on the hearing abilities of northern bottlenose whales. They are likely in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Vocalizations ranges are similar at 300 Hz to 135 kHz (DON 2008a) (Table 4.1).

4.13 Cuvier's Beaked Whale (*Ziphius cavirostris*) and 4.14 Mesoplodon Beaked Whales (*Mesoplodon* spp.): Western North Atlantic Stocks

Abundance, Density, and Stock Status: None of the beaked whales are listed as either endangered or threatened under the ESA. Cuvier's and *Mesoplodon* spp. beaked whales (including True's beaked whale, *M. mirus*; Gervais' beaked whale, *M. europaeus*; Blainville's beaked whale, *M. densirostris*; and Sowerby's beaked whale, *M. bidens*) are difficult to identify to the species level at sea; therefore, much of the available characterization for beaked whales is to genus level only. Because of this, they are grouped into what is called the "undifferentiated complex" of beaked whales and treated together for the purposes of stock assessments. Stock structure is unknown. Off the eastern U.S. and Canadian Atlantic coast the best and minimum population estimates for Cuvier's beaked whales are 6,532 (CV=0.32) and 5,021(Waring et al. 2014) The best and minimum abundance estimate for *Mesoplodon* complex is the sum of the 2011 survey estimates – 7,092 (CV=0.54), and 4,632 (Waring et al. 2014). Neither genus is listed as threatened or endangered under the ESA. The density estimates calculated for beaked whales were 0.0021 for the LME <200 m and 0.0156 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Beaked whales occur principally along the continental shelf edge and in deeper oceanic waters (CETAP 1982; Waring *et al.* 2007). Most sightings are in late spring and summer, which corresponds to survey effort. Distribution is otherwise derived from stranding reports (Waring *et al.* 2009). During spring and summer, Cuvier's and *Mesoplodon* spp. beaked whales occupy shelf-edge and deeper oceanic waters (CETAP 1982; Hamazaki 2002; Palka 2006). They are associated with warm waters (20.7° to 24.9° C), Gulf Stream features and warm-core rings, and steep bathymetry (Tove 1995; Hamazaki 2002; Waring et al. 2001; Palka 2006). During a 2002 survey south of GB, beaked whales were associated with water 500 m to 2000 m deep. Few beaked whales (*Mesoplodon* spp.) were sighted along the Mid-Atlantic Ridge during a summer 2004 vessel survey from the Reykjanes Ridge to north of the Azores, which was likely due to sub-optimal survey conditions (Waring *et al.* 2008).

Acoustics and Hearing: Cuvier's and *Mesoplodon* spp. beaked whales are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Vocalizations ranges are similar at 300 Hz to 135 kHz (DON 2008) (Table 4.1).

4.14 Melon-headed Whale (*Peponocephala electra*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Melon-headed whales are not listed as either endangered or threatened under the ESA. As summarized in Waring *et al.* (2011, and citations therein), the numbers of melon-headed whales off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen in any surveys. A group of melon-headed whales was sighted during both a 1999 (20 whales) and 2002 (80 whales) vessel survey of the western North Atlantic off of Cape Hatteras, North Carolina in waters >2500 m deep. Abundances have not been estimated from the 1999 and 2002 vessel surveys in western North Atlantic because the sighting was not made during line-transect sampling effort; therefore the population size of melon-headed whales is unknown. No melon-headed whales have been observed in any other surveys. The western North Atlantic population is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock(s). Present data are insufficient to calculate a minimum population estimate for this stock and there are insufficient data to determine the population trends. Potential Biological Remoal (PBR) for the western North Atlantic stock of melon-headed whales is unknown because the minimum population size is unknown.

Distribution and Habitat: Melon-headed whales are distributed worldwide in tropical and subtropical waters. They generally occur offshore in deep oceanic waters. Nearshore distribution is generally associated with deep water areas near to the coast (Perryman 2009). Squid appear to be the preferred prey, along with some fish and shrimp (Perryman 2009). They are often in large schools (mean school size is about 200), including in mixed schools with Fraser's dolphins (Perryman 2009, Wade and Gerrodette 1993). They may also form mixed schools with spinner, bottlenose, and rough-toothed dolphins (Perryman 2009). Females reach sexual maturity at approximately 11.5 years of age and males at about 15 years (Perryman 2009).

Acoustics and Hearing: Melon-headed whales are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall *et al.* 2007) (Table 4.1).

4.15 Risso's Dolphin (*Grampus griseus*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Risso's dolphins are not listed as either endangered or threatened under the ESA. Total numbers of Risso's dolphins off the U.S. or Canadian Atlantic coast are unknown, and data are insufficient for determining population trends (Waring *et al.* 2011). The best abundance estimate for Risso's dolphins combines estimates from the two 2011 U.S. Atlantic surveys, 18,250 (CV=0.46). The estimate from the northern U.S. Atlantic is 15,197, and from the southern U.S. Atlantic is 3,053. The minimum population estimate for the western North Atlantic Risso's dolphin is 12,619 (Waring et al. 2014). The density estimates calculated for Risso's dolphin were 0.0022 for the LME <200 m and 0.0844 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Risso's dolphins are distributed along the continental shelf edge from Cape Hatteras northward to GB during the spring, summer, and autumn (CETAP 1982; Payne et al. 1984). In winter, the range begins at the MAB and extends farther offshore into oceanic waters (Payne *et al.* 1984). In general, the population occupies the mid-Atlantic continental shelf edge year round, and is rarely seen in the GOM (Payne *et al.* 1984). During 1990, 1991, and 1993, spring/summer surveys conducted in continental shelf edge and deeper oceanic waters had sightings of Risso's dolphins associated with strong bathymetric features, Gulf Stream warm-core rings, and the Gulf Stream north wall (Waring *et al.* 1992).

Acoustics and Hearing: Risso's dolphins are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Vocalizations range from 400 Hz to 65 Hz (DON 2008) (Table 4.1).

4.16 Long-finned Pilot Whale (*Globicephala melas*): Western North Atlantic Stock

Abundance, Density, and Stock Status: There are two species of pilot whales in the western Atlantic: the long-finned pilot whale, *Globicephala melas melas*, and the short-finned pilot whale, *G. macrorhynchus*; short-finned pilot whales are discussed below (CETAP 1982; Waring *et al.* 2011, 2013). Neither is listed as threatened or endangered under the ESA. The best estimate of abundance for western North Atlantic long-finned pilot whales is 12,619 animals (CV=0.37). This reflects only the portion of the long-finned pilot whale population occupying U.S. waters. This is consistent with guidelines for assessment of trans-boundary stocks since the available mortality estimates are also restricted to U.S. waters. The minimum population estimate for long-finned pilot whales is 9,333 (Waring et al. 2014). The density estimates calculated for both species of pilot whales were 0.0345 for the LME <200 m and 0.0256 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Pilot whales (*Globicephala* sp.) occur throughout the NEFSC survey area from Canada to Cape Hatteras. Long-finned pilot whales concentrate along the Northeast U.S. shelf edge between the 100 m and 1000 m isobaths during mid-winter and early spring (CETAP 1982; Payne and Heinemann 1993; Abend and Smith 1999). In late spring, pilot whales move from the mid-Atlantic region onto GB and the Scotian Shelf, and into the GOM, where they remain through late autumn (Sergeant and Fisher 1957; Mitchell 1975b; CETAP 1982; Payne and Heinemann 1993; Waring *et al.* 2011). Pilot whales generally occur in areas of high relief or submerged banks and are also associated with the Gulf Stream wall and thermal fronts along the continental shelf edge (Hamazaki 2002). Pilot whales feed primarily on squid (Sergeant 1962; Mercer 1975; Gannon *et al.* 1997), but also consume fish (Overholtz and Waring 1991).

Acoustics and Hearing: *Globicephala* spp. are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Their vocalizations range from 2 to 60 kHz (DON 2008) (Table 4.1).

4.17 Short-finned Pilot Whale (*Globicephala macrorhynchus*): Western North Atlantic Stock

Abundance, Density, and Stock Status: The short-finned pilot whale is found in tropical to warm-temperate seas. It usually does not range north of 50° N or south of 40° S. Short-finned pilot whales occur worldwide in tropical to warm temperate waters and may seasonally extend into shelf-edge waters north of Cape Hatteras (Leatherwood and Reeves 1983). As summarized in waring *et al.* (2013), pilot whale biopsy samples were collected during summer months (June-August) from South Carolina to the southern flank of Georges Bank between 1998 and 2007. These samples were identified to species using genetic analysis of mitochondrial DNA sequences. A portion of the mtDNA genome was sequenced from each biopsy sample collected in the field, and genetic species identification was performed through phylogenetic reconstruction of the haplotypes. Samples from stranded specimens that were morphologically identified to species were used to assign clades in the phylogeny to species and thereby identify all survey samples. The probability of a sample being from a short-finned (or long-finned) pilot whale was evaluated as a function of sea surface temperature and water depth using logistic regression. This analysis indicated that the probability of a sample coming from a short-finned pilot whale was near 0 at water temperatures <22°C, and near 1 at temperatures >25°C. The probability of a short-finned pilot whale also increased with increasing water depth.

Spatially, during summer months, this regression model predicts that all pilot whales observed in offshore waters near the Gulf Stream are most likely short-finned pilot whales. The area of overlap between the 2 species occurs primarily along the shelf break off the coast of New Jersey between 38°N and 40°N latitude. This model was used to partition the abundance estimates from surveys conducted during the summer of 2011. The sightings from the southeast shipboard survey covering waters from Florida to central Virginia were predicted to consist entirely of short-finned pilot whales. The aerial portion of the northeast surveys covered the Gulf of Maine and the Bay of Fundy where the model predicted that only long-finned pilot whales would occur, but no pilot whales were observed. The vessel portion of the northeast survey recorded a mix of both species along the shelf break, and the sightings in offshore waters near the Gulf Stream were predicted to consist predominantly of short-finned pilot whales. The best abundance estimate for short-finned pilot whales is thus the sum of the 2004 southeast survey estimate (21,056 [CV=0.54]) and the estimated number of short-finned pilot whales from the northeast vessel survey (3,618 [CV=0.50]). The best available abundance estimate is thus 24,674 (CV=0.45) (Waring et al. 2014). The minimum population estimate for short-finned pilot whales is 17,190 (Waring et al. 2014).

Distribution and Habitat: Short-finned pilot whales occur worldwide in tropical to warm temperate waters and may seasonally extend into shelf-edge waters north of Cape Hatteras (Leatherwood and Reeves 1983). The NEFSC and Southeast Fisheries Science Center (SEFSC) are using genetic and photo-identification data to better define the northern range of this species and habitat overlap with the long-finned pilot whale off the northeastern U.S.

Acoustics and Hearing: Short-finned pilot whale whistles and clicks have a dominant frequency range of 2 to14 kHz and a source level of 180 dB re 1 µPa-m for whistles (DON 2008b). Globicephala spp. are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007) (Table 4.1).

4.18 Atlantic White-sided Dolphin (*Lagenorhynchus acutus*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Atlantic white-sided dolphins are not listed as threatened or endangered under the ESA. There are insufficient data to determine population trends and the total number of white-sided dolphins along the eastern U.S. and Canadian Atlantic coast is unknown (Waring *et al.* 2009). The best estimate of abundance for the western North Atlantic stock of white-sided dolphins is 48,819 (CV=0.61) derived from the 2011 summer surveys (Waring et al. 2014). The minimum population estimate for these white-sided dolphins is 30,403.The density estimates calculated for Atlantic white-sided dolphins were 0.0244 for the LME <200 m and 0.0 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Atlantic white-sided dolphins occur in temperate and sub-polar regions of the North Atlantic, primarily in continental shelf waters to the 100 m depth contour. The species ranges from central West Greenland to North Carolina (about 35˚ N) and perhaps as far east as 43˚ W (Evans 1987). Distribution of sightings, strandings, and incidental takes suggest the possible existence of three stocks: GOM, Gulf of St. Lawrence, and Labrador Sea stocks (Palka et al. 1997). Evidence for a separation between the well-documented unit in the southern GOM and a Gulf of St. Lawrence population comes from a lack of summer sightings along the Atlantic side of Nova Scotia. This was reported in Gaskin (1992), is evident in Smithsonian stranding records, and was seen during abundance surveys during the summers of 1995 and 1999 that covered waters from Virginia to the entrance of the Gulf of St. Lawrence. White-sided dolphins were seen frequently in the GOM and at the mouth of the Gulf of St. Lawrence, but few were recorded between these two regions. The GOM stock of white-sided dolphins is most common in continental shelf waters from Hudson Canyon (approximately 39˚ N) north through GB, and in the GOM to the lower Bay of Fundy.

Sightings data indicate seasonal shifts in distribution (Northridge et al. 1997). During January to May, low numbers of white-sided dolphins are found from GB to Jeffreys Ledge (off New Hampshire), and even lower numbers are found south of GB, as documented by a few strandings on beaches of Virginia and North Carolina. From June through September, large numbers of white-sided dolphins are found from GB to the lower Bay of Fundy, including waters of the western Gulf of Maine and east and southeast of Cape Cod (CETAP 1982; Selzer and Payne 1988; Hamazaki 2002). From October to December, they occur at intermediate densities from southern GB to southern GOM (Payne and Heinemann 1990). Sightings south of GB, particularly around Hudson Canyon, have been made at all times of the year but at low densities. The Virginia and North Carolina observations appear to represent the southern extent of the species range. Prior to the 1970s, white-sided dolphins in U.S. waters were found primarily offshore on the continental slope, while white-beaked dolphins (*L. albirostris*) were found on the continental shelf. During the 1970s, there was an apparent switch in habitat use between these two species. This shift may have been a result of the decrease in herring and increase in sand lance in the continental shelf waters (Katona et al. 1993; Kenney *et al.* 1996). White-sided dolphins are opportunistic feeders and their diet is based on available prey (Waring *et al.* 1990; Craddock *et al.* 2009).

White-sided dolphin habitat preference along the Mid-Atlantic Ridge, based on a summer 2004 vessel survey from the Reykjanes Ridge to north of the Azores, was associated with cold (5-16°C) and less saline (34.6-35.8‰) water masses north of the Charlie-Gibb Fracture Zone (Waring et al. 2008). Water depth ranged between 1200 m and 2400 m.

Acoustics and Hearing: Atlantic white-sided dolphins are in the mid-frequency functional hearing group with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Their vocalizations range from 6 to 15 kHz (DON 2008) (Table 4.1).

4.19 White-beaked Dolphin (*Lagenorhynchus albirostris*): Western North Atlantic Stock

Abundance, Density, and Stock Status: White-beaked dolphins are not listed as threatened or endangered under the ESA. Data are insufficient to determine population trends and the total number of white-beaked dolphins in U.S. and Canadian waters is unknown (Waring *et al.* 2009). The best and only recent abundance estimate for the western North Atlantic white-beaked dolphin is 2003 from 2006. This is presumably negatively biased because the survey only covered part of the species' range. The best estimate is 2,003 (CV=0.94) and the minimum population estimate for these white-beaked dolphins is 1,023 (Waring *et al.* 2009). The density estimates calculated for white-beaked dolphins were 0.0081 for the LME <200 m and 0.0 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: White-beaked dolphins are the more northerly of the two species of *Lagenorhynchus* in the northwest Atlantic (Leatherwood *et al.* 1976). They occur in waters from SNE north to western and southern Greenland and Davis Straits (Leatherwood *et al.* 1976; CETAP 1982), and in the Barents Sea and south to at least Portugal (Reeves *et al.* 1999). In waters off the northeastern U.S. coast, white-beaked dolphin sightings have been concentrated in the WGOM and around Cape Cod (CETAP 1982). The limited distribution of this species in U.S. waters has been attributed to opportunistic feeding (CETAP 1982). Prior to the 1970s, white-sided dolphins (*L. acutus*) in U.S. waters were found primarily offshore on the continental slope, while white-beaked dolphins were found on the continental shelf. During the 1970s, there was an apparent switch in habitat use between these two species. This shift may have been a result of the increase in sand lance in the continental shelf waters (Katona *et al.* 1993; Kenney *et al.* 1996).

White-beaked dolphins were only observed over the central part of the Reykjanes Ridge, during a summer 2004 vessel survey from the Reykjanes Ridge to north of the Azores (Waring *et al.* 2008).

Acoustics and Hearing: White-beaked dolphins are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Their vocalizations range from 6.5 to 15 kHz (DON 2008) (Table 4.1).

4.20 Short-beaked Common Dolphin (*Delphinus delphis*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Although the common dolphin may be one of the most widely distributed cetacean species, total numbers off the U.S. and Canadian Atlantic coasts is unknown, as is stock status within these waters. Data are also insufficient to determine population trends. Common dolphins are not listed as endangered or threatened under the ESA. The best estimate of abundance for common dolphins is 173,486 animals (CV=0.55). The minimum population estimate for the western North Atlantic common dolphin is112,531. The density estimates calculated for short-beaked common dolphins were 0.2115 for the LME <200 m and 0.1875 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Common dolphins are distributed world-wide in temperate, tropical, and subtropical seas. In the North Atlantic, they typically occur over the continental shelf along the 200-2000 m isobaths or over prominent underwater topography from 50º N to 40º N latitude (Evans 1994). The species is less common south of Cape Hatteras, although schools have been reported as far south as eastern Florida (Gaskin 1992). Common dolphins are distributed along the continental shelf -break and slope (100 to 2000 m), and are associated with Gulf Stream features in waters off the northeastern U.S. coast (CETAP 1982; Selzer and Payne 1988; Waring et al. 2007). They are widespread from Cape Hatteras northeast to GB (35˚ to 42˚ N) in outer continental shelf waters from mid-January to May (Hain et al. 1981; CETAP 1982; Payne *et al.* 1984). Common dolphins move northward onto GB and the Scotian Shelf from mid-summer to autumn. Selzer and Payne (1988) reported very large aggregations (greater than 3000 animals) on GB in autumn. They are occasionally found in the GOM, where temperature and salinity regimes are lower than on the continental slope of the GB/mid-Atlantic region (Selzer and Payne 1988). Migration onto the Scotian Shelf and continental shelf off Newfoundland occurs during summer and autumn when water temperatures exceed 11º C (Sergeant *et al.* 1970; Gowans and Whitehead 1995). Common dolphins are opportunistic feeders and their diet is based on available prey (Craddock and Polloni 2006; Overholtz and Waring 1991).

Common dolphins associated with warmer (>14°C) and more-saline (34.8-36.7‰) waters along the Mid-Atlantic Ridge during a summer 2004 vessel survey from the Reykjanes Ridge to north of the Azores (Waring *et al.* 2008). During some observations, the animals were associated with striped dolphins and Cory's shearwaters (*Calonectris diomedea*).

Acoustics and Hearing: Common dolphins are in the mid-frequency functional hearing group with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Their vocalizations range widely from 200 Hz to 150 kHz (DON 2008) (Table 4.1).

4.21 Atlantic Spotted Dolphin (*Stenella frontalis*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Atlantic spotted dolphins are not listed as threatened or endangered under the ESA. The Atlantic spotted dolphin occurs in two forms which may be distinct sub-species: the large, heavily spotted form which inhabits the continental shelf and is usually found inside or near the 200-m isobath; and the smaller, less spotted island and offshore form which occurs in the Atlantic Ocean but is not known to occur in the Gulf of Mexico. Prior to 1998, species of spotted dolphins were not differentiated during surveys, resulting in insufficient data to determine the population trends. Stock status is also unknown (Waring *et al.* 2007).

The best estimate of abundance for the western North Atlantic stock of Atlantic spotted dolphins is 44,715 (CV=0.43), derived from the 2011 surveys (Waring et al. 2014). The minimum population estimate for these Atlantic spotted is 31,610. The density estimates calculated for Atlantic spotted dolphins were 0.0 for the LME <200 m and 0.0208 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Atlantic spotted dolphins are distributed in tropical and warm temperate waters of the western North Atlantic (Leatherwood et al. 1976). They range from SNE, south through the Gulf of Mexico and the Caribbean to Venezuela (Leatherwood *et al.* 1976; Perrin *et al.* 1994). They regularly occur in the inshore waters south of Chesapeake Bay and near the continental shelf edge and continental slope waters north of this region (Payne *et al.* 1984; Mullin and Fulling 2003). Atlantic spotted dolphins north of Cape Hatteras also associate with the north wall of the Gulf Stream and warm-core rings (Waring *et al.* 1992).

Acoustics and Hearing: Atlantic spotted dolphins are in the mid-frequency functional hearing group with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Vocalizations similarly range from 100 Hz to 130 kHz (DON 2008) (Table 4.1).

4.22 Pantropical Spotted Dolphin (*Stenella attenuata*): Western North Atlantic Stock

Abundance, Density, and Stock Status: The pantropical spotted dolphin is distributed worldwide in tropical and some sub-tropical oceans (Perrin 2009b). There are two species of spotted dolphin in the Atlantic Ocean, the Atlantic spotted dolphin, *Stenella frontalis* (see account above), and the pantropical spotted dolphin, *S. attenuata* (Perrin *et al.* 1987). Where they co-occur, the offshore form of the Atlantic spotted dolphin and the pantropical spotted dolphin can be difficult to differentiate at sea. The western North Atlantic pantropical spotted dolphin population is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock(s).

As summarized in Waring *et al.* (2011 and citations therein), total numbers of pantropical spotted dolphins off the U.S. or Canadian Atlantic coast are unknown, although estimates are available from selected regions for select time periods. Sightings have been concentrated in the slope waters north of Cape Hatteras, but in the shelf waters south of Cape Hatteras sightings extend into the deeper slope and offshore waters of the mid-Atlantic. Because *S. frontalis* and *S. attenuata* are difficult to differentiate at sea, the reported abundance estimates, prior to 1998, are for both species of spotted dolphins combined. At their November 1999 meeting, the Atlantic SRG recommended that without a genetic determination of stock structure, the abundance estimates for the coastal and offshore forms should be combined. There remains debate over how distinguishable both species are at sea, though in the waters south of Cape Hatteras identification to species is made with very high certainty. This does not, however, account for the potential for a mixed species herd, as has been recorded for several dolphin assemblages. Pending further genetic studies for clarification of this problem, a single species abundance estimate will be used as the best estimate of abundance, combining species specific data from the northern as well as southern portions of the species' ranges

The best abundance estimate available for western North Atlantic pantropical spotted dolphins is 3,333 (CV=0.91), is derived from the 2011 surveys (Waring et al. 2014). The minimum population estimate is 1,733 dolphins. These surveys covered the waters from central Florida to the lower Bay of Fundy. However, no pantropical spotted dolphins were sighted in the northern component (Virginia to Bay of Fundy) of the surveys (Waring et al. 2014). There are insufficient data to determine population trends for this species, because prior to 1998 spotted dolphins were not differentiated during surveys.

Distribution and Habitat: Distribution of spotted dolphins is worldwide in tropical and some sub-tropical waters between 30-40° N latitude to 20-40° S latitude (Perrin 2009b). Offshore spotted dolphin habitat is characterized by well-stratified water, warm (>25° C) surface temperatures, low salinity, and a sharp, but shallow, thermocline at approximately 50 m (Ballance *et al.* 2006; Perrin 2009b; Reilly *et al.* 2002). Spotted dolphins primarily eat small epipelagic fish, squid, crustaceans, and flying fish in some areas (Perrin 2009b). Pantropical spotted dolphins often occur in large multi-species schools, particularly with spinner dolphins (Perrin 2009b). School size ranges from a few hundred to several thousand, with mean school size of 120 in the ETP (Perrin 2009b).

Acoustics and Hearing: Spotted dolphins are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall *et al.* 2007) (Table 4.1).

4.23 Striped Dolphin (*Stenella coeruleoalba*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Little information exists on stock structure of striped dolphins in the western North Atlantic. The species is not listed as either threatened or endangered under the ESA and data are inadequate to determine population trends (Waring *et al.* 2007). Total numbers of striped dolphins off the U.S. or Canadian Atlantic coast are unknown. The best abundance estimate for striped dolphins is the sum of the estimates from the two 2011 U.S. Atlantic surveys, 54,807 (CV=0.3) (Waring et al. 2014). The minimum population estimate for the western North Atlantic striped dolphin is 42,804. The density estimates calculated for striped dolphins were 0.0 for the LME <200 m and 0.3028 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: Striped dolphins in the western North Atlantic range from Nova Scotia south to, at least, Jamaica, and the Gulf of Mexico (Leatherwood *et al.* 1976; Perrin *et al.* 1994). Off the U.S. east coast, they distribute along the continental shelf edge from Cape Hatteras to the southern margin of GB, and also occur offshore over the continental slope and continental rise in the mid-Atlantic region (CETAP 1982; Mullin and Fulling 2003). Continental shelf edge sightings were generally centered along the 1000 m depth contour in all seasons (CETAP 1982). During 1990 and 1991 cetacean habitat-use surveys, striped dolphins were associated with the Gulf Stream north wall and warm-core ring features. Striped dolphins seen in a survey of the New England Sea Mounts were in waters that were between 20°

and 27° C and deeper than 900 m. Striped dolphins observed along the Mid-Atlantic Ridge during a summer 2004 vessel survey from the Reykjanes Ridge to north of the Azores were associated with warmer waters (> 18°C) (Waring *et al.* 2008). During some observations, animals associated with common dolphins and Cory's shearwater (*C. diomedea*).

Acoustics and Hearing: Striped dolphins are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Their vocalizations range from 6 to > 24 kHz (DON 2008) (Table 4.1).

4.24 Fraser's Dolphin (*Lagenodelphis hosei*): Western North Atlantic Stock

Abundance, Density, and Stock Status: Fraser's dolphins are distributed worldwide in tropical waters (Dolar 2009) and are assumed to be part of the cetacean fauna of the tropical western North Atlantic. As summarized in Waring *et al.* (2011 and citations therein), the paucity of sightings is probably due to naturally low abundance compared to other cetacean species. Sightings in the more extensively surveyed northern Gulf of Mexico are uncommon but occur on a regular basis. Fraser's dolphins have been observed in oceanic waters (>200 m) in the northern Gulf of Mexico during all seasons. The western North Atlantic population is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock(s).

The numbers of Fraser's dolphins off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen in any surveys. A group of an estimated 250 Fraser's dolphins was sighted in waters 3300 m deep in the western North Atlantic off Cape Hatteras during a 1999 vessel survey. Abundance has not been estimated from the 1999 vessel survey in western North Atlantic because the sighting was not made during line-transect sampling effort; therefore, the population size of Fraser's dolphins is unknown. No Fraser's dolphins have been observed in any other surveys. Therefore present data are insufficient to calculate a minimum population estimate for this stock.

Distribution and Habitat: Fraser's dolphins are a tropical species generally found between 30° N and 30° S (Dolar 2009). They are typically oceanic and commonly occur in water depths of 1500-2500 m. They prey primarily on mesopelagic fish, cephalopods, and crustaceans and, in the ETP, are thought to feed at 250 to 500 m depth (Dolar 2009). Fraser's dolphins often occur in tightly grouped, fast moving schools of 100-1,000 individuals. They commonly occur in large mixed-species schools with melon-headed whales in the Eastern Tropical pacific (Dolar 2009, Wade and Gerrodette 1993). They are deep divers and capable of diving to >600 m (Dolar 2009). Life history data is available for Fraser's dolphins off Japan. The age of sexual maturity appears to be 7-10 years for males and 5-8 years for females (Dolar 2009).

Acoustics and Hearing: Fraser's dolphins are classified in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz-160 kHz (Southall *et al.* 2007) (Table 4.1).

4.25 Rough-toothed Dolphin *(Steno bredanensis)*: Western North Atlantic Stock

Abundance, Density, and Stock Status: For management purposes, rough-toothed dolphins observed off the eastern U.S. coast are provisionally considered a separate stock from dolphins recorded in the northern Gulf of Mexico, although there is currently no information to differentiate these stocks. Additional morphological, genetic and/or behavioral data are needed to provide further information on stock delineation.

As summarized in Waring *et al.* (2013, and citations therein), the number of rough-toothed dolphins off the eastern U.S. and Canadian Atlantic coast is unknown, and seasonal abundance estimates are not available for this stock, since it was rarely seen during surveys. With one exception, sightings were exclusively over or seaward of the continental slope north of the Bahamas. Though abundance estimates have been calculated in some cases, given the paucity of sightings as well as limited survey effort in deep, offshore areas, an accurate abundance estimate has not been made, and therefore the population size of rough-toothed dolphins in the western North Atlantic is presently considered unknown. There have been no sightings of rough-toothed dolphins during shipboard or aerial surveys since 1999, except in the Caribbean, despite survey cruises conducted in areas where previous sightings of this species had been made. Survey effort in deep, offshore areas off the eastern U.S. coast and in the Caribbean, where this species may occur with more frequency, has, however, been limited. Recent surveys suggest a best estimate of 271 rough-toothed dolphins and a minimum estimate of 134 dolphins (Waring et al. 2014). The density estimates calculated for rough-toothed dolphins were 0.0 for the LME <200 m and 0.0016 for the offshore research area >200 m (Table 3.4).

Distribution and Habitat: This is a tropical to warm temperate species found in oceanic waters worldwide, as well as over continental shelf and coastal waters in some areas, including the ETP (Jefferson 2009a; May-Collado 2005). A summarized in Waring *et al.* (2011 and citations therein), five rehabilitated and tagged rough-toothed dolphins in the western North Atlantic moved through a large range of water depths averaging greater than 100 m, though each of the five tagged dolphins transited through very shallow waters at some point, with most of the collective movements recorded over a gently sloping sea floor. These five rough-toothed dolphins moved through waters ranging from 17° to 31°C, with temperatures averaging 21° to 30°C. Recorded dives were rarely deeper than 50 m, with the tagged dolphins staying fairly close to the surface. Three rehabilitated rough-toothed dolphins released with tags near Ft. Pierce, Florida in March 2005 were tracked in waters averaging 1,100 m in depth with sea surface temperatures averaging 24°C during the first week of tracking, moving to waters of 19°C. These dolphins are typically seen in small groups of 10-20 animals but larger groups of 50 or more are not uncommon. They feed on a variety of fish and cephalopods but their general ecology is poorly studied. They may stay submerged for up to 15 minutes and are known to dive as deep as 150 m (Jefferson 2009a).

Acoustics and Hearing: As summarized in DON (2008a), the rough-toothed dolphin produces a variety of sounds, including broadband echolocation clicks and whistles. Echolocation clicks typically have a frequency range of 0.1 to 200 kHz, with a dominant frequency of 25 kHz. Whistles have a wide frequency range of 0.3 to greater than 24 kHz but dominate in the 2 to 14 kHz range. They are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007) (Table 4.1).

4.26 Clymene Dolphin (*Stenella clymene*): Western North Atlantic Stock

Abundance, Density, and Stock Status: The numbers of Clymene dolphins off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this species since it was rarely seen in any surveys. The best estimate of abundance for the Clymene dolphin was 6,086 (CV=0.93) (Mullin and Fulling 2003) and represents the first and only estimate to date for this species in the U.S. Atlantic EEZ. No Clymene dolphins have been observed in subsequent surveys. No minimum population estimate is available and there are insufficient data to determine population trends for this stock

Distribution and Habitat: Clymene dolphins are found only in the Atlantic Ocean in tropical to warm-temperate waters; the exact range is not well understood (Jefferson 2009b). Most sightings have been in deep, offshore waters, but may be seen near shore when deep water approaches the coast (ibid). It likely feeds on mesopelagic fishes and squid. They are known to associate with spinner dolphins. Schools of this species are often moderately large but most consist of less than a few hundred animals (ibid).

Acoustics and Hearing: There has been little work done on the acoustic behavior of these animals but they appear to be quite vocal with whistles in the frequency range 0f 6-19 kHz (Jefferson 2009b). It is assumed that they are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007) (Table 4.1).

4.27 Spinner Dolphin (*Stenella longirostris*): Western North Atlantic Stock

Abundance, Density, and Stock Status: The numbers of spinner dolphins off the U.S. or Canadian Atlantic coast are unknown, and seasonal abundance estimates are not available for this stock since it was rarely seen in any of the surveys. Present data are insufficient to calculate a minimum population estimate and there are insufficient data to determine the population trends for this stock.

Distribution and Habitat: Spinner dolphins occur in all tropical and most sub-tropical waters between 30-40° N and 20-40° S latitude, generally in areas with a shallow mixed layer, shallow and steep thermocline, and little variation in surface temperatures (Perrin 2009a). Its distribution in the Atlantic is very poorly known. In the western North Atlantic, these dolphins occur in deep water along most of the U.S. coast south to the West Indies and Venezuela, including the Gulf of Mexico. Spinner dolphin sightings have occurred exclusively in deeper (>2,000 m) oceanic waters (Waring *et al.* 2011 and citations therein) off the northeast U.S. coast. Stranding records exist from North Carolina, South Carolina, Florida and Puerto Rico in the Atlantic and in Texas and Florida in the Gulf of Mexico. The western North Atlantic population is provisionally being considered a separate stock for management purposes, although there is currently no information to differentiate this stock from the northern Gulf of Mexico stock(s). School size varies from a few animals to over a thousand. Mixed schools with other species, particularly pantropical spotted dolphins, are common (Perrin 2009a). Mating appears to be promiscuous. Gestation is about 10 months and breeding is seasonal. Females reach sexual maturity at 4-7 years, and males at 7-10 years. Calving interval is 3 years and calves nurse for 1-2 years (Perrin 2009a).

Acoustics and Hearing: Spinner dolphins produce an array of whistles and burst pulses that vary by activity and geographically (Perrin 2009a). Spinner dolphins are in the mid-frequency functional hearing group of Southall *et al.* (2007), with an estimated auditory bandwidth of 150 Hz to 160 kHz (Table 4.1).

4.28 Common Bottlenose Dolphin (*Tursiops truncatus*): Various Stocks

There are two morphologically and genetically distinct common bottlenose dolphin morphotypes (Duffield *et al.* 1983; Duffield 1986) described as the coastal and offshore forms. Both inhabit waters in the western North Atlantic Ocean (Hersh and Duffield 1990; Mead and Potter 1995; Curry and Smith 1997) along the U.S. Atlantic coast. The two morphotypes are genetically distinct based upon both mitochondrial and nuclear markers (Hoelzel *et al.* 1998). Hersh and Duffield (1990) also described morphological differences between offshore morphotype dolphins and dolphins with hematological profiles matching the coastal morphotype which had stranded in the Indian/Banana River in Florida. North of Cape Hatteras, there is separation of the two morphotypes across bathymetry during summer months.

Abundance, Density, and Stock Status:

<u>Coastal Morphotype</u>

The coastal migratory stock was designated as depleted under the MMPA. From 1995 to 2001, NMFS recognized only one migratory stock of coastal bottlenose dolphins in the western North Atlantic, with the entire stock listed as depleted.

Stock structure was revised in 2002 to recognize both multiple stocks and seasonal management units and again in 2008 and 2009 to recognize resident estuarine stocks and migratory and resident coastal stocks (Waring et al. 2010, Table 3). The western North Atlantic coastal stock was, subsequently, divided into the Central Florida, Northern Florida, South Carolina-Georgia, and the Southern Migratory and Northern Migratory Coastal stocks (Rosel et al. 2009, Waring et al. 2010). All coastal stocks retain the depleted status (Waring et al. 2010). The resident estuarine stocks within range of the NEFSC research area include: Northern North Carolina Estuarine System (NNCES), Southern North Carolina Estuarine System (SNCES), Northern South Carolina Estuarine System (NSCES), Charleston Estuarine System (CES), Northern Georgia/Southern South Carolina Estuarine System (NGSSCES), Southern Georgia Estuarine

System (SGES), Jacksonville Estuarine System (JES), and Indian River Lagoon Estuarine System (IRLES). The Southern Migratory and Northern Migratory Coastal stocks are those most likely to interact with NEFSC fisheries research activities; the estuarine system stocks do not overlap in time or space with most NEFSC-affiliated research activities; only the COASTSPAN and Apex predators surveys occur in areas where these stocks may occur. The species is not listed as threatened or endangered under the ESA (Waring *et al.* 2009).

The best abundance estimates for the Northern and Southern Migratory Coastal stocks are from summer 2010 and 2011 surveys. The resulting abundance estimate for the Northern Migratory Coastal stock was 11,548 and the Southern Migratory Coastal Stock was 9,173. The respective PBRs are 86 and 63 (Waring et al. 2014). Total U.S. fishery-related mortality and serious injury for these stocks cannot be directly estimated because of spatial overlap of several stocks in North Carolina. Best estimates of annual average mortality and serious injury for 2007-2011 was 3.8-5.8 for the Northern Migratory Coastal stock and 2.6-16.5 for the Southern Migratory Coastal stock. Most are taken in the Mid-Atlantic coastal gillnet fishery (Waring et al. 2014).

The best available abundance estimates for the estuarine system stocks are based on 2006 survey data. Please refer to Table 3-2 for abundance estimates for the numerous estuarine stocks. Many of these stocks are small or of unknown size so PBR values are small or cannot be determined for lack of a minimum population estimate. These stocks are considered strategic under the MMPA either because estimated human-caused mortality and serious injury exceeds 10 percent of PBR (i.e., NNCES and SNCES) or because relatively few human-caused mortality and serious injuries would likely exceed PBR if it could be calculated (i.e., stocks with unknown PBR).

The density estimates calculated for offshore stock of bottlenose dolphins were 0.0060 for the LME <200 m and 0.0526 for the offshore research area >200 m (Table 3.4). The density estimates calculated for coastal stocks were 0.1033 for the LME <200 m and 0.0 for the offshore research area >200 m (Table 3.4).

Offshore Morphotype

The western North Atlantic offshore bottlenose dolphin is not listed as depleted under the MMPA, or as threatened or endangered under the ESA. Stock status within U.S. Atlantic waters is unknown and data are insufficient to determine population trends. The best available estimate for offshore morphotype bottlenose dolphins in the western North Atlantic is 77,532 (CV=0.40). This estimate is from summer 2011 surveys covering waters from central Florida to the lower Bay of Fundy (Waring et al. 2014. Additional abundance estimates were obtained from aerial surveys of the northern portion of the range in August 2002 (southern edge of GB to Maine: 5,100 animals) and in August 2006 (southern edge of GB to the upper Bay of Fundy and to the entrance of the Gulf of St. Lawrence: 2,989 animals) (Waring *et al.* 2009). Although the latter estimates encompass only a portion of the range of western North Atlantic bottlenose dolphins, they include most of the area in which NEFSC conducts surveys. Please refer to Table 3-2 for abundance estimates for the numerous stocks of offshore bottlenose dolphin.

Distribution and Habitat: The coastal morphotype of bottlenose dolphins is continuously distributed along the Atlantic coast south of Long Island, New York around the Florida peninsula and into the Gulf of Mexico. The offshore form is distributed primarily along the outer continental shelf and continental slope from GB to Cape Hatteras during spring and summer (CETAP 1982; Kenney 1990). North of Cape Hatteras, there is separation of the two morphotypes across bathymetry during summer months. Aerial surveys flown during 1979-1981 indicated a concentration of bottlenose dolphins in waters < 25 m deep corresponded with the coastal morphotype, and an area of high abundance along the shelf break, corresponded with the offshore stock (CETAP 1982; Kenney 1990). Biopsy tissue sampling and genetic analysis demonstrated that bottlenose dolphins concentrated in nearshore waters (< 20 m deep) were of the coastal morphotype, while those in waters > 40 m depth were from the offshore morphotype (Garrison *et al.* 2003). Torres *et al.* (2003) found a statistically significant break in the distribution of the morphotypes at 34 km from shore, based upon the genetic analysis of tissue samples collected in nearshore and offshore waters.

The offshore morphotype was found exclusively seaward of 34 km and in waters deeper than 34 m. Within 7.5 km of shore, all animals were of the coastal morphotype. More recently, offshore morphotype animals have been sampled as close as 7.3 km from shore, in water depths of 13 m (Garrison *et al.* 2003). Systematic biopsy collection surveys were conducted coast-wide during summer and winter 2001-2005 to evaluate the degree of spatial overlap between the two morphotypes. Over the continental shelf south of Cape Hatteras, the two morphotypes overlap spatially, and the probability of a sampled group being from the offshore morphotype increased with increasing depth (Garrison *et al.* 2003). During winter months, bottlenose dolphins are rarely observed north of the North Carolina-Virginia border, and their northern distribution appears to be limited by water temperatures < 9.5 ºC (Garrison *et al.* 2003; Kenny 1990).

Acoustics and Hearing: Coastal and offshore stocks of bottlenose dolphins are in the mid-frequency functional hearing group, with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall *et al.* 2007). Bottlenose dolphin vocalization frequencies range from 3.4 to 130 kHz (DON 2008) (Table 4.1).

4.29 Harbor Porpoise (*Phocoena phocoena*): Gulf of Maine/Bay of Fundy Stock

Abundance, Density, and Stock Status: The stock of harbor porpoise found in U.S. and Canadian Atlantic waters is the GOM/Bay of Fundy stock (Waring *et al.* 2014). This stock is currently not listed under the ESA. In 1993, however, NMFS proposed listing the GOM harbor porpoise as threatened under the ESA (NMFS 2001). NMFS subsequently made available a review of the biological status of the GOM/Bay of Fundy harbor porpoise population and the determination was made that listing under the ESA was not warranted. The stock was removed from the ESA candidate species list (NMFS 2001). Population trends for this species are unknown. The best, and most recent, population estimate for harbor porpoise in the GOM/Bay of Fundy region is 79,833 (CV=0.32), based on 2011 survey results. The minimum estimated population size is 61,415 (Waring *et al.* 2011, 2014).

The density estimates calculated for harbor porpoise were 0.0193 for the LME <200 m and 0.0 for the offshore research area >200 m (Table 3.4). Distribution and Habitat: The Gulf of Maine/Bay of Fundy harbor porpoise population primarily occupies cooler (< 17° C) and relatively shallow (< 200 m) coastal waters off the Northeast U.S. and adjacent waters in the Bay of Fundy and southwest Nova Scotia, Canada (Gaskin 1984; Palka *et al.* 1996; Read 1999). Observed bycatch in the winter Atlantic pelagic drift gillnet fishery off Cape Hatteras (Read *et al.* 1996) and satellite tracks of a rehabilitated animal (Westgate *et al.* 1998) indicate that they also use deeper (> 1800 m) waters off the Northeast U.S. Harbor porpoise exhibit strong seasonal distribution patterns off the Northeast U.S. coast. During summer (July to September), they concentrate in the northern GOM and southern Bay of Fundy region, with highest densities in waters between 10° and 15.5° C (Gaskin 1977; Gaskin and Watson 1985; Kraus *et al.* 1983; Palka 1995a, b; Palka *et al.* 1996). There are a few sightings in the upper Bay of Fundy and on the northern edge of GB at that time (Palka 2000). During fall (October-December) and spring (April-June), harbor porpoise are widely dispersed from New Jersey to Maine, with lower densities farther north and south. A component of the population occupies shelf waters between Massachusetts and North Carolina during fall (Palka *et al.* 1996). During winter (January to March), intermediate densities of harbor porpoise can be found in waters off New Jersey to North Carolina, and lower densities are found in waters off New York to New Brunswick, Canada. Habitat use is believed to be associated with prey, particularly Atlantic herring (Recchia and Read 1989; Palka 1995; Gannon *et al.* 1998).

