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Programmatic Environmental Assessment

for

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Appendix A

NEFSC Research 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.

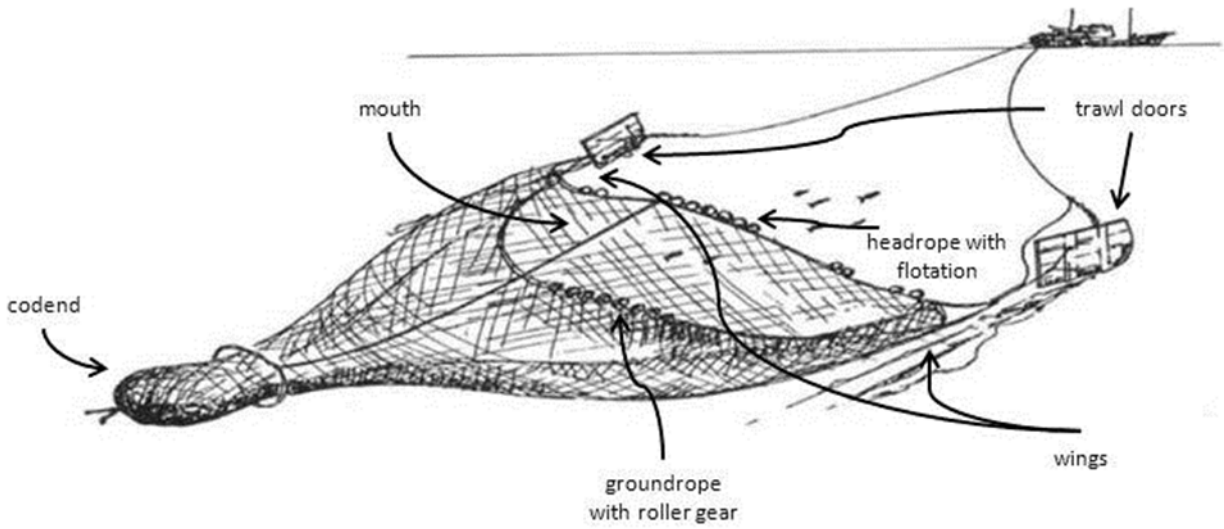

Figure A-1. Bottom trawl illustration

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

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.

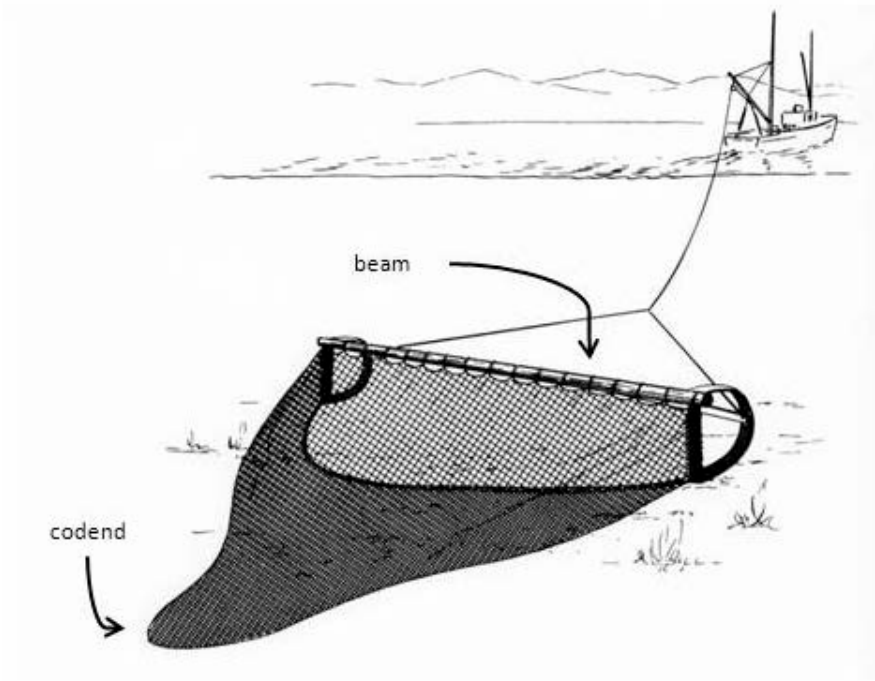

Figure A-4. Beam trawl illustration

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.