Acoustics and Hearing: Harbor porpoise are in the high-frequency functional hearing group, whose estimated auditory bandwidth is 200 Hz to 180 kHz (Southall *et al.* 2007). Their vocalizations range from 110 to 150 kHz (DON 2008) (Table 4.1).

4.30 Harbor Seal (*Phoca vitulina concolor*): Western North Atlantic Stock

Abundance, Density, and Stock Status: The stock structure of the western North Atlantic population of harbor seals is unknown, although those found along the eastern U.S. and Canadian coasts are thought to represent one population (Temte et al. 1991). Observed counts of harbor seals along the New England coast have been steadily increasing since passage of the MMPA in 1972. The most recent coast-wide aerial survey along the Maine coast was conducted in May/June 2001 during pupping (Gilbert et al. 2005). The survey included replicate surveys and radio tagged seals to obtain a correction factor for animals not hauled out. The corrected estimate for 2001 is 99,340 (Waring *et al.* 2009). The minimum population estimate is 91,546. Uncorrected counts of seals increased from 10,543 to 38,014 between 1981 and 2001, for an annual rate of increase of 6.6 percent (Gilbert *et al.* 2005). However, Waring *et al.* (2014) suggest a slight decrease in abundance with a best estimate of 70,142 (CV=0.29) harbor seals and a minimum estimate of 48,980 seals. Increased abundance of seals in the Northeast region has ~~also~~ been documented at overwintering haul-out sites from the Maine/New Hampshire border to eastern Long Island and New Jersey (Payne and Selzer 1989; Rough 1995; Barlas 1999; Schroeder 2000; deHart 2002). The density estimates calculated for harbor seals were 0.2844 for the LME <200 m and 0.0 for the offshore research area >200 m (Table 3.4). Harbor seals are not considered threatened or endangered under the ESA.

Distribution and Habitat: Harbor seals occupy all nearshore waters of the Atlantic Ocean and adjoining seas above about 30º N (Katona *et al.* 1993). In the western north Atlantic, they are distributed from the eastern Canadian Arctic and Greenland south to SNE and New York, and occasionally to the Carolinas (Mansfield 1967; Boulva and McLaren 1979; Katona *et al.* 1993; Gilbert and Guldager 1998; Baird 2001). In U.S. waters, breeding and pupping normally occur in waters north of the New Hampshire/Maine border, although breeding occurred as far south as Cape Cod in the early part of the 20th century (Temte *et al.* 1991; Katona *et al.* 1993). Harbor seals are year-round inhabitants of the coastal waters of eastern Canada and Maine (Katona et al. 1993), and occur seasonally along the SNE and New York coasts from September through late May (Schneider and Payne 1983). In recent years, their seasonal interval along the SNE to New Jersey coasts has increased (Barlas 1999; Hoover *et al.* 1999; Slocum et al. 1999; Schroeder 2000; deHart 2002). Scattered sightings and strandings have been recorded as far south as Florida (NMFS unpublished data). A general southward movement from the Bay of Fundy to SNE waters occurs in autumn and early winter (Rosenfeld *et al.* 1988; Whitman and Payne 1990; Barlas 1999; Jacobs and Terhune 2000). A northward movement from SNE to Maine and eastern Canada occurs prior to the pupping season, which takes place from mid-May through June along the Maine coast (Richardson 1976; Wilson 1978; Whitman and Payne 1990; Kenney 1994; deHart 2002). No pupping areas have been identified in SNE (Payne and Schneider 1984; Barlas 1999). More recent information suggests that some pupping is occurring at high-use haul-out sites off Manomet, Massachusetts.

Harbor seals use a variety of terrestrial and aquatic habitats in U.S. waters. Their activities are influenced by regional topography, life history requirements, environmental parameters, anthropogenic activities, prey distribution, and, possibly, inter-specific competition with gray seals (Richardson 1976, Gilbert and Stein 1981, Schneider and Payne 1983, Payne and Selzer 1989, Barlas 1999, Lucas and Stobo 2000, Schroeder 2000, deHart 2002, Bowen et al. 2003, Renner 2005, Robillard *et al.* 2005). Rocky areas (i.e., small islands, isolated rocks, tidal ledges) are the predominant haul-out substrate in coastal waters from the Maine – Canadian border south to Plymouth, Massachusetts (Richardson 1976, Schneider and Payne 1983, Harris *et al.* 2003, Gilbert *et al.* 2005, Renner 2005). Rocky substrates are also used during pupping, breeding and molting seasons when harbor seals are concentrated in Maine coastal waters (Richardson 1976, Katona *et al.* 1993, Guldager 2001, Gilbert *et al.* 2005). Between Cape Cod and New Jersey, the coastal geology is more variable and seals utilize a wider variety of substrates (i.e., tidally exposed sand and gravel bars, sand-peat hummock in tidal marshes, sandy beaches and islands, rock outcroppings and stone jetties) (Schneider and Payne 1983, Payne and Selzer 1989, Barlas 1999, Schroeder 2000, deHart 2002). Seals also haul-out on near-shore ice (Katona *et al.* 1993), and small groups have been observed on ice floes around Cape Cod in winter when conditions restrict access to traditional (i.e., sandy beach) haul-out sites (John Prescott, pers. comm., Massachusetts Audubon Society, Wellfleet, Massachusetts).

Further, storm events alter the characteristics of or access to "sandy" haul-out sites, particularly around the outer portion of Cape Cod and eastern Nantucket Sound. Harbor seals readily acclimate to newly formed haul-out sites (i.e., barrier beach breaks, re-emerged sand bars), thus giving the appearance of a "sudden influx" or "population growth" of seal populations in Cape Cod waters. The use of non-coastal waters (i.e. > 25 nm from the coast) has been documented in fishery bycatch data (Waring *et al.* 2007).

Harbor seals are opportunistic predators and the diet composition exhibits temporal and spatial preferences (Selzer and Payne 1989; Williams 1999; Craddock and Polloni 2006). Harbor seal diet off the Northeast U.S. coast reflects seasonal spatial distributions of prey delineated in NEFSC research trawl surveys (Mountain and Murawski 1992; Garrison 2001). For example, sandlance (*Ammodytes* spp.) are abundant on Stellwagen Bank, which is adjacent to a major harbor seal haul-out location on the outer portion of Cape Cod, and, silver hake (*Merluccius bilinearis*) is widely distributed in the Gulf of Maine.

Acoustics and Hearing: Harbor seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall *et al.* 2007). Vocalizations range from 25 Hz to 4 kHz (DON 2008) (Table 4.1).

4.31 Gray Seal *(Halichoerus grypus)*: Western North Atlantic Stock

Abundance, Density, and Stock Status: The western North Atlantic stock of gray seals is equivalent to the eastern Canada population, and ranges from New England to Labrador (Mansfield 1966; Katona et al. 1993; Davies 1957; Lesage and Hammill 2001). Approximately 57 percent of the western North Atlantic population is from the Sable Island, Canada stock. Current estimates of the total western Atlantic gray seal population are not available, but the stock's abundance appears to be increasing in Canadian and U.S. waters. The species is not listed as threatened or endangered under the ESA (Waring *et al.* 2011). The size of the total Canadian population from 1969-2012 has been estimated using updated age-specific reproductive rate data, and accounting for higher pup mortality in the Gulf breeding colony due to years with poor ice condition (DFO, 2012, in review; Hammill *et al.* 2012, in review). For Sable Island the 2012 pup production estimate is 67,000 (95% CI=56,000 to 85,000), the total population size estimate of 262,000 (95% CI 219,000-332,000). Model estimates for coastal Nova Scotia were 2,300 (95% CI =1,100-3800) pups and a total population of 20,000 (95% CI= 17,000-23,000) in 2012. For the Gulf in 2012, pup production was estimated to be 7,000 (95% CI=2,900-15,200), and a total population of 49,000 (95% CI=27,000-102,000). The combined 2012 pup production is estimated to be 76,300 (95% CI=60,000-105,000), with a total population of 331,000 (95% CI=262,000-458,000). Data are currently insufficient to calculate the minimum population estimate, or density estimates, for U.S. waters (Waring et al. 2014).

Distribution and Habitat: Gray seals occur on both sides of the North Atlantic, with three major populations in eastern Canada, northwestern Europe and the Baltic Sea (Katona et al. 1993). There are two breeding concentrations in eastern Canada: one at Sable Island, and one on the pack ice in the Gulf of St. Lawrence (Laviguer and Hammill 1993). Tagging studies indicate that there is little intermixing between the two breeding groups (Zwanenberg and Bowen 1990), and for management purposes, they are treated by the Canadian Department of Fisheries and Oceans as separate stocks (Mohn and Bowen 1996).

In U.S. waters, gray seals currently pup at three established colonies: Muskeget Island, Massachusetts, Green Island, Maine, and Seal Island, Maine, as well as, more recently, at Matinicus Rock and Mount Desert Rock in Maine. Gray seals have been observed using the historic pupping site on Muskeget Island in Massachusetts since 1990. Pupping has taken place on Seal and Green Islands in Maine since at least the mid 1990s. Aerial survey data from these sites indicate that pup production is increasing. A minimum of 2,620 pups (Muskeget= 2,095, Green= 59, Seal= 466) were born in the U.S. in 2008 (Wood LaFond 2009).

Gray seals are also observed in New England outside of the pupping season. In April-May 1994 a maximum count of 2,010 was obtained for Muskeget Island and Monomoy combined (Rough 1995). Maine coast-wide surveys conducted during summer revealed 597 and 1,731 gray seals in 1993 and 2001, respectively (Gilbert *et al.* 2005). In March 1999 a maximum count of 5,611 was obtained in the region south of Maine (between Isles of Shoals, Maine and Woods Hole, Massachusetts) (Barlas 1999). In March 2011 a maximum count of 15,756 was obtained in southeastern Massachusetts coastal waters (Waring et al. 2014).

Gray seals use a variety of terrestrial and aquatic habitats in U.S. waters, and topography, life history requirements, environmental parameters, anthropogenic activities, prey distribution, and, perhaps, competition with harbor seals influence their activities (Lucas and Stobo 2000; Robillard *et al.* 2005; Murray 2009). They readily acclimate to newly formed haul-out sites, such as barrier beach breaks and re-emerged sand bars, thus giving the appearance of a "sudden influx" or "population growth" of seal populations in Cape Cod waters. Gray seal use of waters > 25 nm from the coast has been documented through fishery bycatch data (Waring *et al.* 2007). Tagging studies in Atlantic Canada and New England have also documented trans-boundary movements of gray seals (Wood 2009; NMFS/NEFSC, unpublished data). Gray seals are opportunistic predators and diet composition reflects temporal and spatial prey preferences (Rough 1995; Craddock and Polloni 2006; Ampela 2009).

Acoustics and Hearing: Gray seals, as with all pinnipeds, are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall *et al.* 2007). Vocalizations range from 100 Hz to 3 kHz (DON 2008) (Table 4.1).

4.32 Harp Seal (*Pagophilus groenlandica*): Western North Atlantic Stock

Abundance, Density, and Stock Status: The world's harp seal population is divided into three separate stocks, each identified with a specific breeding site (Bonner 1990; Lavigne and Kovacs 1988). The largest stock is located off eastern Canada and is divided into two breeding herds which breed on the pack ice. The Front herd breeds off the coast of Newfoundland and Labrador, and the Gulf herd breeds near the Magdalen Islands in the middle of the Gulf of St. Lawrence (Sergeant 1965; Lavigne and Kovacs 1988). The second stock breeds on the West Ice off eastern Greenland (Lavigne and Kovacs 1988). The third stock breeds on the ice in the White Sea off the coast of Russia. The Front/Gulf stock is equivalent to western north Atlantic stock. The status of the western north Atlantic harp seal stock in the U.S. Atlantic is unknown, but the stock's abundance appears to have stabilized (McAlpine and Walker 1990). The species is not listed as threatened or endangered under the ESA (Waring *et al.* 2009).

The population size for western North Atlantic harp seals in 2012 was 7.1 million animals (95% CI 5.9-8.3 million; Hammill *et al.* 2012), based on a population model that was applied to 1952-2012 population data (Waring et al. 2014). Data are insufficient to calculate the minimum population estimate and density estimates for U.S. waters (Waring et al. 2014). The increased number of stranded harp seals suggests an increasing harp seal population in U.S. waters (Waring et al. 2014).

Distribution and Habitat: Harp seals occur throughout much of the North Atlantic and Arctic Oceans (Ronald and Healey 1981; Lavigne and Kovacs 1988) and are highly migratory (Sergeant 1965; Stenson and Sjare 1997). Breeding occurs at different times for each stock between mid-February and April. Adults then assemble north of their whelping patches to undergo the annual molt. The migration then continues north to Arctic summer feeding grounds. In late September, after a summer of feeding, nearly all adults and some of the immature animals of the western north Atlantic stock migrate southward along the Labrador coast, usually reaching the entrance to the Gulf of St. Lawrence by early winter. There they split into two groups, one moving into the Gulf and the other remaining off the coast of Newfoundland.

The southern limit of the harp seal's habitat extends into the U.S. Atlantic waters during winter and spring.

In recent years, numbers of sightings and strandings have been increasing off the east coast of the U.S. from Maine to New Jersey (Katona *et al.* 1993; Stevick and Fernald 1998; McAlpine 1999; Lacoste and Stenson 2000). These extralimital appearances usually occur in January-May (Rubinstein 1994; Harris *et al.* 2002), when the western North Atlantic stock of harp seals is at its most southern point of migration. Concomitantly, a southward shift in winter distribution off Newfoundland was observed during the mid-1990s, which was attributed to abnormal environmental conditions (Lacoste and Stenson 2000). Most of the information on their distribution in Northeast U.S. waters is limited to fishery bycatch and stranding records (Waring *et al.* 2007). In coastal regions, individual harp seals have been observed on coastal beaches, frozen ponds, up coastal rivers or on ice floes. Overall, little is known regarding the ecology of harp seals in U.S. waters.

Acoustics and Hearing: Harp seal, as with other pinnipeds, are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall *et al.* 2007). The frequencies of underwater vocalizations range from 66 to 120 kHz (DON 2008) (Table 4.1).

4.33 Hooded Seal (*Cystophora cristata*): Western North Atlantic Stock

Abundance, Density, and Stock Status: The western North Atlantic stock of hooded seals appears to be increasing in abundance, although stock status in U.S. Atlantic waters is unknown. The number of hooded seals in the western North Atlantic is relatively well known and is derived from pup production estimates produced from whelping pack surveys. The best abundance estimate for western North Atlantic hooded seals is 592,100. The minimum population estimate based on the 2005 pup survey is 512,000. Data are not currently adequate to calculate the minimum population estimate or density estimates for U.S. waters. The species is not listed as threatened or endangered under the ESA (Waring *et al.* 2007).

Distribution and Habitat: The hooded seal occurs throughout much of the North Atlantic and Arctic Oceans (King 1983) preferring deeper water and occurring farther offshore than harp seals (Sergeant 1976; Campbell 1987; Lavigne and Kovacs 1988; Stenson *et al.* 1996). The western North Atlantic stock of hooded seals whelps off the coast of eastern Canada and is divided into three whelping areas. The Front herd (largest) breeds off the coast of Newfoundland and Labrador, Gulf herd breeds in the Gulf of St. Lawrence, and the third area is in the Davis Strait. Hooded seals are highly migratory and may wander as far south as Puerto Rico (Mignucci-Giannoni and Odell 2001), with increased occurrences from Maine to Florida. These appearances usually occur between January and May in New England waters, and in summer and autumn off the southeast U.S. coast and in the Caribbean (McAlpine et al. 1999; Harris et al. 2001; Mignucci-Giannoni and Odell 2001). Three of 4 hooded seals stranded, satellite tagged, and released in the U.S. in 2004 migrated to the eastern edge of the Scotian Shelf and 2 of the 4 seals moved to the southeast tip of Greenland (Waring *et al.* 2009; WHALENET at http://whale.wheelock.edu). Although it is not known which stock these seals come from, it is known that during spring, the northwest Atlantic stock of hooded seals are at their southernmost point of migration in the Gulf of St. Lawrence.

Acoustics and Hearing: Like other pinnipeds, hooded seals are assigned to functional hearing groups based on the medium (air or water) through which they are detecting the sounds, for an estimated auditory bandwidth of 75 Hz to 75 kHz (Southall *et al.* 2007). Vocalizations range from <4 to 120 kHz (DON 2008) (Table 4.1).

5.0 TYPE OF INCIDENTAL TAKE AUTHORIZATION REQUESTED

Regulations and a five year Letter of Authorization (LOA) for the incidental taking of marine mammals is requested pursuant to Section 101(a)(5)(A) of the Marine Mammal Protection Act (MMPA).

The term "take," as defined in Section 3 (16 U.S. Code [U.S.C.] 1362 of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of "harassment", Level A (injury) and Level B (disturbance).

The NEFSC requests regulations and LOA to authorize potential lethal and non-lethal incidental takes during its planned scientific operations. The requested numbers of authorized lethal and serious injury[7] takes and non-serious injury "Level A" and "Level B" harassment takes per year are discussed in Section 6. Although instances of mortality and serious injury are rare during NEFSC research activities, the NEFSC requests that the LOA authorize a small number of incidental, non-intentional, lethal or serious injury takes of marine mammals in the event that they might occur, and in spite of the monitoring and mitigation efforts described in Sections 11, 13, and 14.

Potential gear-related takes: The possible take during NEFSC surveys using Gourock high-speed midwater rope trawl nets, pelagic trawl nets, and bottom trawl nets (e.g., 4-seam, 3-bridle bottom trawl; see Table 1-1a, b) may occur in two forms: (1) take by accidental entanglement that may cause mortality and serious injury, and (2) take by accidental entanglement that may cause non-serious injury ("Level A" harassment take). The surveys using the Gourock high speed trawl are used to assess Atlantic herring and are integral to the acoustic segment of the herring surveys; pelagic trawl nets are used to assess young gadoids (e.g., cod, haddock, pollock) and deepwater biodiversity, and 4-seam, 3-bridle bottom trawls are used in an assortment of surveys (see Table 1-1a, b).

A single instance of a short term entanglement of a minke whale occurred in the 2009 Atlantic Herring Survey. According to the incident report, "The net's cod end and whale were brought aboard just enough to undo the cod end and free the whale. It was on deck for about five minutes. While on deck, it was vocalizing and moving its tail up and down. The whale swam away upon release and appeared to be fine. Estimated length was 19 feet." This incidental take was later classified as a serious injury using NMFS criteria for such determinations published in January 2012 (Cole and Henry 2013).

Incidental mortality of a single harbor seal was recorded in fyke net sampling conducted by the Marine Estuaries Diadromous Survey in Penobscot Bay on 25 October 2010. Subsequent to that, a marine mammal excluder device was added to the net and no further incidental takes were reported.

The NEFSC or cooperating institutions may incidentally take marine mammals during surveys using gillnets. A single common bottlenose dolphin mortality was recorded in a gillnet conducted by a NEFSC cooperative research partner in South Carolina in 2008. Incidental take resulting in mortality and serious injury and "Level A" harassment may also occur by longline even though there is no history of such a take during NEFSC fishery surveys.

The NEFSC also uses dredge gear, fish and shellfish pots/traps, beach seines, rotary screw traps, oceanographic and hydrographic sampling instruments, various plankton nets, Van Veen sediment grabs, towed camera sleds, and remotely operated vehicles (Tables 1-1 and 1-2), but will not request

[7] NMFS interprets the regulatory definition of serious injury (i.e., "any injury that will likely result in mortality") as any injury that is "more likely than not" to result in mortality, or any injury that presents a greater than 50 percent chance of death to a marine mammal (http://www.nmfs.noaa.gov/pr/pdfs/serious_injury_procedure.pdf). Thus, the definition does not require that all such injured animals actually die, but rather requires only that the animal is more likely than not to die. Further, an injury must directly contribute to the death or likely death of the animal to be classified as a serious injury (NMFS Policy Directive 02-238, January 27, 2012).

mortality/serious injury or non-serious Level A takes for this gear since no takes have occurred historically and no marine mammals are expected to be taken in the future.

The “Level B” take by harassment may occur as the result of using active acoustic sources during survey operations in all areas surveyed by the NEFSC. The ‘take’ may be manifested as a temporary threshold shift (TTS) (Southall *et al.* 2007) in the immediate vicinity of the sound source where the received levels of sound exposure might be high enough to cause a temporary loss of hearing sensitivity, or in the zone of responsiveness where the received level is such that the animal responds by causing behavioral modifications, or by vessel movement in areas where marine mammals occur (Holt 2008). No permanent hearing loss or physiological damage (permanent threshold shift [PTS] Southall et al. 2007) is expected to occur to marine mammals by the acoustic gear or vessel movements during NEFSC surveys in the western North Atlantic Ocean.

Level B harassment may also occur due to the physical presence of researchers for a small set of research activities along the Penobscot River estuary in Maine. There is one tidal ledge where harbor seals and gray seals haul out on a regular basis and where researchers may disturb them incidental to passing the area in small skiffs. Researchers avoid close passes of the haulout and do not set research gear near the haulout. Behavioral disturbance may include head lifts, shifts in body position towards the water, or seals entering the water. Small numbers of such disturbances are estimated in Section 6.3.

6.0 THE NUMBER OF MARINE MAMMALS THAT MAY BE TAKEN BY EACH TYPE OF TAKING, AND THE NUMBER OF TIMES SUCH TAKINGS BY EACH TYPE OF TAKING ARE LIKELY TO OCCUR

6.1 Estimated number of potential marine mammal takes by mortality/serious injury or 'Level A' harassment and derivation of the number of potential takes

6.1.1 Introduction

As stated in the response to Question 5, potential take during NEFSC surveys using Gourock high-speed midwater rope trawl nets, pelagic trawl nets, bottom trawl nets (e.g., 4-seam, 3-bridle bottom trawl), gillnets, fyke nets, and longline gear (see Table 1-1a, b), may occur in two forms: (1) take by accidental entanglement that may cause mortality and serious injury, and (2) take by accidental entanglement that may cause non-serious injury ("Level A" harassment take). The surveys using the Gourock high speed trawl are used to assess Atlantic herring and are integral to the acoustic segment of the herring surveys; pelagic trawl nets are used to assess young gadoids, and 4-seam, 3-bridle bottom trawls are used in an assortment of surveys. In addition, incidental take resulting in mortality and serious injury and "Level A" harassment may also occur by longline gear or gillnets sampling pelagic sharks, coastal sharks, and other shark surveys within the survey areas. The justification for potential take of these species and the estimated mortalities and injuries is discussed in the following sections.

6.1.2 Use of historical interactions as a basis for take estimates

It is anticipated that all species with historic interactions with NEFSC survey gears could potentially be taken in the future. For the duration of the regulations, we estimated the numbers of marine mammals that may be caught during NEFSC surveys based on historic interactions data for a species. Historical interactions with marine mammals during NEFSC surveys (Table 6.1) were taken from NOAA's Protected Species Incidental Take (PSIT) database, a real-time internal monitoring tool for reporting interactions with protected species that occur during NMFS-directed or funded fisheries research surveys including partner or contracted surveys. The discussion below describes how NEFSC estimated potential encounters with survey gear based on historical interactions during 2004-2013 in various research gears. These estimates are based on the assumption that annual effort (e.g., total annual trawl tow time) over the requested five year authorization period would be similar to the annual effort during the period 2004-2013.

For purposes of estimating potential serious injury / mortality takes and Level A harassment takes (Table 6.2), the NEFSC calculated the average number of reported interactions for each marine mammal species in all gear types deployed during 2004-2013. The NEFSC take estimates (for serious injury/mortality and Level A harassment) for historically captured species for this request was determined by rounding the annual average take for a particular species by gear interaction up to the nearest whole number (to reflect a value that was representative of an entire animal) and multiplying by 5 to account for the five year authorization period (Table 6.2). For example, if a species interacted with NEFSC mid-water trawl gear 0.2 times per year, on average, this number was rounded up to 1 and then multiplied by 5 to determine a take request of 5. Based on past experience, the NEFSC expects there to be some variability in the actual number of annual gear interactions. By using an average based approach, it is expected to capture the variability that may occur on an annual basis over the period of this authorization. Furthermore, mitigation measures have been developed and implemented subsequent to some of the years upon which the take estimates are based. These further reduce the likelihood that these estimates would be exceeded. Because there is a very fine line between the two take categories (serious injury / mortality and Level A harassment), the NEFSC believes it would be unjustified to estimate potential takes in each category based only on historic interactions in that category; a Level A harassment take could easily have been a serious injury or mortality under a slightly different set of circumstances and vice versa. Thus, the potential take estimates encompass both mortality / serious injury and Level A harassment.

Historical interaction: Summary of potential trawl survey efforts

Marine mammals may be caught in Gourock high-speed midwater rope trawl nets, pelagic trawl nets, bottom trawl nets (e.g., 4-seam, 3-bridle bottom trawl). The surveys using the Gourock high speed trawl are used to assess Atlantic herring and are integral to the acoustic segment of the herring surveys; pelagic trawl nets are used to assess young gadoids, and 4-seam, 3-bridle bottom trawls are used in an assortment of survey. Given the timing and geographic scope of its trawl surveys, the NEFSC believes it could take any age class of marine mammal for which it estimates potential take.

The species that have been historically caught in these trawl nets include one minke whale which was released alive (later classified as a serious injury). As summarized in section 4.5, minke whales are common and widely distributed off the northeast U.S. coast, particularly in the GOM/GB regions. There appears to be a strong seasonal component to minke whale distribution. They are most abundant, widespread, and common in New England waters in spring and summer but their numbers diminish during fall and in winter, when they are largely absent from the area. When present, minke whales occupy the continental shelf proper, including bays and estuaries rather than shelf-edge waters. It is assumed that both sexes and all age groups have similar distributions and/or vulnerabilities to this gear, so it follows that multiple age classes of these species could be susceptible to take by NEFSC trawl activities.

A second species that has been historically caught in trawl nets is the short-beaked common dolphin. Two short-beaked common dolphins were taken in a mid-water trawl in 2004 and one was taken in a bottom trawl in 2007. Both sexes and all age groups have similar distributions and/or vulnerabilities to this gear, so it follows that multiple age classes of these species could be susceptible to take by NEFSC trawl activities.

Historical interaction: Summary of potential gillnet survey efforts

The COASTSPAN gillnet survey caught and killed one common bottlenose dolphin in 2008 while a cooperating institution was conducting the survey in South Carolina. This was the only occurrence of incidental take in these surveys. Although no genetic information is available from this dolphin, based on the location of the event it was recently assigned to the Northern South Carolina Estuarine System stock (Waring et al. 2014). There is insufficient data to estimate abundance for this stock and it is considered strategic under the MMPA. The coastal morphotype of bottlenose dolphins is continuously distributed along the Atlantic coast south of Long Island, New York around the Florida peninsula and into the Gulf of Mexico. This stock may also occur in nearshore waters where the historical take occurred so there is some uncertainty regarding the actual identity of the stock from which the take occurred. Because these surveys are conducted during summer in estuarine and coastal waters, multiple age classes of this species could be suscetible to take.

A single gray seal and a single harbor porpoise were taken in the same anchored set gillnet in the course of the NEFSC Northeast Fisheries Observer Program Training trip off Massachusetts in 2009. This is the only set from this program to have incidentally taken marine mammals.

Historical interaction: Summary of potential fyke net survey efforts

Fyke nets are normally set inshore by small boat crews. From April to May the nets are set weekly, then twice per month through November. One harbor seal died in October 2010 during the Marine Estuaries Diadromous Survey while NEFSC scientists were conducting salmon research near shore. Because these surveys are conducted during spring through fall in coastal waters, multiple age classes of this species could be susceptible to take.

6.1.3 Approach for estimating takes of species captured historically

To date, infrequent interactions of trawl nets, gillnets, and fyke nets with marine mammals have occurred in the western North Atlantic during NEFSC research activities. The NEFSC interaction rates have exhibited some inter-annual variation in numbers, possibly due to changing marine mammal densities and distributions and dynamic oceanographic conditions. The NEFSC uses the calculated average annual numbers of takes that occurred in the past ten years (2004-2013) and “rounds up” this annual average to the next highest whole number of animals. Since the LOA application requests takes for a five year period, this intentionally inflated annual average is multiplied by five to produce an estimate higher than the historic average take for each species that has been taken incidentally during NEFSC research. This methodology has been used in order to ensure accounting for the maximum amount of potential take in the future.This method helps to account for the fluctuations in inter-annual variability observed during that time period.

During 2004-2013, the NEFSC interacted with marine mammals on trawl, gillnet, and fyke net surveys, including: one minke whale (mid-water trawl - released alive), 3 short-beaked common dolphins in trawls, one common bottlenose dolphin (by a cooperating institution) in a gillnet, one harbor porpoise in a gillnet, one gray seal in a gillnet, and one harbor seal in a fyke net. Thus eight marine mammals interacted with NEFSC research gears during 2004-2013, of which, 1 animal was released alive (determined to be a serious injury at a later date), and seven were killed (Table 6-1).

As described above, an average based approach (Level A and serious injury/mortality combined) for each species in each gear was used as a basis for estimating potential take. The five year serious injury/mortality and Level A harassment take request for the NEFSC is described in Table 6.2.

Although the NEFSC take estimates for species captured historically are based on an average take during 2004-2013, it should be emphasized that there is still an inherent level of uncertainty in estimating potential take both in terms of numbers and species of marine mammals that may actually be taken. Further, the NEFSC continues to invest significant resources in better understanding the factors that contribute to interactions and developing mitigation measures and evaluating its operations to minimize these occurrences in the future.

6.1.4 Approach for estimating take of “other” species (i.e., those not historically taken by the NEFSC)

In addition to those species the NEFSC has directly interacted with research fishing gear over the 10 year period (2004-2013), the NEFSC believes it is appropriate to include estimates for future incidental takes of a number of species that have not been taken historically but inhabit the same areas and show similar types of behaviors and vulnerabilities to such gear as the “reference” species taken in the past. The NEFSC believes the potential for take of these other “analogous” species would be low and would occur rarely, if at all, based on lack of takes over the past ten years.

Vulnerability of analogous species to different gear types is informed by the record of interactions by the analogous and reference species with commercial fisheries using gear types similar to those used in research. Furthermore, when determining the amount of take requested, a distinction is made between analogous species thought to have *the same* vulnerability for being taken as the reference species and those analogous species that *may have a similar* vulnerability. In those cases thought to have the *same* vulnerability the request is for the same number per year as the reference species. In those cases thought to have *similar* vulnerability the request is less than the reference species. For example, the NEFSC believes the vulnerability of harbor seals to be taken in gillnets is *the same* as for gray seals (one per year) and thus requests one harbor seal per year (total of 5 over the authorization period). Alternatively, the potential for take of Atlantic white sided dolphins in gillnets is expected to be *similar* to harbor porpoise (one per year) and the reduced request relative to this reference species is one Atlantic white sided dolphin over the entire five year authorization period.

The approach outlined below reflects: (1) concern that some species with which we have not had historical interactions may interact with these gears, (2) acknowledgment of variation between sets, and (3) understanding that many marine mammals are not solitary so if a set results in take, the take could be greater than one animal. In these particular instances, the NEFSC estimates the take of these species to be equal to the maximum interactions per any given set of a reference species that was historically taken during 2004-2013.

Thus, to estimate the requested taking of analogous species, the NEFSC identified several species in the western North Atlantic Ocean which may have *similar* vulnerability to research based trawls as the short-beaked common dolphin. The maximum take of short-beaked common dolphin was two individuals in one trawl set in 2004. Therefore, on the basis of similar vulnerability, the NEFSC requests two potential takes over the five year authorization period for each of the following species in trawls: Risso's dolphin, common bottlenose dolphin (offshore and coastal stocks only), Atlantic-white-sided dolphin, white-beaked dolphin, Atlantic spotted dolphin, long-finned pilot whale, short-finned pilot whale, and harbor porpoise (Table 6.2). Other dolphin species may have similar vulnerabilities as those listed above but because of the timing and location of NEFSC research activities, the NEFSC concluded that they were not likely to be taken. Those species include: pantropical spotted dolphin, striped dolphin, Fraser's dolphin, rough-toothed dolphin, Clymene dolphin, and spinner dolphin.

As above with trawl gear, the NEFSC believes that its use of fyke nets and gillnets may interact with marine mammal species with similar vulnerabilities to this gear – due to similar behaviors, distributions, etc. – and may potentially be taken in the future. For fyke nets, the NEFSC believes that gray seals have a similar vulnerability to be taken as do harbor seals which interacted once in a single fyke net set during the past ten years. For the period of this authorization, the NEFSC therefore requests one take in fyke net for gray seals over the five year authorization period (Table 6.2).

Gillnet surveys typically occur nearshore in bays and estuaries. One gray seal and one harbor porpoise were caught during a Northeast Fisheries Observer Program training gillnet set and a bottlenose dolphin (unknown stock) was taken in a COASTSPAN gillnet set. The NEFSC believes that harbor seals have the same vunerability to be taken in gillnets as gray seals and therefore requests five takes of harbor seals in gillnets over the five year authorization period. Likewise, the NEFSC believes that Atlantic white-sided dolphins and short-beaked common dolphins have a similar vunerability to be taken in gillnets as harbor porpoise and bottlenose dolphins (Waring et al. 2014) and requests one take each of Atlantic white-sided dolphin and short-beaked common dolphin in gillnet gear over the five year authorization period.

While the NEFSC has not historically interacted with large whales or other cetaceans in its longline gear, it is well documented that some of these species are taken in commercial longline fisheries. The 2013 List of Fisheries classifies commercial fisheries based on prior interactions with marine mammals. Although the NEFSC used this information to help make an informed decision on the probability of specific cetacean and large whale interactions with longline gear, many other factors were also taken into account (e.g., relative survey effort, survey location, similarity in gear type, animal behavior, prior history of NEFSC interactions with longline gear, etc.). Therefore, there are several species that have been shown to interact with commercial longline fisheries but for which the NEFSC is not requesting take. For example, the NEFSC is not requesting take of large whales in longline gear. Although large whale species could become entangled in longline gear, the probability of interaction with NEFSC longline gear is extremely low considering a low level of survey effort relative to that of commercial fisheries. Although data on commercial fishing effort are not publically available, based on the amount of fish caught by commercial fisheries versus NEFSC fisheries research, the "footprint" of research effort compared to commercial fisheries is very small.

Species that were previously caught (as outlined in the 2013 List of Fisheries) in analogous commercial fisheries were considered to have a higher probability of take but all were not included for potential take by the NEFSC. Additionally, marine mammals have never been caught or entangled in NEFSC longline gear; if interactions occur marine mammals depredate caught fish from the gear but leave the hooks attached and unaltered. They have never been hooked nor had hooks taken off gear during depredation. However, such gear could be considered analogous to potential commercial longline surveys that may be conducted elsewhere (e.g., Garrison 2007; Roche *et al.* 2007; Straley et al. 2014). Given the potential for interactions, NEFSC estimates one take over the LOA authorization period of the following cetaceans in longline gear: Risso's dolphin, common bottlenose dolphin (offshore and coastal stocks only), short-beaked common dolphin, long-finned pilot whale, and short-finned pilot whale (Table 6-2).

In addition, several pinniped species may be taken in commercial fisheries analogous to NEFSC research trawl activities. In general these species are deemed less susceptible to incidental take in NEFSC trawl activities due to the seasonal timing and low frequency of this research as well as the higher distribution of the pinniped species near shore when compared to the more offshore distribution of NEFSC trawl activities. Therefore, NEFSC requests one potential take each of gray and harbor seals in trawls over the LOA authorization period.

There are several species that were not included in our take request that have been documented to interact with commercial fisheries or that could be considered analogous to requested species; however, we focused on the commonly occurring species in the marine waters where NEFSC fisheries research is conducted.

Estimating take of species listed under the ESA

Historically, the NEFSC has not interacted with listed marine mammals. Further, the NEFSC is very concerned about the prospect of taking ESA-listed marine mammals, and it has invested heavily in developing sampling protocols that include mitigation measures designed to minimize the risk of taking these species. However, for purposes of estimating potential take the NEFSC did not differentiate between ESA-listed or non-listed marine mammals. Marine mammal species listed or not, deemed to have a similar vulnerability to gear(s) to those that have historically interacted was the overriding factor in estimating potential takes.

Undetermined species and other whales

There are situations when a caught animal cannot be identified to species with certainty. One such case might occur if an adult phocid seal was caught in longline gear and quickly released. Those animals are very difficult to differentiate at sea in poor lighting making exact identification difficult. Similarly some cetacean species are difficult to identify to species under poor field conditions. Thus, under those situations, the NEFSC requests one undetermined pinniped take in fyke, gillnet, and longline gear and one undetermined delphinid take in trawl, gillnet, and longline gear during the effective period of these regulations and subsequent LOAs (Table 6.2).

Surveys for which NEFSC Anticipates no Level A, Serious Injury or Mortality Takes

The following surveys and research activities have no history of taking marine mammals in research gear and do not use sampling gear that is considered to have the highest risk of marine mammal interactions (i.e., trawls, longline gear, gillnets, and fyke nets). Given the general mitigation measures in place to avoid ship strikes or other incidental contact with marine mammals during research, the NEFSC is requesting no injury, serious injury, or mortality takes for these research activities (see Table 1-1 for descriptions).

- Annual Assessments of Sea Scallop Abundance and Distribution in Selected Closed/Rotational Areas
- NEFOP Observer Scallop Dredge Training Trips
- Sea Scallop Survey

- Surfclam and Ocean Quahog Dredge Survey
- Beach Seine Survey, Maine
- Beach Seine Survey, New Jersey
- Coastal Maine Telemetry Network
- Deep-sea Coral Survey
- DelMarVa Habitat Characterization
- DelMarVa Reefs Survey
- Diving Operations
- Ecology of Coastal Ocean Seascapes
- Finfish Nursery Habitat Study
- Gear Effects on Amphipod Tubes
- Gulf of Maine Ocean Observing System Mooring Cruise
- Hydroacoustic Surveys
- Nutrients and Frontal Boundaries
- Ocean Acidification
- Pilot Studies
- Rotary Screw Trap (RSTs) Survey
- Sea Bed Habitat Classification Survey
- U.S. Army Corps of Engineers Bottom Sampling
- Opportunistic Hydrographic Sampling

6.1.5 Mitigation and minimization of takes

Because of the suite of mitigation measures NEFSC has implemented, it expects the total number of marine mammals taken in these gears to decrease in the future and be substantially less than the estimated level of take when summed across all species. Current mitigation protocols are described later in this application, so they are just mentioned briefly here: use of acoustic pingers on trawls, limits on trawl tow times, and marine mammal watches and a "move-on" rule if one is sighted prior to deploying gear. The NEFSC continues to look for additional ways to minimize marine mammal takes during the course of its fisheries research, such as conducting retrospective analyses to pinpoint the most significant contributors to take in each gear and to develop new sampling methods that eliminate the possibility of marine mammal mortalities (*e.g.* video and acoustic sampling). The results of these studies are expected to influence future sampling protocols and gear development.

6.1.6 Conclusion

The NEFSC has used its historical interactions with marine mammals in fisheries research surveys as a basis for estimating potential takes of these species and of other species it has not interacted with, but which it believes shares similar vulnerabilities to longline and trawl gears. Because of the low level of historical interactions, as well as the low level of predicted takes (lethal, serious injury, and non-serious injury) relative to population size, and that harassment will likely be avoided through the implementation of the NEFSC proposed mitigation measures, the NEFSC believes that its activities: (1) will have a minimal impact on the affected species or stocks of marine mammals (based on the likelihood that the activities will not affect annual rates of recruitment or survival); and (2) will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses. The basis for this statement is discussed in greater detail in Section 7 of this application.

Further, the NEFSC notes that, despite its best efforts to estimate realistic potential marine mammal takes, it believes actual takes would be substantially lower than its take estimates, and many of the species for which it estimated take would not be taken. There is substantial inherent uncertainty in estimating numbers and species that could be potentially taken, and the NEFSC take estimates reflect this uncertainty. Our understanding of the potential effects of NEFSC activities on marine mammals is continually evolving. Reflecting this, the NEFSC proposes to include an adaptive management component within the application (see Section 13 of this application). This allows the NEFSC, in concert with NMFS, to consider, on a case-by-case basis, new data to determine whether mitigation and monitoring measures should be modified.

Table 6-1 Historical interactions with marine mammals during NEFSC surveys from 2004 to 2014 as recorded in NOAA's Protected Species Incidental Take database.

Survey Name	Protected Species Taken	Gear Type	Date (Time) Taken	# Killed	# Released Alive	Total Taken
2010						
Maine Estuaries Diadromous Survey	Harbor seal	Fyke Net	25 October (3:10 pm)	1	0	1
2009						
Atlantic Herring Survey	Minke whale	Midwater trawl	11 October (11:17 pm)	0	1[1]	1
NEFOP Observer Gillnet Training Trips	Harbor porpoise	Gillnet	4 May (10:24 am)	1	0	1
NEFOP Observer Gillnet Training Trips	Gray seal	Gillnet	4 May (7:39 am)	1	0	1
2008						
COASTSPAN	Common bottlenose dolphin (NSCES stock)	Gillnet	29 September (12:40 pm)	1	0	1
2007						
NEFSC Standard Bottom Trawl Survey	Short-beaked common dolphin (Western NA stock)	Bottom trawl	11 November (12:18 am)	1	0	1
2004						
Atlantic Herring Survey	Short-beaked common dolphin (Western NA stock)	Midwater trawl	8 October (5:22 am)	2	0	2
Total				**7**	**1**	**8**

Classified as a "serious injury/mortality" event. See text in Chapter 5 for details.

Table 6-2 The potential number of animals of each marine mammal species (all stocks have been combined) that could be taken by mortality and serious injury (M&SI) and non-serious Level A harassment over the five year authorization period.