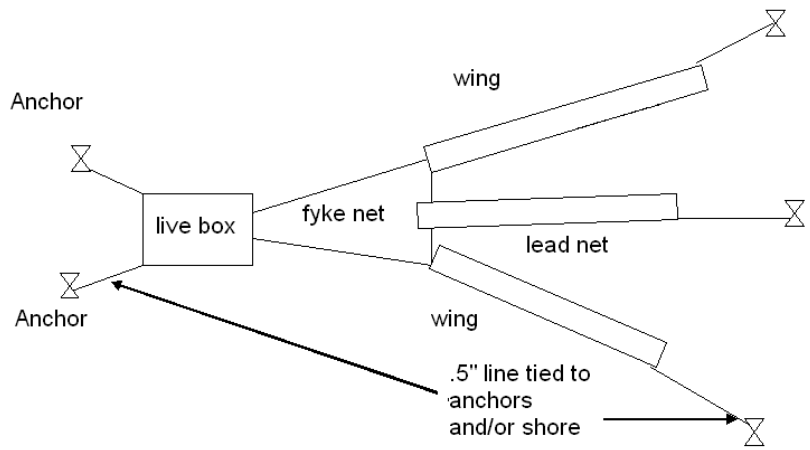

Figure A-5. Sketch of typical fyke net deployment

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

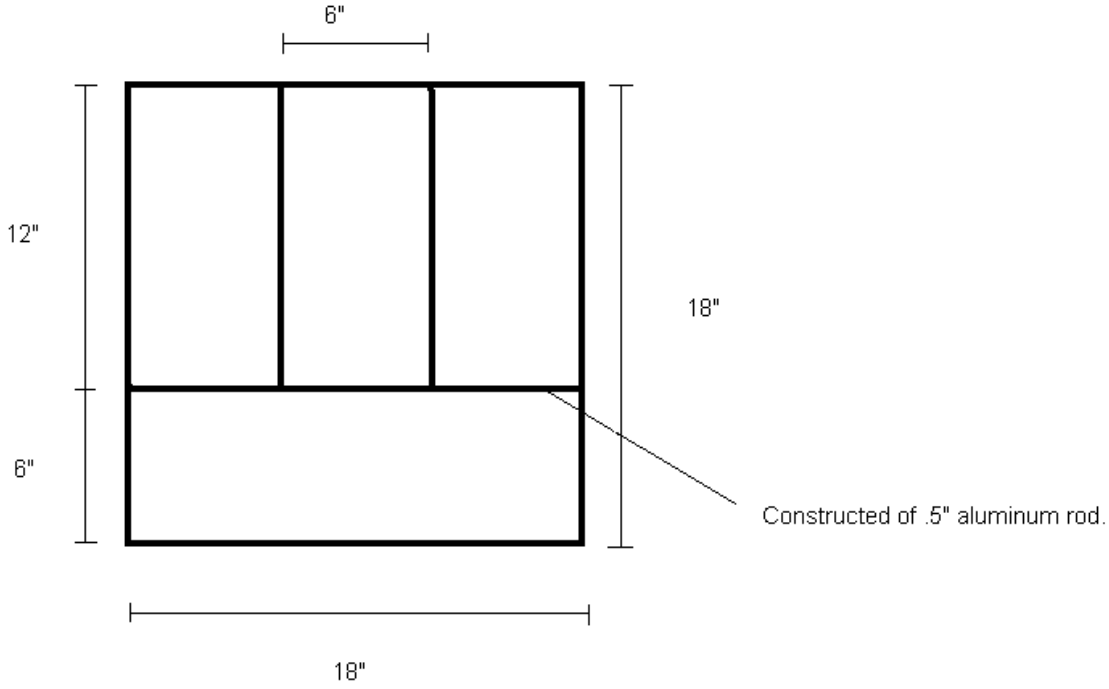

Figure A-6. Sketch of marine mammal excluder device used in the fyke net

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).

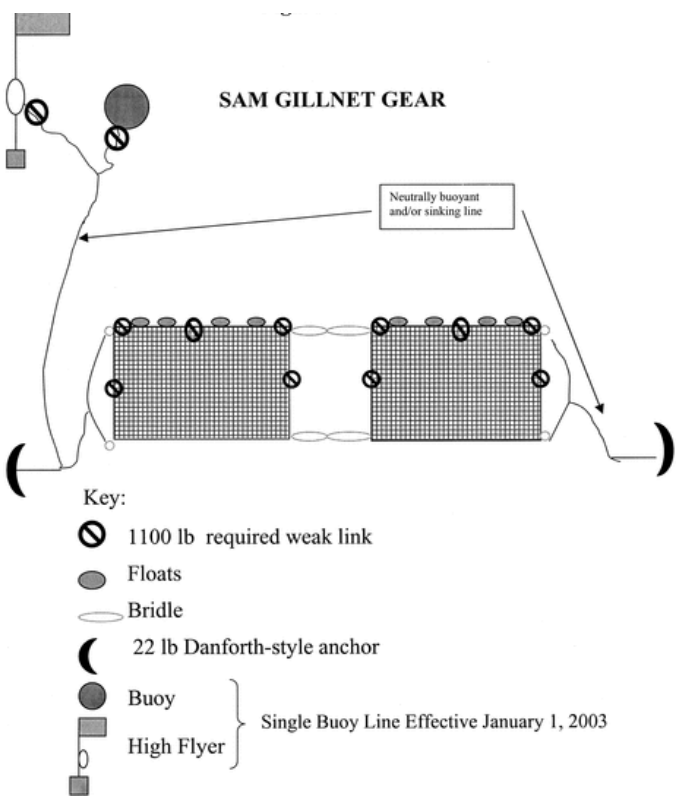

Figure A-7. Anchored sinking gillnet

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).

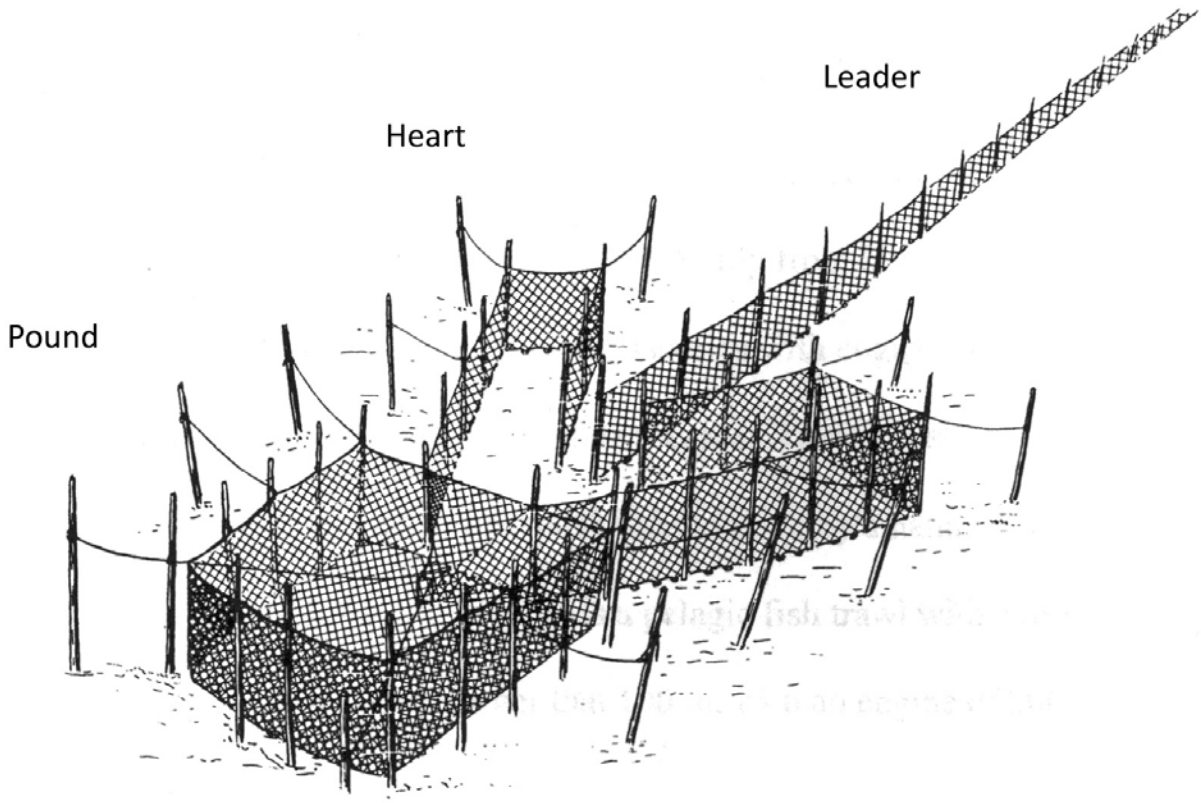

Figure A-8. Pound net diagram

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.

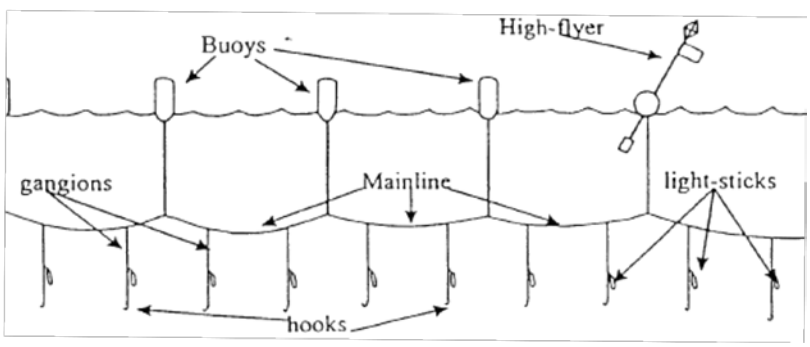

Figure A-9. Pelagic longline gear diagram

'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.