		Potential Take (2015-2019)			
	Historical Interactions (2008-2012)	M&SI and Level A			
		Trawl	Fyke	Gillnet	Longline
CETACEANS					
Minke whale	trawl	5	0	0	0
Risso's dolphin		2	0	0	1
Long-finned pilot whale		2	0	0	1
Short-finned pilot whale		2	0	0	1
Atlantic white-sided dolphin		2	0	1	0
White-beaked dolphin		2	0	0	0
Short-beaked common dolphin	trawl	5	0	1	1
Atlantic spotted dolphin		2	0	0	0
Common bottlenose dolphin	gillnet	2	0	5	1
Harbor porpoise	gillnet	2	0	5	0
Undetermined delphinid		1	0	1	1
PINNIPEDS					
Harbor seal	fyke net	1	5	5	0
Gray seal	gillnet	1	1	5	0
Undetermined pinniped		0	1	1	1
	Total	**29**	**7**	**24**	**7**

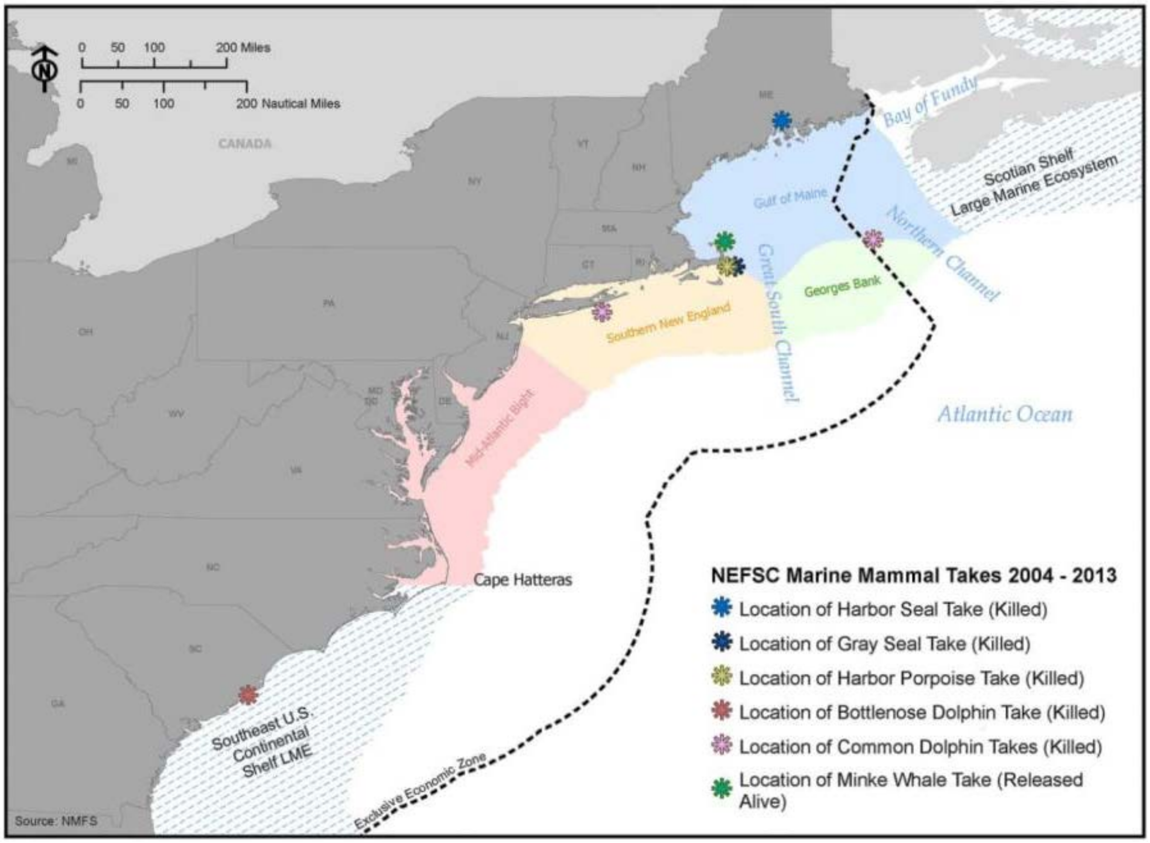

Figure 6-1 Location of marine mammal takes during NEFSC research from 2004-2013

The harbor porpoise and gray seal incidental take locations are the same.

6.2 Estimated Level B Harassment of Marine Mammals due to Acoustic Sources and Derivation of the Estimate

Estimating sound exposures leading to behavioral and physical effects of intermittent high frequency sounds from active acoustic devices used in fisheries research is challenging for a variety of reasons. Among these are the wide variety of operating characteristics of these devices, variability in sound propagation conditions throughout the typically large areas in which they are operated, uneven (and often poorly understood) distribution of marine species, differential (and often poorly understood) hearing capabilities in marine species, and the uncertainty in the potential for effects from different acoustic systems on different species. The NEFSC took a dual approach in assessing the impacts of high-frequency active acoustic sources used in fisheries research in two different geographical areas where it operates these devices (Northeast LME and Offshore Deep-Water).

The first approach was a qualitative assessment of potential impacts across species and sound types. This analysis considers a number of relevant biological and practical aspects of how marine species likely receive and may be impacted by these kinds of sources. This assessment (described in greater detail in section 7.2 below) considered the best available current scientific information on the impacts of noise exposure on marine life and the potential for the types of acoustic sources used in NEFSC surveys to have behavioral and physiological effects. The results indicate that a subset of the sound sources used are likely to be entirely inaudible to all marine species, that some of the lower frequency and higher power systems will be detectable over moderate ranges for some species (although this depends strongly on inter-specific differences in hearing capabilities). As discussed in more detail (see section 7.2), current scientific information supports the conclusion that direct physiological harm is quite unlikely but behavioral avoidance may occur to varying degrees in different species. Consequently, any potential direct injury (as defined by NMFS relative to the U.S. Marine Mammal Protection Act as Level A harassment and currently estimated as 180 and 190 dB RMS received levels respectively for cetaceans and pinnipeds) from these fisheries acoustic sound sources was deemed highly unlikely and were not directly calculated.

Building on this assessment to attempt to quantify behavioral impacts, an analytical framework was derived and applied to estimate potential Level B harassment by acoustic sources (as defined relative to the MMPA). This analysis used characteristics of active acoustic systems, their expected patterns of use in each of the two NEFSC operational areas, and characteristics of the marine mammal species that may interact with them to estimate Level B harassment of marine mammals. This approach is relatively straightforward and (although certain adaptations enable a more realistic spatial depiction of exposed animals in the water column) relies on average density values of marine species. While the NEFSC believes this quantitative assessment benefits from its simplicity and consistency with the current NMFS guidelines regarding estimates of Level B harassment by acoustic sources, based on a number of deliberately precautionary assumptions, the resulting take estimates should be seen as a very likely substantial overestimate of behavioral harassment from the operation of these systems. Additional details on the approach used and the assumptions made that result in a conservative estimate (i.e., higher numbers of exposures at received levels identified as Level B harassment) are described below.

6.2.1 Framework for quantitative estimation of potential Level B harassment by acoustic takes

The discussion in section 7.2 below considers the differential frequency bands of hearing in marine animals in deriving a qualitative assessment of the probable risk of particular acoustic impacts from general categories of active acoustic sources, and is likely a more appropriate means of assessing their overall impact from a limited set of deployments given the level of scientific uncertainty in a variety of areas. However, in order to meet the compliance requirements for assessing the potential environmental impact of NEFSC operations, in this case acoustic impacts, a quantitative estimate of individual Level B harassment was required.

Different sound exposure criteria are typically used for impulsive and continuous sources (Southall *et al.*, 2007). Under the current NMFS guidelines for calculating Level B harassment, an animal is taken if it is exposed to continuous sounds at a received level of 120 dB RMS or impulsive sounds at a received level of 160 dB RMS. These are simple step-function thresholds that do not consider the repetition or sustained presence of a sound source nor does it account for the known differential hearing capabilities between species. Sound produced by the fisheries acoustic sources here are very short in duration (typically on the order of milliseconds), intermittent, have high rise times, and are operated from moving platforms. They are consequently considered impulsive sources, which would be subject to the 160 dB RMS criterion. A mathematical method for estimating Level B harassment according to this step-function was derived and applied in each of the NEFSC ecosystem areas of operation where active acoustic gear is used – the Northeast LME and Offshore Region.

The assessment paradigm for active acoustic sources used in NEFSC fisheries research is relatively straightforward and has a number of key simplifying assumptions, most of which are deliberately precautionary given the known areas of uncertainty. These underlying assumptions (described in greater detail below) very likely lead to an overestimate of the number of animals that may be exposed at the 160 dB RMS level in any one year on average for each area. Conceptually, Level B harassment may occur when a marine mammal interacts with an acoustic signal. Estimating the number of exposures at the specified received level requires several determinations, each of which is described sequentially below:

1. A detailed characterization of the acoustic characteristics of the effective sound source or sources in operation;
2. The operational areas exposed to levels at or above those associated with Level B harassment when these sources are in operation;
3. A method for quantifying the resulting sound fields around these sources; and
4. An estimate of the average density for marine mammal species in each ecosystem area of operation

Quantifying the spatial and temporal dimensions of the sound exposure footprint of the active acoustic devices in operation on moving vessels and their relationship to the average density of marine mammals enables a quantitative estimate of the number of individuals for which sound levels exceed NMFS' Level B Harassment threshold for each area. The number of Level B harassment events is ultimately estimated as the product of the volume of water insonified at 160 dB RMS or higher and the volumetric density of animals determined from simple assumptions about their vertical stratification in the water column. Specifically, reasonable assumptions based on what is known about diving behavior across different marine mammal species were made to segregate those that predominately remain in the upper 200m versus those that regularly dive deeper during foraging and transit. Methods for estimating each of these calculations are described in greater detail in the following sections, along with the simplifying assumptions made, and followed by the take estimates for each region.

6.2.2 NEFSC Sound source characteristics

An initial characterization of the general source parameters for the primary NEFSC vessels operating active acoustic sources was conducted (Appendix A). This process enabled a full assessment of all sound sources, including those within the category 1 sources (identified in section 7.2 below) that are entirely outside the range of marine mammal hearing (not shown here). This auditing of the active sources also enabled a determination of the predominant sources that, when operated, would have sound footprints exceeding those from any other simultaneously used sources. These sources were effectively those used directly in acoustic propagation modeling to estimate the zones within which the 160 dB RMS received level would occur.

The full range of sound sources used in fisheries acoustic surveys were considered (Appendix A). Many of these sources can be operated in different modes and with different output parameters. In modeling their potential impact areas for these vessels when used and also when they are operated from non-NOAA vessels used for NEFSC survey operations, those features among those given below that would lead to the most precautionary estimate of maximum received level ranges (i.e. largest ensonified area) were used (e.g., lowest operating frequency). The effective beam patterns took into account the normal modes in which these sources are typically operated. While these signals are very brief and intermittent, a very conservative assumption was taken in ignoring the temporal pattern of transmitted pulses in calculating Level B harassment events. This assumption would not be appropriate in the context of assessing potential auditory effects. These operating characteristics of each of the predominant sound sources were used in the calculation of effective line km (section 6.2.3) and area of exposure (section 6.2.4) for each source in each survey.

Sources operating at frequencies above the functional hearing range of any marine mammal (typically above 180 kHz; see section 7.2) were excluded from quantitative analysis. Among those operating within the audible band of marine mammal hearing, eight predominant sources were identified as having the largest potential impact zones during operations, based on their relatively lower output frequency, higher output power, and their operational pattern of use. In determining the effective line km for each of these predominant sources (Appendix A) the operational patterns of use relative to one another were further applied to determine which source was the predominant one operating at any point in time for each survey. When multiple sound sources were used simultaneously, the one with the largest potential impact zone in each relevant depth strata was used in calculating takes. For example, when species (e.g., sperm whales) regularly dive deeper than 200m, the largest potential impact zone was calculated for both depth strata and in some cases resulted in a different source being predominant in either depth strata. This enabled a more comprehensive way of accounting for maximum exposures for animals diving in a complex sound field resulting from simultaneous sources with different spatial profiles. This overall process effectively resulted in three sound sources (EK60, ME70, and DSM300) comprising the total effective line km, their relative proportions depending on the nature of each survey in each region (see Tables 6.4a, b and 6.5).

Table 6-3 Output characteristics for six predominant NEFSC acoustic sources

Acoustic system	Operating frequencies (kHz)	Source level (dB re 1 µPa at 1 m)	Nominal beam width (deg)	Effective exposure area: Sea surface to 200 m depth (km^2)	Effective exposure area: Sea surface to depth at which sound is 160 dB SPL (km^2)
Simrad EK60 Scientific Echo Sounder (surrogate for ES60)	18, 38, 70, 120, 200, 333	224	11@18kHz; 7@38kHz	0.0142	0.1411
Simrad ME70 Multi-Beam Echo Sounder	70-120	205	140	0.0201	0.0201
Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP), Ocean Surveyor	75	223.6	N/A	0.008600	0.018700
Raymarine SS260 transducer for DSM300 (surrogate for FCV-292)	50, 200	217	50kHz-19deg; 200kHz-6 deg	0.0144	0.0303
Simrad EQ50	50, 200	210	16-50kHz; 7-200kHz	0.0075	0.008
NetMind	30, 200	190	50	.0004	.0004

6.2.3 Calculating effective line km for each survey

As described below, based on the operating parameters for each source type, an estimated volume of water insonified to the 160 dB RMS received level was determined. In all cases where multiple sources are operated simultaneously, the one with the largest estimated acoustic footprint (and thus leading to higher estimated Level B harassment) was used as the effective source. This was calculated for each depth strata (0-200m and > 200m), where appropriate (i.e. in the LME region, where depth is generally <200m, only the exposure area for the 0-200m depth strata was calculated). In some cases, this resulted in different sources being predominant in each depth strata for all line km when multiple sources were in operation; this was accounted for in estimating overall exposures for species that utilize both depth strata (deep divers). For each ecosystem area, the total number of line km that would be surveyed was determined, as was the relative percentage of surveyed linear km associated with each source type. The total line km for each vessel, the effective portions associated with each of the dominant sound type, and the effective total km for operation for each sound type is given in Tables 6.4a and 6.4b and 6.5.

Table 6-4a Annual linear survey km for each vessel type and its predominant sources within the 0-200m depth stratum for the LME area.

Vessel	Survey(s)	Line kms/ Vessel	Source	Overall % Source Usage	% Time Source Dominant (0-200m)	Line km/ Dominant Source (0-200m)
Bigelow	BTS, Spring ECOMon	27303	ES60	100%	5%	1365.15
			ME70	100%		
			ADCP	95%	95%	25937.85
			Doppler Spd log	95%		
			Doppler Spd log	25%		
	Marine mammal Pop-up retrieval	913 <200 m	EK60	2%	2%	18.26
	Marine mammal abundance	1700	EK60	50%	50%	850
G. Michelle	Mass DMF Inshore Spring & Fall Bottom Trawl Survey	8000	DSM300	100%	100%	8000
Pisces	Gulf of Maine Northern Shrimp Survey	6000	DSM300	100%	100%	6000
	Pelagics	4773	EK60	100%	5%	238.65
			ES60	100%		
			ME70	95%	95%	4534.35
			ADCP	95%		
			Doppler Spd log	25%		
	Atlantic Herring	8300	EK60	100%	25%	2075
			ME70	75%	75%	6225
			ADCP	100%		
G. Gunter	LMRCSC	2880	EK60	100%	100%	2880
			Simrad EQ50	100%		
	Pelagics	9500	EK60	100%	100%	9500
			Simrad EQ50	100%		

Table 6-4b Annual linear survey km for each vessel type and its predominant sources within the two depth strata for the offshore (>200m water depth) habitat.

Vessel	Survey(s)	Line kms/ vessel	Source	Overall % source usage	% Time source dominant (>200m)	% Time source dominant (>200m)	Line km/ dominant source (0-200m)	Line km/ dominant source (>200m)
Bigelow	Deepwater corals/habitat	4808	EK60	100%	5%	100%	240.4	4808
			ES60	100%				
			ME70	95%	95%	0%	4567.6	
			ADCP	95%				
			Doppler Spd log	25%				
	Marine Mammal Abundance	3359	EK60	50%	50%	50%	1679.5	1679.5
Pisces	Deepwater Biodiversity	2328	EK60	100%	75%	100%	1746	2328
			ES60	5%				
			ME70	25%	25%	0%	582	
			ADCP	100%				
			Doppler Spd log	100%				

Table 6-5 Effective total annual survey km for which each source type is predominant acoustic source for take calculations for the LME area and offshore (>200 m depth) habitat.

Source	Summed line kms/source (0-200m)	Summed line kms/source (>200m)	Summed dominant source % of total line km (0-200m)	Summed dominant source % of total line km (>200m)
LME Region				
EK60	16927	NA	25%	NA
ME70	36697	NA	54%	NA
DSM300	14000	NA	21%	NA
Offshore Region				
EK60	3666	8816	42%	100%
ME70	5150	0	58%	0

6.2.4 Calculating volume of water insonified to 160 dB RMS received level

The cross-sectional area of water insonified to 160+ dB RMS received level was calculated using a simple model of sound propagation loss, which accounts for the loss of sound energy over increasing range. We used a spherical spreading model (where propagation loss = 20 * log (range) - such that there would be 60 dB of attenuation over 1000 m), a reasonable approximation over the relatively short ranges involved, and accounted for the frequency dependent absorption coefficient and beam pattern of the highly directional nature of most of these sound sources. The lowest frequency was used for systems that are operated over a range of frequencies. The vertical extent of this area is calculated for two depth strata (surface to 200 m, and for deep water operations, surface to range at which the on-axis received level reaches 160 dB RMS). This was applied differentially based on the typical vertical stratification of marine mammals (see Tables 6.9-6.11). A simple visualization of a 2-dimensional slice of modeled sound propagation is shown below to illustrate the predicted area ensonified to the 160 dB level by an EK-60 operated at 18kHz.

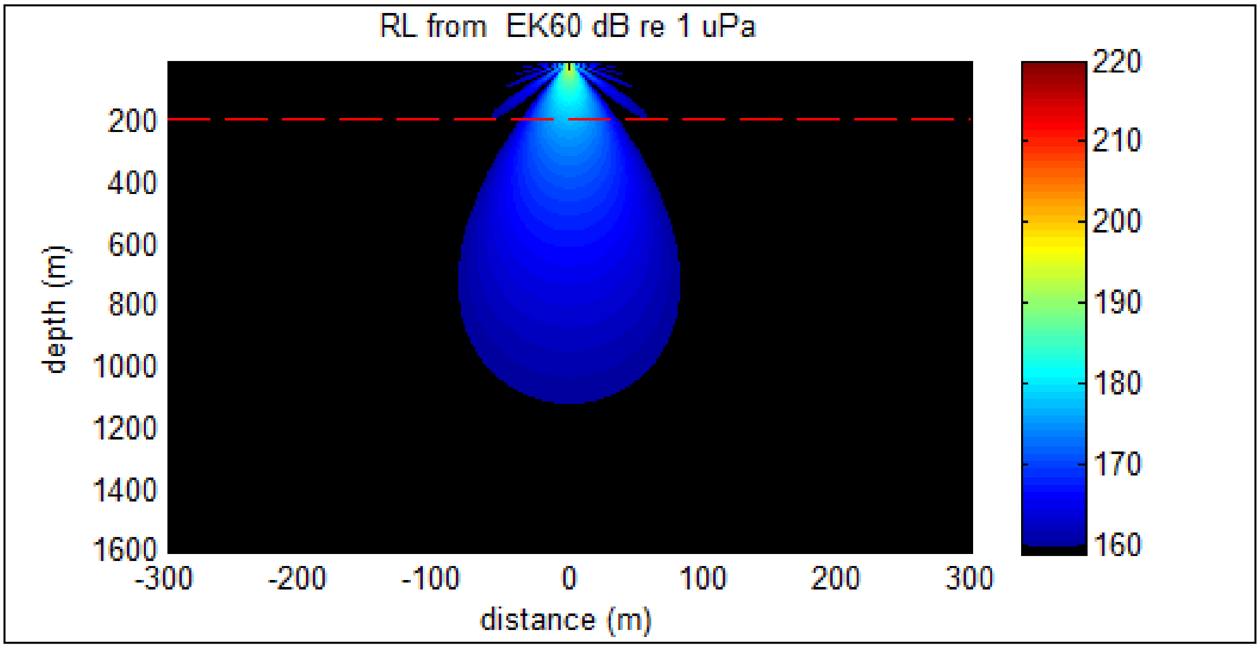

Figure 6-2 Visualization of a 2-dimensional slice of modeled sound propagation to illustrate the predicted area ensonified to the 160 dB level by an EK-60 operated at 18 kHz.

The dashed red line marks the transition between the two depth strata (0-200m and >200m)

Following the determination of effective sound exposure area for transmissions considered in two dimensions, the next step was to determine the effective volume of water insonified >160 dB RMS for the entirety of each survey in each region. For each of the three predominant sound sources, the volume of water insonified is estimated as the athwartship cross-sectional area (in km^2) of sound above 160 dB RMS (as shown in the figure above) multiplied by the total distance traveled by the ship. Where different sources operating simultaneously would be predominant in each different depth strata (e.g. ME70 and EK60 operating simultaneously in deep water may be predominant in the shallow and deeper bins respectively), the resulting cross sectional area calculated took this into account. Specifically, for shallow-diving species this cross-sectional area was determined for whichever was predominant in the shallow strata whereas for deeper diving species in deeper water this area was calculated from the combined effects of the predominant source in the shallow strata and the (sometimes different) source predominating in the deeper strata) This creates an effective total volume characterizing the area insonified when each predominant source is operated and accounts for the fact that deeper diving species may encounter a complex sound field in different portion of the water column.

6.2.5 Species-specific marine mammal densities

One of the primary limitations to traditional estimates of behavioral harassment takes from acoustic exposure is the assumption that animals are uniformly distributed in time and space across very large geographical areas, such as those being considered here. There is ample evidence that this is in fact not the case and marine species are highly heterogeneous in terms of their spatial distribution, largely as a result of species-typical utilization of heterogeneous ecosystem features. Some more sophisticated modeling efforts have attempted to include species typical behavioral patterns and diving parameters in movement models that more adequately assess the spatial and temporal aspects of distribution and thus exposure to sound. While simulated movement models were not used to mimic individual diving or aggregation parameters in the determination of animal density in this estimation, the vertical stratification of marine mammals based on known or reasonably assumed diving behavior was integrated into the density estimates used.

First, typical two-dimensional marine mammal density estimates (animals/km^2) were obtained from various sources for each ecosystem area. These included marine mammal Stock Assessment Reports for the western North Atlantic (Table 3.1). There are a number of caveats associated with these estimates:

(1) They are often calculated using visual sighting data collected during one season rather than throughout the year. The time of year when data were collected and from which densities were estimated may not always overlap with the timing of NEFSC fisheries surveys see section 1.6 or Table 1-1a, b for survey dates).

(2) The densities used for purposes of estimating acoustic harassment takes do not take into account the patchy distributions of marine mammals in an ecosystem, at least on the moderate to fine scales over which they are known to occur. Instead, animals are considered evenly distributed throughout the assessed area and seasonal movement patterns are not taken into account.

In addition and to account for at least some coarse differences in marine mammal diving behavior and the effect this has on their likely exposure to these kinds of sometimes highly directional sound sources, a volumetric density of marine mammals of each species was determined. This value is estimated as the abundance averaged over the two-dimensional geographic area of the surveys and the vertical range of typical habitat for the population. Habitat ranges were categorized in two generalized depth strata (0-200 m, and 0 to >200 m) based on gross differences between known generally surface-associated and typically deep-diving marine mammals (Reynolds and Rommel, 1999; Perrin *et al.*, 2008). Animals in the shallow diving strata were reasonably estimated, based on empirical measurements of diving with monitoring tags and reasonable assumptions of behavior based on other indicators to spend a large majority of their lives (>75%) at depths of 200 m or shallower. Their volumetric density and thus exposure to sound is thus limited by this depth boundary. In contrast, species in the deeper diving strata were reasonably estimated to regularly dive deeper than 200 m and spend significant time at these greater depths. Their volumetric density and thus potential exposure to sounds up to the 160 dB RMS level is extended from the surface to the depth at which this received level condition occurs and/or the water depth in the region of interest (e.g. the LME region was generally considered to be comprised of water no deeper than 200m).

The volumetric densities are estimates of the three-dimensional distribution of animals in their typical depth strata. For shallow diving species the volumetric density is the area density divided by 0.2 km (i.e., 200 m). For deeper diving species, the volumetric density is the area density divided by a nominal value of 0.5 km (i.e., 500 m), or the depth of the region of interest (e.g. in the LME area density for deep diving species was divided by 0.2km to reflect the depth of the region). The two-dimensional and resulting three dimensional (volumetric) densities for each species in each ecosystem area are shown in the Table 6.6.

Table 6-6 Volumetric densities for each species in the Northeast LME and adjacent offshore waters

Species	Typical depth strata		LMEarea density (#/km^2)	Offshore area density (#/km^2)	LME area volumetric density (#/km^3)	Offshore area volumetric density (#/km^3)
	0-200 m	>200 m ("deep divers")				
Cetaceans						
North Atlantic right whale	X		0.0018	0	0.00900	0.00000
Humpback whale	X		0.0009	0.0006	0.00450	0.00300
Fin whale	X		0.0036	0.0007	0.01800	0.00350
Sei whale	X		0.0027	0.00004	0.01350	0.00020
Minke whale	X		0.0066	0	0.03300	0.00000
Blue whale	X		0	0.0026	0.00000	0.01300
Sperm whale		X	0.00001	0.0152	0.00005	0.03040
Dwarf sperm whale		X	0.00002	0.002	0.00010	0.00400
Pygmy sperm whale		X	0.00002	0.002	0.00010	0.00400
Killer Whale	X					
Pygmy killer whale	X					
Northern bottlenose whale		X	0	0.0017	0.00000	0.00340
Cuvier's beaked whale		X	0.0021	0.0156	0.01050	0.03120
Mesoplodon beaked whales		X	0.0021	0.0156	0.01050	0.03120
Melon-headed whale	X				0.00000	0.00000
Risso's dolphin	X		0.0022	0.0844	0.01100	0.42200
Long-finned pilot whale		X	0.0345	0.0256	0.17250	0.05120
Short-finned pilot whale		X	0.0345	0.0256	0.17250	0.05120
Atlantic white-sided dolphin	X		0.0244	0	0.12200	0.00000
White-beaked dolphin	X		0.0081	0	0.04050	0.00000
Short-beaked common dolphin	X		0.2115	0.1875	1.05750	0.93750
Atlantic spotted dolphin	X		0	0.0208	0.00000	0.10400
Pantropical spotted dolphin	X					
Striped dolphin	X		0	0.3028	0.00000	1.51400
Fraser's dolphin	X					
Rough toothed dolphin	X		0	0.0016	0.00000	0.00800
Clymene dolphin	X					
Spinner dolphin		X				
Common bottlenose dophin (offshore)	X		0.0060	0.0526	0.03000	0.26300
Common bottlenose dolphin (coastal)	X		0.1033	0	0.51650	0.00000

Species	Typical depth strata		LMEarea density (#/km^2)	Offshore area density (#/km^2)	LME area volumetric density (#/km^3)	Offshore area volumetric density (#/km^3)
	0-200 m	>200 m (“deep divers”)				
Harbor Porpoise	X		0.0193	0	0.09650	0.00000
Pinnipeds						
Harbor Seal	X		0.2844		1.42200	0.00000
Gray Seal	X					
Harp Seal	X					
Hooded Seal	X					

6.2.6 Using areas insonified and volumetric density to calculate acoustic takes

Level B harassment by acoustic sources, according to current NMFS guidelines, could be calculated for each area by using (1) the combined results from output characteristics of each source and identification of the predominant sources in terms of usage and acoustic output (6.2.2); (2) their relative annual usage patterns for each operational area (6.2.3); (3) a source-specific determination made of the area of water associated with received sounds at either the extent of a depth boundary or the 160 dB RMS received sound level (6.2.4); and (4) determination of a biologically-relevant volumetric density of marine mammal species in each area (6.2.5). Estimates of Level B harassment by acoustic sources are the product of the volume of water insonified at 160 dB RMS or higher for the predominant sound source for each portion of the total line km for which it is used and the volumetric density of animals for each species.

Table 6-7 Estimated annual Level B harassment by acoustic sources by sound type for each marine mammal species in the Northeast LME and adjacent offshore waters.

For each species and sound source, the cross sectional area for the relevant depth strata (Table 6-3,6-4ab) was multiplied by the effective line km for each respective depth strata for the relevant survey area (Table 6-6) and the volumetric density (shown here) to estimate Level B harassment.

Species	Volumetric density (#/km^3)	Estimated Level B harassment (#s of animals) in 0-200m depth stratum			Estimated Level B harassment in >200m depth stratum	Total take
		EK60	ME70	DSM300	EK60	
LME Area Cetaceans						
North Atlantic right whale	0.009	2	7	2	NA	11
Humpback whale	0.0045	1	3	1	NA	5
Fin whale	0.018	4	13	4	NA	21
Sei whale	0.0135	3	10	3	NA	16
Minke whale	0.033	8	24	7	NA	39
Blue whale	0	0	0	0	NA	10[1]
Sperm whale	0.00005	0	0	0	NA	10[1]
Dwarf sperm whale	0.0001	0	0	0	NA	10[1]
Pygmy sperm whale	0.0001	0	0	0	NA	10[1]
Killer Whale	0	0	0	0	NA	10[1]
Pygmy killer whale	0	0	0	0	NA	10[1]
Northern bottlenose whale	0	0	0	0	NA	10[1]
Cuvier's beaked whale	0.0105	3	8	2	NA	13
Mesoplodon beaked whales	0.0105	3	8	2	NA	13
Melon-headed whale	0	0	0	0	NA	10[1]
Risso's dolphin	0.011	3	8	2	NA	13
Long-finned pilot whale	0.1725	41	127	35	NA	203
Short-finned pilot whale	0.1725	41	127	35	NA	203
Atlantic white-sided dolphin	0.122	29	90	25	NA	144
White-beaked dolphin	0.0405	10	30	8	NA	48
Short-beaked common dolphin	1.0575	254	780	213	NA	1247
Atlantic spotted dolphin	0	0	0	0	NA	10[1]
Pantropical spotted dolphin	0	0	0	0	NA	10[1]
Striped dolphin	0	0	0	0	NA	10[1]
Fraser's dolphin	0	0	0	0	NA	10[1]
Rough toothed dolphin	0	0	0	0	NA	10[1]
Clymene dolphin	0	0	0	0	NA	10[1]
Spinner dolphin	0	0	0	0	NA	10[1]
Common bottlenose dolphin (offshore)	0.0300	7	22	6	NA	35
Common bottlenose dolphin (coastal)	0.5165	124	381	104	NA	609
Harbor Porpoise	0.0965	23	71	19	NA	113

LME Area Pinnipeds						
Harbor Seal	1.422	342	1049	287	NA	1678
Gray Seal	0.00000	0	0	0	NA	10[1]
Harp Seal	0.00000	0	0	0	NA	10[1]
Hooded Seal	0.00000	0	0	0	NA	10[1]
Offshore Area Cetaceans						
North Atlantic right whale	0	0	0		0	10[1]
Humpback whale	0.003	0	0		0	10[1]
Fin whale	0.004	0	0		0	10[1]
Sei whale	0.0002	0	0		0	10[1]
Minke whale	0	0	0		0	10[1]
Blue whale	0.013	1	1		0	2
Sperm whale	0.0304	2	3		14	19
Dwarf sperm whale	0.004	0	0		2	2
Pygmy sperm whale	0.004	0	0		2	2
Killer Whale	0	0	0		0	10[1]
Pygmy killer whale	0	0	0		0	10[1]
Northern bottlenose whale	0.0034	0	0		2	2
Cuvier's beaked whale	0.0312	2	3		15	20
Mesoplodon beaked whales	0.0312	2	3		15	20
Melon-headed whale	0	0	0		0	10[1]
Risso's dolphin	0.422	22	44		0	66
Long-finned pilot whale	0.0512	3	5		24	32
Short-finned pilot whale	0.0512	3	5		24	32
Atlantic white-sided dolphin	0	0	0		0	10[1]
White-beaked dolphin	0	0	0		0	10[1]
Short-beaked common dolphin	0.9375	49	97		0	146
Atlantic spotted dolphin	0.104	5	11		0	16
Pantropical spotted dolphin	0	0	0		0	10[1]
Striped dolphin	1.514	79	157		0	236
Fraser's dolphin	0	0	0		0	10[1]
Rough toothed dolphin	0.008	0	1		0	1
Clymene dolphin	0	0	0		0	10[1]
Spinner dolphin	0	0	0		0	10[1]
Common bottlenose dolphin (offshore)	0.2630	14	27		0	41

Notes:

1. For all species with unknown or very low volumetric density, i.e., ≤0.004 animals per km3,or for species unlikely to be impacted by the predominant acoustic sources outlined above, we have requested a precautionary Level B Harassment take of 10 individuals. The number chosen is indicative of the very low probability of sighting or interaction with these species during most research cruises with the active acoustic instruments used in NEFSC research.

6.2.7 Summary of the total estimates of Level B harassment due to acoustic sources

The results given in Table 6.7 were based on the approach taken here to estimate marine mammal Level B harassment under the MMPA and should be interpreted with considerable caution. This method is prescribed by the current definition of acoustic thresholds associated with Level B harassment given in NMFS policy guidelines for acoustic impacts with several modifications specific to the directional nature of high-frequency fisheries acoustic sources and the vertical stratification of marine species applied. Given the simplistic step-function approach and lack of species-specific hearing parameters inherent in the NMFS prescribed approach, significant uncertainty in some areas, and a number of underlying assumptions based on how these sources may be used variably in the field, this approach should be considered to result in a highly precautionary estimate of impact (e.g., higher number of estimated Level B harassment than are in fact likely). Factors believed to result in the estimated Level B harassment by acoustic sources being conservative (i.e., higher than what may actually occur in situ) include the following:

- Based on current NMFS guidelines, the known differences in hearing sensitivities of different marine mammal species (see section 7.2 below) are not considered in NEFSC estimates of Level B harassment by acoustic sources; all species are assumed to be equally sensitive to all acoustic systems below 180 kHz.
- Other known aspects of hearing as they relate to transient sounds (specifically auditory integration times) are also not taken into account in this estimation. Specifically, sounds associated with these fisheries acoustic sources are typically repetitive and quite brief in duration. While some animals may potentially hear these signals well (e.g. odontocete cetaceans), for other animals, the perceived sound loudness will be considerably reduced based on their brief nature and the fact that auditory integration times in many species likely exceed the duration of individual signals.
- Density estimates underlying take calculations presume a uniform distribution of animals, while in reality for more species they are considerably patchy. The use of vertical stratification and volumetric density here is an improvement over simple geographical density estimates, although a homogenous distribution (albeit in three dimensions) is still used.
- Several other precautionary assumptions are made, including a fairly conservative interpretation of beamwidth of these directional sources and the use of the low frequencies (with greatest potential propagation to higher received levels) in cases where multiple frequencies are used.

In conclusion, the estimated Level B harassment likely overestimates the actual magnitude of behavioral impacts of these operations for the reasons given above. This approach is deemed appropriate, however, given some of the uncertainties in terms of response thresholds to these types of sounds, overall density estimates, and other complicating factors.

6.3 Estimated Level B Harassment due to Physical Presence of Fisheries Research Activities

Four gear types (fyke nets, beach seine, rotary screw traps, and Mamou shrimp trawl) are used to monitor fish communities in the Penobscot River Estuary. Annual surveys are conducted using all gear types over specific sampling periods: Mamou trawling is conducted year-round; fyke net and beach seine surveys are conducted April-November, and rotary screw trap surveys from April-June. It is anticipated that trawl, fyke net, and beach seine surveys may disturb harbor seals and gray seals hauled out on tidal ledges. These surveys are conducted in upper Penobscot Bay above Fort Point Ledge where there is only one minor seal ledge (Odum Ledge) used by approximately 50 harbor seals (i.e., based on a early June 2001 survey). It cannot be assumed that the number of seals using this region is stable over the April-November survey period; it is likely lower in spring and autumn. No gray seals were seen in the 2001 survey but recent anecdotal information suggests that a few gray seals may share the haulout site. These fisheries research activities do not entail intentional approaches to seals on ledges (i.e., boats avoid close approach to tidal ledges and no gear is deployed near the tidal ledges), only behavioral disturbance incidental to small boat activities is anticipated. Behavioral disturbance may include head lifts, shifts in body position towards the water, or seals entering the water. The NEFSC takes a conservative approach and estimates that all hauled out seals may be disturbed by passing research skiffs, although researchers have estimated that only about 10 percent (5 animals in a group of 50) have been visibly disturbed in the past. The NEFSC calculates 50 harbor seals and 20 gray seals may be disturbed by the passage of researchers for each survey effort (100 fyke net sets, 100 beach seine sets, and 200 Mamou shrimp trawls per year). The resulting estimate is that 20,000 harbor seals and 8,000 gray seals may be disturbed (Level B harassment) by the physical presence of researchers in skiffs each year (Table 6-8). The NEFSC recognizes this level is very likely a large over-estimate and that actual taking by harassment will be considerably smaller. This level of periodic, infrequent, and temporary disturbance is unlikely to affect the use of the haulout by either species.

Rotary-screw traps are deployed further up the river, beyond where seals have been reported. Thus, we do not expect that this gear will result in incidental harassment of seal populations.

Table 6-8 Estimated annual Level B harassment take of seals associated with surveys in the lower estuary of the Penobscot River above Fort Point Ledge

Species	Estimated seals on ledge haulout	Survey gear	Number of sets	Survey Season	Estimated Level B take
Harbor seal	50	Fyke net	100	April-November	5000
Gray seal	20				2000
Harbor seal	50	Beach seine	100	April-November	5000
Gray seal	20				2000
Harbor seal	50	Mamou shrimp trawl	200	Year-round	10,000
Gray seal	20				4000

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7.0 THE ANTICIPATED IMPACT OF THE ACTIVITY UPON THE SPECIES OR STOCK

We anticipate that the specified activities could impact the species or stocks of marine mammals by causing mortality, serious injury, and/or Level A (non-serious injury) harassment (through gear interaction) or by causing Level B (behavioral) harassment (through use of active acoustic sources or by human presence during near shore surveys). These could occur through the following:

- Entanglement in nets or longlines;
- Accidental hooking; and
- Alterations in behavior caused by acoustics sources or by human presence during near shore surveys.
- Other potential effects of the activity could include hearing impairment, masking, or non-auditory physiological effects, such as stress responses, resonance, and other types of organ or tissue damage related to the use of active acoustics. However, for reasons described below, we do not expect that these effects would occur.

In addition, we do not expect that the anticipated impact of the activity upon the species or stocks would include the potential for effects on marine mammals from the following: Collision or vessel strike.

The NEFSC does not expect its survey operations or its cooperative surveys with other research entities would cause the marine mammal populations in western Atlantic Ocean to experience reductions in reproduction, numbers, or distribution that might appreciably reduce their likelihood of surviving and recovering in the wild. Although these surveys have the potential to adversely impact the health and condition of an individual marine mammal, we anticipate no adverse effects on annual rates of recruitment or survival of the affected marine mammal species or stocks. The NEFSC notes, however, that marine mammal distribution and abundance is not uniform in all parts of the study area, and varies substantially in different seasons. Most marine mammal surveys are conducted during the summer and fall; however, density information is not available for every season in all the study regions. But the NEFSC believes that the direct effects on species or stocks are minor since over the course of the operations as reported in the PSIT database (2004-2013) only 6 marine mammal species have been incidentally caught of which one was released alive. These animals caught include a minke whale (released alive), a common bottlenose dolphin, a harbor porpoise, a gray seal, a harbor seal and 3 short-beaked common dolphins (Figure 6-1; Table 6-1).

While there are different approaches that could be taken to evaluate the significance of anticipated interactions with marine mammals during the course of fisheries research, the PBR level used in classifying commercial fisheries is well established. PBR is defined by the MMPA as the maximum number of animals that may be removed from a marine mammal stock, not including natural mortalities, while allowing that stock to reach or maintain its optimum sustainable population. The PBR level is the product of the minimum population estimate of the stock, one-half the maximum theoretical or estimated net productivity rate of the stock at a small population size, and a recovery factor of between 0.1 and 1.0.

In using PBR to evaluate the impact of NEFSC fisheries research activities on affected marine mammal stocks, two assumptions should be noted. First, as described in section 6 of this application, NEFSC has requested a single number of takes in each gear for each stock in a combined category that includes Level A injury, serious injury and mortality. It is likely that some marine mammals that interact with NEFSC research gears will experience only non-serious injuries. However, for purposes of evaluating the significance of the NEFSC take request relative to PBR we assume the worst-case outcome that all animals in this combined category will be seriously injured or killed. The rationale for this binning of Level A injury, serious injury and mortality takes is described in greater detail in Section 6 of this application.

Second, NEFSC is assuming its anticipated take will equal its actual take of marine mammals in fisheries research activities. PBR was developed as a tool to evaluate actual human-caused removals from a population, not anticipated future removals. Nonetheless, the take request described in Section 6 is based on historical interactions, and as such NEFSC believes its request is a reasonable approximation of the number of takes that may occur in the future. Clearly, the actual number of serious injuries and mortalities that result from NEFSC research will need to be evaluated to understand the significance of these activities. As described in Section 11 of this application, NEFSC plans to implement an adaptive management approach to evaluating its actual takes and continuing to revisit its mitigation measures in light of take events to ensure they are appropriate.

7.1 Physical Interactions with Gear

The NEFSC incidentally caught eight marine mammals during research activities from 2004-2013 (Table 6-1). The seven mortalities occurred during gillnet gear research, gillnet observer training, mid-water trawls, bottom trawls, and in fyke net sampling studies. A minke whale was captured and released alive during a mid-water trawl survey (later assigned to the serious injury/mortality cateogory).

Several gear types used during NEFSC fisheries research surveys are similar to those used in commercial fishing operations in the western North Atlantic Ocean. Included are bottom and mid-water trawls, pelagic longlines, gillnets, fyke nets, and pots/traps (cod and lobster). However, it is important to note that the size of the gear, its configuration, and protocols used by most of the long-term research surveys conducted by the NEFSC and its research partners differ significantly from commercial fishing operations, thereby reducing or eliminating the likelihood of incidental catch of marine mammals. For example, the annual NEFSC BTS is based on a stratified random sampling design and covers the entire northeast continental shelf (Cape Hatteras to Gulf of Maine). BTS tows are of a shorter duration (~20-30 minutes) than tows in commercial fishing operations, which often exceed two or three hours, and the survey does not deliberately target important fishing grounds, which may also have higher concentrations of marine mammals.

Short-term cooperative research projects funded through the NEFSC are often conducted on commercial fishing vessels with commercial gear or modified commercial gear. These projects are also designed to sample fish populations or compare catch rates of different gear configurations rather than to catch as much fish or invertebrates as possible. For some projects, tow/set times may extend over an hour or two but they are still generally much shorter than commercial operations. These research efforts are also very small relative to the amount of commercial fishing effort. While there is risk of incidental take of marine mammals in these types of research projects, the NEFSC is proposing additional protected species training, mitigation, and reporting measures as a requirement of contracts for cooperative research projects that are expected to reduce the risk of adverse interactions in the future (see Sections 11 and 13).

Commercial fishing gear such as fixed, bottom-tending fishing gear (i.e. pots and gill nets) is a source of human-caused injury or mortality in marine mammals. There were 153 confirmed entanglements of baleen whales along the U.S. eastern seaboard between 2003 and 2007. Twenty-one of these were fatal and 16 caused serious injury (Glass *et al.* 2009). Although not always as immediately fatal as ship strikes, entanglements in commercial fishing gear can lead to prolonged weakening or deterioration of an animal (Knowlton and Kraus 2001). This is particularly true for large whales; small whales, dolphins, porpoises, and seals are more likely to die when entangled. Commercial fisheries along the U.S. east coast with known bycatch of marine mammals include those using pelagic longlines, sink gillnets, drift gillnets, lobster traps/pots, mixed species traps/pots, bottom trawls, mid-water trawls, purse seines, stop seine/weirs, and haul/beach seines (Waring *et al.* 2011; Zollet 2009).

Because of the low level of historical takes by various gear types used during NEFSC fisheries research surveys, as well as the low level of predicted future takes associated with the use of such gear in research activities in the western North Atlantic Ocean, the NEFSC believes that the surveys described below: (1)

will have a minimal impact on the affected species or stocks of marine mammals (based on the likelihood that the activities are not expected to measurably affect annual rates of recruitment or survival); and (2) will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses.

7.1.1 Anticipated impact of trawl surveys that may take marine mammals by mortality and by serious injury, or by non-serious injury (Level A harassment) in the Northeast LME

Please refer to Appendix C for a description of the trawl nets and vessels used by NEFSC during their fisheries research. Marine mammals may be caught infrequently while using these nets. Mitigation measures include a move-on rule to minimize chances for gear to be deployed with marine mammals within 1 nm (see Section 11 and 13 below for additional information on mitigation and monitoring).

<u>Benthic Habitat Surveys</u>

NEFSC also uses the 4-seam, 3-bridle bottom trawl with roller gear in the benthic survey which is conducted yearly in July in the Hudson Canyon/Georges Bank areas. There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

<u>Changes in the Community Structure of Benthic Fishes</u>

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

<u>Fish collection for laboratory experiments</u>

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

<u>Habitat Characterization</u>

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

<u>Habitat Mapping Survey</u>

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

<u>Living Marine Resources Center Survey</u>

NEFSC also uses the 4-seam, 3-bridle bottom trawl and the 2m beam bottom trawl with single wire in the LMRCSC survey which is conducted yearly in January in the Mid-Atlantic Bight. There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

<u>MA Division of Marine Fisheries Bottom Trawl Surveys</u>

Survey operations are conducted during daylight hours in Massachusetts territorial waters from the Rhode Island to New Hampshire border. There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

<u>Northeast Area Monitoring and Assessment Program (NEAMAP) Near Shore Trawl Program</u>

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

Northeast Fisheries Observer Program (NEFOP) Observer Bottom and Mid-water Trawl Training Trips

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

Northern Shrimp

NEFSC also uses the 4-seam modified commercial shrimp bottom trawl in the northern shrimp survey which is conducted yearly in July in the Gulf of Maine. There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

NEFSC Standard Bottom Trawl Surveys (BTS)

A single short-beaked common dolphin was incidentally killed in November 2007, approximately 10 miles south of Southampton, New York (Figure 6-1), during a gear testing trip where new doors, scope ratio (amount of wire attached to net versus depth) and an auto-trawl system used aboard the *H.B. Bigelow* were being tested with the 4-seam, 3-bridle bottom trawl. The tow was made around midnight, and tow duration was 45 minutes as opposed to standard 20-30 minutes for bottom trawl surveys. Tow durations during gear testing cruises are not standardized; their duration depends on what is being observed on net sonar system. At this point in time, no further gear testing cruises are anticipated within the next five years.

Atlantic Herring Survey

NEFSC uses the Gourock high speed midwater rope trawl in the Atlantic Herring Survey which is conducted in fall in the Gulf of Maine and northern Georges Bank.

The only baleen whale taken during a trawl survey was a 19 foot long minke whale caught on October 11, 2009. This occurred during the NMFS fall Atlantic Herring Survey at approximately 2300 hours and 15 nm east of Race Point, Cape Cod (Figure 6-1). The whale was caught in the codend of the mid-water trawl net, most likely near the surface during haul back. The whale and codend were lifted from the water without being landed, the codend was tripped and the whale slid back into the water. No biological data were collected in the interest of safety. The whale appeared in good condition and swam away upon release. Darkness precluded visual detection of the whale. The net, instrumented with trawl sonar, was monitored during the tow and provided indications that the whale entered the net during haul back.

Two short-beaked common dolphins were incidentally killed in a midwater trawl during the Atlantic Herring Survey on October 8, 2004, at 5:22 am. These animals were caught approximately 142 nm east of Cape Cod (Figure 6-1).

Atlantic Salmon Trawl Survey

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

Deepwater Biodiversity Survey

NEFSC also uses the 4-seam, 3-bridle bottom trawl with roller gear and the international young gadoid pelagic trawl in this survey which is conducted yearly (summer) in the western North Atlantic. There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

Penobscot Estuarine Fish Community and Ecosystem Survey

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

Northeast Integrated Pelagic Survey

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

Calibration survey

NEFSC also uses the 4-seam, 3-bridle bottom trawl in the calibration survey which it conducts in spring and fall from Cape Hatteras to the western Scotian Shelf. There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

Trawling to Support Finfish Aquaculture Research

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

7.1.2 Anticipated impact of longline surveys that may take marine mammals by mortality and serious injury or by non-serious injury (Level A harassment) in the Northeast LME

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this gear, however a small number of interactions may occur in the future using this gear. A summary of these surveys is presented in section 1.4 and Tables 1-1 and 1-2.

Apex pelagic shark

This survey is conducted in spring from Florida to Canada and is accomplished using the 'Yankee' swordfish-style pelagic longline gear. This survey and the Apex Coastal Shark survey are conducted in alternate years, contingent on funding. Apex coastal shark

This survey is conducted in spring from Florida to Delaware and uses the Florida style bottom longline.

Cooperative Atlantic States shark pupping and nursery survey (COASTSPAN)

This survey is conducted in spring in coastal Delaware, New Jersey, and Rhode Island. It uses bottom longline gear (and gillnets) and separate surveys are conducted for juvenile and adult fish.

Tagging shark bycatch on commercial fishing vessels (summer-autumn)

This research does not employ NEFSC longline gear but participates with commercial longline operations. NEFSC scientists are present during the haul-back of gear when they tag and release sharks caught as bycatch in the Grand Banks off Newfoundland and Georges Bank.

NEFOP Observer Bottom Longline Training Trips

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

7.1.3 Anticipated impact of longline surveys that may take marine mammals by mortality and serious injury or by non-serious injury (Level A harassment) in the Southeast LME

Apex Predators Bottom Longline Coastal Shark

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear.

COASTSPAN Longline Surveys

There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however, a small number of interactions may occur in the future using this gear.

7.1.4 Anticipated impact of various gear that may take marine mammals by mortality and serious injury or by non-serious injury (Level A harassment) in the Northeast LME

There have been four marine mammal mortalities associated with these surveys (see fyke nets and gill nets, below). A summary of these surveys is presented in section 1.6 and Table 1-1 and 1-2.

Fyke nets

The Maine Estuaries Diadromous Survey uses fyke nets to monitor the fish community in the Penobscot River estuary. One harbor seal died when caught in a 2 m fyke net on October 25, 2010, about 2 nm downstream from Bucksport, Maine. The animal was discovered at 7:15 am and was captured despite a short soak time (<2 hours) and visual monitoring from NEFSC scientists conducting salmon research near shore. Since that mortality NEFSC has added an excluder design to the net (see Appendix A) and have had no incidents since then. The excluder device will be used in future research.

Beach seine

Beach seines are used by the Atlantic salmon program to monitor the fish community in the Penobscot River estuary and in New Jersey. There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey, however a small number of interactions may occur in the future using this gear**.**

Rotary screw trap surveys

Rotary screw traps are used by the Atlantic salmon program to monitor the fish community in the Penobscot River estuary from April to June, daily (mornings). There have been no marine mammal mortalities, serious injury, or Level A takes associated with this gear, however a small number of interactions may occur in the future using this gear.

Gillnets (trammel nets)

The NEFSC Northeast Fisheries Observer Program Gillnet Training program caught and killed one gray seal and one harbor porpoise using an anchored sinking gillnet on May 4, 2009. The gray seal was discovered at 7:39 am while the harbor porpoise was discovered at 10.24 am as the net was retrieved. These takes occurred approximately 5 nm southeast of Chatham, Massachusetts (Figure 6-1).

The COASTSPAN gillnet survey is conducted from Florida to Rhode Island. NEFSC conducts these surveys in Delaware, New Jersey, and Rhode Island estuarine and coastal waters. Other areas are surveyed by cooperating institutions and agencies annually during summer. There have been no marine mammal mortalities, serious injury, or Level A takes associated with this survey in the Northeast LME, however a small number of interactions may occur in the future using this gear**.**

Serious injury or Level A takes associated with gillnet gear may occur in the future.

7.1.5 Anticipated impact of various gear that may take marine mammals by mortality and serious injury or by non-serious injury (Level A harassment) in the Southeast LME

Gillnets (trammel nets)

The COASTSPAN gillnet survey is conducted from Florida to Rhode Island. NEFSC conducts these surveys in Delaware, New Jersey, and Rhode Island estuarine and coastal waters. Other areas are surveyed by cooperating institutions and agencies annually during summer. One mortality of a common bottlenose dolphin occurred on September 29, 2008 at about 12:40 pm while a cooperating institution was conducting the survey in South Carolina. The take occurred about 0.3 nm from the closest land in waters about 5 nm east of Awendaw, South Carolina (Figure 6-1). This take was subsequently assigned to the Northern South Carolina Estuarine System stock based on its location (Waring et al. 2014).

7.1.6 Anticipated impact of NEFSC fisheries research activities in the western Atlantic Ocean on marine mammal stocks

As described in Section 6, the NEFSC relied heavily on its historic marine mammal interactions with its trawl surveys and other gear and used other relevant information in developing its take request. Table 7-1 compares the total NEFSC take request for all gears for each species relative to each stock's PBR. The take request is based on a five year authorization period, not an annual basis, so the total take request for all gears was divided by five and rounded up to the next whole number to provide an annual average take for each species with which to compare to the annual PBR values. For most of the 12 species for which takes are requested, average estimated takes in all gear types are less than or equal to 10% of PBR. This level of mortality, if it occurred, would be unlikely to affect the survival or reproductive success of any species. The potential exception involves one of the six currently defined coastal stocks of common bottlenose dolphin, which are analyzed in Table 7-2.

The NEFSC take request for common bottlenose dolphin includes two in trawl gear, five in gillnet gear, and one in longline gear over the five year authorization period. The total for all gear types is eight, which rounds up to an average of two bottlenose dolphins per year in all gear types. These takes could be distributed among all 16 currently defined stocks within the overall region of NEFSC research. However, such taking would be more likely to occur in the offshore stock and the two coastal migratory stocks due to their greater numbers and occurrence in waters where the great majority of NEFSC research activity takes place. In addition, there is a small but reasonable chance that such takes could occur with animals from three coastal stocks south of Cape Hatteras. Furthermore, there is a small possibility for these two takes to be concentrated in one stock in any one year. Thus a "worst case" analysis would assume this was the case and would assess the relative impact to each stock on the assumption that all takes occurred within each of the six stocks most likely to coincide with NEFSC research activities (Table 7-2). NMFS considers all of these stocks to be strategic stocks because the total human-caused mortality and serious injury is greater than 10 percent of PBR and may exceed PBR (Waring et al. 2014).

Following this approach, in the case of the offshore stock, two coastal migratory stocks, and the coastal stocks for South Carolina & Georgia and Central Florida, two takes per year would be less than 10 percent of their respective PBRs (Table 7-2). The PBR for the Northern Florida coastal stock is seven and if the entire requested take of two per year occurred in this stock it would be in excess of 10 percent of PBR and could have population-level impacts to the stock. However, it is very unlikely that NEFSC-affiliated research would actually capture two animals from any of these stocks in a given year based on the lack of historical takes, the active mitigation measures employed, and the limited amount of NEFSC-affiliated research which occurs in nearshore areas within the range of this stock.

The one historical NEFSC take of a bottlnose dolphin was assigned to the Northern South Carolina Estuarine System stock in the most recent stock assessment report (Waring et al. 2014). However, the take occurred in 2008 before this stock was delineated and the assignment was based only on the location of the take, not a genetic sample or any other morphological data. Given that dolphins from other stocks are known to occur in this same area there is considerable uncertainty regarding the actual identity of the stock from which the historical take occurred. The COASTSPAN longline and gillnet survey is the only NEFSC-affiliated research effort which occurs in nearshore areas within the range of this stock. Because of the limited research effort, the mitigation measures in place for this survey, and the uncertainty about the historical take assigned to this stock, the NEFSC considers the chance of taking any animals from this stock or any other estuarine stock to be remote and, therefore, no take is requested from an estuarine stock of bottlenose dolphin.

Excluding the remote possibility of multiple takes from the small Northern Florida Coastal stock of bottlenose dolphins, both the low level of annual take requests and low level of historical interactions associated with NEFSC surveys lead the NEFSC to believe that these fisheries research activities will not affect annual rates of recruitment or survival of the requested species/stocks.

Table 7-1 Stocks for which NEFSC is requesting trawl, gillnet/fyke net and longline annual take, and evaluation of impact relative to PBR.

	Average Annual NEFSC Take Request for all Gears[1,2,3] (2015-2019)	PBR[4]	% PBR Requested
Minke whale	1	162	0.6
Risso's dolphin	1	126	0.8
Long-finned pilot whale	1	199	0.5
Short-finned pilot whale	1	159	0.6
Atlantic white-sided dolphin	1	304	0.3
White-beaked dolphin	1	10	10.0
Short-beaked common dolphin	2	1,125	0.01
Atlantic spotted dolphin	1	316	0.3
Common bottlenose dolphin	2	See Table 7-2	See Table 7-2
Harbor porpoise	2	706	0.3
Harbor seal	3	1,469	0.2
Gray seal	2	undetermined	NA

1. The summed take requests for the five year authorization period in Table 6-2 were divided by 5 and rounded up to the nearest whole number to obtain the average annual values in this column.
2. NEFSC requested 3 unidentified delphinid species and 3 unidentified pinniped species in all gear over the five year authorization period; these additional takes (0.6 takes each per year) have NOT been included in this table.
3. The NEFSC request is for Level A and serious injury/ mortality takes. For purposes of evaluating impact of this request, all takes are assumed to result in serious injury/mortality.
4. Waring et al. (2014).

Table 7-2 Evaluation of impact relative to PBR for all requested stocks of common bottlenose dolphin under a "worst case" assumption

Stock of Common Bottlenose Dolphin	PBR[4]	% PBR if Two Takes Per Year Were from a Single Stock
Western North Atlantic Offshore	561	0.4
Coastal, Northern Migratory	86	2.3
Coastal, Southern Migratory	63	3.2
Coastal, South Carolina & Georgia	31	6.0
Coastal, Northern Florida	7	28.6
Coastal, Central Florida	29	6.9

7.1.7 Survey gears for which no take of marine mammals by mortality or serious injury and by non-serious injury (Level A harassment) is being requested

Dredge gear, grab samplers, and ROVs and towed camera arrays that are operated by the NEFSC have never had a marine mammal take and none are expected in the future. The scallop dredge survey has been conducted annually since 1982 and sampled waters off Cape Hatteras, North Carolina to the Scotian Shelf, Canada. The surf clam and ocean quahog survey had been conducted triennially since 1976 and sampled waters off Cape Hatteras, North Carolina to the Scotian Shelf, Canada with no marine mammal incidents

The NEFSC uses Van Veen sediment grab, bongo nets, and other gear during its fisheries survey operations; refer to Table 1-1a and 1-1b and Appendix A for a full list and descriptions of their use. NEFSC conducts sediment pot/trap surveys that are not expected to take marine mammals. The Van Veen sediment grab is used in the benthic and LMRCSC surveys and no marine mammals are expected to be taken by this gear.

All the gear listed in this section is not considered to have the potential to take marine mammals by mortality/serious injury or non-serious Level A take given their physical characteristics, how they are fished, and the environments where they are used. There have been no marine mammal mortalities, serious injury, or Level A takes associated with any of these gear types. Because of this, NEFSC is not requesting marine mammal take for these gears, and as such they are not expected to have an impact on marine mammal stocks in the NEFSC study areas. These studies are described in Section 1.6 and Table 1-1a and 1-1b. A list of those studies by gear type follows.

Dredge Gear

Annual Assessments of Sea Scallop Abundance and Distribution in Selected Closed/Rotational Areas

NEFOP Observer Scallop Dredge Training Trips

Sea Scallop

Surf Clam and Ocean Quahog Dredge Survey

Surveys Using Other Gear

Coastal Maine Telemetry Network

Deep-sea Coral Survey

Diving Operations

Ecology of Coastal Ocean Seascapes

Northeast Integrated Pelagic Survey (previously called Ecosystem Monitoring)

Finfish Nursery Habitat Study

Gear Effects on Amphipod Tubes

Gulf of Maine Ocean Observing System Mooring Cruise

Hydroacoustic surveys

Nutrients and Frontal Boundaries

Ocean Acidification

Pilot Studies

Sea Bed Habitat Classification Survey

Shellfish Aquaculture

Shellfish Aquaculture: Environmental Interaction

U.S. Army Corps of Engineers Bottom Sampling

DelMarVa Habitat Characterization

DelMarVa Reefs Survey

Miscellaneous Fish Collections and Experimental Survey Gear Trials

Opportunistic Hydrographic Sampling

7.1.8 Cooperative Research that may take marine mammals by mortality and serious injury or by non-serious injury (Level A harassment)

NEFSC participates in a variety of cooperative research projects with the fishing industry and other research entities that are focused on mitigation of protected species bycatch (marine mammals, sea turtles, and fish). Gear types used in this work include trawls, longlines, pound nets, gillnet, and dredge. These activities may have had serious injury or mortality interactions with marine mammals. However, under the cooperative programs, the protocol is to assign the bycatch to the fishery and include the observed interactions (SI and mortality) into the fishery interaction tables in Atlantic stock assessment reports (Waring *et al.* 2012). The effect of such taking is analyzed in the process of authorizing incidental take under the commercial fisheries exemption process via General Permits issued to industry.

7.2 Disturbance and Behavioral Changes

7.2.1 Due to Physical Presence of Researchers

As described in section 6.3, during surveys conducted near shore in the Penobscot River Estuary, pinnipeds are expected to be hauled out and at times experience relatively close approaches by the survey vessel during the course of its fisheries research activities. NEFSC expects some of these animals will exhibit a behavioral response to the visual stimuli (e.g., including flushing, vocalizing and head alerts), and as a result estimates of Level B harassment have been calculated. These events are expected to be infrequent and cause only a very temporary disturbance (minutes long). However, relevant studies of pinniped populations that experience more regular vessel disturbance indicate that population level impacts are unlikely to occur. Some key findings from these studies are summarized below.

In a popular tourism area of the Pacific Northwest where human disturbances frequently occur, past studies observed stable populations of seals over a 20-year period (Calambokidis *et al.* 1991). Despite high levels of seasonal disturbance by tourists using both motorized and non-motorized vessels, Calambokidis *et al.* (1991) observed an increase in site use (pup rearing) and classified this area as one of the most important pupping sites for seals in the Pacific Northwest. Another study observed an increase in seal vigilance only when vessels passed the haul-out site, but then vigilance relaxed within 10 minutes of the vessels' passing (Fox 2008). If vessels were frequent to occur within a short time period (e.g., 24 hours), a reduction in the total number of seals present was also observed (Fox 2008).

Based on these studies, repeated disturbance can cause behavioral disturbance and alter normal activity patterns, and as such minimizing these types of disturbances, particularly those that are frequent and prolonged, is important. However, if disturbances resulting from research activities are brief and infrequent (often the case during NEFSC surveys), NEFSC does not expect the close approaches to result in prolonged or permanent separation of mothers and pups or to result in responses of the frequency or magnitude that would adversely affect annual recruitment or survival or the health and condition of pinniped species or stocks.

7.2.2 Due to Noise

Characteristics of hearing and the effects of noise on marine life have been reviewed extensively (Richardson *et al.* 1995; Wartzok and Ketten 1999; Nowacek *et al.* 2007; Southall *et al.* 2007; Au and Hastings 2008). General characteristics of hearing in marine mammals is described briefly here primarily for the purposes of categorization with regard to the potential impacts of high frequency active acoustic sources, as well as current information regarding sound exposures that may be detectable, disturbing, or injurious to marine mammals.

Hearing in Marine Mammals

Within marine taxa, there is probably the most known about the hearing capabilities of marine mammals. However many species and in fact entire taxa (e.g., large whales) have not been measured directly in controlled/laboratory settings. Current knowledge is based on direct measurements (using behavioral testing methods with trained animals and electrophysiological measurements of neural responses to sound production), as well as various ways of predicting hearing sensitivity using ranges of vocalization, morphology, observed behavior, and/or taxonomic relatedness to known species (e.g., Ketten 1997; Houser *et al.* 2001). While less than a third of the >120 marine mammal species have been tested directly, sufficient data exist to indicate general similarities and differences within taxa (e.g., Richardson *et al.* 1995; Wartzok and Ketten 1999; Au and Hastings 2008) and reasonably assign marine mammal species into functional hearing groups (as in Southall *et al.* 2007). Based on the functional hearing groupings made in Southall *et al.* (2007) conclusions may be made about marine mammal hearing, as described below.

No direct measurements of hearing exist in large whales, primarily because of their sheer size and the resulting difficulties in housing and testing them in normal captive settings. Conclusions about their hearing capabilities must be considered somewhat speculative, but some general conclusions and predictions are possible (Richardson *et al.* 1995; Ketten 1997; Wartzok and Ketten 1999; Houser *et al.* 2001; Erbe 2002; Clark and Ellison 2004). The thirteen species of baleen whales have been determined to comprise a low frequency cetacean functional hearing group with estimated functional hearing between 7 Hz and 22 kHz (Southall *et al.* 2007; Figure 7-1). Humpback whales produce sounds with some energy above 24 kHz (Au *et al.* 2006), so it is possible that functional hearing could extend slightly higher in this group. Empirical measurements of Frankel (2005) in demonstrating minor avoidance behavior in gray whales to 21-25 kHz sounds and the anatomical predictions of Parks *et al.* (2007) are consistent with the interpretation of a slightly higher upper frequency hearing cut-off in mysticetes, perhaps extending close to 30 kHz in some species.

Odontocetes are segregated into two functional hearing groups based on their relative specialization (or lack thereof) to detect very high frequency sounds (Tables 4.1). Southall *et al.* (2007) distinguished these into the mid-frequency cetaceans including 32 species and subspecies of “dolphins”, 6 species of larger toothed whales, and 19 species of beaked and bottlenose 148 whales. These species are determined, based on direct behavioral and electrophysiological methods, to have functional hearing between approximately 150 Hz and 160 kHz (see references in Southall *et al.* 2007).

High frequency cetaceans include eight species and subspecies of true porpoises, six species and subspecies of river dolphins plus the Franciscana (*Pontoporia blainvillei*)), *Kogia*, and four species of cephalorhynchids and have functional hearing between 200 Hz and 180 kHz (Southall *et al.* 2007, and citations therein).

The pinnipeds (seals and sea lions) function in both air and water and have functional hearing in each media. Only underwater hearing is considered here, given that the active acoustic sources associated with NEFSC research vessels are operated in water. This group includes 16 species and subspecies of sea lions and fur seals (otariids), 23 species and subspecies of true seals (phocids), and two subspecies of walrus (odobenids). Based on the existing empirical data on hearing in laboratory individuals of nine pinniped species, Southall *et al.* (2007) estimated functional underwater hearing sensitivity in this group to be between 75 Hz and 75 kHz, but noted that there is considerable evidence that phocid seals have a broader range of hearing sensitivity than the otariids; the use of this bandwidth is thus a precautionary estimate in terms of how high frequency sounds might affect otariid pinnipeds.

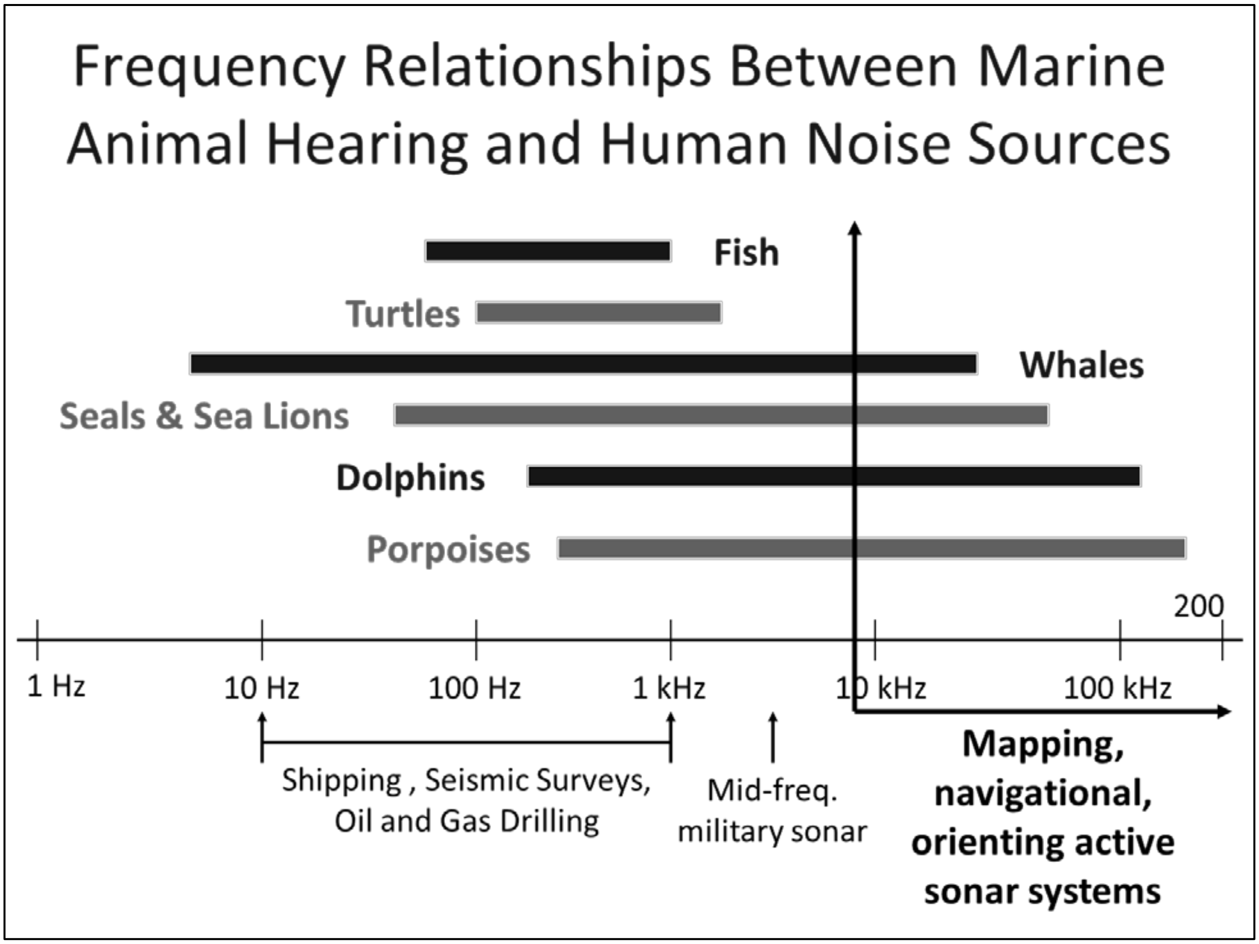

Figure 7-2 Typical frequency ranges of hearing in marine animals shown relative to various underwater sound sources, particularly high frequency active acoustic source

Effects of anthropogenic noise on marine mammals

Anthropogenic sounds cover a broad range of frequencies and sound levels and can have a range of impacts on marine life, from no or minor responses to potentially severe, depending on received levels, behavioral context and various other factors. Many of the kinds of sources that have been investigated included sounds that are either much lower frequency and/or higher total energy (considering output sound levels and signal duration) than the high frequency mapping and fish-finding sonars used by the NEFSC. These include low- and mid-frequency military sonars, seismic airguns used in geophysical research, pile-driving sounds associated with marine construction, and low- and mid- frequency sounds associated with vessel operations (NRC 1994, 2000, 2003, 2005; Nowacek *et al.* 2007; Southall *et al.* 2007; Popper and Hastings 2009). Other than the Navy's studies on the High-Frequency Marine Mammal Monitoring (HF/M3) active sonar system since 2001, there has been relatively little attention given to the potential impacts of high-frequency sonar systems on marine life, largely because their combination of high output frequency and relatively low output power is likely to render them less likely to impact many marine species than some of the other acoustic sources. However, it should be noted that some species of marine animals do hear and produce sounds at some of the frequencies used in these sources and ambient noise is much lower at high frequencies, increasing the relative probability of their detection relative to other sounds in the environment. Because, as seen in Figure 7-1, there is very little probability of fish even hearing active high frequency acoustic sources, the primary discussion here is related to marine mammals, with particular emphasis on the odontocete cetaceans.

Sounds must presumably be audible to be detected and the known or estimated functional hearing capabilities for different species are indicated in Figure 7-1. Additionally, Southall *et al.* (2007) provided a recent and extensive review on the effects of noise on marine mammal hearing and behavior.

The results of that review indicate that relatively high levels of sound are likely required to cause temporary hearing threshold shifts (TTS) in most pinnipeds and odontocete cetacean species (e.g., Schlundt *et al.* 2000; Finneran *et al.* 2000, 2002, 2005, 2007b, 2010a and b; Kastak *et al.* 1999, 2005, 2007). The exposures required are often measured with a variety of sound exposure metrics related to level (e.g., RMS, peak, or peak-peak sound pressure level) or sound energy (e.g., sound exposure level that considers level as well as exposure duration). While clearly dependent on sound exposure frequency, level, and duration, based on the results of these studies, for the kinds of relatively brief exposures associated with transient sounds such as the active acoustic sources usd by the NEFSC, RMS sound pressure levels in the range of approximately 180-220 dB re: 1μPa are required to induce onset TTS levels for most species. Recently, Lucke *et al.* (2009) found a TTS onset in a harbor porpoise exposed to airgun noise at much lower (>20 dB) levels than reported by Finneran *et al.* (2002) for belugas using a similar impulse noise source; Kastelein (unpubl. data) has similarly observed increased sensitivity in this species. Additionally, Finneran and Schlundt (2010) indicate relatively lower TTS onset levels for higher sound exposure frequencies (20 kHz) than for lower frequencies (3 kHz) in some cetaceans. However, for these animals, which are better able to hear higher frequencies and may be more sensitive to higher frequencies, exposures on the order of ~170 dB RMS or higher for brief transient signals are likely required for even temporary (recoverable) changes in hearing sensitivity that would likely not be categorized as physiologically damaging. The corresponding 150 estimates for permanent threshold shift (PTS), which would be considered injurious, would still be at quite high received sound pressure levels that would rarely be experienced in practice.

Southall *et al.* (2007) provided a number of extrapolations to assess the potential for permanent hearing damage (permanent threshold shift or PTS) from discrete sound exposures and concluded that very high levels (exceeding 200 dB re: 1μPa received sound pressure levels) would be required; typically quite large TTS is required (~40 dB) to result in PTS from a single exposure. Southall *et al.* (2007) also provided some frequency weighting functions for different marine mammal groups, which essentially account for the fact that impacts of noise on hearing depends in large part on the frequency overlap between noise and hearing. Based on the Southall *et al.* (2007) results, Lurton and DeRuiter (2011) modeled the potential impacts (PTS and behavioral reaction) of conventional echosounders on marine mammals. They estimated PTS onset at typical distances of 10m to 100m for the kinds of sources in the fisheries surveys considered here. They also emphasized that these effects would very likely only occur in the cone ensonified below the ship and that animal responses to the vessel at these extremely close ranges would very likely influence their probability of being exposed to these levels. For certain species (e.g., odontocete cetaceans and especially harbor porpoises), these ranges may be somewhat greater based on more recent data (Lucke *et al.* 2009; Finneran and Schlundt 2010), although they are likely still on the order of hundreds of meters for most fisheries acoustic sources. In addition, the behavioral responses that typically occur (described below) further reduce this already low likelihood that an animal may approach close enough for any type of hearing loss to occur.

The overall conclusion here is that the available information on hearing and potential auditory effects in marine mammals would suggest that the high frequency cetacean species would be the most likely to have temporary (not permanent) hearing losses from a vessel operating high frequency sonar sources, but that even for these species, individuals would have to either be very close to and also remain very close to vessels operating these sources for multiple exposures at relatively high levels. Given the moving nature of vessels in fisheries research surveys, the likelihood that animals may avoid the vessel to some extent based on either its physical presence or active acoustic sources, and the intermittent nature of many of these sources, the potential for TTS is probably low for high frequency cetaceans and very low to zero for other species.

Behavioral responses of marine mammals are extremely variable depending on a host of exposure factors, including exposure level, behavioral context and other factors. The most common type of behavioral response seen across studies is behavioral avoidance of areas around sound sources. These are typically the types of responses seen in species that do clearly respond, such as harbor porpoises, around temporary/mobile higher frequency sound sources in both the field (e.g., Culik *et al.* 2001; Johnston *et al.* 2002) and in the laboratory settings (e.g., Kastelein *et al.* 2000, 2005, 2008a and b). However, what appears to be more sustained avoidance of areas where high frequency sound sources have been deployed for long durations has also been documented in some odontocete cetaceans, particularly those like porpoises and beaked whales that seem to be particularly behaviorally sensitive (e.g., Olesiuk *et al.* 2002; Carretta *et al.* 2008; Southall *et al.* 2007). While low frequency cetaceans and pinnipeds have been observed to respond behaviorally to low- and mid-frequency sounds, there is little evidence of behavioral 151 responses in these species to high frequency sound exposure (see e.g., Jacobs and Terhune 2002; Kastelein *et al.* 2006).

Active acoustic sources used by the NEFSC and their effect on marine mammals

A brief discussion of the general characteristics of high frequency acoustic sources associated with fisheries research activities is given below, followed by a qualitative assessment of how those sources may affect marine life. Marine mammals, as opposed to marine fish and sea turtles, are the focus of this assessment given their overlapping hearing capabilities (Figure 7.1) with the sounds produced by high frequency sound sources.

The high frequency transient sound sources operated by the NEFSC are used for a wide variety of environmental and remote-object sensing in the marine environment. They include various echosounders (e.g., multibeam systems), scientific sonar systems, positional sonars (e.g., net sounders for determining trawl position), and environmental sensors (e.g., current profilers). The specific acoustic sources used in NEFSC active acoustic surveys, are described in section 6.2. As a general categorization, however, the types of active sources employed in fisheries acoustic research and monitoring may be considered in two broad categories here, based largely on their respective operating frequency (e.g., within or outside the known audible range of marine species) and other output characteristics (e.g., signal duration, directivity). As described below, these operating characteristics result in differing potential for acoustic impacts on marine mammals and other protected species.

<u>Category 1 active acoustic sources</u>

Certain active fisheries acoustic sources (e.g., short range echosounders, acoustic Doppler current profilers) are distinguished by having very high output frequencies (>180 kHz) and generally short duration signals and highly directional beam patterns. Based on the frequency band of transmissions relative to the functional hearing capabilities of marine species, they are not expected to have any negative effect on marine life. They are thus not considered explicitly in the qualitative assessment below (or in the quantitative analysis conducted in section 6.2). Additionally, passive listening sensors which are sometimes described as elements of fisheries acoustic systems that exist on many oceanographic research vessels have no potential impact on marine life because they are remotely and passively detecting sound rather than producing it.

These sources are determined to have essentially no probability of being detected by or resulting in any potential adverse impacts on marine species. This conclusion is based on the relative output frequencies (> 180 kHz) and the fact that this is above the known hearing capabilities of any marine species (as described above). Sounds that are above the functional hearing range of marine animals may be audible if sufficiently loud (e.g., see Møhl, 1968). However, the relative output levels of these sources and the levels that would likely be required for animals to detect them would be on the order of a few meters. The probability for injury or disturbance from these sources is essentially zero. In fact, NOAA does not regulate or require take assessments for acoustic sources with source frequencies at or above 180 kHz because they are above the functional hearing range of any known marine animal (including high frequency odontocete cetaceans, such as harbor porpoises).

Category 2 active acoustic sources

These acoustic sources, which are present on most NEFSC fishery research vessels, include a variety of single, dual, and multi-beam echosounders (many with a variety of modes), sources used to determine the orientation of trawl nets, and several current profilers with slightly lower output frequencies than Category 1 sources. Category 2 active acoustic sources have moderate to very high output frequencies (10 to 180 kHz), generally short ping durations, and are typically focused (highly directional) to serve their intended purpose of mapping specific objects, depths, or environmental features. A number of these sources, particularly those with relatively lower sound frequencies coupled with higher output levels can be operated in different output modes

(e.g., energy can be distributed among multiple output beams) that may lessen the likelihood of perception by and potential impact on marine life.

Category 2 active acoustic sources are likely to be audible to some marine mammal species. Among the marine mammals, most of these sources are unlikely to be audible to whales and most pinnipeds, whereas they may be detected by odontocete cetaceans (and particularly high frequency specialists such as harbor porpoise). There is relatively little direct information about behavioral responses of marine mammals, including the odontocete cetaceans, but the responses that have been measured in a variety of species to audible sounds (see Nowacek *et al.* 2007; Southall *et al.* 2007 for reviews) suggest that the most likely behavioral responses (if any) would be short-term avoidance behavior of the active acoustic sources.

The potential for direct physical injury from these types of active sources is low, but there is a low probability of temporary changes in hearing (masking and even temporary threshold shift) from some of the more intense sources in this category. Recent measurements by Finneran and Schlundt (2010) of TTS in mid-frequency cetaceans from high frequency sound stimuli indicate a higher probability of TTS in marine mammals for sounds within their region of best sensitivity; the TTS onset values estimated by Southall *et al.* (2007) were calculated with values available at that time and were from lower frequency sources. Thus, there is a potential for TTS from some of the Category 2 active sources, particularly for mid- and high-frequency cetaceans. However, even given the more recent data, animals would have to be either very close (few hundreds of meters) and remain near sources for many repeated pings to receive overall exposures sufficient to cause TTS onset (Lucke *et al.* 2009; Finneran and Schlundt 2010). If behavioral responses typically include the temporary avoidance that might be expected (see above), the potential for auditory effects considered physiological damage (injury) is considered extremely low so as to be negligible in relation to realistic operations of these devices.

Acoustic summary

Based on current scientific understanding and knowledge of the kinds of sources used in field operations, many of the high frequency, directional, and transient active acoustic sources used in NEFSC fisheries research operations are unlikely to be audible to and thus have no adverse impacts on most marine mammals. Sources operating at lower output frequencies, higher output levels, more continuous types of operation and with less directed acoustic energy are more likely to be audible to and affect more marine species.

Among the marine mammals, the whales and pinnipeds are the least likely to detect and be affected by these sounds. The most likely taxa to hear and react would be the odontocete cetaceans (and especially the high frequency specialized and relatively behaviorally sensitive harbor porpoises), who have specialized echolocation systems and associated high frequency hearing and excellent temporal processing of short-duration signals. The current NMFS acoustic step-function threshold of (160 dB RMS received level, irrespective of sound frequency,) is applied in the quantitative assessment in Section 6.2 because this is the current requirement. However, for many marine mammal species with reduced functional hearing at the higher frequencies produced by category 2 active sources (e.g., 40-180 kHz), based purely on their auditory abilities, the potential impacts are likely much less (or non-existent) than might be calculated in the quantitative assessment since these relevant factors are not taken into account.

For species that can detect sounds associated with high frequency active sources, based on the limited observational and experimental data on these and similar sound sources, the most likely impacts would be localized and temporary behavioral avoidance. These kinds of reactions, depending on their relative duration and severity, have been considered relatively low to moderately significant behavioral responses in the severity scaling assessment for marine mammals by Southall *et al.* (2007).

There is a low probability of some temporary hearing impacts and an even lower probability of direct physical harm for odontocete cetaceans to the loudest kinds of these high frequency sources over very localized areas (tens of meters) around the source. There is no published evidence for marine mammal stranding events as a function of high frequency active acoustic sources.

As a general conclusion, while some of the active acoustic sources used in NEFSC active acoustics during fisheries research surveys are likely to be detected by some marine species (particularly phocid pinnipeds and odontocete cetaceans), the potential for direct injury or hearing impairment is extremely low and the most likely responses involve temporary avoidance behavior. Consequently, and in a manner consistent with the current NMFS acoustic guidelines for defining Level B harassment of marine mammals from impulse noise sources, a quantitative framework was developed (Section 6.2) for assessing the potential impacts of NEFSC active acoustic sources used in fisheries research.

7.3 Surveys That May Take Marine Mammals by Level B Harassment

Current NMFS practice regarding exposure of marine mammals to sound is that cetaceans and pinnipeds exposed to impulsive sounds of 180 and 190 dB RMS or above, respectively, are considered to have been taken by Level A (i.e., injurious) harassment. Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds at or above 160 dB RMS or impulse sounds (e.g., impact pile driving) and 120 dB RMS for continuous noise (e.g., vibratory pile driving), but below injurious thresholds. For airborne noise, pinniped disturbance from haul-outs has been documented at 100 dB for pinnipeds in general, and at 90 dB for harbor seals. NMFS uses these levels as guidelines to estimate when harassment may occur.

Gear interactions causing mortality/serious injury on non-serious Level A harassment may occur in NEFSC fisheries surveys described at 7.2; Level B harassment associated with use of active acoustics equipment may also occur in NEFSC fisheries surveys. These surveys are described at 1.6 and 7.2 and include the following. The NEFSC believes that the activities listed below: will have a minimal impact on the affected species or stocks of marine mammals (based on the likelihood that the activities will not affect annual rates of recruitment or survival).

7.3.1 Surveys conducted in the Northeast LME and offshore region that may take marine mammals by Level B harassment using category 2 acoustic sources

Level B harassment associated with use of active acoustics may occur for the following research activities that use trawl gear:

- Benthic Habitat Survey
- Changes in the Community Structure of Benthic Fishes
- Fish collection for laboratory experiments

- Habitat Characterization
- Habitat Mapping Survey
- Living Marine Resources Center Survey
- MA Division of Marine Fisheries Bottom Trawl Surveys
- Northeast Area Monitoring and Assessment Program (NEAMAP) Near Shore Trawl Program
- Northeast Observer Program (NEFOP) Observer Bottom AND Mid-water Trawl Training Trips
- Northern Shrimp Survey
- NEFSC Standard Bottom Trawl Surveys (BTS)
- Atlantic Herring Survey
- Atlantic Salmon Trawl Survey
- Deepwater Biodiversity Survey
- Penobscot Estuarine Fish Community and Ecosystem Survey
- Northeast Integrated Pelagic Survey

Level B harassment associated with use of active acoustics may occur for the following research activities that use longline gear:

- Apex Pelagic Shark
- Apex Predators Bottom Longline Coastal Shark
- Apex Predators Pelagic Nursery Grounds Shark
- Cooperative Atlantic States Shark Pupping and Nursery Survey (COASTSPAN)
- NEFOP Observer Bottom Longline Training Trips

Level B harassment associated with use of active acoustics may occur for the following research activities that use dredge gear:

- Annual Assessments of Sea Scallop Abundance and Distribution in Selected Closed/Rotational Areas
- NEFOP Observer Scallop Dredge Training Trips
- Sea Scallop
- Surf Clam and Ocean Quahog Dredge Survey

Level B harassment associated with use of active acoustics may occur for the following research activities that use other gears:

- Deep-sea Coral Survey
- Ecology of Coastal Ocean Seascapes
- Northeast Integrated Pelagic Survey (previously called Ecosystem Monitoring
- Finfish Nursery Habitat Study
- Maine Estuaries Diadromous Survey
- Gulf of Maine Ocean Observing System Mooring Cruise

- Hydroacoustic surveys
- NEFOP Observer Gillnet Training Trips
- Nutrients and Frontal Boundaries
- Ocean Acidification
- Pilot Studies
- Rotary Screw Trap (RSTs) Survey
- Sea Bed Habitat Classification Survey
- Trawling to Support Finfish Aquaculture Research
- U.S. Army Corps of Engineers Bottom Sampling
- DelMarVa Habitat Characterization
- DelMarVa Reefs Survey
- Miscellaneous Fish Collections and Experimental Survey Gear Trials

7.4 Collision and Ship Strike

Collisions with vessels, or ship strikes, threaten numerous marine animals and are of great concern for endangered large whales, particularly right whales. Ship strikes with marine mammals can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds (Knowlton and Kraus 2001). Large whales, such as fin whales, are occasionally found draped across the bulbous bow of large ships upon arriving in port. Massive propeller wounds can be immediately fatal. If more superficial, the whales may survive the collisions (Silber *et al.* 2009). Jensen and Silber (2003) summarized large whale ship strikes world-wide from 1975 to 2003 and found that most collisions occurred in the open ocean involving large vessels. Commercial fishing vessels were responsible for four of 134 records (3%), and one collision (0.75%) was reported for a research boat, pilot boat, whale catcher boat, and dredge boat.

Ship strikes are a major cause of mortality and serious injury in North Atlantic right whales, accounting for 35% of deaths from 1970-1999 (Knowlton and Kraus 2001). Average annual reported mortality and serious injury from ship strikes, 2002-2006, was 2.4 (Waring *et al.* 2009). Ship strikes occur less frequently with humpbacks (1.4/year, 2002-2006) and fin whales (0.8/year, 2002-2006) (Waring *et al.* 2009).

Even though the likelihood of a ship strike is very small, we reviewed the available literature to assess the possible impact of ship strike as it applies to NEFSC survey vessels. Williams and O'Hara (2009) summarized their modeling efforts to characterize ship strikes of large cetaceans in British Columbia. Their information on ship strikes was based on ship activity provided to them by the Canadian Coast Guard. Spatially-explicit statistical modeling and Geographic Information System visualization techniques identified areas of overlap between shipping activity and waters used by humpback, fin and killer whales. Areas of highest risk were far removed from areas with high concentrations of people, suggesting that many beach-cast carcasses could go undetected. With few exceptions, high-risk areas were found in geographic bottlenecks, such as narrow straits and passageways. Although not included in the geographic area of the Williams and O'Hara study, the NEFSC survey area is such an area where large numbers of cargo ships transit the area each year, yet evidence for ship collisions are rare. Williams and O'Hara (2009) state that their risk assessments illustrate where ship strikes are most likely to occur, but cannot estimate how many strikes might occur. Propeller wounds on live killer whales were common in their study region, and fatal collisions have been reported in B.C. for all three species.

Several mitigation measures, to which NEFSC-affiliated research vessels adhere, were implemented to minimize the risk of vessel collisions with right whales. Other species also benefit. The compliance guide for the right whale ship strike reduction rule (NMFS 2008b) states that all vessels 19.8m in overall length or greater must slow to speeds of 10 kts or less in seasonal management areas. Northeast U.S. Seasonal Management Areas include: Cape Cod Bay (1 Jan-15 May), off Race Point (1 Mar-30 Apr) and GSC (1 Apr-31 July). Mid-Atlantic Seasonal Management Areas include several port or bay entrances from 1 November to 30 April.

When research vessels are actively sampling, cruise speeds are less than 5 kts, a speed at which the probability of collision and serious injury of large whales is low. However, when transiting between sampling stations, research vessels travel at speeds up to14 kts. NEFSC vessel captains and crew watch for marine mammals while underway during daylight hours and take necessary actions to avoid them, but there are no dedicated Marine Mammal Observers (MMOs) aboard the vessels.

No collisions with large whales have been reported from any fisheries research activities conducted or sponsored by the NEFSC. That, combined with adherence to the above mentioned mitigation measures, indicate that vessel collisions are possible, but unlikely to occur, and anticipated impacts to most species would be negligible to minor. The exception to this determination is right whales. Although it is highly unlikely that a NEFSC-affiliated fisheries research vessel would strike a right whale, doing so, especially if fatal, would be considered a substantial impact for this small population of endangered whales and would result in the initiation of ESA Section 7 consultation.

NOAA vessels are subject to ship strike management measures. Measures apply to vessels 19.8 m (65 ft) in length or greater, including commercial vessels (fishing vessels, tugs and tows, passenger vessels, passenger vessels for hire, large commercial vessels) and recreational vessels (NERO 2004). NMFS based the 19.8 m threshold on analysis of ship strike mortalities and serious injuries. Most vessels involved were greater than 80 m long. One right whale calf was, however, struck and killed by a 25 m vessel. Vessels smaller than 19.8 m may also pose a threat, but the 19.8 m threshold was deemed appropriate since it included most vessels involved in collisions and corresponded with established size criteria used in several other existing regulatory requirements (NERO 2004, NMFS 2008a).

In an analysis of the probability of lethal mortality of large whales at a given speed, results of a study using a logistic regression model showed that the greatest rate of change in the probability of a lethal injury to a large whale, as a function of vessel speed, occurs between vessel speeds of 8.6 and 15 kts (Vanderlaan and Taggart, 2007). Across this speed range, they found that the chances of a lethal injury decline from approximately 80% at 15 kts to approximately 20% at 8.6 kts. Notably, it is only at speeds below 11.8 kts that the chances of lethal injury drop below 50% and above 15 ks the chances asymptotically increase toward 100%.

Injuries and death to marine mammals resulting from ship collisions caused by vessels during NEFSC research are not likely to occur. The probability of vessel and marine mammal interactions occurring during NEFSC research is unlikely due to the vessel's slow operational speed, which is typically 3.5 mph (5.5 km/hr; 3.0kts). Outside of operations, each vessel's cruising speed would be approximately 9.2 to 13.8 mph (14.8 to 22.2 km/hr; 8.0 to 12.0 kts) which is generally below the speed at which studies have noted reported increases of marine mammal injury or death (Laist *et al.*, 2001). Considering this slow speed and the continual observation for marine mammals during all ship, the NEFSC believes that the vessels will be able to change course if any marine mammal is sighted in the line of vessel movement and avoid a strike. Even under the remote chance that a strike occurs by a NEFSC vessel it is unlikely to result in mortality.

There is a potential for vessels to strike cetaceans while traveling at slow speeds. For example, a NOAA contracted survey vessel traveling at low speed while conducting multi-beam mapping surveys off the central California coast struck and killed a female blue whale in October 2009. Pace and Silber (2005) found that the probability of death or serious injury increased rapidly with increasing vessel speed.

Specifically, the predicted probability of serious injury or death increased from 45% to 75% as vessel speed increased from 10 to 14 kts, and exceeded 90 percent at 17 kts. Higher speeds during collisions result in greater force of impact, but higher speeds also appear to increase the chance of severe injuries or death by pulling whales toward the vessel. Computer simulation modeling showed that hydrodynamic forces pulling whales toward the vessel hull increase with increasing speed (Clyne 1999; Knowlton *et al.* 1995). In the case of NEFSC vessels, we anticipate that vessel collisions with marine mammals are unlikely, unpredictable events for which there are no preventive measures. That said, although these surveys have the potential for vessel collision, we anticipate no adverse effects on annual rates of recruitment or survival of the affected marine mammal species or stocks because of the slow speed of the vessels, the move on rule, and visual monitoring.

7.5 Conclusions Regarding Impacts of NEFSC Fisheries Research Activities on Marine Mammal Species and Stocks

As outlined in this and previous sections, there are several NEFSC fisheries research activities that have the potential to cause Level B harassment, Level A harassment with the potential for injury, and serious injury or mortality of marine mammals in the northwest Atlantic study areas. However, because of the low level of historical interactions and low level of predicted future takes associated with NEFSC research relative to the abundance of affected populations, the mitigation measures that have been implemented to reduce the risks of interactions, and plans for improvements in these measures as outlined in this application, the NEFSC believes its activities will not affect annual rates of recruitment or survival or the health and condition of the species or stock of the requested species.

As discussed earlier in this Section, the requested annual takes associated with entanglement or hooking in NEFSC fisheries research surveys over the five year authorization period (2015-2019) do not exceed any stock's PBR, and for most affected stocks the NEFSC take request is only a small fraction of PBR.

In the coastal study areas, NEFSC expects due to the density of pinnipeds hauled out some animals will experience Level B harassment when the survey vessel passes during the course of conducting research operations (Table 6-8). However, these events are expected to be infrequent and temporary. Further, cited studies on pinniped disturbance do not indicate that impacts would be of the magnitude are likely to result in population-level impacts.

NEFSC surveys use a variety of active acoustic systems. These are expected to result in Level B harassment for marine mammals in close proximity to the survey vessel and its active acoustic systems.

However, as noted previously in this section exposure to active acoustics used on NEFSC fisheries research surveys is not expected to result in injury to animals and behavioral disturbance is expected to be relatively short lived and not result in population level impacts.

Based on this information the NEFSC believes that its activities will have a minimal impact on the affected species or stocks of marine mammals (based on the likelihood that the activities will not affect annual rates of recruitment or survival).

8.0 THE ANTICIPATED IMPACT OF THE ACTIVITY ON THE AVAILABILITY OF THE SPECIES OR STOCKS OF MARINE MAMMALS FOR SUBSISTENCE USES

The proposed activity will take place in the Northeast LME and adjacent offshore region, and would not affect Arctic marine mammals that are harvested for subsistence use. Therefore, there are no relevant subsistence uses of marine mammals implicated by this action as identified in MMPA Section 101(a)(5)(A)(i).

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9.0 THE ANTICIPATED IMPACT OF THE ACTIVITY UPON THE HABITAT OF THE MARINE MAMMAL POPULATIONS, AND THE LIKELIHOOD OF RESTORATION OF THE AFFECTED HABITAT

9.1 Changes in Food Availability

Prey of marine mammals varies by species, season, and location and, for some, is not well documented. NEFSC fisheries research removals of species commonly utilized by marine mammals are relatively low. Prey of right whales, sei whales, and blue whales are primarily zooplankton, which are not directly targeted by NEFSC fisheries research, so the likelihood of research activities changing prey availability is low and impact negligible to none. There is some overlap in prey of humpback and fin whales (e.g., Atlantic herring and sandeels) and possibly sperm whales (squid). The removal by NEFSC fisheries research, regardless of season and location is, however, insignificant relative to that taken through commercial fisheries. For example, the 2009 research catch of Atlantic herring in GOM/GB represented 0.009% of the 2010 Allowable Biological Catch (ABC) for commercial harvest. Similarly, research catch of Atlantic mackerel in 2009 equaled 0.001% of the 2010 ABC and research catch for longfin squid was 0.021% of ABC. Table 9-1 provides additional examples of marine mammal prey species caught in NEFSC-affiliated research (including cooperative research projects). These data are based on catch records from 2008-2012 and with a projected increase of 30% effort in the cooperative research program over the status quo conditions. In almost all cases, research catch of marine mammal prey species (fish and invertebrates) is a small fraction caught commercially and recreationally. The few exceptions are those species that are not usually targeted by commercial or recreational fisheries and therefore have small landings totals. Impacts of prey removal may be further reduced by spatial dispersion, since the stratification of the bottom trawl surveys disperses catch over the entire Northeast US shelf, whereas marine mammals may concentrate feeding in localized areas. NEFSC fisheries research catch levels are unlikely to affect changes in prey type or quantity available to threatened and endangered marine mammals. The resulting impact of the catch level on prey resources would, therefore, be negligible.

Marine mammals are significant consumers of prey (zooplankton, forage fish, groundfish, and squid) in the Northeast region (Kenney *et al.* 1997; Col *et al.* 2012). Whales, dolphins, and porpoises were estimated to consume approximately 4.1million mt of fish, 283,000 mt of shrimp, 109,000 mt of squid, and 89,000 mt of zooplankton annually on the U.S. Northeast Shelf. (Col *et al.* 2012). These data represent recent analyses conducted by NEFSC, and provide a useful metric for comparing food needs to commercial harvests and research catch.

Protecting marine ecosystems and accounting for predator consumption are considered when determining ABC and Optimum Yield (OY) of commercially harvested fish species (e.g., NEFMC 2010). This is particularly relevant for forage fish, such as Atlantic herring, that is important prey for several marine mammal species in the Northeast region (NEFMC 2010). Beginning in around 2008, marine mammal consumption became a specific Term of Reference for all fish stock assessments conducted by the NEFSC.

With pinniped populations increasing and ranges expanding in New England and mid-Atlantic region, food availability does not appear to be a limiting factor (Baraff and Loughlin 2000). Gray and harbor seals are opportunistic predators that consume a wide assortment of fish and squid, including managed species such as cod, haddock, hake, pollock, herring, squid, and flounder (summarized in Baraff and Loughlin 2000; Ampela 2009). The highest total catch of any of these species in NEFSC research surveys was less than 0.2% of the 2010 ABC. Given the comparatively low catch rate of pinniped prey by NEFSC surveys and the ability for pinnipeds to switch prey, the potential for NEFSC research to indirectly impact seal populations through reductions of prey is negligible.

Table 9-1 Comparison of potential marine mammal prey species caught under the Proposed Action compared to commercial catch (landings) and recreational catch in the Northeast Region

Species are listed in descending order of total research catch by weight. Only species with total catch greater than one ton (2000 pounds) are listed

Species	Stock status[1]	Estimated Total average NEFSC affiliated research catch per year (tons)	Total average annual commercial and recreational catch (tons)	Average NEFSC research catch compared to commercial and recreational catch (percentage)
Fish Species				
Spiny dogfish	Not overfished	191.8	6,918.2	2.77%
Butterfish	Not overfished	40.3	663.0	6.08%
Little skate	Not overfished	26.5	4,481.8	0.59%
Winter skate	Not overfished	25.3	NA	NA
Summer flounder (fluke)	Not overfished	24.8	9,288.5	0.27%
Scup	Not overfished	18.2	6,947.1	0.26%
Silver hake (whiting)	Not overfished	17.5	8,193.7	0.21%
Atlantic croaker	Unknown	13.9	10,162.2	0.14%
Atlantic herring	Not overfished	13.5	89,754.8	0.02%
Winter flounder (blackback)	GOM: Unknown; GB: Not overfished; SNE/MAB: Overfished	12.3	2,388.8	0.51%
Smoothhound (smooth dogfish)	Unknown	12.2	1,412.4	0.86%
Haddock	GOM: approaching overfished/ overfishing; GB: Not overfished	10.8	7,631.1	0.14%
Acadian redfish	Not overfished	9.4	1,731.4	0.54%
Red hake	Not overfished	9.2	663.7	1.39%
Yellowtail flounder	Cape Cod/GOM & GB: Overfished/ overfishing; SNE/MAB: Not overfished	8.2	1,767.0	0.46%
Atlantic cod	GOM and GB: Overfished/ overfishing	7.8	10,854.2	0.07%

Species	Stock status[1]	Estimated Total average NEFSC affiliated research catch per year (tons)	Total average annual commercial and recreational catch (tons)	Average NEFSC research catch compared to commercial and recreational catch (percentage)
Weakfish	Unknown	7.8	276.6	2.82%
Spot	Unknown	7.5	3,144.9	0.24%
Clearnose skate	Not overfished	6.4	NA	NA
Fourspot Flounder	Unknown	5.6	7.9	70.89%
Striped bass	Not overfished	5.4	16,083.8	0.03%
Goosefish (monkfish)	Not overfished	5.1	9,928.6	0.05%
White hake	Not overfished	4.3	2,132.9	0.20%
Windowpane flounder (sand dab)	GOM & GB: Overfished/ overfishing; SNE & MAB: not overfished	3.1	74.2	4.18%
Barndoor skate	Not overfished	3.1	NA	NA
Bluefish	Not overfished	3.0	10,556.2	0.03%
Northern searobin	Unknown	3.0	49.6	6.05%
Spotted Hake	Unknown	2.9	NA	NA
Atlantic mackerel	Unknown	2.9	15,087.3	0.02%
Alewife	Unknown	2.4	830.1	0.29%
American plaice	Not overfished	2.5	1,460.2	0.17%
Longhorn Sculpin	Unknown	2.5	NA	NA
Black sea bass	Not overfished	1.9	2,408.3	0.08%
Pollock	Not overfished	1.6	9,231.2	0.02%
Striped anchovy	Unknown	1.5	NA	NA

Species	Stock status[1]	Estimated Total average NEFSC affiliated research catch per year (tons)	Total average annual commercial and recreational catch (tons)	Average NEFSC research catch compared to commercial and recreational catch (percentage)
Invertebrate Species				
Sea scallop	Not overfished	62.3	28,371.25	0.22%
Long-finned squid (Loligo spp.)	Unknown	12.8	10,940.43	0.12%
American lobster	GOM and GB not overfished; SNE overfished and depleted	10.8	58,187.64	0.02%
Ocean quahog	Not overfished	10.1	14,384.04	0.07%
Horseshoe crab	NA	3.8	753.98	0.50
Atlantic Surfclam	Not overfished	3.4	22,007.62	0.02%
Northern (Pandalus) shrimp	Not overfished	2.4	4,481.99	0.05%

1. Source: Status of stocks information from NOAA Fisheries Office of Sustainable Fisheries, Second quarter 2013 Status of U.S. Fisheries. Available online: http://www.nmfs.noaa.gov/sfa/statusoffisheries/SOSmain.htm

9.2 Physical damage to benthic (seafloor) habitat

The potential effects of NEFSC fishery research activities on the physical environment vary depending on the survey gear and other equipment used but generally includes:

- Biological damage to infauna and epifauna
- Removal of organisms which produce structure, and
- Alteration of the turbidity and geochemistry of the water column.

Fishing gear that contacts the seafloor can alter and/or physically damage seafloor habitat. Physical damage includes furrowing and smoothing of the seafloor as well as the displacement of rocks and boulders as fishing gear is towed across the bottom (Morgan and Chuenpagdee 2003). Physical damage to the seafloor can increase with multiple tows in the same area (Stevenson *et al.* 2004).

The impacts are primarily caused by bottom trawling and dredging equipment as it comes in contact with the seafloor (Morgan and Chuenpagdee 2003). Bottom contact fishing gear used in NEFSC fishery research activities and funded fishery research activities include otter trawls, sea scallop dredges, and hydraulic surfclam dredges (Table 2.1). Other fishing gear that contacts the seafloor, such as pots and traps, can cause physical damage but the impacts are localized and minimal as this type of gear is fixed in position.

In general, physical damage to the seafloor recovers within 1.5 years through water currents and natural sedimentation with the exception of rocks and boulders which may be permanently displaced (Stevenson *et al.* 2004). The majority of the seafloor in the GOM, GB, and the MAB is made of a number of sediment types including silt, sand, clay, gravel and boulders. Therefore any physical damage caused by NEFSC surveys and funded fishery research activities would be expected to recover within 1.5 years.

The geographical area directly affected by NEFSC bottom trawl and dredge surveys every year is estimated to be about 181 km^2. In addition, cooperative research activities not contributable to commercial fishing is likely to affect 150 - 250 km^2 each year. The area affected by research each year is a very small fraction of the total area involved in survey efforts. Given the small magnitude of area affected by research and the short-term nature of physical damage effects, these impacts are considered minor or negligible.

9.3 Physical damage to infauna and epifauna

Infauna are animals that live in the seafloor or within structures that are on the seafloor. Infauna usually constructs tubes or burrows and are commonly found in deeper and subtidal waters. Clams, tubeworms, and burrowing crabs are infaunal animals. Epifauna live on the surface of the seafloor or on structures on the seafloor such as rocks, pilings, or vegetation. Epifauna may attach themselves to such surfaces or range freely over them, as by crawling or swimming. Mussels, crabs, starfish, and flounder are epifaunal animals. Fishing gear that contact the seafloor can disturb infauna and epifauna by crushing them, burying them or exposing them to predators (Morgan and Chuenpagdee 2003). The level of biological damage to infauna and epifauna can vary from very minimal to more severe particularly with repeated disturbance in the same areas (Stevenson *et al.* 2004).

The recovery time for damage to infauna and epifauna varies based on the type of fishing gear used, the type of seafloor surface (i.e., mud, sand, gravel, mixed substrate), and the level of repeated disturbances. In general, biological damage from a single disturbance is 1-18 months, and up to 3 years from repeated disturbances (Stevenson *et al.* 2004). Because research surveys are conducted in the same areas but not in the exact same locations they are expected to cause single rather than repeated disturbances in any one area. Therefore any physical damage caused by NEFSC surveys and funded fishery research activities would be expected to recover within 1-18 months. Given the small magnitude of area affected by research and the short-term nature of physical damage effects, these impacts are considered minor or negligible.

9.4 Removal of organisms which produce structure

Organisms such as cold water corals create structure on the seafloor that not only contain a high diversity of corals but also provide an important habitat for other infauna (Auster and Langton 1999; Stevenson *et al.* 2004). Cold water corals are generally slow growing, fragile and long lived that makes them particularly vulnerable to damage. Fishing gear that contacts coral can break or disrupt corals reducing structural complexity and reducing species diversity of the corals and other animals that utilize this habitat (Freiwald *et al.* 2004).

The removal of structural organisms may only be reversible over hundreds of years (Freiwald *et al.* 2004). Cold-water corals such as *Lophelia pertusa* and *Madrepora oculata* are reported from the northeast region however their exact distribution and abundance are poorly understood (CORIS 2010).As such the extent of overlap between cold water corals and NEFSC survey vessels cannot be quantified. However this impact is expected to be limited given the small number and small areal extent of NEFSC surveys and funded fishery research using bottom trawl and dredging equipment. Further, most surveys are limited to 366 m, whereas, most coldwater corals are deeper than this and in areas to rugged for trawling. In addition, there were no records of corals being taken by NEFSC bottom contact surveys in 2009-2011. Although fisheries research effects on corals may be long-term, the magnitude of this potential effect is likely to be minimal and is considered negligible.

9.5 Alteration of the turbidity and geochemistry of the water column

Fishing gear that contacts the seafloor can increase the turbidity of the water by the suspension of fine sediments and benthic algae. Suspension of fine sediments and turnover of sediment can also alter the geochemistry of the seafloor and the water column (Stevenson *et al.* 2004).

The impacts of alteration of turbidity and geochemistry in the water column are not very well understood (Stevenson *et al.* 2004). However, these types of effects from fisheries research activities would be periodic, temporary, and localized and are therefore considered negligible.

10.0 ANTICIPATED IMPACT OF LOSS OR MODIFICATION OF HABITAT ON MARINE MAMMALS

As stated in response to Question 9 above, the proposed activities are not anticipated to result in impacts to marine mammal habitats or to the food resources on which they depend. Therefore, we do not expect any long-term adverse impacts to marine mammals resulting from loss of or modification to marine mammal habitats as a result of the proposed activities.

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11.0 THE AVAILABILITY AND FEASIBILITY (ECONOMIC AND TECHNOLOGICAL) OF EQUIPMENT, AND MANNER OF CONDUCTING SUCH ACTIVITY OR OTHER MEANS OF EFFECTING THE LEAST PRATICABLE ADVERSE IMPACT UPON THE AFFECTED SPECIES OR STOCKS, THEIR HABITAT, AND ON THEIR AVAILABILITY FOR SUBSISTENCE USES, PAYING PARTICULAR ATTENTION TO ROOKERIES, MATING GROUNDS, AND AREAS OF SIMILAR SIGNIFICANCE

The following suite of mitigation measures will be employed by the NEFSC during fisheries research. The procedures described are based on protocols used during previous research surveys and/or best practices developed for commercial fisheries using similar gear. The NEFSC continually reviews its procedures and investigates options for incorporating new mitigation measures and equipment into its on-going survey programs. Evaluations of new mitigation measures include assessments of their effectiveness in reducing risk to marine mammals but any such measures must also pass safety considerations and allow survey results to remain consistent with previous data sets. Additional mitigation measures may be considered and developed further and may be implemented by the NEFSC during the five year life of the permit.

11.1 Protected Species Training and Reporting for all Gear Types

The NEFSC acknowledges that some mitigation measures such as the move-on rule require judgments about the risk of gear interactions with protected species and the best procedures for minimizing that risk on a case-by-case basis. Officers on Deck (OOD) and Chief Scientists (CS) are charged with making those judgments at sea. They are all highly experienced professionals but there may be inconsistencies across the range of research surveys conducted and funded by the NEFSC in how those judgments are made. In addition, some of the mitigation measures could also be considered “best practices” for safe seamanship and avoidance of hazards during fishing (e.g., prior surveillance of a sample site before setting trawl gear). At least for some of the research activities considered in this LOA application, especially those conducted by cooperative research partners, explicit links between the implementation of these best practices and their usefulness as mitigation measures for avoidance of protected species have not been formalized and clearly communicated with all scientific parties and vessel operators. In the case of at least some of the cooperative research projects funded through the NEFSC, scientific procedures and data reporting protocols have been specified in contracts with cooperating research partners but specific procedures to avoid or report interactions with protected species have not been incorporated into contracts. The NEFSC will therefore implement a series of improvements to its protected species training, awareness, and reporting procedures as part of its continuing research program. The NEFSC expects these new procedures will facilitate and improve the implementation of the mitigation measures described.

11.1.1 Judgment consistency

As part of its continuing research program, the NEFSC will initiate a process for its Chief Scientists and vessel captains to communicate with each other about their experiences with protected species interactions during research work with the goal of improving decision-making regarding avoidance of adverse interactions. There are many situations where professional judgment is used to decide the best course of action for avoiding marine mammal interactions before and during the time research gear is in the water. The intent of this new training program would be to draw on the collective experience of people who have been making those decisions, provide a forum for the exchange of information about what went right and what went wrong, and try to determine if there are any rules-of-thumb or key factors to consider that would help in future decisions regarding avoidance practices. The NEFSC would coordinate not only among its staff and vessel captains but also with those from other fisheries science centers and other institutions with similar experience.

11.1.2 Protected species training

NEFSC scientists conducting longline surveys for highly migratory species (e.g., Apex Predator Surveys and COASTSPAN) have received, and will continue to receive, formal training through NMFS Highly Migratory Species/Protected Species Safe Handling, Release, and Identification Workshops. Participants review mitigation methods required under various commercial fisheries whale and sea turtle take reduction plans as well as methods to release protected species safely (sea turtles, marine mammals, and smalltooth sawfish). However, such formalized training has not been required under the status quo conditions for researchers working with other gear types, although all NOAA Corps officers and NEFSC Chief Scientists are knowledgeable about the mitigation requirements of all take reduction and ship strike avoidance plans and these protocols are described in written cruise instructions and safety placards posted on research vessels. In an effort to help standardize and further emphasize the importance of protected species information, the NEFSC will implement a formalized protected species training program for all crew members as part of its continuing research program that will be required for all NEFSC-affiliated research projects, including cooperative research partners. Training programs will be conducted on a regular basis and will include topics such as monitoring and sighting protocols, species identification, decision-making factors for avoiding take, procedures for handling and documenting protected species caught in research gear, and reporting requirements. This will be accomplished through participation in protected species training programs developed by the regional commercial fisheries Observer Program, which would typically be the Northeast Fisheries Observer Program (NEFOP) but some NEFSC cooperative partners may receive training through the Southeast Region Fisheries Observer Program. The Fisheries Observer Program currently provides protected species training (and other types of training) for NMFS-certified observers placed on board commercial fishing vessels. NEFSC Chief Scientists and appropriate members of NEFSC research crews will be trained using the same monitoring, data collection, and reporting protocols for protected species as is required by NEFOP. All NEFSC research crew members that may be assigned to monitor for the presence of marine mammals and sea turtles during future surveys will be required to attend an initial training course and refresher courses annually or as necessary. The implementation of this training program will formalize and standardize the information provided to all crew that might experience protected species interactions during research activities.

11.1.3 Written protocols

For all NEFSC-affiliated research projects and vessels, written cruise instructions and protocols for avoiding adverse interactions with protected species are reviewed by the vessel coordinator and center director and, if the research is conducted on a NOAA vessel, such instructions are finalized by the Commanding Officer. If any inconsistencies or deficiencies are found, such written instructions will be made fully consistent with the NEFOP training materials and any guidance on decision-making that arises out of the two training opportunities described above. In addition, informational placards and reporting procedures will be reviewed and updated as necessary for consistency and accuracy. Many research cruises already include pre-sail review of protected species protocols for affected crew but the NEFSC will emphasize the need for such pre-sail briefings and require them to be included before all research cruises, including those conducted by cooperating partners, as part of its continuing research program.

11.1.4 Contract language

The NEFSC will incorporate specific language into its contracts that specifies all Chief Scientists and cooperating research partners will be trained in mitigation measures, operating procedures, monitoring, and reporting requirements for protected species on chartered vessels.

11.2 Trawl Surveys (Beam, Mid-water, and Bottom)

11.2.1 Monitoring methods

The OOD, CS (or other designated member of the Scientific Party), and crew standing watch on the bridge visually scan for marine mammals (and other protected species) during all daytime operations. Bridge binoculars are used as necessary to survey the area upon arrival at the station, during visual and sonar reconnaissance of the trawl line to look for potential hazards (e.g., commercial fishing gear, unsuitable bottom for trawling, etc.), and while the gear is deployed. If any marine mammals are sighted by the bridge or deck crew prior to or after setting the gear, the bridge crew and/or Chief Scientist are alerted as soon as possible. Environmental conditions (lighting, sea state, precipitation, fog, etc.) often limit the distance for effective visual monitoring of protected species.

11.2.2 Operational procedures

Move-on Rule: If any marine mammals are sighted around the vessel before setting the gear, the vessel may be moved away from the animals to a different section of the sampling area if the animals appear to be at risk of interaction with the gear at the discretion of the OOD. Small moves within the sampling area can be accomplished without leaving the sample station. After moving on, if marine mammals are still visible from the vessel and appear to be at risk, the OOD may decide to move again or to skip the station. The OOD will consult with the CS or other designated scientist (identified prior to the voyage and noted on the cruise plan) and other experienced crew as necessary to determine the best strategy to avoid potential takes of these species. Strategies are based on the species encountered, their numbers and behavior, their position and vector relative to the vessel, and other factors. For instance, a whale transiting through the area and heading away from the vessel may not require any move, or may require only a short move from the initial sampling site, while a pod of dolphins gathered around the vessel may require a longer move from the initial sampling site or possibly cancellation of the station if the dolphins follow the vessel. In most cases, research trawl gear is not deployed if marine mammals have been sighted near the ship unless those animals do not appear to be in danger of interactions with the trawl, as determined by the judgment of the OOD and CS. The efficacy of the "move-on" rule is limited during night time or other periods of limited visibility; research gear is deployed as necessary when visibility is poor, although operational lighting from the vessel illuminates the water in the immediate vicinity of the vessel during gear setting and retrieval.

Once the trawl net is in the water, the OOD, scientists, and/or crew standing watch will continue to monitor the waters around the vessel and maintain a lookout for presence of marine mammals. If marine mammals are sighted before the gear is fully retrieved, the most appropriate response to avoid incidental take will be determined by the professional judgment of the OOD, in consultation with the CS and other experienced crew as necessary. These judgments take into consideration the species, numbers, and behavior of the animals, the status of the trawl net operation (net opening, depth, and distance from the stern), the time it would take to retrieve the net, and safety considerations for changing speed or course. It may sometimes be safer to continue trawling until the marine mammals have lost interest or transited through the area before beginning haulback operations. In other situations, swift retrieval of the net may be the best course of action. The appropriate course of action to minimize the risk of incidental take of marine mammals is determined by the professional judgment of the OOD and appropriate crew based on all the situation variables, even if the choices compromise the value of the data collected at the station.

If trawling operations have been delayed because of the presence of marine mammals, the vessel resumes trawl operations (when practical) only when the animals have not been sighted near the vessel or otherwise determined to no longer be at risk. This decision is at the discretion of the OOD and is situationally dependent.

Care will be taken when emptying the trawl, including opening the cod end as close as possible to the deck of the checker (or sorting table) in order to avoid damage to marine mammals that may be caught in the gear but are not visible upon retrieval. The gear will be emptied as quickly as possible after retrieval in order to determine whether or not marine mammals are present

11.2.3 Tow duration

The NEFSC will implement standard tow durations excluding deployment and retrieval time of not more than 30 minutes to reduce the likelihood of incidental take of protected species. The exceptions are AHAPTS and deep-water biodiversity surveys where total time in the water (deployment, fishing, haulback), respectively are (40-60 minutes and 180 minutes).

Bottom trawl tows will be made in either straight lines or following depth contours, whereas AHAPTS tows target fish aggregations and deep-water biodiversity tows may be made along oceanographic or bathymetric features. Sharp course changes will be avoided in all surveys.

Trawl tow distances will be not more than 3 nautical miles (nm) to reduce the likelihood of incidentally taking marine mammals. Typical tow distances are 1-2 nm, depending on the survey and trawl speed.

11.2.4 Gear maintenance

The vessel’s crew will clean trawl nets prior to deployment to remove prey items that might attract marine mammals. Catch volumes are relatively small, with every attempt made to collect all organisms caught in the trawl, to avoid cross-contamination of subsequent tows.

11.2.5 Speed limits and course alterations

The vessel’s speed during active sampling with trawl nets will not exceed 5 kts. Typical towing speeds are 2-4 kts.

Transit speed between active sampling stations will range from 10-12 kts, except in areas where vessel speeds are regulated to lower speeds. When operating in North Atlantic right whale Seasonal Management Areas, Dynamic Management Areas, or in the vicinity of right whales or surface active groups of large baleen whales the vessel’s speed will not exceed 10 kts. Further, vessels will reduce speed and change course in the vicinity of resting groups of large whales.

As noted above, if marine mammals are sighted prior to deployment of the trawl net, the vessel may be moved away from the animals to a new station at the discretion of the OOC.

At any time during a survey or in transit, any crew member that sights marine mammals that may intersect with the vessel course will immediately communicate their presence to the bridge for appropriate course alteration or speed reduction as possible to avoid incidental collisions.

11.3 Dredges (Hydraulic, New Bedford-type, Commercial, and Naturalist)

11.3.1 Monitoring methods

The monitoring procedures for dredge gear are the same as described for trawl gear.

11.3.2 Operational procedures

The “move-on” rule and other decisions regarding the best course of action to avoid potentially adverse interactions with protected species are similar to those as described for trawl gear.

Care will be taken when emptying the dredge to avoid damage to protected species that may be caught in the gear but are not visible upon retrieval. The gear will be emptied as quickly as possible after retrieval in order to determine whether or not protected species are present.

11.4 Longline Gear (Pelagic or Demersal)

11.4.1 Monitoring methods

Longline surveys are conducted aboard smaller vessels and with fewer crew than most trawl surveys but the monitoring procedures for longline gear are the same as described for trawl gear. Once the longline gear is set, the crew continually monitors the set for protected species that may interact with the gear or for signs that protected species may be entangled in the gear.

11.4.2 Operational procedures

The precautions for setting longline gear are similar to those described for trawl gear; longline sets may be delayed if marine mammals have been detected near the vessel in the 30 minutes prior to setting the gear (The Apex Predators Bottom Longline Coastal Shark Survey uses a one nautical mile radius around the vessel as a guide for this decision). The vessel may be moved to a new location if marine mammals are present, and the OOD uses professional judgment to minimize the risk to marine mammals from potential gear interactions.

During longline sets, the OOD, CS, and crew standing watch will monitor the gear as best as possible to look for hooked, trapped, or entangled marine mammals and other protected species.

NEFSC longline sets are conducted with either drifting pelagic gear marked at both ends with high flyers or radio buoys and at specific intervals throughout the line with buoys or bottom set gear also marked at both ends with high flyers and buoys at specific intervals throughout the line (Appendix A). The NEFSC has established standard soak times of 3 hours for bottom longline and 2-5 hours for pelagic longline surveys (Appendix C). The CS will ensure that soak times do not exceed 5 hours, except in cases where weather or mechanical difficulty delay gear retrieval. Hooks vary in size depending on the gear. For bottom longline a Mustad 3/0 #349703 hook is used. This was the standard hook in the commercial industry in Florida when this survey started, changes to this hook would affect the accuracy of the survey. For pelagic longline hook size and offset is legislated depending on location. Compliance with Atlantic Shark Fisheries Regulations in Amendment 2 to the Consolidated HMS FMP is required. A 16/0 or 18/0 circle hooks (non-stainless steel) are used.

NEFSC longline protocols specifically prohibit chumming (releasing additional bait to attract target species to the gear). Bait is removed from hooks during retrieval and retained on the vessel until all gear is removed from the area. The crew will not discard offal or spent bait while longline gear is in the water to reduce the risk of marine mammals detecting the vessel or being attracted to the area.

If marine mammals are detected while longline gear is in the water, the OOD exercises similar judgments and discretion to avoid incidental take of marine mammals as described for trawl gear. The species, number, and behavior of the marine mammals are considered along with the status of the ship and gear, weather and sea conditions, and crew safety factors.

If marine mammals are present during setting operations, immediate retrieval or halting the setting operations may be warranted. If setting operations have been halted due to the presence of marine mammals, resumption of setting will not begin until no marine mammals have been observed for at least 15 minutes. When visibility allows, the OOD, CS, and crew standing watch will conduct set checks every 15 minutes to look for hooked, trapped, or entangled marine mammals.

If marine mammals are present during retrieval operations, haul-back will be postponed until the OOD determines that it is safe to proceed. Marine mammals caught during longline sampling are typically only caught during retrieval, so extra caution must be taken during this phase of sampling.

11.5 Fyke Nets

11.5.1 Monitoring methods

Fyke nets are normally set inshore by small boat crews, who will visually survey areas prior to deployment of nets.

11.5.2 Operational procedures

A 2-m fyke net will be deployed with a marine mammal excluder device that reduces the effective mouth opening to <15 cm. The 1-m fyke net does not require an excluder device as the opening is 12 cm. These small openings will prevent marine mammals from entering the nets.

Monitoring is done prior to setting and during net retrieval. Monitoring/retrieval is conducted every 12 to 24-hour soak period. If marine mammals are in close proximity (~100 m) of the setting location, the field team will make a determination if the set location needs to be moved. If marine mammals are observed to be interacting with the gear during the setting, it will be lifted and removed from the water.

11.6 Beach Seines

11.6.1 Monitoring methods

Beach seines are set inshore by small boat crews. Seines are deployed with one end held on shore by a crew member and the net slowly deployed by boat in an arc and then retrieved by pulling both ends onto shore. Typical seine hauls are less than 15 minutes with the resultant catch sampled and released.

11.6.2 Operational procedures

Seine nets are deployed in close proximity to shore. Sites are visually surveyed for marine mammals prior to set. Due to the nature of the gear mammals are unlikely to interact with the net as they would not remain on the shore or in the water in the presence of the field crew. If marine mammals are observed to be interacting with the gear, it will be lifted and removed from the water.

11.7 Rotary Screw Trap

11.7.1 Monitoring methods

Rotary screw traps (RST) are deployed in April and removed according to sampling schedule (generally June). Sites are visually surveyed for marine mammals prior to set, and the traps are tended daily by sampling crews. Sampling period can be modified (shortened), delayed, or concluded depending on the numbers of marine mammals nearby and their potential for interacting with the gear, as determined by the professional judgment of the researchers. Under most conditions the live car (i.e., catch holding pen) is about 75 percent full of water, which would allow trapped mammals to breath.

11.7.2 Operational procedures

RSTs are made of heavy gage aluminum and are anchored to trees, ledge, or boulders within the river/estuary using six strand 9.5 mm (3/8 in) steel cable. Traps operated by the NEFSC are in three sizes 1.2 m (4 ft), 1.5 m (5 ft) and 2.4 m (8 ft). RST tending schedules are adjusted according to conditions of the river /estuary and threats to protected species (i.e., presence of ESA-listed fish or marine mammals in the area). Sampling period can be modified (shortened), delayed, or concluded according to the threat to Atlantic salmon or other protected species.

11.8 Cooperative Research (Trawl, Dredge, Longline, Gillnet)

Implementing requirements described above on commercial fishing vessels engaged in NEFSC cooperative research activities, including conservation engineering projects, will be more challenging. Commercial fishing vessels operating off the northeast US are significantly smaller than the NOAA white boats, and depending on their size and configuration, marine mammal sighting may be difficult to make during all aspects of fishing operations. Further, on all size classes it is unlikely that the individual(s) searching for marine mammals will have unrestricted 360 degree visibility around the vessel. Observations during approach to a fishing station, and during gear setting and haulback may be feasible from the wheelhouse. However, for safety, scientific personnel are normally restricted from the deck during gear setting and haulback operations.

Therefore, as feasible, commercial fishing vessels engaged in NEFSC cooperative research will adhere to monitoring, mitigation, data collection and reporting requirements delineated for NOAA vessels. Required protocols and training guides will be included in all survey instructions, contracts, and agreements.

11.9 Plankton Nets, Oceanographic Sampling Devices, Video Camera and ROV Deployments

The NEFSC deploys a wide variety of gear to sample the marine environment during all of their research cruises. These types of gear are not considered to pose any risk to marine mammals and are therefore not subject to specific mitigation measures. However, the OOD and crew monitor for any unusual circumstances that may arise at a sampling site and use their professional judgment and discretion to avoid any potential risks to marine mammals or other protected species during deployment of all research equipment.

11.10 Handling Procedures for Incidentally Captured Marine Mammals

Captured live or injured marine mammals are released from research gear and returned to the water as soon as possible with no gear or as little gear remaining on the animal as possible. Animals will be released without removing them from the water if possible. Data collection will be conducted in such a manner as not to delay release of the animal(s) and will be limited to species identification, sex identification if genital region is visible, estimated length, disposition at release (e.g., live, dead, hooked, entangled, amount of gear remaining on the animal, etc.) and photographs. When authorized to do so, trained personnel may attempt to obtain a skin sample for genetic analysis using biopsy gear (e.g., cross bow or hand-held pole). Marine mammals incidentally killed during research activities will be retained if suitable storage is available for subsequent examination once the appropriate authorizations are obtained.

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12.0 WHERE THE PROPOSED ACTIVITY WOULD TAKE PLACE IN OR NEAR A TRADITIONAL ARCTIC SUBSISTENCE HUNTING AREA AND/OR MAY AFFECT THE AVAILABILITY OF A SPECIES OR STOCK OF MARINE MAMMAL FOR ARCTIC SUBSISTENCE USE, THE APPLICANT MUST SUBMIT EITHER A "PLAN OF COOPERATION (POC)" OR INFORMATION THAT IDENTIFIES WHAT MEASURES HAVE BEEN TAKEN AN/OR WILL BE TAKEN TO MINIMIZE ANY ADVERSE EFFECTS ON THE AVAILABILITY OF MARINE MAMMALS FOR SUBSISTENCE USE.

Not applicable. The proposed activity will take place off the East Coast of the United States as discussed in section 1.2, and no activities will take place in or near a traditional Arctic subsistence hunting area. There are no relevant subsistence uses of marine mammals implicated by this action.

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13.0 MONITORING AND REPORTING PLAN

13.1 Monitoring

Marine mammal watches are now a standard part of conducting fisheries research activities, particularly those that use gears (e.g., longlines and mid-water trawls) that are known to interact with marine mammals or that we believe have a reasonable likelihood of doing so in the future. Marine mammal watches and monitoring occur prior to deployment of gear, and they continue until gear is brought back on board. If marine mammals are sighted in the area then the sampling station is either moved or canceled. When dedicated marine mammal observers are on board they will record the estimated species and number of animals present and their behavior. If marine mammal observers are not on board or available (due to vessel size limits and bunk space) then NEFSC may develop the protocols, provide training as practical, and evaluate the reports. This information can be valuable in understanding whether some species may be attracted to vessels or gears. NOAA vessels are required to monitor interactions with protected species (and report interactions to the NEFSC Director) but in reality are limited to direct interactions and reporting floaters or entangled whales. Similarly, there is a condition of grant and contract awards for monitoring of protected species takes.

13.2 Reporting

The NEFSC will coordinate with the local Northeast/Greater Atlantic Regional Fisheries Office Stranding Coordinator and the NMFS Stranding Coordinator for any unusual marine mammal behavior and any stranding, beached live/dead, or floating marine mammals that are encountered during field research activities.

In the event of any incidental capture or entanglement of marine mammals in any research gear or any collisions with marine mammals with research vessels, vessel or scientific personnel will be required to contact scientific staff in the NEFSC Protected Species Branch, NMFS Office of Protected Resources, the NMFS Northeast/Greater Atlantic Stranding Network Coordinator, and the U.S. Coast Guard for guidance. This contact should be made as soon as possible and no longer than 24 hours after the incident. As part of this communication, a written report will be provided that details the events that preceded the incidental take, including the mitigation measures that were implemented and how they were implemented, whether any marine mammals were observed before the interaction occurred (species, numbers, and behavior relative to the ship or research gear), any decisions that were made regarding avoidance of the marine mammals (e.g, change of course or speed, early removal of research gear from the water, or other efforts), and a post-hoc analysis of the decision-making process before the take (e.g., who made the decision, other members of the crew or scientific party that were involved in the decision, and whether an alternative course of action may have avoided the take).

Chief Scientists provide reports of adverse marine mammal interactions to NEFSC leadership by event, survey leg, and cruise. However, the Cruise Leader is not generally on the bridge during fishing operations and will need to rely on forms completed by either scientists or crew. As a result, when marine mammal takes occur or when animals are present and no takes occur a report provided by the Cruise Leader will summarize the behavior and species of animals present, weather and viewing conditions, and other important circumstances of these events that will allow the NEFSC to better evaluate the conditions under which takes are most likely occur. We believe in the long term this will allow us to avoid some of these situations in the future.

NOAA Fisheries has established a formal incidental take reporting system, the Protected Species Incidental Take (PSIT) database, requiring that incidental takes of MMPA and ESA listed species be reported within 24 hours of the occurrence. The PSIT generates automated messages to agency leadership and other relevant staff and alerts them to the event and that updated information describing the circumstances of the event have been inputted into the database. The PSIT represents not only a valuable real-time reporting and information dissemination tool, but also an archive of information that could be mined at later points in time to study why takes occur, by species, gear, etc. Ultimately, NEFSC would hope that a single reporting tool capable of disseminating and archiving all relevant details of protected species interactions during fisheries research activities could be developed and implemented. Until that time, NEFSC will input data both into the PSIT database and submit detailed event reports, which will also be uploaded to PSIT

A final and equally important component of reporting being implemented by NEFSC will facilitate serious injury (SI) determinations for marine mammals that are released alive. As discussed in Section 11, NEFSC is requiring that scientists complete data forms (already developed and used by commercial fisheries observer programs) and address supplemental questions, both of which have been developed to aid in SI determinations. NEFSC understands the critical need to provide scientists who make serious injury determinations with as much relevant information as possible about marine mammal interactions to inform their decisions.

14.0 COORDINATING RESEARCH TO REDUCE AND EVALUATE INCIDENTAL TAKE

NOAA Fisheries and the NEFSC provide a significant amount of funding and support to marine research. Specifically, NOAA Fisheries provides significant funding annually to universities, research institutions, federal laboratories, private companies, and independent researchers around the world to study marine mammals. The NEFSC actively participates on Take Reduction Teams and in Take Reduction Planning and it conducts a variety of studies, convenes workshops and engages in other activities aimed at developing effective bycatch reduction technologies, gears and practices. For example, the NEFSC has an active conservation engineering program designed to reduce takes of marine mammals, turtles, and other listed species in fisheries. Recent research is described at http://www.nefsc.noaa.gov/read/protspp/PR_gear_research/. The NEFSC will continue to foster this research to further reduce takes of protected species in both its operations and in commercial fisheries to the lowest practicable levels.

Following the first year of implementation of the LOA the NEFSC will convene a workshop with NERO Protected Species, NEFSC fishery scientists, and NOAA research vessel personnel to review data collection, marine mammal interactions, and refine data collection and mitigation protocols, as required.

The NEFSC has a keen awareness that an increase in fisheries research effort could result in more marine mammal takes over time. For this reason and because of resource limitations, the NEFSC maximizes efficient use of the charter and NOAA ship time it can attain. We also engage in operational plans with the SEFSC in order to clearly delineate our respective research responsibilities and to ensure we avoid research gaps and duplication of effort between fisheries science centers. In short, the NEFSC is on the water conducting fisheries research activities no more often than is necessary to fulfill its responsibilities to provide scientific advice to the Greater Atlantic Regional Fisheries Office and other relevant domestic and international management bodies.

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16.0 APPENDIX A - NEFSC GEAR AND VESSEL DESCRIPTIONS

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1. Trawl Nets

A trawl is a funnel-shaped net towed behind a boat to capture fish. The codend, or ‘bag,’ is the fine-meshed portion of the net most distant from the towing vessel where fish and other organisms larger than the mesh size are retained. In contrast to commercial fishery operations, which generally use larger mesh to capture marketable fish, research trawls often use smaller mesh to enable estimates of the size and age distributions of fish in a particular area. The body of a trawl net is generally constructed of relatively coarse mesh that functions to gather schooling fish so they can be collected in the codend. The opening of the net, called the ‘mouth’, is extended horizontally by large panels of wide mesh called ‘wings.’ The mouth of the net is held open by hydrodynamic force exerted on the trawl doors attached to the wings of the net. As the net is towed through the water, the force of the water spreads the trawl doors horizontally apart.

The trawl net is usually deployed over the stern of the vessel, and attached with two cables, or ‘warps,’ to winches on the deck of the vessel. The cables are played out until the net reaches the fishing depth. Commercial trawl vessels may travel at speeds between two and five knots while towing the net for up to several hours, whereas most NEFSC trawl surveys involve tow speeds from 1.4 to 4.0 knots, and tow durations from 15 to 60 minutes. The speed and duration of the tow depend on the purpose of the trawl, the catch rate, and the target species. At the end of the tow, the net is retrieved and the contents of the codend are emptied onto the deck. For research purposes, the speed and duration of the tow and the characteristics of the net must be standardized to allow meaningful comparisons of data collected at different times and locations. Active acoustic devices incorporated into the research vessel and the trawl gear monitor the position and status of the net, speed of the tow, and other variables important to the research design.

NEFSC research trawling activities use both ‘pelagic’ (surface or mid-water) trawls, which are designed to operate at various depths within the water column, as well as ‘bottom’ trawls, which are designed to capture target species at or near the seafloor (see Figure A-1). Marine mammals can become entangled by trawl gear when swimming with risks differing widely between species. Many species of marine mammals forage and swim at mid-water depths, putting them at risk of being captured or entangled in pelagic trawls. In the Northeast United States, pilot whales and white-sided dolphins are particularly susceptible to being caught in mid-water trawls in nearshore areas. Species that forage on or near the seafloor are at risk of being captured or entangled in bottom trawl netting or tow lines. Humpback whales in the southern Gulf of Maine commonly feed along the seafloor (Ware et al. 2013), making them vulnerable to entanglement in bottom trawl gear. There is also potential for marine mammals to interact with bottom trawl equipment near the surface of the water, as the gear is retrieved from fishing depth and brought aboard the vessel. Historically, the NEFSC has recorded marine mammal interactions with both bottom trawl and pelagic trawl nets (Section 4.2.4).

4-seam, 3-bridle bottom trawl: Several NEFSC research programs utilize a 4-seam, 3-bridle bottom trawl, manufactured using 12 centimeter and 6 cm mesh. The effective mouth opening of the 4-seam, 3-bridle bottom trawl is approximately 70 square meters (14 meter spread x 5 meters high), spread by a pair of trawl doors. The footrope of the trawl is 89 feet in length, and is ballasted with heavy rubber discs or roller gear. The head rope is approximately 79 feet in length and is supported by 60 Nokalon #508, eight inch center hole, orange trawl floats. For certain research activities, a liner may be sewn into the codend to minimize the loss of small fish.

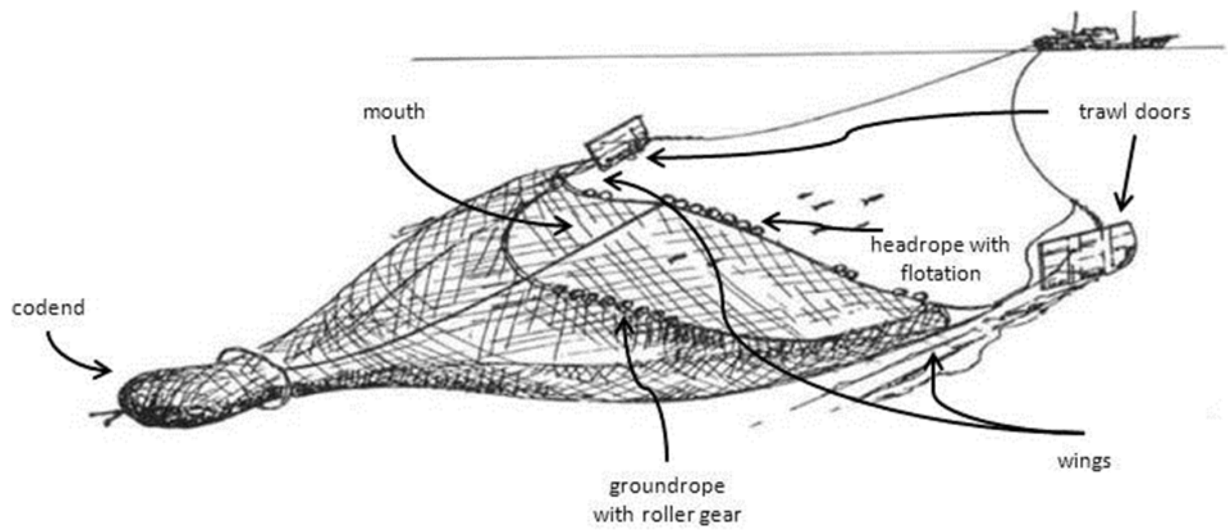

Figure A-1. Bottom trawl illustration

NEFSC uses the 4-seam, 3-bridle bottom trawl for a variety of research programs along the U.S. east coast. The objectives of these cruises include tracking mature animals, determination of juvenile abundance, assessment of habitat distribution, and collection of data on seasonal migrations. The trawl is fished at depth for 15 - 60 minutes at a time at speeds of 1.5 - 4 knots.

Midwater Rope Trawl: the High Speed Midwater Rope Trawl (Gourock HSMRT design R202825A) used for the NEFSC's fisheries acoustics surveys employs a four-seam box design with a 174 feet headrope, footrope, and breastlines (see Figure A-2). The mouth opening of the HSMRT is approximately 13.3 meters vertical and 27.5 meters horizontal. Once the net is deployed, changes in the position of the net in the water column are made by increasing or decreasing the speed of the vessel, or by bringing in or letting out trawl wire. Active acoustics are also deployed to monitor the ship and net positions and status. As with bottom trawl nets, protected species may interact with pelagic trawl nets during the deployment and retrieval of the net when the net is at or near the surface of the water. However, because pelagic nets are operated above the seafloor, impacts related to bottom habitat degradation and interactions with bottom-dwelling species are minimal. Because pelagic trawl nets are not designed to contact the seafloor, they do not have bobbins or roller gear, which are often used to protect the foot rope of a 'bottom' trawl net as it is dragged along the bottom.

Figure A-2. Emptying the codend of the High Speed Midwater Rope Trawl

Credit: NEFSC Photo Archives.

Figure A-3. The Isaacs-Kidd Midwater Trawl (IKMT) net

Credit: Joe Warren, Stony Brook University

<u>Other Towed Nets</u>: In addition to the nets described above, NEFSC uses various small, fine-mesh, towed nets designed to sample plankton, small fish, and pelagic invertebrates. The Isaacs-Kidd Midwater Trawl (IKMT), shown in Figure A-3, is used to collect deep water biological specimens larger than those taken by standard plankton nets. The mouth of the net is approximately 1.5 meters wide by 2 meters high, and is attached to a wide, V-shaped, rigid diving vane that keeps the mouth of the net open and maintains the net at depth for extended periods (Yasook et al. 2007). The IKMT is a long, round net approximately 6.5 meters long, with a series of hoops decreasing in size from the mouth of the net to the codend that maintain the shape of the net during towing (Yasook et al. 2007). While most trawls must be towed at speeds of 1 to 2 knots because of the high level of drag exerted by the net in the water, an IKMT can be towed at speeds as high as five knots. The MOCNESS, or Multiple Opening/Closing Net and Environmental Sensing System, uses a stepping motor to sequentially control the opening and closing of the net. The MOCNESS uses underwater and shipboard electronics to control the device. The electronics system continuously monitors the functioning of the nets, frame angle, horizontal velocity, vertical velocity, volume filtered, and selected environmental parameters, such as salinity and temperature. The MOCNESS is used for specialized zooplankton surveys. Similarly, the Tucker trawl is an opening and closing mid-water zooplankton trawl. It is typically equipped with a full suite of instruments, including inside and outside flow meters, CTD, pitch sensor and stepper motor. The Tucker trawl used for NEFSC research surveys uses 333 micron plankton nets with 1.0 meter by 1.4 meter openings. The nets operate at a 45 degree angle during fishing which results in an effective fishing area of 1.0 square meter. The Tucker trawl is designed for deep oblique tows where up to three replicate nets can be sequentially operated by a double release mechanism. There has never been an interaction with a protected species for any of the gear types described in this paragraph during NEFSC research activity.

A beam trawl is a type of bottom trawl that uses a wood or metal beam to hold the net open as it is towed along the sea floor (see Figure A-4). The beam holds open the mouth of the net so that no trawl doors are needed. Beam trawls are generally smaller than other types of bottom trawls. Commercial beam trawls have beam lengths of up to 12 meters, while beam trawls for research purposes typically use beams two to four meters in length.

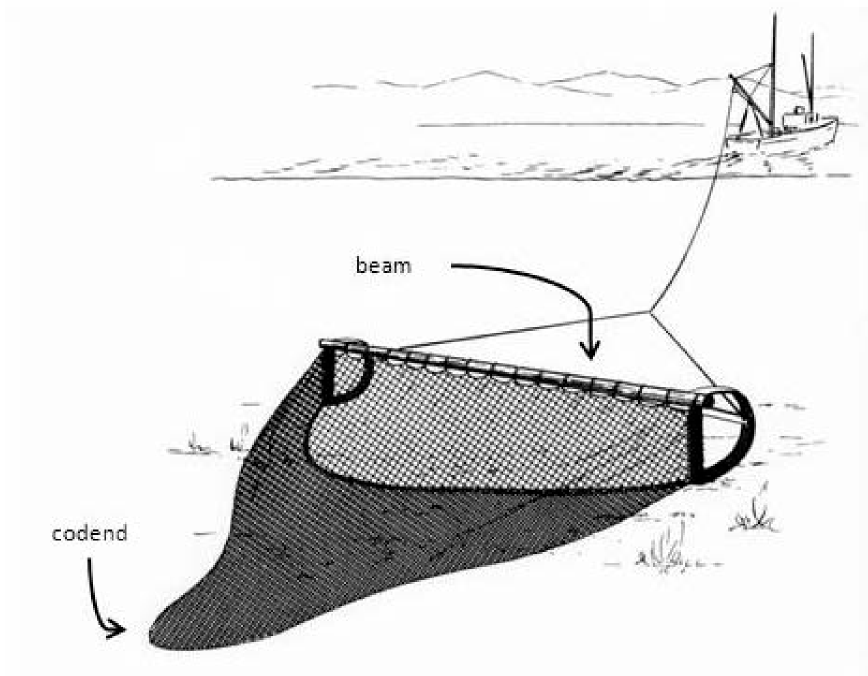

Figure A-4. Beam trawl illustration

Credit: FAO 2001

2. Fyke nets

Fyke nets are bag-shaped nets which are held open by frames or hoops. The fyke nets used in NEFSC survey activities are constructed of successively smaller plastic coated square metal tube frames that are covered with mesh net (0.6 centimeters for small, 1.9 centimeters for large). Two 9.1 meters wings extend from the opening of each fyke at an angle of approximately 30 degrees (Figure A-5). The wings have a weighted footrope and floats on the head-rope and are the same height (either 0.91 meters or 1.83 meters high) and comprised of the same net mesh as the fyke net itself. Each net has two throats tapering to a semi-rigid opening of 12.7 centimeters for the small net and 45.7 centimeters for the larger net. The fish pass through these throats before becoming trapped in the live box. For the large fyke, the final compartment of the net is configured with a rigid framed live box (2 x 2 x 3 meters) at the surface for removal of catch directly from above without having to retrieve the entire net.

A marine mammal excluder device is attached to the outer-most throat of the larger fyke to stop marine mammals from entering the net and becoming trapped. The exclusion device consists of a grate constructed of aluminum bars as shown in Figure A-6. The size of the openings is approximately 14 centimeters, which effectively prohibits marine mammals from entering the net. The dimensions of the grate openings were based on exclusion devices on Penobscot Hydroelectric fishway facilities that are four to six inches and allow for passage of numerous target species including river herring, eels, striped bass, and adult salmon.

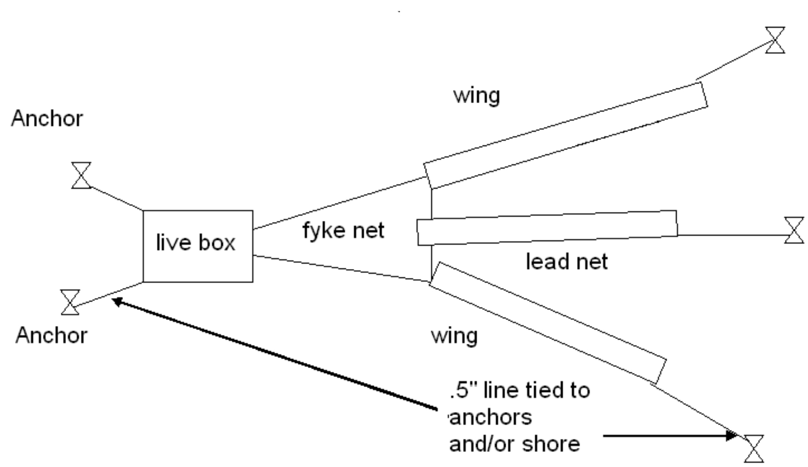

Figure A-5. Sketch of typical fyke net deployment

Orientation may be into, opposite, or perpendicular to flow as appropriate for site.

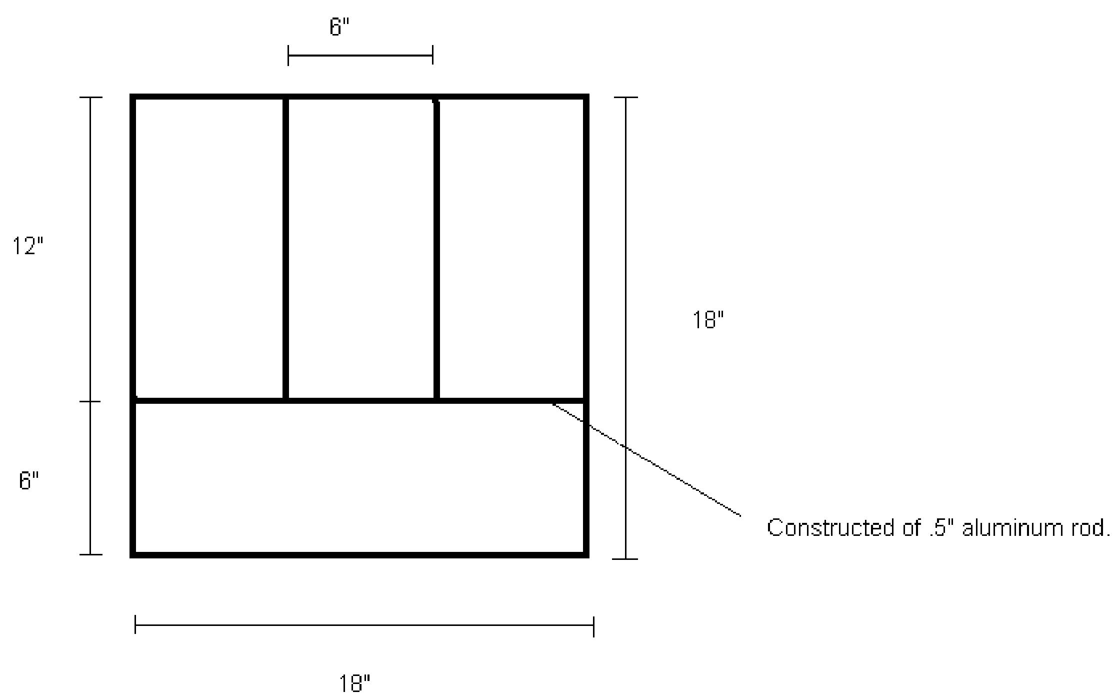

Figure A-6. Sketch of marine mammal excluder device used in the fyke net

The bottom of the grate is parallel to the net bottom as to not exclude small semi-benthic fish.

3. Gillnets

Gillnets consist of vertical netting held in place by floats and weights to selectively target fish of uniform size depending on the netting size (Walden 1996). Typical Gillnets are made of monofilament, multi-monofilament, or multifilament nylon constructed of single, double, or triple netting/paneling of varying mesh sizes, depending on their use and target species (Hovgård and Lassen 2000). A specific mesh size will catch a target species of a limited size range, allowing this gear type to be very selective.

The types of gillnets used in NEFSC survey activities are anchored sinking gillnets. Anchored sinking gillnets are fixed to the ocean floor or at a set distance above (typically in the lower one-third of the water column), held in place by anchors or ballasts with enough weight to counteract the buoyancy of the floats used to hold the net up (Nedelec and Prado 1990). Figure A-7 provides an example of an anchored sinking gillnet. NEFSC survey activities use gillnets that range from 50 to 325 feet in length, 8 to 10 feet in height, with mesh sizes from 6.5 to 12 inches. In some cases, gillnets may be configured in 10-panel strings totaling 3,000 feet long. All gillnets used in NEFSC research use weak links of particular strength and locations on the gear, as specified by the Large Whale Take Reduction Plan, in order to minimize the risk of large whales becoming entangled in the gear. Soak times for long-term surveys are typically 3 hours (Table 2.2-1) but short-term cooperative research projects have used soak times up to 96 hours (Table 2.2-2).

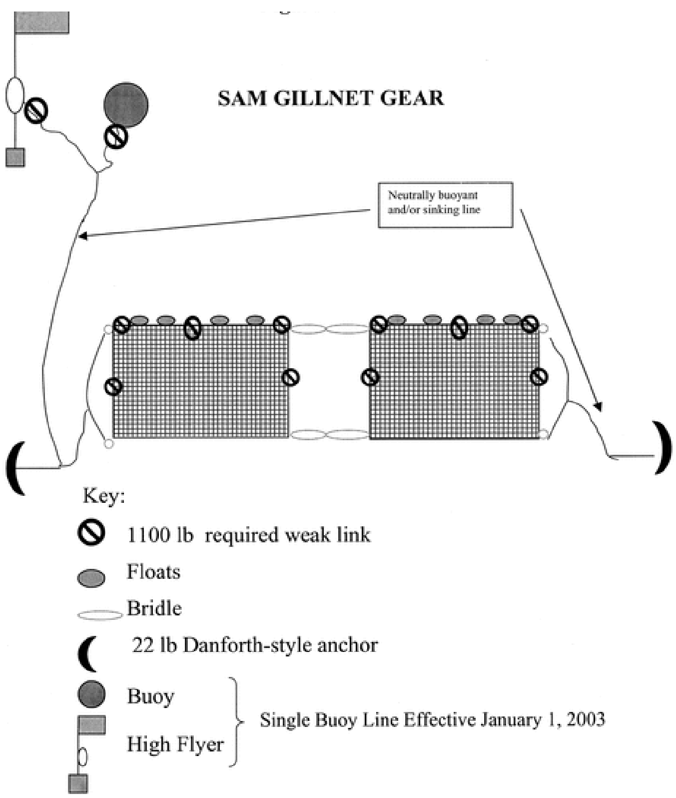

Figure A-7. Anchored sinking gillnet

Credit: 67 FR 1142

4. Pound nets

A pound net is a fixed fishing device that consists of poles or stakes secured into the bottom with netting attached. The structure includes a pound with a netting floor, a heart-shaped enclosure, and a straight wall or leader (Figure A-8). Pound nets are generally set close to shore and the leader is set perpendicular to the shore to guide migrating fish into the pound. The leader is a wall of mesh webbing that extends from the sea floor to approximately the sea surface and may be up to several hundred meters in length (Silva et al. 2011).

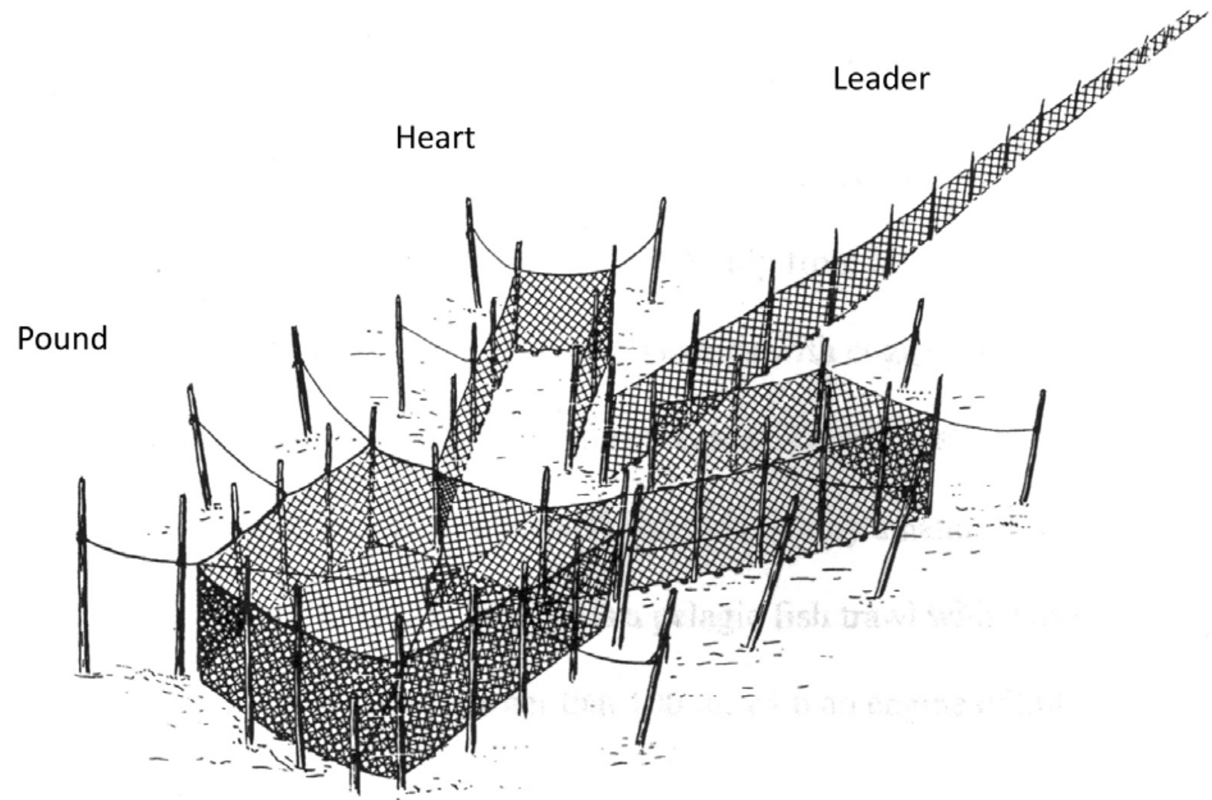

Figure A-8. Pound net diagram

Credit: Silva et al. 2011

Fish swimming laterally along the shoreline encounter the leader and generally turn towards deeper water to circumvent the obstruction (DeAlteris et al. 2005). The heart and pound portions of the net, located at the deep end of the leader, direct and trap the fish so they cannot escape. The pound is usually a rectangular enclosure 6 to 13 meters long constructed of small mesh (DeAlteris et al. 2005). Pound nets are relatively non-selective, and are used to capture several species of live fish (DeAlteris et al. 2005). NEFSC has previously conducted research focused on the relationships between pound net leader design and bycatch of sea turtles and other protected species (DeAlteris et al. 2005; Silva et al. 2011).

5. Longline

Longline vessels fish with baited hooks attached to a mainline or ‘groundline’(see Figure A-9). The length of the longline and the number of hooks depend on the species targeted, the size of the vessel, and the purpose of the fishing activity. Commercial longlines can be over 62 miles long and can have thousands of hooks attached, however longlines used for research purposes are usually shorter. The longline gear used for NEFSC research purposes typically uses 100-400 hooks attached to a line 2 to 10 miles in length, except for the small-scale Cooperative Atlantic States Shark Pupping and Nursery (COASTSPAN) surveys that typically use 25-50 hooks attached to a 1,000 feet mainline. Hooks are attached to the longline by another thinner line called a ‘gangion’ The length of the gangion and the distance between gangions depends on the purpose of the fishing activity.

Depending on the fishery, longline gear can be deployed on the seafloor (bottom longline), in which case weights are attached to the mainline, or longline gear can be deployed near the surface of the water (pelagic longline), in which case buoys are attached to the mainline to provide flotation and keep the baited hooks suspended in the water. Radar reflectors, radio transmitters, and light sources are often used to help fishers determine the location of the longline gear prior to retrieval. Light sources may also be attached to the gangions to attract target species to the gear. Because pelagic longline gear is not anchored to the seafloor, it floats freely in the water, and may drift considerable distances between the time of deployment and the time of retrieval.

‘Yankee’ swordfish-style pelagic longline gear consists of 5/16 inches tarred nylon mainline, with 24-33 foot gangions composed of 13 feet of 3/16 inches nylon, 7 feet of 3/32 inches stainless steel leader, and a #40 Japanese tuna hook. For research purposes, the hooks are baited with whole Atlantic mackerel, and attached at 170 feet intervals. Floats are attached at five hook intervals on 40 feet float lines. Flag buoys, or ‘high flyers,’ are located at each end of the gear.

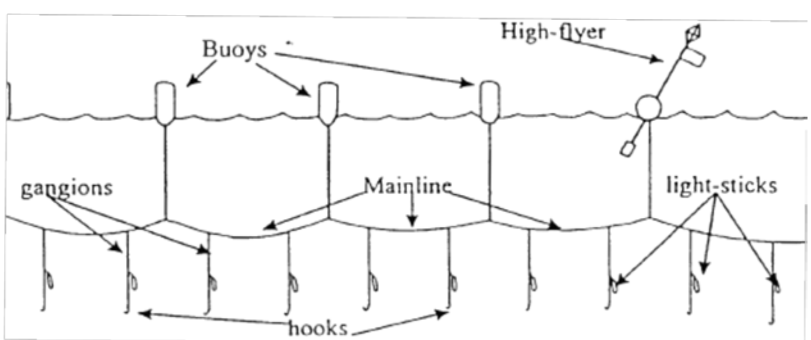

Figure A-9. Pelagic longline gear diagram

‘Florida’ commercial-style bottom longline gear consists of 940-pound test monofilament mainline with 12 feet gangions made of 730-pound test monofilament with a longline clip at one end and a 3/0 shark hook at the other. Hooks are baited with chunks of spiny dogfish and are attached to the mainline at roughly 60 feet intervals. Five-pound weights are attached at 15 hook intervals, and 15-pound weights and small buoys are attached at 50 hook intervals. To ensure that the gear fishes on the bottom, 20-pound weights are placed at the beginning and end of the mainline after a length of line two to three times the water depth is deployed. A 20 feet flag buoy (‘high flyer’) equipped with radar reflectors and flashing lights is attached to each end of the mainline. The flag buoys used for bottom longline gear use long buoy lines to allow the weighted groundline to rest on the seafloor while the attached buoys float on the surface to enable retrieval of the gear.

The small-scale COASTSPAN surveys use two types of anchored bottom longline gear: one for targeting small juvenile sharks and the other targets large juveniles and adult sharks. The juvenile gear consists of 1000 feet of 1/4 inches braided nylon mainline with at least 200 feet of additional line on each side for scope, and 50 gangions attached at 20 feet intervals, comprised of 12/0 Mustad circle hooks with barbs depressed, 20 inches 1/16 stainless cable, and 40 inches of 1/4 inch braided nylon line with 4/0 longline snaps. The large juvenile/adult survey uses the same type and length of mainline as the juvenile gear with 25 gangions attached at 40 feet intervals, comprised of 16/0 Mustad circle hooks with barbs depressed, 20 inches of 3/32 stainless cable, and 80 inches of 3 mm clear monofilament with 4/0 longline snaps. Previously frozen Atlantic mackerel or herring are purchased and used as bait for both juvenile and large juvenile/adult shark longline gear

The time between deployment and retrieval of the longline gear is the ‘soak time.’ Soak time is an important parameter for calculating fishing effort. For commercial fisheries the goal is to optimize the soak time to maximize catch of the target species while minimizing the bycatch rate, and minimizing damage to target species caught on the hooks that may result from predation by sharks or other predators. Soak time can also be an important factor for controlling longline interactions with protected species. Marine mammals, turtles, and other protected species may be attracted to bait, or to fish caught on the longline hooks. Protected species may become caught on longline hooks or entangled in the longline while attempting to feed on the catch before the longline is retrieved.

Birds may be attracted to the baited longline hooks, particularly while the longline gear is being deployed from the vessel. Birds may get caught on the hooks, or entangled in the gangions while trying to feed on the bait. Birds may also interact with longline gear as the gear is retrieved.

6. Hydraulic dredge

Hydraulic dredges are used to harvest Atlantic Surfclams (*Spisula solidissima*) and Ocean Quahogs (*Arctica islandica*) using pressurized water jets to wash clams out of the seafloor. The water jets penetrate the sediment in front of the dredge and help to propel the dredge forward. A blade on the front of the dredge then lifts the clams that have been separated from the sediment, and guides them into the body, or “cage,” of the dredge. The hydraulic dredges used for the NEFSC surfclam/ocean quahog survey employ a 12.5 feet blade and are towed at a rate of 1.5 knots. During survey tows, the dredge is deployed at depth for a duration of five minutes. As they are towed along the seafloor, hydraulic dredges may interact with sea turtles, and considerable effort has been made to develop devices and modify dredge design in order to minimize interactions between hydraulic dredges and sea turtles. Turtle mats and excluder devices (described below) may reduce the severity of some turtle interactions by preventing turtles from entering the dredge (Murray 2011).

7. New Bedford-type dredge

The New Bedford-type dredge is primarily used to harvest sea scallops in the Georges Bank and Mid-Atlantic scallop fisheries. The forward edge of the New Bedford-type dredge uses a cutting bar to create turbulence that drives scallops from the sediment into the bag of the dredge (see Figure A-10). The bag is made of metal rings and drags on the seafloor. Towing times for commercial scallop dredges are highly variable, depending on the size of the bag and the density of sea scallops at the fishing location. New Bedford-type dredges may interact with sea turtles, and NEFSC surveys use a turtle mat to minimize the impacts of dredge sampling on turtles.

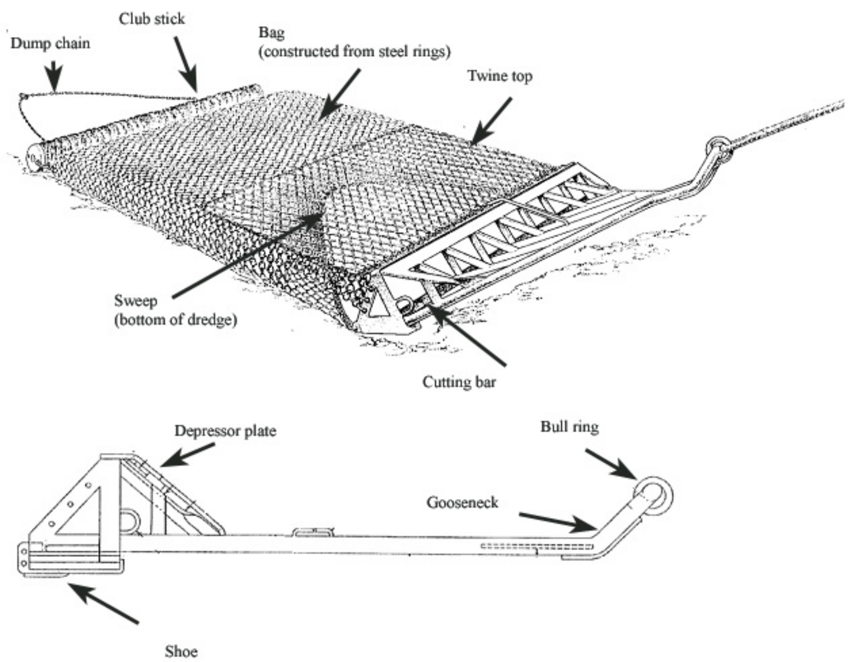

Figure A-10. Standard New Bedford sea scallop dredge

In response to the observed capture of sea turtles in scallop dredge gear, including serious injuries and mortality as a result of capture, NMFS proposed a modification to scallop dredge gear (70 FR 30660, May 27, 2005). The rule, finalized as proposed (71 FR 50361, August 25, 2006), required federally permitted scallop vessels fishing with dredge gear in Mid-Atlantic waters south of 41 °9'N from the shoreline to the outer boundary of the EEZ between May and November to modify their gear by adding an arrangement of horizontal and vertical chains (hereafter referred to as a "chain mat" or "turtle mat") between the sweep and the cutting bar (see Figure A-11). The requirement was subsequently modified by emergency rule on November 15, 2006 (71 FR 66466), and by a final rule published on April 8, 2008 (73 FR 18984). On May 5, 2009, NMFS proposed additional minor modifications to the regulations on how chain mats are configured (74 FR 20667). Chain mats consist of vertical and horizontal chains hung between the sweep and cutting bar and are intended to reduce the severity of some turtle interactions by preventing turtles from entering the dredge bag (Murray 2011). Monitoring the effectiveness of chain mats is difficult because interactions could still be occurring, but the chain mat prevents the turtle from being captured and observed (Murray 2011). However, chain mats are not expected to reduce the overall number of sea turtle interactions with scallop dredge gear.

Figure A-11. Turtle chain mat on traditional scallop dredge frame

Additional design modifications to a traditional New Bedford style scallop dredge were evaluated by NEFSC in cooperation with the Coonamesset Farm Foundation to prevent loggerhead sea turtles from snagging on top of the dredge frame or becoming trapped under the dredge bale, while maintaining efficiency for dredging sea scallops (Smolowitz *et al*. 2008). The final design, the Coonamesset Farm turtle excluder dredge (see Figure A-12), proved effective at guiding turtles over the top of the dredge by eliminating most of the bale bars and forming a ramp with a forward positioned cutting bar and closely spaced struts leading back at a forty-five degree angle (Smolowitz *et al.* 2008).

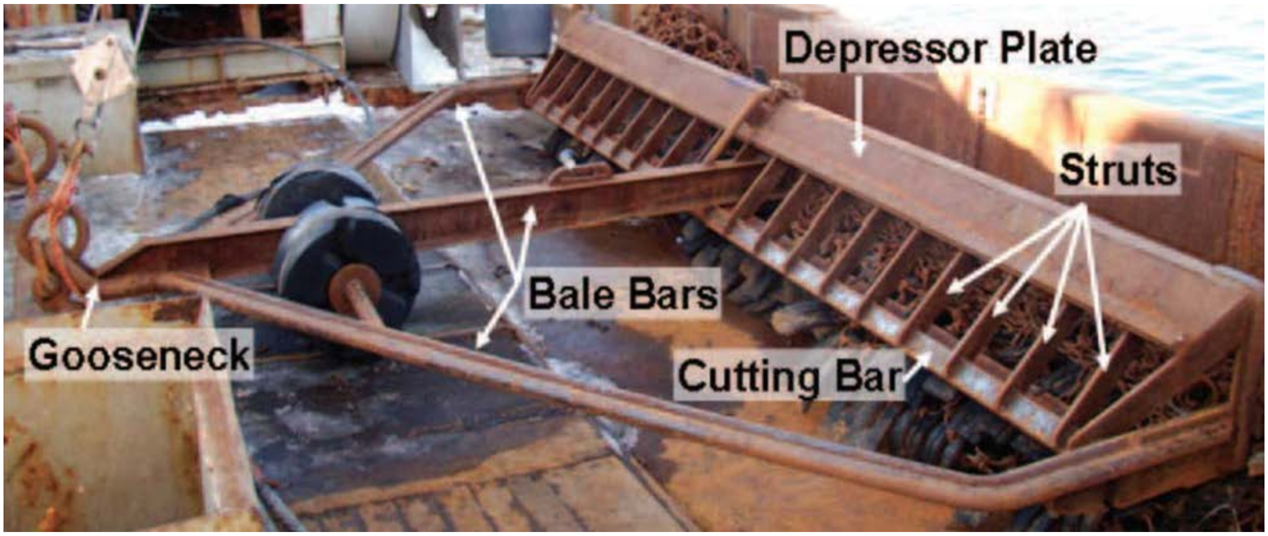

Figure A-12. Coonamessett Farm turtle deflector dredge

8. Naturalist dredge

The Naturalist dredge, shown in Figure A-13, is primarily used to obtain samples of megafaunal species, such as oysters, crabs, mussels and whelks. The Naturalist dredge is typically small (1 meter wide) and towed along the seafloor over a relatively short distance (30 to 200 feet) in order avoid overfilling the dredge and losing part of the sample. All megafauna from the dredge samples are picked out by hand and processed on deck after retrieval of the dredge. Due to the small size of the Naturalist dredge and the limited periods of time over which it is deployed, interactions with protected species are expected to be minimal. However, dredges do disturb bottom habitats, and may potentially interact with sea turtles.

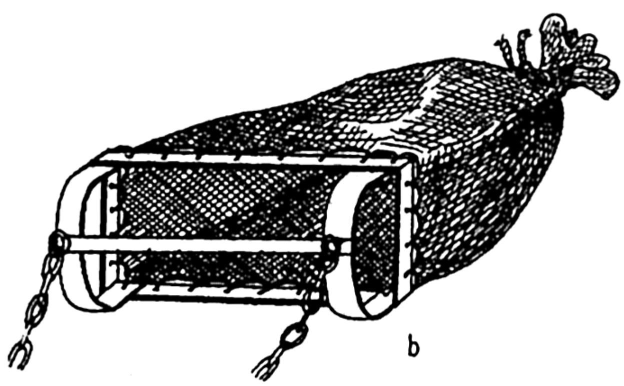

Figure A-13. Naturalist dredge

9. Fish / Lobster Pots

Several NEFSC and cooperative research surveys use fish or lobster pots to selectively capture species for research, tagging studies, and sample collection. Fish pots can be designed to select for particular species by configuring the entrances, mesh, and escape tunnels (or "vents") to allow retention of the target species, while excluding larger animals, and allowing smaller animals to escape from the pot before retrieval. In many instances, animals remain alive in the pot until it is pulled, making pots a preferred method for collecting some species for tagging or mark / recapture studies.

The NEFSC research set aside program targeting black sea bass in southern New England (SNE) and Mid-Atlantic waters uses unvented pots 43½ inches long, 23 inches wide, and 16 inches high made with 1½ inches by 1½ inches coated wire mesh, a single mesh entry head, and a single mesh inverted parlor nozzle (see Figure A-14).

Figure A-14. Retrieval of a pot targeting black sea bass

Other NEFSC research activities targeting various finfish and shellfish species use different pot configurations, depending on the species of interest. Figure A-15 shows examples of different types of pots.

Figure A-15. Examples of pot equipment

10. Rotary Screw Trap

Rotary screw traps (RSTs) enable live capture of smolts emigrating from several coastal rivers, including the Narraguagus, Penobscot, Pleasant, and Sheepscot Rivers. RSTs are used to estimate smolt populations, enumerate and sample smolts (and other co-occurring species), and to better understand factors that limit smolt production and migration success. Figure A-16 shows a RST that was used on the Sheepscot River to capture Atlantic salmon smolts. RSTs are also platforms for telemetry studies that provide valuable data on smolt behavior and migratory success. RSTs are positioned in the water channels to maximize fish capture. Fish enter the trap through the large end of a revolving and half-submerged screen cone suspended between two pontoons. The NEFSC uses RSTs with different size openings (4 ft, 5 ft, and 8 ft models). As the river current turns the cone, the fish are guided downstream into a live car, where they are held in river water until retrieved for sampling. Traps are tended daily, so fish spend as little time as possible in the live car. As smolts tend to move downstream at night, they often confined for less than 12 hours.

RSTs require adequate water depth and current to rotate the cone for most effective “fishing.” Although RSTs can be used in high flow conditions, they sometimes become jammed with debris. River conditions are monitored closely to prevent fish injury. RSTs are equipped with a hubodometer that records the number of revolutions of the cone, allowing for an estimation of catch per unit of effort.

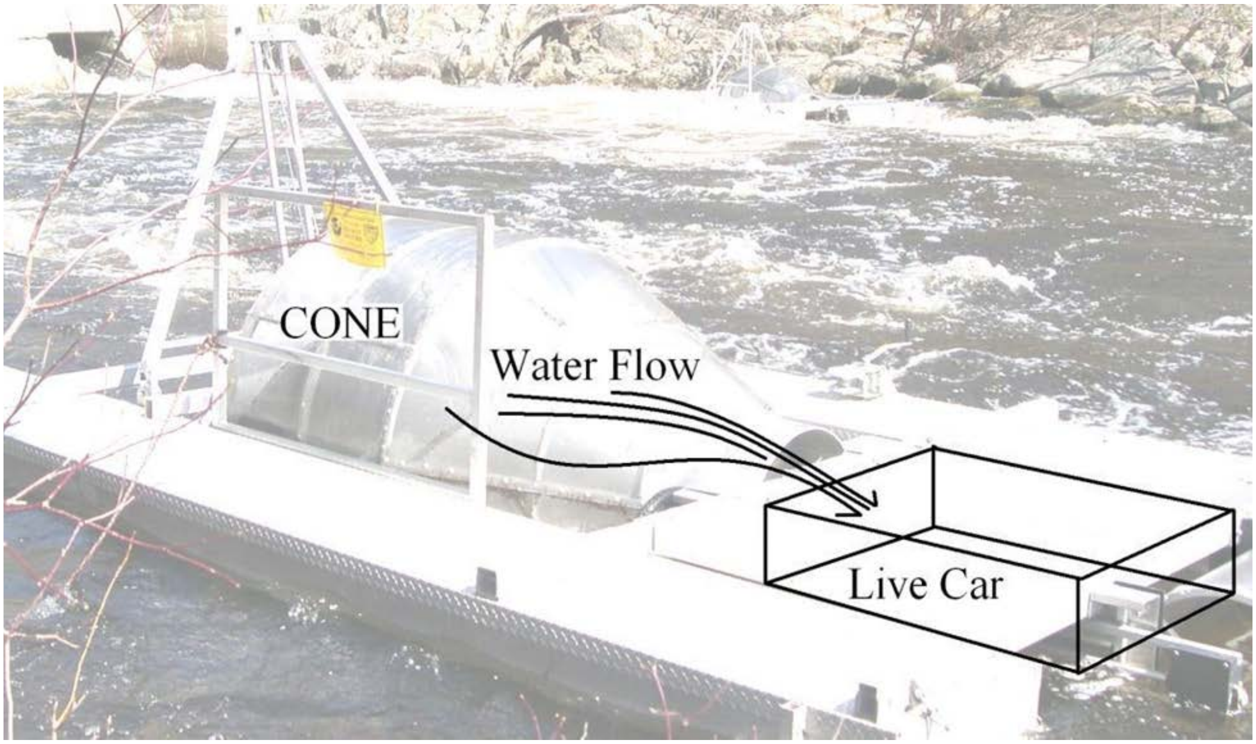

Figure A-16. Rotary screw trap

Credit: NOAA archives

11. Various plankton nets (Bongo Nets)

NEFSC research activities include the use of several plankton sampling nets that employ very small mesh to sample plankton and fish eggs from various parts of the water column. Plankton sampling nets usually consist of fine mesh attached to a weighted frame. The frame spreads the mouth of the net to cover a known surface area. The Bongo nets used for NEFSC surveys typically have openings 61 centimeters in diameter and employ either 333 micrometer or 505 micrometer mesh. The nets are 3 meters in length with a 1.5 meters cylindrical section coupled to a 1.5 meters conical portion that tapers to a detachable codend constructed of 333 micrometers or 0.505 micrometer nylon mesh (Figure A-17).

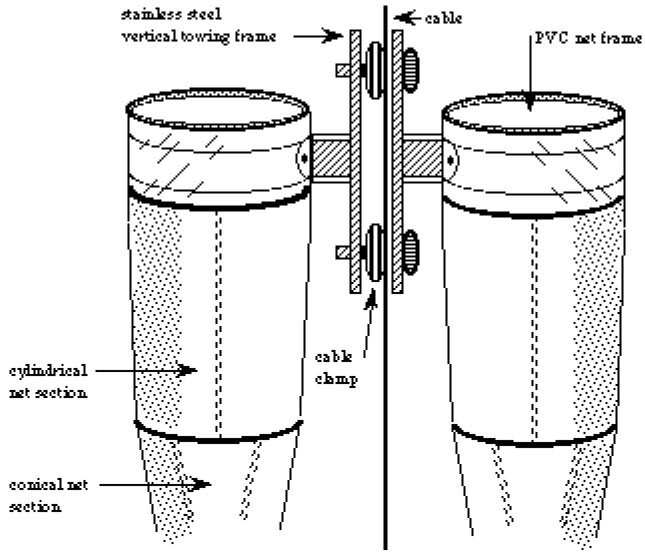

Figure A-17. Bongo net diagram

Credit: Aquatic Research Instruments (2011)

The bongo nets are towed through the water at an oblique angle to sample plankton over a range of depths. During each plankton tow, the bongo nets are deployed to a depth of approximately 210 meters and are then retrieved at a controlled rate so that the volume of water sampled is uniform across the range of depths. In shallow areas, sampling protocol is adjusted to prevent contact between the bongo nets and the seafloor. A collecting bucket, attached to the codend of the net, is used to contain the plankton sample. When the net is retrieved, the collecting bucket can be detached and easily transported to a laboratory. Some bongo nets can be opened and closed using remote control to enable the collection of samples from particular depth ranges. A group of depth-specific bongo net samples can be used to establish the vertical distribution of zooplankton species in the water column at a site. Bongo nets are generally used to collect zooplankton for research purposes, and are not used for commercial harvest.

12. Van Veen sediment grab sampler

Sediment grab samplers are used to collect sediments and assess populations of benthic fauna from the seafloor. The Van Veen grab sampler is comprised of a hinged pair of scoops that can be deployed over the side of the vessel and lowered to the seafloor on a cable (see Figure A-18). The scoops are approximately 31 centimeters wide to allow sampling of a 0.1 square meter area of the seafloor. Sharp cutting edges on the bottoms of the scoops enable them to penetrate up to about 40 centimeters into the sediment. The grab sampler may be galvanized, stainless steel, or Teflon-coated.

Prior to deployment, the sampler is cocked with the safety key in place. The sampler is then deployed over the side of the vessel, the safety key is removed, and the sampler is slowly lowered to the bottom. After bottom contact has been made (indicated by slack in the cable), the tension on the cable is slowly increased, causing the scoops to close. Once the sampler is back on board, the top doors are opened for inspection of the sediment sample (Stubbs et al. 1987).

The Van Veen sediment grab sampler is designed to collect sediments and invertebrates from the seafloor and potential interactions with marine mammals, turtles, or birds are believed to be negligible.

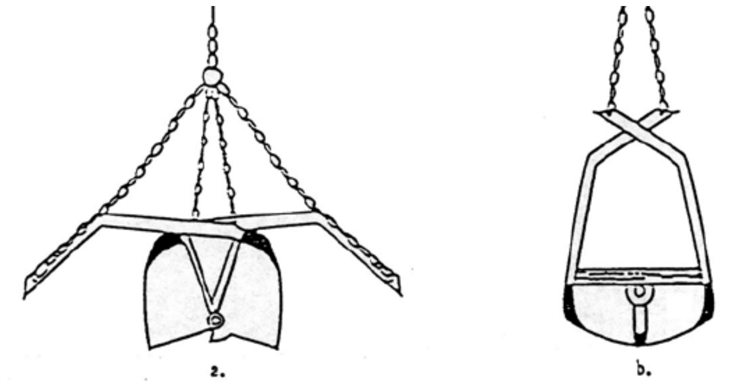

Figure A-18. Van Veen grab sampler: a) cocked position b) closed position

Credit: modified from Stubbs et al. (1987)

13. ADCP

An Acoustic Doppler Current Profiler, or ADCP, is a type of sonar used for measuring water current velocities simultaneously at a range of depths. In the past, current depth profile measurements required the use of long strings of current meters. ADCP enables measurements of current velocities across an entire water column, replacing the long strings of current meters. An ADCP anchored to the seafloor can measure current speed not just at the bottom, but also at equal intervals all the way up to the surface (WHOI 2011). An ADCP instrument can also be mounted to a mooring, or to the bottom of a boat.

The ADCP measures water currents with sound, using the Doppler Effect. A sound wave has a higher frequency when it moves towards the sensor (blue shift) than when it moves away (red shift). The ADCP works by transmitting "pings" of sound at a constant frequency into the water. As the sound waves travel, they ricochet off particles suspended in the moving water, and reflect back to the instrument (WHOI 2011). Due to the Doppler Effect, sound waves bounced back from a particle moving away from the profiler have a slightly lowered frequency when they return. Particles moving toward the instrument send back higher frequency waves. The difference in frequency between the waves the profiler sends out and the waves it receives is called the Doppler shift. The instrument uses this shift to calculate how fast the particle and the water around it are moving. Sound waves that hit particles far from the profiler take longer to come back than waves that strike close by. By measuring the time it takes for the waves to return to the sensor, and the Doppler shift, the profiler can measure current speed at many different depths with each series of pings (WHOI 2011).

ADCPs operate at frequencies between 75 and 600 kilohertz. High frequency pings yield more precise data, but low frequency pings travel farther in the water. Thus, a compromise must be made between the distance that the profiler can measure and the precision of the measurements (WHOI 2011).

ADCPs that are bottom-mounted need an anchor to keep them on the bottom, batteries, and a data logger. Vessel-mounted instruments need a vessel with power, a shipboard computer to receive the data, and a

GPS navigation system so the ship's movements can be subtracted from the current velocity data (WHOI 2011).

14. CTD profiler

‘CTD’ is an acronym for Conductivity, Temperature, and Depth. A CTD profiler measures these parameters, and is the primary research tool for determining chemical and physical properties of seawater. A shipboard CTD is made up of a set of small probes attached to a large (1 to 2 meters in diameter) metal rosette wheel (see Figure A-19). The rosette is lowered through the water column on a cable, and CTD data are observed in real time via a conducting cable connecting the CTD to a computer on the ship. The rosette also holds a series of sampling bottles that can be triggered to close at different depths in order to collect a suite of water samples that can be used to determine additional properties of the water over the depth of the CTD cast. A standard CTD cast, depending on water depth, requires 2 to 5 hours to complete (WHOI 2011). The data from a suite of samples collected at different depths are often called a depth profile, and are plotted with the value of the variable of interest on the x-axis and the water depth on the y-axis. Depth profiles for different variables can be compared in order to glean information about physical, chemical, and biological processes occurring in the water column.

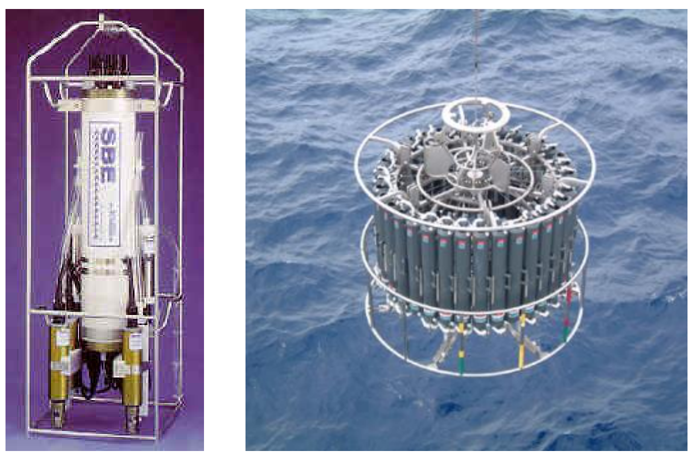

Figure A-19. Sea-Bird 911*plus* CTD profiler and deployment on a sampling rosette

Credit: Sea-Bird Electronics, Bellevue, WA

Conductivity is measured as a proxy for salinity, or the concentration of salts dissolved in the seawater. Salinity is expressed in ‘practical salinity units’ (psu) which represent the sum of the concentrations of several different ions. Salinity is calculated from measurements of conductivity. Salinity influences the types of organisms that live in a body of water, as well as physical properties of the water. For instance, salinity influences the density and freezing point of seawater.

Temperature is generally measured using a high-sensitivity thermistor protected inside a thin walled stainless steel tube. The resistance across the thermistor is measured as the CTD profiler is lowered through the water column to give a continuous profile of the water temperature at all water depths.

The depth of the CTD sensor array is continuously monitored using a very sensitive electronic pressure sensor. Salinity, temperature, and depth data measured by the CTD instrument are essential for characterization of seawater properties.

15. Still and video camera images taken from an ROV

The NEFSC maintains and deploys remotely operated vehicles (ROVs)(See Figure A-20). The ROVs are used to quantify fish and shellfish, photograph fish for identification, and provide information for habitat-type classification studies. Still and video camera images are also used to monitor the operation of bycatch reduction devices. Precise geo-referenced data from ROV platforms also enables SCUBA divers to use bottom time more effectively for collection of brood stock and other specimens.

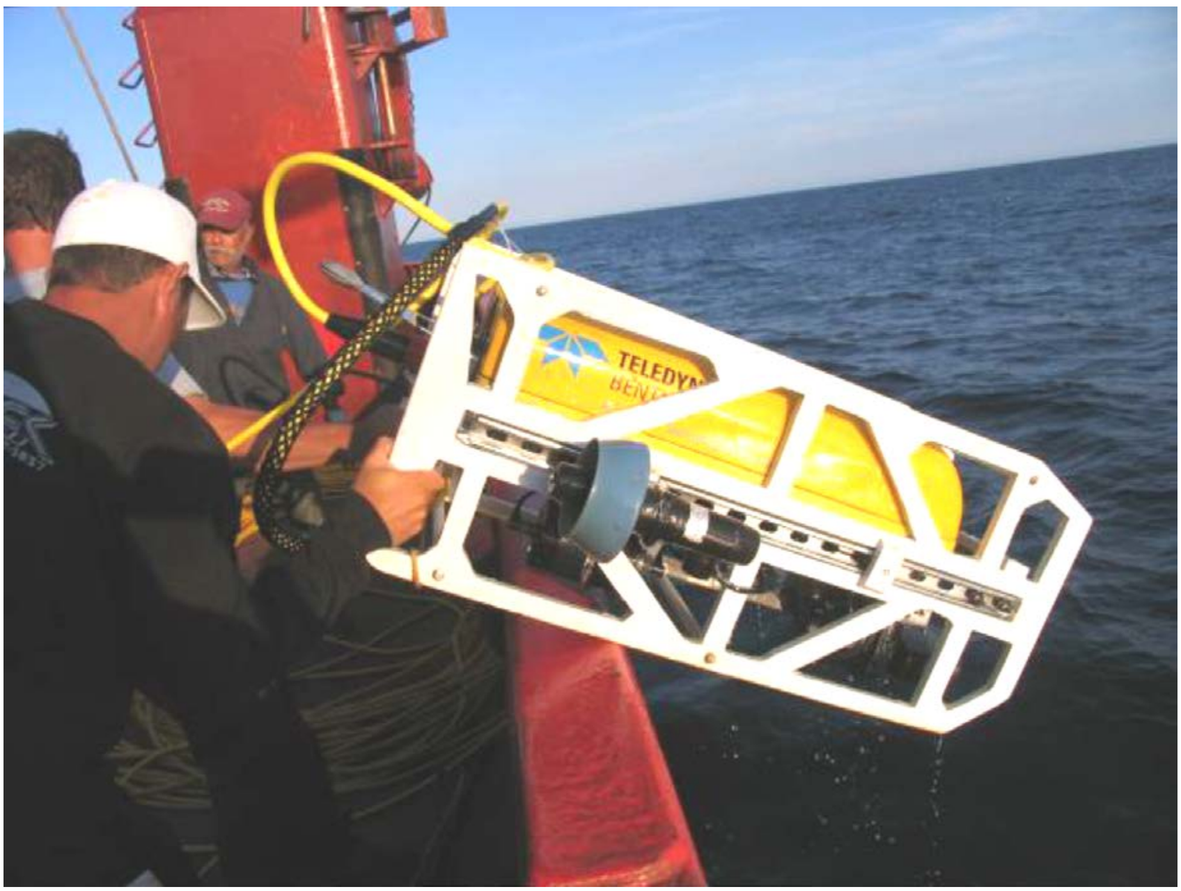

Figure A-20. ROV being deployed from scallop vessel

The Seabed Observation and Sampling System (SEABOSS) was designed for rapid, inexpensive, and effective collection of seabed images and sediment samples in coastal/inner-continental shelf regions. The observations from video and still cameras, along with sediments collected in the sampler, are used in conjunction geophysical mapping surveys to provide more comprehensive interpretations of seabed character.

The SEABOSS incorporates two video cameras, a still camera, a depth sensor, light sources, and a modified Van Veen sediment sampler (see Figure A-21). These components are attached to a stainless steel frame that is deployed through an A-frame, using a power winch, as the SEABOSS weighs 300 pounds. The SEABOSS frame has both a stabilizing fin capable of orienting the system while it drifts, and base plates that prevent over-penetration when the system rests on the sea floor. Undisturbed samples are taken with the modified Van Veen sampler. The system begins imaging the sea floor with a 35-millimeter camera before touching bottom, at 30 inches height above bottom. Scale, time, and exposure number are annotated on each image. These images are later scanned into a digital format. A downward-looking video camera overlaps the field of view of the still camera. The second video camera is mounted in a forward-looking orientation, providing an oblique sea floor view and enables a shipboard operator to monitor for proper tow-depth and for obstacles to the SEABOSS while operations are underway. (Blackwood *et al.* 2000).

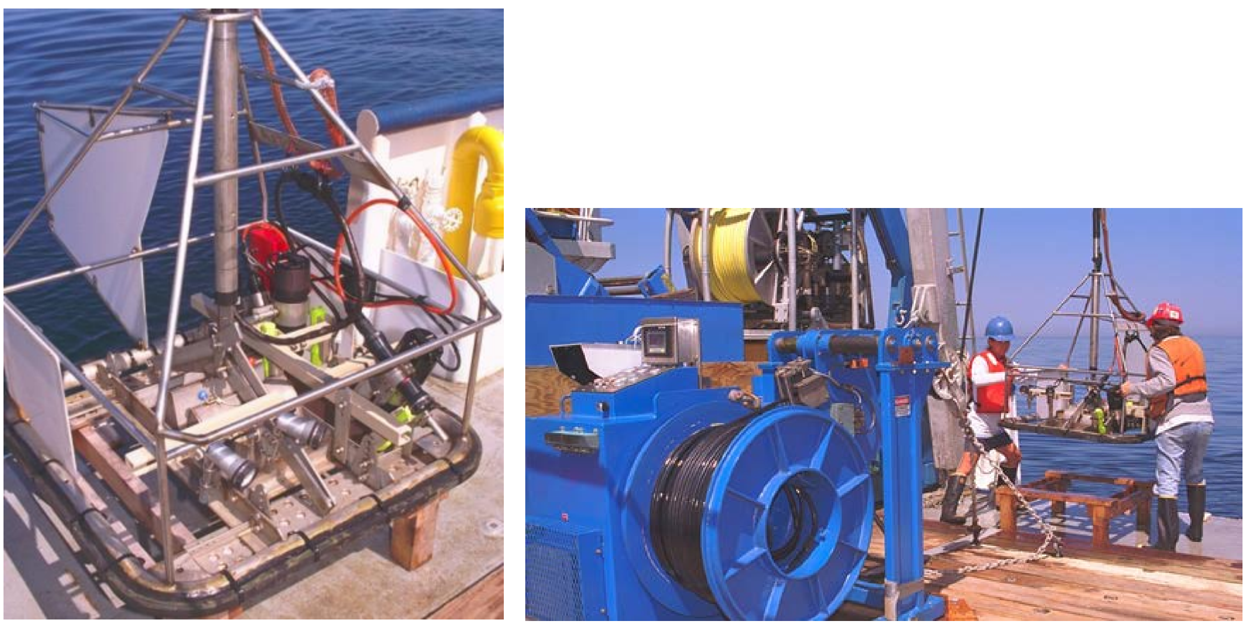

Figure A-21. The SEABOSS benthic observation system

16. Active Acoustic Sources used in NEFSC Fisheries Surveys

A wide range of active acoustic sources are used in NEFSC fisheries surveys for remotely sensing bathymetric, oceanographic, and biological features of the environment. Most of these sources involve relatively high frequency, directional, and brief repeated signals tuned to provide sufficient focus and resolution on specific objects. Important characteristics of the nine predominant NEFSC acoustic sources are provided below in Tables A-1, followed by descriptions of some of the primary sources.

Table A-1 Output characteristics for the seven predominant NEFSC active acoustic sources.

Active Acoustic System (product name and #)	Operating frequencies (kHz)	Maximum source level (dB re 1 μPa at 1 m)	Single ping duration	Nominal beam width (degrees)
Simrad EK60 Narrow Beam Scientific Echo Sounder	18, 38, 70, 120, 200, & 333	224	1 millisecond	11° at 18 kHz; 7° at 38, 120, 200 & 333 kHz
Simrad ME70 Multi-Beam Echo Sounder	70-120	205	150 microsecond	140°
Teledyne RD Instruments Acoustic Doppler Current Profiler (ADCP), Ocean Surveyor	75	224		30°
Simrad SX90 Narrow Beam Sonar (conservative assumption--pointed horizontally)	20-30	219		7°
Raymarine SS260 (DSM300 sounder)	50, 200	217		19° at 50 kHz; 6° at 200 kHz
NetMind	30, 200	190		50°
Simrad EQ50	50, 200	210		16° at 50 kHz; 7° at 200 kHz

17. Multi-frequency Narrow Beam Scientific Echo Sounders (Simrad EK60 - 18, 38, 70, 120, 200, 333 kilohertz)

Similar to multibeam echosounders, multi-frequency split-beam sensors are deployed from NOAA survey vessels to acoustically map the distributions and estimate the abundances and biomasses of many types of fish; characterize their biotic and abiotic environments; investigate ecological linkages; and gather information about their schooling behavior, migration patterns, and avoidance reactions to the survey vessel. The use of multiple frequencies allows coverage of a broad range of marine acoustic survey activity, ranging from studies of small plankton to large fish schools in a variety of environments from shallow coastal waters to deep ocean basins. Simultaneous use of several discrete echosounder frequencies facilitates accurate estimates of the size of individual fish, and can also be used for species identification based on differences in frequency-dependent acoustic backscattering between species. The NEFSC uses devices that transmit and receive at six frequencies ranging from 18 to 333 kilohertz.

18. Single Frequency Omnidirectional Sonars (Simrad SX-90)

Low frequency, high-resolution, long range fishery sonars including the SX-90 operate with user selectable frequencies between 20 and 30 kilohertz providing longer range and prevent interference from other vessels. These sources provide an omnidirectional imaging around the source with three different vertical beamwidths, single or dual vertical view and 180° tiltable vertical views are available. At 30 kilohertz operating frequency, the vertical beamwidth is less than seven degrees. This beam can be electronically tilted from +10 to -80 degrees, which results in differential transmitting beam patterns. The cylindrical multi-element transducer allows the omnidirectional sonar beam to be electronically tilted down to -60 degrees, allowing automatic tracking of schools of fish within the whole water volume around the vessel. The signal processing and beamforming is performed in a fast digital signal processing system using the full dynamic range of the signals.

19. Multi-beam echosounder (Simrad ME70)

Multibeam echosounders and sonars work by transmitting acoustic pulses into the water then measuring the time required for the pulses to reflect and return to the receiver and the angle of the reflected signal (see Figure A-22). The depth and position of the reflecting surface can be determined from this information, provided that the speed of sound in water can be accurately calculated for the entire signal path.

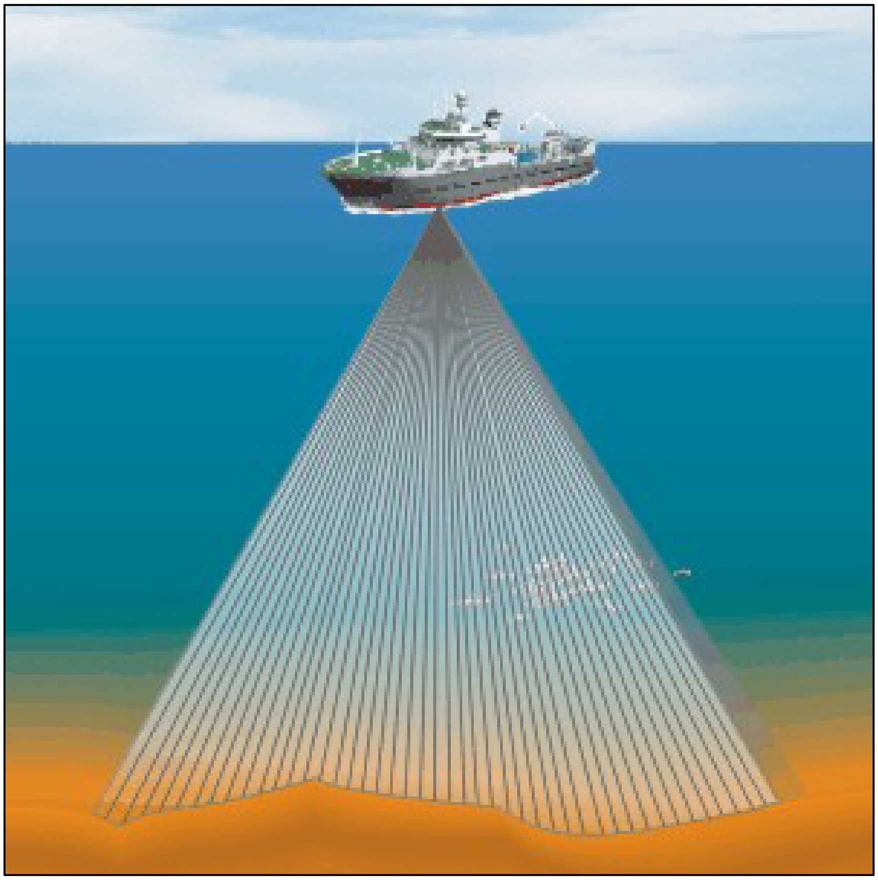

Figure A-22. Multi-beam echosounder

Credit: Simrad – www.simrad.com

The use of multiple acoustic ‘beams’ allows coverage of a greater area compared to single beam sonar. The sensor arrays for multibeam echosounders and sonars are usually mounted on the keel of the vessel and have the ability to look horizontally in the water column as well as straight down. Multibeam echosounders and sonars are used for mapping seafloor bathymetry, estimating fish biomass, characterizing fish schools, and studying fish behavior. The multibeam echosounders used by NEFSC are mounted to the hull of the research vessels and emit frequencies in the 70-120 kilohertz range.

20. NEFSC Vessels used for Survey Activities

NMFS employs NOAA-operated research vessels, chartered vessels, and vessels operated by cooperating agencies and institutions to conduct research, depending on the survey and type of research.

Figure A-23. R/V ***Delaware II***

The NOAA research vessel (R/V) *Delaware II* was used for trawl surveys for many years during the baseline years described in this application. It was retired from NOAA service in 2012 and sold so it is not anticipated to be one of the vessels used in the future. The R/V *Delaware II* was a 155 foot steel-hulled, purpose-built research vessel powered by two General Motors diesel engines with a total of 1,230 horsepower (Figure A-23). The R/V *Delaware II* used a single propeller to achieve a sustained cruising speed of 10.0 knots. The deck equipment featured six winches, one deck crane, two A-frames, and a moveable stern gantry. Each of the winches served a specialized function ranging from trawling to hydrographic surveys. The ship had a beam of 30.2 feet and a draft of 14.8 feet, and could accommodate a crew of 32 people including up to 14 scientists for voyages of up to 16 days. The ship's normal operating area was the Gulf of Maine, Georges Bank, and the continental shelf and slope from Southern New England to Cape Hatteras, NC.

Figure A-24. R/V ***Henry B. Bigelow***

The NOAA research vessel *Henry B. Bigelow*, shown in Figure A-24, was launched in 2005 to replace the *Albatross IV*. The 209 feet steel-hulled *Henry B. Bigelow* uses an integrated diesel electric drive system, with two 1,542 horsepower propulsion motors, and a single 14.1 feet propeller to achieve a sustained cruising speed of up to 12 knots. The ship has a beam of 49.2 feet and a draft of 19.4 feet and can accommodate up to 39 crew, including 15 scientists, for voyages of up to 40 days. The deck equipment features five winches, one deck crane, two A-frames, and a moveable stern gantry. The ship's primary operating area is offshore waters of the Northeast Continental Shelf LME. The *Henry B. Bigelow* has a number of features engineered specifically to reduce transmission of ship noise into the ocean, which enhances its utility for research because fish and marine mammals are less likely to react to ship noise.

Figure A-25. R/V ***Hugh R. Sharp***

The R/V *Hugh R. Sharp,* shown in Figure A-25, is a 146 feet acoustically quiet research vessel operated by the University of Delaware Marine and Earth Studies program, as a member of the University-National Oceanographic Laboratory System (UNOLS). The vessel is powered by a diesel-electric propulsion system with twin Z-drives and a tunnel-style bow thruster. The vessel has a dynamic positioning system, enabling it to maintain a precise location 'on-station' during research activities. It has a nominal cruising speed of 11 knots, and can carry 14 to 20 scientists on cruises up to 18 days in duration. It typically operates in the coastal waters from Long Island, New York, to Cape Hatteras, North Carolina, as well as the Delaware and Chesapeake Bays. Projects occasionally require the vessel to work as far north as the Gulf of Maine, as far south as Florida, and as far offshore as Bermuda. Operational support for the R/V *Hugh R. Sharp* is provided primarily by the National Science Foundation (NSF), the Office of Naval Research (ONR), and the National Oceanic and Atmospheric Administration (NOAA). The R/V *Hugh R. Sharp* is a purpose-built research vessel designed with special attention to controlling underwater radiated noise to minimize effects on the marine environment.

Figure A-26. R/V ***Gloria Michelle***

The R/V *Gloria Michelle* is a 72 feet steel–hulled stern trawler operated by NOAA and used for Gulf of Maine shrimp trawl surveys (Figure A-26). The vessel is powered by a Caterpillar 3406 producing 365 horsepower, driven through a single fixed-pitch 64 inches four-blade propeller. The F/VF/V *Gloria Michelle* has a beam of 20 feet, a draft of 9.5 feet, and can accommodate a crew of two officers and eight scientists for voyages up to five days in length.

In addition to NOAA-operated research vessels, research activities may be conducted from chartered or cooperative vessels. A wide range of commercial fishing vessels participate in such cooperative research, ranging from small open boats to modern trawlers and longliners. The sizes of the vessels used for cooperative research, engine types, cruising speeds, etc. vary depending upon the location and requirements of the research for which the vessel is used.

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17.0 APPENDIX B - COOPERATIVE RESEARCH MATRIX

Table B-1 Cooperative Research Matrix 2008-2012

This table indicates the scope and type of short-term research projects conducted under status quo conditions in the recent past. The projects are organized by general purpose and gears used. All vessels used for these projects were commercial fishing vessels or chartered vessels capable of deploying the commercial fishing gears used in these types of projects.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
SURVEY PROJECTS						
Projects using trawl gear						
An industry-based survey for winter flounder in Southern New England	SNE, West of Closed Area (CA) I and north of Nantucket Lightship CA	5 survey cruises completed June-Oct. 2010	F/V *Seel*, F/V *Sasha Lee*, F/V *Sea Siren*, F/V *Iberia II*, F/V *United States*	Flat fish otter trawl	Bottom trawl. 60 ft head rope length x 80 ft ground rope length. Otter trawl survey net designed by Reider's Inc. 21 in rock hopper disks on sweep, tapered to 18 in and 16 in on wings, 20 fathoms bridle, 2-seam flat net using 4 mm Euro twine, 4.5 in mesh	288 tows at 20 to 30 min per tow
An industry-based survey for yellowtail flounder in Southern New England	SNE, Rhode Island Bight, Vineyard Sound, Long Island, NY	Aug.-Sept. 2011 (9 total trips were taken)	F/V *Heather Lynn*, F/V *Travis and Natalie*, F/V *Mary Elena*	Flat fish otter trawl	Bottom trawl. 360 x 6 in 2-seam flatfish otter trawl net, 3 in cookies, 135 ft sweep, 3 in codend mesh size	263 total tows at 20 to 30 min per tow
Cookie versus rock hopper sweep comparison	Paired trawl experiment: GOM, GB, SNE. Twin trawl experiment: SNE Fishing in 30 to 50 meter depth.	Twin trawl experiment: fall of 2009, 2 cruises lasting 5 days each, 10 DAS. Paired trawl experiment: fall of 2009, 6 cruises of 10 days each, 60 DAS	Twin trawl: F/V *Karen Elizabeth* Paired trawl: F/V *Endurance*, F/V *Moragh Kay*, F/V *Mary Kay*	Otter trawls with different sweeps (cookie and rock hopper)	Bottom trawl. Bigelow 4-seam 3-bridle net: two exact same nets with different sweeps (one cookie and one rock hopper)	Twin trawls: 100 tows, 20 min at 3 kts Paired tow experiment: 527 tows, 20 min at 3 kts

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using dredge gear						
Scallop survey transition and calibration tows from NMFS R/V ***Albatross*** **to the University of Delaware's** R/V ***Hugh R. Sharpe***	Entire range of Atlantic scallop resources, i.e., GOM, GB, SNE, MAB	Spring and fall survey periods, 2008	R/V *Albatross*, R/V *Hugh R. Sharpe*	Standard scallop survey dredge.	8 ft scallop dredge rigged with turtle chains, bag liner. Twin dredges towed simultaneously.	491 paired tows total.
Projects using hook and line gear						
Penobscot East bottom longline and jig fishing survey	GOM, up to 30 nm offshore between Vinehaven and Grand Manan Channel	July-Oct. 2013 and spring and fall 2014 pending funding, 20 DAS	F/V *Andanamra and* F/V *Tricia Clarke*	Longline and jig gear	Longline: 2000 hooks per set, ground line #7 with 1 fathom between hooks, #550 green gangion, #12 mustad semi-circle easy baiter hooks. Sets are soaked for 2 hr each. Jig: 80 pound power pro spectra with line on reel 40 pound braid. 3 hook setup (9/0 hook on bottom, 8/0 hooks on top and middle), 16-36 ounce diamond jig.	44 longline sets distributed among three depth strata, 88 total soak-hr 48 stratified random jigging stations, 5 lines per station, 5 min soak time.
Video hook-and-line survey to further knowledge of cusk (*Brosme brosme*) distribution and habitat preferences.	Statistical area 514 (western GOM, Old Scantum and New Scantum)	Aug.-Sept. 2011 and May-June 2012 (10 trips of approx. 4 hr)	F/V *Too Far*	Hook and line fishing gear and video equipment	Hook-and-line, drop camera (deep sea camera mounted on towed body)	10 trips, average of 4 rod-hours per trip
Projects using pot gear						
Application of broadband sonar technology for fisheries assessment and research	GOM – Coast wide in Maine waters	Year round sampling during 2009 commercial fishing season.	F/V *Jennifer and Emily*	Lobster boats equipped with acoustic sonar	Hydroacoustic sampling gear: Simrad ES70 single beam, dual-frequency systems.	Samples or numbers of lobster boat cruises not available

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Cooperative industry/university/government based scup and sea bass survey utilizing fixed gear	Scup: bays offshore MA and RI. Black sea bass: Four zones along East Coast (MA, RI, NJ, and VA).	Scup: 5 cycles, June 15-Oct. 15, 2010 Black sea bass: 16 locations sampled monthly Apr.-Oct. depending on the region. Southern sites sampled in the spring, northern sites in summer and fall.	F/V *Drake*, F/V *Evangeline*, F/V *Captain Robert*, others	Pot gear Black sea bass: 10 individual pots per set. 30 sets on random hard bottom areas.	Scup: unvented 2 ft x 2 ft x 2 ft pots constructed of 1.5 in mesh fished for 1-2 days. Black sea bass pots: 43.5 in x 23 in x 16 in pots constructed with 1.5 in coated wire mesh, fished for 1 day.	Scup: 30 pots at each of 15 sites every 4 weeks. Total 2700 pot hauls. Black sea bass: 30 pots at each of 16 sites sampled monthly. Total 3360 pot hauls.
CONSERVATION ENGINEERING PROJECTS						
Projects using trawl gear						
A method to reduce butterfish retention in the offshore *Loligo* squid fishery through the use of a bycatch reduction device (BRD) adapted to pre-existing gear.	SNE and MAB (Hudson Canyon region)	Nov.-Dec. 2010 and Jan.-Mar. 2011, 4 trips of 6-day durations.	F/V *Karen Elizabeth*	Otter trawl (twin trawl with experimental and standard squid nets).	Bottom trawl. Comparisons between the standard legal codend mesh size of 1 7/8 in to larger mesh sizes (2.5 in) test of economic viability and butterfish escapement.	1 hr tows, 7 tows per day. 84 tows total.
A method to reduce winter flounder retention through the use of avoidance gear; adaptations in the small mesh trawl fishery within the Southern New England/Mid-Atlantic winter flounder stock area	SNE and MAB	July 2010 10 DAS	Trawl vessel	Trawl gear	Bottom trawl. Side by side parallel tows, 1 fishing experimental and one fishing the regular commercial trawl.	1 hr tows at 3.2 kts, 4-6 tows per day, 40-60 paired tows total

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Collaborative network approach to reduce bycatch in the Southern New England/Mid-Atlantic squid trawl fishery (SQUIDNET)	SNE, MAB out to EEZ, Hudson Canyon and MAB	Fall 2010. Day and night sampling with 3 to 4 depth strata. 10-12 DAS	F/V *Karen Elizabeth*	Standard Bigelow net with acoustic equipment on net	Bottom trawl. 4-seam Bigelow net, Ecoview acoustic data to estimate density entering net or escapement, thus catchability. Same protocols as NEAMAP and Bigelow.	20 min tows. 40 day v. 40 night samples for comparisons.
Design and test of an innovative large mesh whiting trawl to reduce spiny dogfish bycatch in the Southern New England whiting fishery	SNE between Block Island and Nantucket Island	Aug.-Sept. 2010 10 DAS	Two whiting trawl vessels	Semi-pelagic trawl	Mid-water trawl. Side by side parallel tows, 1 fishing experimental and one fishing the regular commercial trawl.	1 hr tows at 3.2 kts, 4-6 paired tows per day, 40-60 paired tows total.
Design and test of a squid trawl with raised footrope rigging and a grid device to reduce winter flounder, scup and butterfish bycatch (SQUIDGRID)	Nantucket Sound (Statistical Block Numbers 99, 100, 101, 102, 115, 116)	June 1-Oct. 30, 2010 10 DAS per vessel	Two 70 ft squid trawlers	Experimental squid trawl	Bottom trawl. Paired tows with experimental and standard squid gear.	1 hr tows, 6 tows per day, 60 paired tows total.
Development and introduction of a low impact semi-pelagic (LISP) trawl.	Various areas, anticipated to occur in GOM, GB, and SNE	Two trips of 5-10 days each, trips may occur anytime during 2013.	F/V *Teresa Marie III*, F/V *Teresa Marie IV*, F/V *Harmony*, F/V *Nobska*, F/V *Morue*	2-seam otter trawl with 6 in mesh size, semi-pelagic doors.	Mid-water trawl. Netmind system to measure door spread and monitor door height off bottom, Gopro U/W camera to visually monitor doors and net.	2-4 hr tows, anticipated to complete 25 hauls per trip, 50 hauls total.
Eliminating flounder in the cod fishery with the use of a rigid escape vent behind the first bottom belly of the trawl.	Likely in SNE, Rhode Island Bight and GB	2013, 4 one-day trips	F/V *Lightening Bay*	Otter trawl	Bottom trawl. 360 ft x 60 ft 2-seam otter trawl with flounder escape vent and camera to observe fish response to gear.	1.5 hr tows, estimated 5 tows per day, 20 tows total.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Evaluation of a (modified) turtle excluder device (TED) design in the Southern New England and Mid-Atlantic summer flounder trawl fisheries	Coastal waters of SNE and MAB	June- Sept. 2008	Commercial trawl	Trawl	Bottom trawl. Experimental trawl with TED.	1.5 hr tows at 3 kts, 40 tows in SNE, 40 tows in MAB
Exploring bycatch reduction of summer, winter, yellowtail, and windowpane flounders using 12 in drop chain trawl net design in the small mesh fishery	Block Island Sound and Rhode Island Sound	May-Nov. 2010 12 DAS total	Two commercial trawlers	Bottom trawl	Side-by-side tow method comparing the control net with the experimental net, nets changed between vessels every 3 trips.	40 min tows, 4 to 5 tows per day, 48-60 paired tows total
Fishing efficiency and bottom contact effects of trawling with low-contact ground cables	GOM, Statistical Area 513	May–June 2013	F/V *Ellen Diane*, F/V *Sandi Lynn*	Demersal otter trawl	2-seam 6 in mesh, low contact ground cables. Tow speed approximately 2-3 kts.	Sample size unknown at this time.
Fuel saving in the topless trawl	GOM, Statistical area 514	May–June 2013	F/V *Mystic*	2-seam demersal otter trawl	6 in mesh size, head rope much longer than ground cable, topless configuration.	Sample size unknown at this time.
Groundfish net modified into topless flounder trawl	GOM, Statistical Area 133	May-June 2013	F/V *Stormy Weather*	Otter trawl modified to topless trawl	Standard 2-seam demersal trawl, 6 in trawl body and 6.5 in square mesh codend.	60 tows, 29-99 min at 2-3 kts
Reduce catch of white hake while targeting other groundfish species such as flounders in deep water habitat	GOM	May-June 2013	F/V *Jocka*	Demersal 2-seam otter trawl	6 in mesh, modified to topless trawl and rigged for deep water trials. Towed at 2-3 kts.	Sample size unknown at this time.
Reduction of butterfish and scup bycatch in the inshore *Loligo* squid fishery	Rhode Island Sound and Block Island Sound, Stat area 539	May-June and Sept.-Oct. 2009 10 DAS for each vessel	Two commercial bottom trawl vessels	Bottom trawl	Comparison of experimental and standard shrimp trawl gears	45-60 min tows at 3 kts, 120 tows total

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Rigid mesh belly escapement panel for SNE winter flounder in the small mesh *Loligo* trawl fishery	Off Long Island, New York	June–Oct. 2010, 16 trips	F/V *Rianda S*	Avoidance Gear Adaptations (AGA) otter trawl	Bottom trawl. Comparison of experimental and standard trawl gears	45 tows each for the control and experimental nets, 90 tows total.
Squid mesh study and field staff	Between Montauk, NY and Ocean City, MD at depths ranging between 60 m and 134 m	Sept.–Oct. 2008	F/V *Karen Elizabeth*	Twin otter trawl methods (demersal)	Comparison of experimental and standard trawl gears. High-opening *Loligo* nets, two-seam, two- bridle “rope trawls” with detachable codends (3.4 m diameter).	70 paired tows, 1 hr tows at 3 kts
Testing of new Reidar's haddock trawl on Georges Bank	GB	Likely June-Aug. 2013	F/V *Sao Paulo*	Demersal otter trawl	6 to 8 in mesh sizes	40 estimated tows, towed at 2-3 kts for 120 min
Testing of 6 in mesh-sized square and top belly on large mesh haddock trawl	GB, Statistical area 522	Year round but will be completed in June 2013, one 7-day trip	F/V *Sao Paulo*	Demersal otter trawl targeting haddock	6 in mesh size with large mesh panel in the top of the belly	As many tows as possible, 1 hr tows
Topless trawl in Southern New England and Mid-Atlantic summer flounder trawl fishery to reduce sea turtle interactions.	Panama City, FL, SNE, and MAB	June 15-Aug. 15, 2010 14 DAS, 7 on each vessel	Two commercial vessels	Topless trawl	Bottom trawl. Comparison of experimental topless trawl and standard trawl gear	90 min tows, 3 paired tows per day, 40 paired tows total.
Projects using dredge gear						
Testing of a sea scallop dredge designs: mesh size twine top for finfish bycatch reduction	GB Closed Areas I & II, SNE Nantucket Light Ship and Rhode Island Bight, Elephant Trunk Access Area, MAB DelMarVa Access Area	This has been an on-going research initiative since 2002. Most recent work done in 2009–2010. Most work was conducted Aug. 2009–Jan. 2010	F/V *Westport*, F/V *Kathy Ann*, F/V *Tradition*, F/V *Celtic*, F/V *Diligence*	Scallop dredge (modified turtle dredge, twin top, bag design) using various mesh sizes and graduation of mesh configurations and chain mat designs.	Standard New Bedford and modified turtle deflector scallop dredges (4-5 meters wide), using twine top mesh sizes ranging from 6–12 in and hung at ratios from 2:1 and with various numbers of meshes across the apron.	52-239 tows at 4- 4.5 kts per experiment. Total number of tows for project was 1675.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using hook and line gear						
Evaluating the practicality and economic viability of a pilot redfish jig fishery	Offshore banks in the GOM - Platts Bank and Jeffreys Bank	June-Aug. 2010 10 day-trips, 10 DAS total	Hook-and-Line vessel	Jig	3 jig lines from the vessel, 10 hr fishing time	30 line hr per trip, 300 line hr total
Projects using gillnets						
Application of up to three styles of gillnets to assess species selectivity and avoidance of low allocation species	GOM, Statistical area 513	June-July 2013, 4 trips	F/V *Karen Lynn*, F/V *Miss Maura*, F/V *Capt. Al*, F/V *Sweet Misery*	Sink gillnet	Three styles of nets: 2 ft raised footrope, 7 in mesh and 6.5 in mesh with larger twine. 100 ft long gillnet panels.	At least 12 sets each of three different gillnets
Bycatch Reduction Engineering Program (BREP) monkfish gillnet - sturgeon	New Jersey water in Statistical areas 612, 614 and 615	Nov.–Dec. 2010 and 2011	F/V *Dana Christine*, F/V *Traveller II*	Sink gillnet	Control nets: 12 meshes by 12 in mesh size with 48 in tie downs spaced 24 ft apart. Experimental nets: 6 meshes by 12 in mesh size with 48 in. tie downs spaced 12 ft apart. Gillnets configured in 10-panel strings totaling 3,000 ft long. Soak time: 96 hr or less.	120 total hauls with 60 replicates each year.
Projects using other gear						
Are Norwegian cod pots an effective and economically viable gear type for catching cod in New England?	GOM near Cape Cod, MA in statistical areas 537, 526, and 525	May-June 2013.	F/V *Illusion*, F/V *Rose Marie*, F/V *Heritage*, F/V *Evan Christine*, F/V *James and Matthew*	Norwegian cod pots in conjunction with standard commercial otter trawls.	Gear specifics not available at this time.	Sample size unknown at this time.
Reducing juvenile alewife, blueback, and American shad bycatch in the coastal poundnet and floating fish trap fisheries	GOM inshore waters - Bailey's Island	2009	Commercial vessels	Floating fish traps and pound nets	Large fish pound nets that are stationary. Catch is gathered up using large dip nets after pursing the pound net to concentrate the fish.	Sample size unknown at this time.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Sea turtle-scallop fishery interaction study	MAB and coastal waters off NJ and MD out to edge of shelf	Oct. 2011-Aug. 2012. Two research trips completed in 2011 (tagging) and follow-up cruise to conduct transects for turtle observing.	Commercial scallop dredgers, F/V *Kathy Ann*, F/V *Ms. Manya*, F/V *Celtic*	ROV equipped with underwater video, radio tagging of turtles	Ultra-Miniature Digital Scanning Sonar (model 852-000-100) designed by Imagenex Technology Corporation mounted on ROV and operated at a frequency of 675/850 kHz to scan a full 360° with a range of 150 mm up to 50 m. 10 Satellite Relay Data Loggers (SRDL) with Argos Fastloc GPS tags.	Transects run at 4 kts until turtles spotted. Then turtle following mode implemented with ROV.
TAGGING PROJECTS						
Projects using trawl gear						
Movement and migration patterns of winter flounder (*Pseudopleuronectes americanus*) tagged along the Maine coast	Throughout inshore waters from NH to Eastport, ME	Mid-Mar. and July 2011 32 DAS	Two commercial trawl vessels	Maine shrimp net	Mid-water trawl. 15- 20 min tows at 2.5 kts	Up to 10 tows made daily by each vessel, 650 total tows
Northeast cooperative research dogfish tagging program	GOM, GB, SNE	Feb. 2011 to Dec. 2012	F/V *Lisa Ann II*, F/V *Sao Paulo*, F/V *Heather Lynn*	Commercial otter trawl	Bottom trawl. 20 to 30 min tows	34,604 individual fish were tagged
Projects using hook and line gear						
Is Cape Cod a natural delineation for migratory patterns in U.S. and Canadian spiny dogfish stocks?	North and south of Cape Cod	3 periods in 2011, spring (early June), summer (Aug.), and Fall (Oct.).	Commercial longline and gillnet vessels	Longline and gillnet	Longline gear deployed for 30 min; Gillnets: 10 min sets	Longline: 5 sets per trip, 15 sets total Gillnets: 5 sets per trip, 15 sets total
Tagging - Halibut	Coastal waters of Maine (2-24 nm offshore)	May–July 2007 and 2008	Commercial vessels	Longline gear	1800 ft of ground line with 3 ft gangions, 300 hooks per set. Circles hooks of numbers and (sizes): 33 (12/0), 33 (14/0) and 34 (16/0) were randomly assigned on a center point.	51 stations. Soak time was between 5 and 24 hr.

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using gillnets						
Tagging to assess monkfish (*Lophius americanus*) movements and stock structure in the Northeastern U.S. and age validation of monkfish in the Gulf of Maine	GOM, SNE and MAB (two sample sites each in Southern and Northern Management Areas)	Sept. 2007 to Jan. 2008, 18 separate DAS	F/V *C.W. Griswold*, F/V *Gertrude H.*	Commercial gillnets	8 to 12 in mesh gillnets, soak times ranged from 2-5 days	Sample size unknown at this time.
LIFE HISTORY PROJECTS						
Projects using trawl gear						
Defining Atlantic wolffish aggregations in Massachusetts Bay	Massachusetts Bay, Stellwagen Bank National Marine Sanctuary Stat area 514	May 22-June 30, 2011 10 DAS	Trawl vessels	Bottom trawl.	<30 min tows at 2.8 kts	5 tows per day, 50 tows total
Synoptic acoustic and trawl surveys to characterize biomass and distribution of the spring spawning aggregations of Atlantic cod in Ipswich Bay	Ipswich Bay, Statistical area 133	Single nights: late March, mid-May, mid-June, and mid-July of 2011; 8 DAS total	Two bottom trawlers	Bottom trawl and echosounder	10 min tows at 2 kts	10 pre-planned, and 5 adaptive tows per vessel per day, 4 days towing each, 120 tows total
Temporal aspects of habitat utilization and interspecies competition: defining the ecological impacts of spiny dogfish in structuring ecosystem dynamics of Southern New England	Off the coast of Rhode Island (Block Island)	May-Aug. 2009, 1 day per month	Commercial trawlers F/V *Proud Mary*, F/V *Elizabeth Helen*	Bottom trawl, midwater trawl	30 min tows for vessel at 2.5 –3 kts. Codend 15.2 cm mesh – 5.1 cm liner, sweep 23.7 m, spread 10.7 m.	5 tows each per day, 50 tows total

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using pot gear						
Examining settlement dynamics of postlarval American lobster, (*Homarus americanus*), in Lobster Management Area 2	Buzzards Bay, Rhode Island Sound, and Narragansett Bay (Statistical areas 538, 537, and 539)	May-Oct. 2009	Lobster vessels	Settlement collectors, satellite drifters	Settlement collectors will be deployed for about 90 days.	Varies
Expansion of the coastwide ventless lobster trap survey in Southern New England	Buzzards Bay, Rhode Island Bight, Block Island Sound, Long Island Sound.	June-Sept. 2010	F/V *Sherri & Deke*, F/V *Aaron Cebula*, F/V *Andrea C*, F/V *Jarrett Drake*, F/V *Cynthia Lee*	Standardized lobster pots	Alternating vented /ventless lobster pots, 21 in x 40 in x 14 in. 3-5 days soak time.	2 hauls per month, 8 hauls total
Exploratory fixed gear survey in the inshore Gulf of Maine, utilizing trap gear and targeting Atlantic wolffish	GOM, focusing on Boothbay Harbor, ME	Mid-Apr. to mid-June 2010, 2011, and 2012 6 DAS	Commercial lobster boat	Lobster pots with modified trap gear	Soak time depends on results	10 pots per sample, sample once per week
The Buzzards Bay lobster resource: are changes in reproduction having a negative impact on the fishery?	Buzzards Bay, MA, Lobster Management Area 2, Statistical area 538.	30 days in June-July, and one week in Nov. 2009 and 2010 6 DAS total	Lobster vessels	Lobster pots	24 to 48 hr soaks, pots set in June, retrieved in July, re-set in Nov., retrieved the end of Nov.	Total of 120 traps, 20 trawls (strings) grouped in 4 locations, 5 trawls per location, total of 40 vertical buoy lines
The use of settlement collectors to investigate the early life history of Atlantic wolffish (*Anarhichas lupus*) and Cusk (*Brosme brosme*) in the Gulf of Maine	Closed Area on Jeffery's Ledge	Nov. 2012-Aug. 2013, 8 trips total	F/V *Lady Victoria*	Lobster pots filled with cobble.	60 cm x 91 cm x 15 cm pots	32 pots total, 3-4 per month

Survey Name/Description	General Area of Operation	Season, Frequency, Annual DAS	Vessel Used	Gear Used	Gear Details	Number of Samples
Projects using other gear						
A fisherman-scientist collaboration to re-assess lobster nurseries in Narragansett Bay after two decades of environmental change	Narragansett Bay, Rhode Island	July 1, 2011–June 30, 2013	Commercial vessel. Also, cobble-filled collectors deployed by lobstermen.	Scuba divers and cobble collectors	Scuba divers using visual and suction sampling of 1 m^2 sampling units at 5 m and 10 m deep. Lobstermen place cobble collectors (2 ft x 4 ft mesh baskets filled with cobble)	20 quadrats per site, 4-5 sites per day. Visual counts and suction sampling at all sites.
An assessment of quahog larval supply and distribution in the Upper Narragansett Bay with a focus on spawning sanctuaries and alternative area management strategies	Narragansett Bay, Rhode Island	Sept.-June 2011-2013 (on-going - no final report	Not available	Not available	Not available	Sample size unknown at this time.
Studying the population of the channeled whelk (*Busycotypus canaliculatus*) fishery	Nantucket Sound, Vineyard Sound	June 2011-Oct. 2012 – varies but mostly during summer	Commercial vessels	Standard commercial whelk traps	Traps and bait used are variable. Typically about 22 in x 22 in x 10 in with 12 in x 12 in openings, weighted down with concrete blocks and deployed in strings of up to 10 pots.	Sample at least 200 individual animals
HABITAT PROJECTS						
Projects using other gear						
High resolution video survey of the sea scallop resource, recruitment patterns and habitat of Closed Areas relative to scallop and groundfish management	GB- Closed Area	2013	Commercial scallop vessel	Drop camera, towed vehicle coupled with dredge sampling	Commercial scallop dredge	Sample size unknown at this time.

FINAL
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July 2016

Appendix D

Northeast Fisheries Science Center Protected Species Biological Sampling Guide

Prepared for the National Marine Fisheries Service by:
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Northeast Fisheries Science Center Protected Species Biological Sampling Guide [1]

[1] Excerpted from Northeast Fisheries Science Center Observer Program Biological Sampling and Catch Estimation Manual 2013; 16 December 2013

STURGEON SAMPLING

Genetic Sample Collection Instructions

For all sturgeons

1. Photograph, including something for scale
2. Biosample[1]:

   Cut the tip of the dorsal fin off to about the size of a dime
   Place sample in vial (one vial per fish)
   Put parafilm around each cap to prevent leaking
   Label each vial with the following:

   Cruise number,
   Station number, and
   Sturgeon salvage form number

   Wipe knife clean between samples to avoid cross contamination, using a clean cloth or paper towel
   Store samples at room temperature and send in with your trip
3. Scan for PIT Tags on entire sturgeon (if issued a PIT tag scanner) If present, record the PIT tag number in the tag number field on the Sturgeon Salvage Form
4. See *Sturgeon Identification* cheatsheet for more details on identification and photograph requirements.

Photographs to take

- Whole fish in profile
- Underside of head (mouth)
- Top of head
- Post-dorsal fin lateral view
- Post-dorsal fin dorsal view
- Post-anal scutes ventral view
- Any wounds, marks, scars, or damage

Figure 23: Atlantic Sturgeon on deck.

1 Sampling permits not effective as of date of printing. Please reference the most recent sturgeon sampling memos for up-to-date information.

Recording Sturgeon on the Sturgeon Salvage Form

1. Obtain a measured fork length and actual weight, if possible
2. **Provide detailed ID characteristics in the comments section**, as well as detailed description of animal condition (*e.g.,* injuries, bruises)
3. If a DNA sample was taken, BIOSAMP (Y/N) should be marked as 1 (Yes)
4. Record the presence or absence of tags (including PIT tags),
   If present, record tag number and tagging program name and contact information
   In comments, record whether or not a sturgeon was scanned, regardless of the presence/absence of a PIT tag

ID Characteristics to Note

- Width of inside lips compared to interorbital width
- Presence/absense of bony plates between base of anal fin and lateral row of scutes
- Presence/absense of body plates post-dorsal fin above lateral plates
- Complex/simple pattern of ventral post-anal scutes/ plates

NOTE: In 1994, sturgeon were stocked in the Hudson River, New York. These fish were marked by removing their left pelvic fin. Today these fish would be near 6 feet in length. Should you come across a large sturgeon that is missing its left pelvic, in addition to the above protocols, please photograph the missing fin and comment on the Sturgeon Salvage Form.

STURGEON SAMPLING

MARINE MAMMAL SAMPLING PROTOCOLS

Precautions When Handling Marine Mammals

Marine mammals can carry microbes which may cause illness in humans and other animals.

<u>Safety measures to prevent illness and infections</u>

- Use common sense!
- Wear gloves and other protective gear when handling animals and specimens.
- Wash hands and areas of contact thoroughly after contact.
- Clean/wash gear thoroughly after each use.
- Report any animal bite, scratch, or other significant exposure to marine animal blood, saliva, or excretions.
- Tell your physician that you work with marine animals

Marine Mammal Samples

Minimum sampling requirements should always be collected. **Whole animals** should be collected whenever possible. If whole animal cannot be retained, collect **head/jaw**.

Sample priorities after collection of above tissue when additional sampling is feasible should be:

stomach	fetus
blubber	kidney
muscle	heart
liver	

Live animals:
1. Photograph and video
2. Describe identifying characteristics and condition, including any visible wounds
3. Release and comment on behavior and any gear remaining on animal

DO NOT TAG LIVE ANIMALS

Dead animals:
1. Collect DNA Sample (2"x2") from trailing edge of dorsal fin (cetaceans) or rear flipper webbing (pinnipeds)
   See *Submitting Large Samples* on page 36
*2. Tag, using **yellow** marine mammal carcass tag
   Apply around tail stock (cetaceans) or hind flipper (pinnipeds)
*3. Photograph, including something for scale
*4. Describe identifying characteristics and condition, including any visible wounds
5. Collect Body Measurements (shown on next page):
   7 for cetaceans (bottlenose = 11), 4 for pinnipeds
6. Collect Body Temperature
7. Determine Sex
*8. Release and comment on behavior (e.g., sank immediately) and any gear remaining on animal

Photographs to take
- Entire animal on **all** sides
- Close-up of gear entanglement
- Close-ups of the head and teeth
- Genital area
- Any wounds, marks, scars, or damages
- Close-up of dorsal fin on both sides (cetaceans)
- Any tags, new or existing

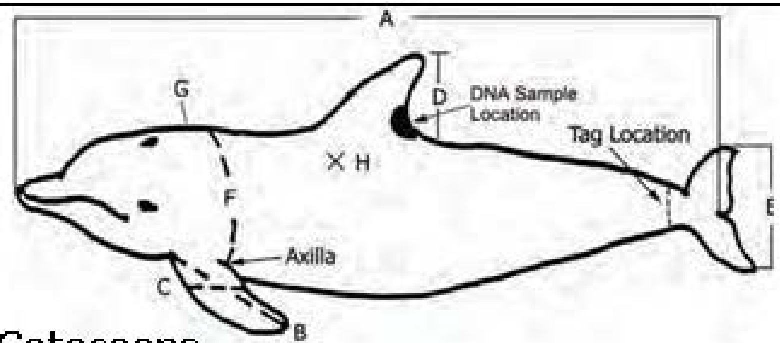
Figure 24: Marine mammal carcass tag

Tagged animals (alive or dead): record tag number and photograph, if possible

MARINE MAMMAL SAMPLING PROTOCOLS

MARINE MAMMAL SAMPLING PROTOCOLS

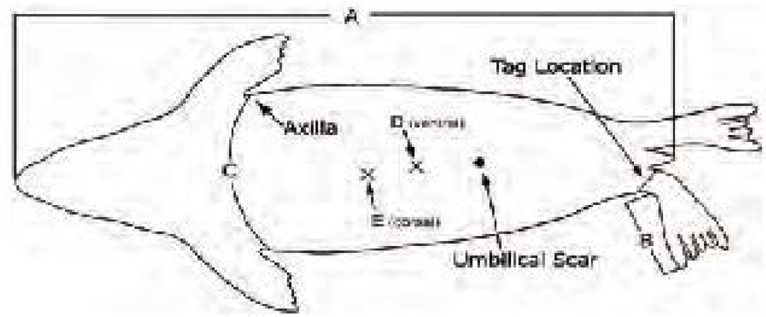
Marine Mammal Body Measurements



Cetaceans

A. Total Length - snout tip to fluke notch
B. Flipper Length
C. Flipper Width, maximum
D. Height of Dorsal Fin
E. Fluke Width, from tips of flukes
F. Girth at Axilla (circumference)
G. Blubber Thickness
H. Body Temperature

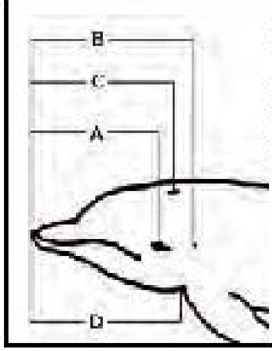
Figure 25: Cetacean body measurements.



Pinnipeds

A. Total Length - snout to tip of tail
B. Rear Flipper Length
C. Girth at Axilla (circumference)
D. Blubber Thickness (ventral)
E. Body Temperature (dorsal)

Figure 26: Pinniped body measurements.



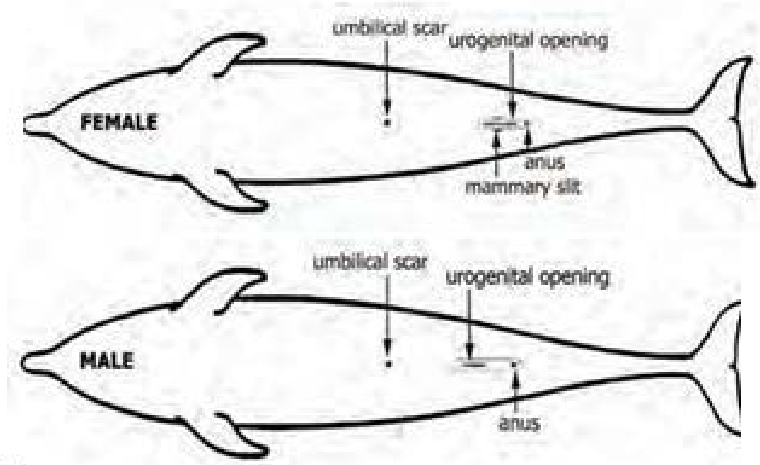
Bottlenose Dolphins

A. Snout to Center of Eye
B. Snout to Ear
C. Snout to Center of Blowhole
D. Snout to Flipper Anterior Insertion

Figure 27: Additional measurements for Bottlenose dolphins only.

All measurements must be taken in a straight line (*i.e.,* not curved with the body) except girth
<u>Blubber thickness</u>: include skin layer
<u>Body temperature</u>: insert probe about 1" deep

Marine Mammal Sex Determination

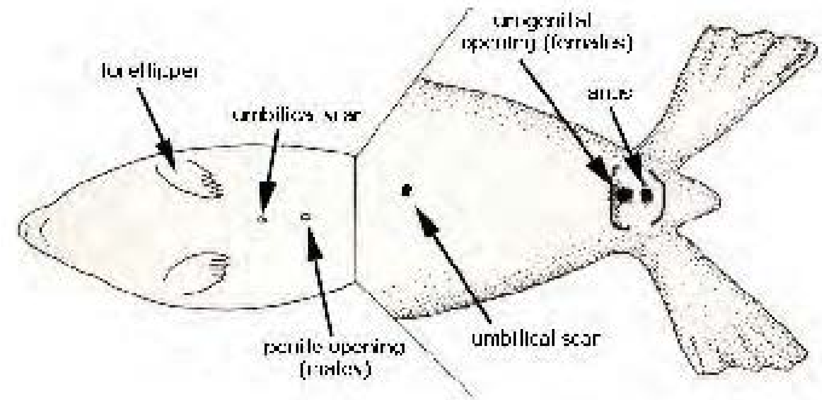


Cetaceans

Probe the urogenital opening

- Female: forward, towards the head
- Male: backward, towards the fluke

Figure 28: External sex characteristics of cetaceans.



Pinnipeds

Stretch the rear flippers very wide apart at base of tail
Look inside the outer (urogential) opening

- Female: 2 distinct inner openings (anal and vaginal)
- Male: 1 inner opening (anal)

Figure 29: External sex characteristics of pinnipeds.

MARINE MAMMAL SAMPLING PROTOCOLS

SEA BIRD SAMPLING PROTOCOLS

Live animals:
1. Photograph and video
2. Describe identifying characteristics and condition, including any visible wounds
3. Check for the presence of bands
   Record band number and photograph, if possible
4. Release and comment on behavior and any gear remaining on animal
   Release away from gear, with vessel slowed
   Lower bird by hand as close to water as possible, releasing hold of the head last

Dead animals:
1. Photograph, including something for scale
2. Describe identifying characteristics and condition, including any visible wounds
3. Check for the presence of bands
   Record band number and retain, if possible
4. Retain whole seabird, if possible
   Only retain 'dead, fresh' animals; otherwise release

NOTE: If birds cannot be retained whole, collect 20-30 breast feathers ('dead, fresh' animals only). Samples should be bagged and labeled with Tyvek tags (see page 36).

Photographs to take

- Overall dorsal
- Overall ventral
- Close-up of beak/head
- Any bands or tags
- Any wounds, marks, scars, or damage

Figure 30: Placement of a bird band around the leg, and tag on the wing.

SEA TURTLE SAMPLING PROTOCOLS

Sampling Requirements (all turtles)

1. Photograph and video, including something for scale
2. Describe identifying characteristics (see box at right) and condition, including any visible wounds
3. Check for the presence of tags
   Record tag number and photograph, if possible
4. Body Measurements (3, curvilinear)
5. Biopsy/tissue (genetic) sample
   Live Animals: Biopsy (if >25 cm notch-to-tip)
   Dead Animals: Retain whole animal, if possible; otherwise biopsy
6. Tag with Inconel tag(s) on rear flipper(s)
   Live Animals: 2 tags (if >26 cm notch-to-tip)
   Dead Animals: 1 tag
7. Scan for PIT tags on flippers and all soft tissues
   (if issued a PIT tag scanner)
8. If alive or comatose, attempt rescuscitation
   If obviously dead (*e.g.,* damaged shell, severely wounded), release

<u>Photographs and video to take</u>

- Close-ups of head:
  - Pre-frontal scute pattern
  - Top of head
  - Each side (left/right)
- Overall dorsal
- Overall ventral
- Any bands or tags
- Any wounds, marks, scars, or damage

<u>Identification Criteria</u>

- Vertebral scute count
- Lateral scute count
- Inframarginal scute count
- 1 pair of prefrontal scales?
- Overlapping scutes?
- Dorsal Color

SEA TURTLE SAMPLING PROTOCOLS

SEA TURTLE SAMPLING PROTOCOLS

Inconel Tag Location

Tag along trailing edge of rear flipper

Leatherback Turtles: 5cm (~2") from base of tail

All Other Turtles: soft tissue between body and first scale

Approximately 1/3 of the tag should overhang body after it is attached

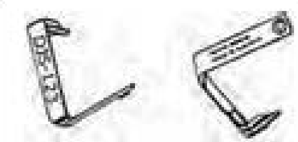


Figure 31: Metal Inconel turtle tags.

Biopsy Location

Just outside (away from the body) of the tag location

One crescent shape biopsy per rear flipper (2 total)

Other Tags

Dead Turtles ONLY

Metal Inconel tags: record tag number and information, leave on animal.

Any other tag (metal, plastic, satellite, etc.): remove from the animal and retain.

Tag number and information should still be recorded for all tags.

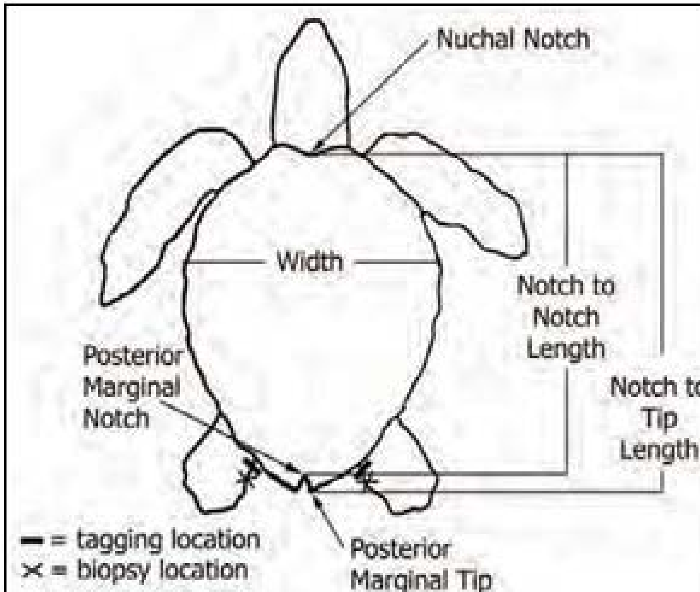


Figure 32: Sea turtle measurements (curvilinear), tagging, and biopsy locations.

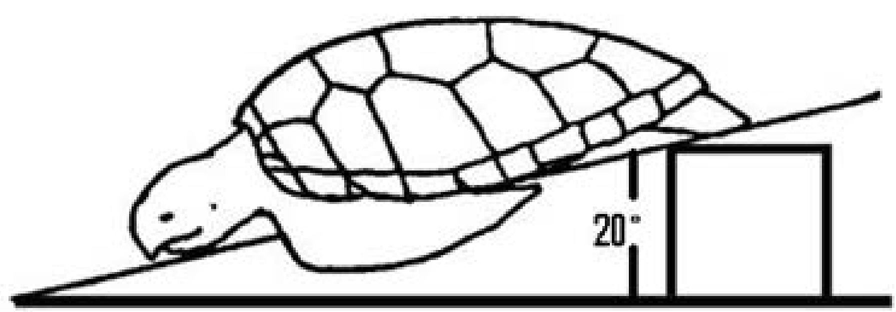
Resuscitation

Resuscitation must be attempted on sea turtles that are comatose or inactive, but not dead. **Do not assume that an inactive turtle is dead**. The onset of rigor mortis is often the only definitive indication that a turtle is dead.

1. Place the turtle right side up (on the bottom shell or plastron)
2. Elevate the hindquarter 20º for a period of 4 up to 24 hours
3. Protect from environmental conditions
4. Periodically rock the turtle from side to side (left to right) by holding the outer edge of the carapace and lifting one side about 3 inches.
5. Reflext Test: Lightly touch the upper eyelid, soft tissues surrounding the nose, or pinch the tail or flippers periodically to see if there is a response

Those that revive and become active must be **released over the stern** of the boat when **fishing gear is not in use**, when the **engine gears are in neutral** position, and in areas where they are unlikely to be recaptured or injured by fishing gear or vessels. Sea turtles that fail to respond to the reflex test or fail to move within several hours (up to 24, if possible) should be returned to the water in the same manner.

Figure 33: Position for resuscitation of sea turtles.



SEA TURTLE SAMPLING PROTOCOLS

FINAL
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July 2016

Appendix E

Addendum to the NEFSC LOA Application

Prepared for the National Marine Fisheries Service by:

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Addendum
to December 2014 Application

The NEFSC submitted its LOA application to NMFS Office of Protected Resources (OPR) in December 2014 based on the information presented in the Draft PEA, including the analysis of effects on marine mammals presented in Section 4.2.4 and 4.3.4. However, during the rulemaking process, the NEFSC had an additional incidental take of a gray seal during the Standard Bottom Trawl Survey (April 2, 2015). This information, along with some additional information and technical corrections that affected the NEFSC take request, were submitted to OPR as an addendum to the LOA application. This supplemental information was incorporated into the proposed rule by OPR on July 9, 2015 (80 FR 39542), with addendums to the proposed rule published on 6 August, 2015 (80 FR 46939) and 17 August, 2015 (80 FR 49196). The reduced take request for bottlenose dolphin stocks was an administrative decision to analyze these stocks in the SEFSC EA and LOA application, which is currently being developed.

Table 3-4 - Estimated density (animals/km^2) of marine mammals within the Northeast LME and offshore NEFSC fisheries research areas

Common Name	Scientific Name	Survey year	Density estimate LME < 200 m	Density estimate Offshore > 200 m
CETACEANS				
Northern right whale	*Eubalaena glacialis*	2012	0.0018	0
Humpback whale	*Megaptera novaeangliae*	2004, 2006	0.0009	0.0006
Fin whale	*Balaenoptera physalus*	2004	0.0036	0.0007
Sei whale	*Balaenoptera borealis*	2004	0.0027	0.00004
Minke whale	*Balaenoptera acutorostrata acutorostrata*	2006	0.0066	0
Blue whale	*Balaenoptera musculus*	2009	0	0.0026
Sperm whale	*Physeter macrocephalus*	2004	0.00001	0.0152
Dwarf sperm whale	*Kogia sima*	2004	0.00002	0.0020
Pygmy sperm whale	*Kogia breviceps*			
Killer Whale	*Orcinus orca*	unknown		
Pygmy killer whale	*Feresa attenuata*	unknown		
Northern bottlenose whale	*Hyperoodon ampullatus*	2004	0	0.0017
Cuvier's beaked whale	*Ziphius cavirostris*	2004	0.0021	0.0156
Mesoplodon beaked whales	*Mesoplodon spp.*			
Melon-headed whale	*Peponocephala electra*	unknown		
Risso's dolphin	*Grampus griseus*	2004	0.0022	0.0844
Long-finned pilot whale	*Globicephala melas melas*	2004	0.0345	0.0256
Short-finned pilot whale	*Globicephala macrorhynchus*			
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	2006	0.0244	0
White-beaked dolphin	*Lagenorhynchus albirostris*	2006	0.0081	0
Short-beaked common dolphin	*Delphinus delphis delphinis*	2004	0.2115	0.1875
Atlantic spotted dolphin	*Stenella frontalis*	2004	0	0.0208
Pantropical spotted dolphin	*Stenella attenuata*	2011	0	0
Striped dolphin	*Stenella coeruleoalba*	2004	0	0.3028
Fraser's dolphin	*Lagenodelphis hosei*	unknown		
Rough toothed dolphin	*Steno bredanensis*	1998	0	0.0016
Clymene dolphin	*Stenella clymene*	unknown		
Spinner dolphin	*Stenella longirostris*	unknown		
Common bottlenose dolphin (offshore)	*Tursiops truncatus truncatus*	2004	0.0060	0.0526
Common bottlenose dolphin (coastal)	*Tursiops truncatus truncatus*	2002	0.1033	0
Harbor Porpoise	*Phocoena phocoena*	2006	0.0193	0

PINNIPEDS				
Harbor Seal	*Phoca vitulina concolor*	2012	0.3074[1]	0
Gray Seal	*Halichoerus grypus*	unknown		
Harp Seal	*Pagophilus groenlandica*	unknown		
Hooded Seal	*Cystophora cristata*	unknown		

[1] Revision to harbor seal density estimate (0.8244) in the 2014 application.

Table 6-1 - Historical interactions with marine mammals during NEFSC surveys from 2004 to 2015 as recorded in NOAA's Protected Species Incidental Take database.

Revision to table 6-1 to account for a gray seal take that occurred in April, 2015.

Survey Name	Protected Species Taken	Gear Type	Date (Time) Taken	# Killed	# Released Alive	Total Taken
2015						
NEFSC Standard Bottom Trawl Survey	Gray seal	Bottom trawl	02 April (10:37 am)	1	0	1
2010						
Maine Estuaries Diadromous Survey	Harbor seal	Fyke Net	25 October (3:10 pm)	1	0	1
2009						
Atlantic Herring Survey	Minke whale	Midwater trawl	11 October (11:17 pm)	0	1[1]	1
NEFOP Observer Gillnet Training Trips	Harbor porpoise	Gillnet	4 May (10:24 am)	1	0	1
NEFOP Observer Gillnet Training Trips	Gray seal	Gillnet	4 May (7:39 am)	1	0	1
2008						
COASTSPAN	Common bottlenose dolphin (NSCES stock)	Gillnet	29 September (12:40 pm)	1	0	1
2007						
NEFSC Standard Bottom Trawl Survey	Short-beaked common dolphin (Western NA stock)	Bottom trawl	11 November (12:18 am)	1	0	1
2004						
Atlantic Herring Survey	Short-beaked common dolphin (Western NA stock)	Midwater trawl	8 October (5:22 am)	2	0	2
Total				**7**	**1**	**8**

[1] Classified as a "serious injury/mortality" event. See text in Chapter 5 for details.

Table 6-2 - The potential number of animals of each marine mammal species (all stocks have been combined) that could be taken by mortality and serious injury (M&SI) and non-serious Level A harassment over the five year authorization period.

		Potential Take (2015-2019)			
	Historical Interactions (2008-2015)	**M&SI and Level A**			
		Trawl	**Fyke**	**Gillnet**	**Longline**
CETACEANS					
Minke whale	trawl	5	0	0	0
Risso's dolphin		2	0	0	1
Long-finned pilot whale		2	0	0	0
Short-finned pilot whale		2	0	0	0
Atlantic white-sided dolphin		2	0	1	0
White-beaked dolphin		2	0	0	0
Short-beaked common dolphin	trawl	5	0	1	1
Atlantic spotted dolphin		2	0	0	0
Common Bottlenose Dolphin….					
Western North Atlantic offshore stock	gillnet	2	0	5	1
Coastal, Northern Migratory stock		2	0	5	1
Coastal, Southern Migratory stock	gillnet	2	0	5	1
Coastal, South Carolina & Georgia		0	0	0	0
Coastal, Northern Florida		0	0	0	0
Coastal, Central Florida		0	0	0	0
Northern Northern Carolina Estuarine System		0	0	0	0
Southern Northern Carolina Estuarine System		0	0	0	0
Northern South Carolina Estuarine System		0	0	0	0
Charleston Estuarine System	gillnet	0	0	0	0
Northern Georgia/Southern South Carolina Estuarine System		0	0	0	0
Southern Georgia Estuarine System		0	0	0	0
Jacksonville Estuarine System		0	0	0	0
Indian River Lagoon estuarine System		0	0	0	0
Harbor porpoise	gillnet	2	0	5	0
Undetermined delphinid		1	0	1	1
PINNIPEDS					
Harbor seal	fyke net	1	5	5	0
Gray seal	Gillnet, trawl	5	1	5	0
Undetermined pinniped		0	1	1	1
	Total	**37**	**7**	**34**	**9**

Table 7-1- Stocks for which NEFSC is requesting trawl, gillnet/fyke net and longline annual take, and evaluation of impact relative to PBR.

	Average Annual NEFSC Take Request for all Gears[1,2,3] (2015-2019)	PBR[4]	% PBR Requested
Minke whale	1	162	0.6
Risso's dolphin	1	126	0.8
Atlantic white-sided dolphin	1	304	0.3
White-beaked dolphin	1	10	10.0
Short-beaked common dolphin	2	1,125	0.01
Atlantic spotted dolphin	1	316	0.3
Common bottlenose dolphin	2	See Table 7-2	See Table 7-2
Harbor porpoise	2	706	0.3
Harbor seal	3	1,469	0.2
Gray seal	2	undetermined	NA

[1] The summed take requests for the five year authorization period in Table 6-2 were divided by 5 and rounded up to the nearest whole number to obtain the average annual values in this column.

[2] NEFSC requested 3 unidentified delphinid species and 3 unidentified pinniped species in all gear over the five year authorization period; these additional takes (0.6 takes each per year) have NOT been included in this table.

[3] The NEFSC request is for Level A and serious injury/ mortality takes. For purposes of evaluating impact of this request, all takes are assumed to result in serious injury/mortality.

[4] Waring *et al*. (2014).

Table 7-2 - Evaluation of impact relative to PBR for all requested stocks of common bottlenose dolphin under a "worst case" assumption.

Stock of Common Bottlenose Dolphin	PBR[1]	% PBR if Two Takes Per Year Were from a Single Stock
Western North Atlantic Offshore	561	0.4
Coastal, Northern Migratory	86	2.3
Coastal, Southern Migratory	63	3.2

[1] Waring *et al*. (2014).