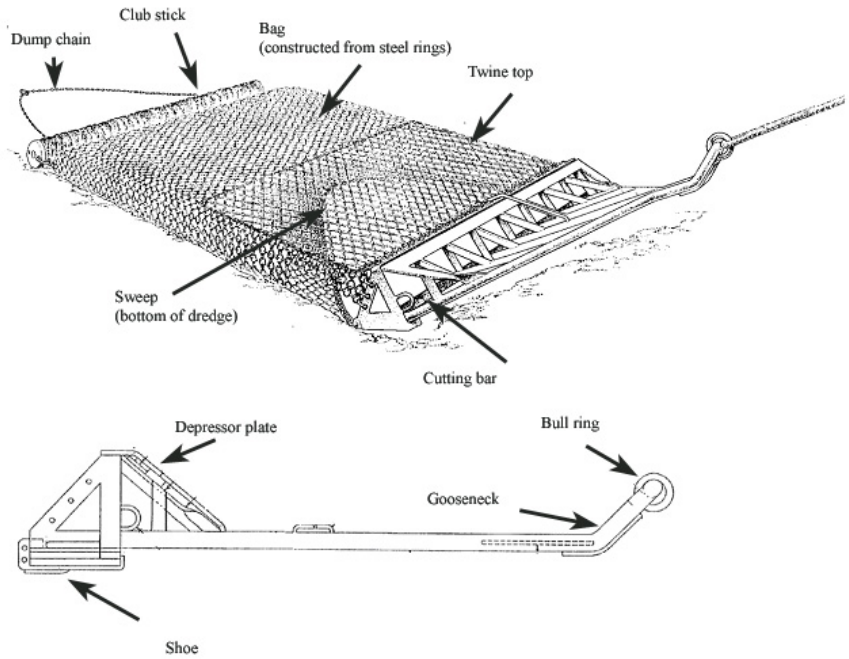

Figure A-10. Standard New Bedford sea scallop dredge

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).

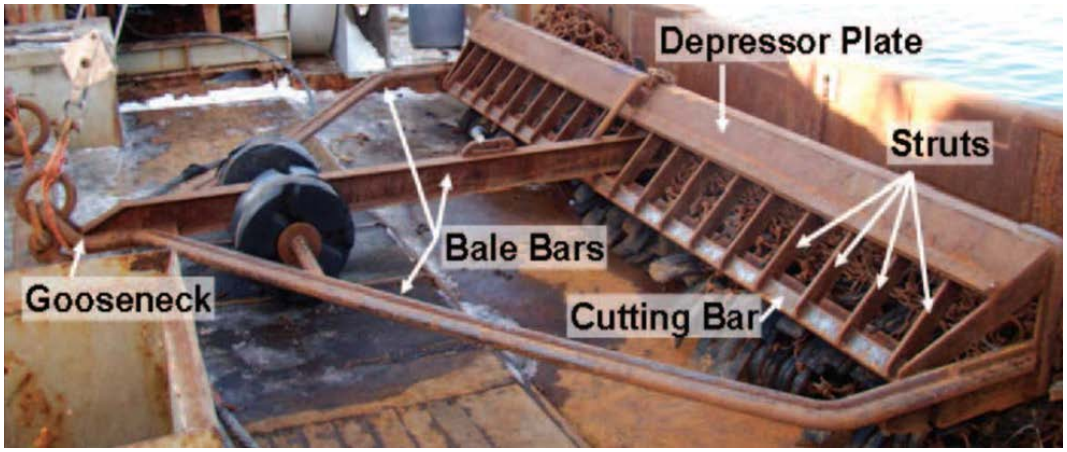

Figure A-12. Coonamessett Farm turtle deflector dredge

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.

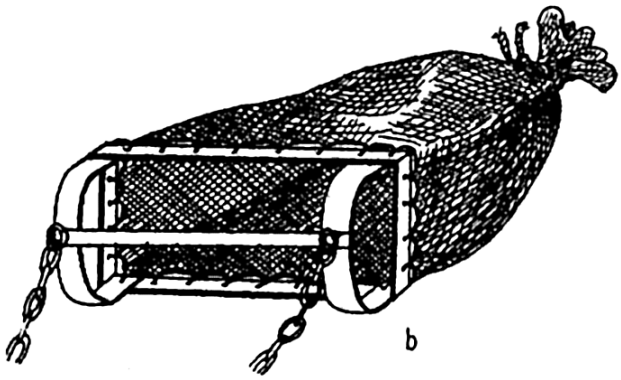

Figure A-13. Naturalist dredge

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.

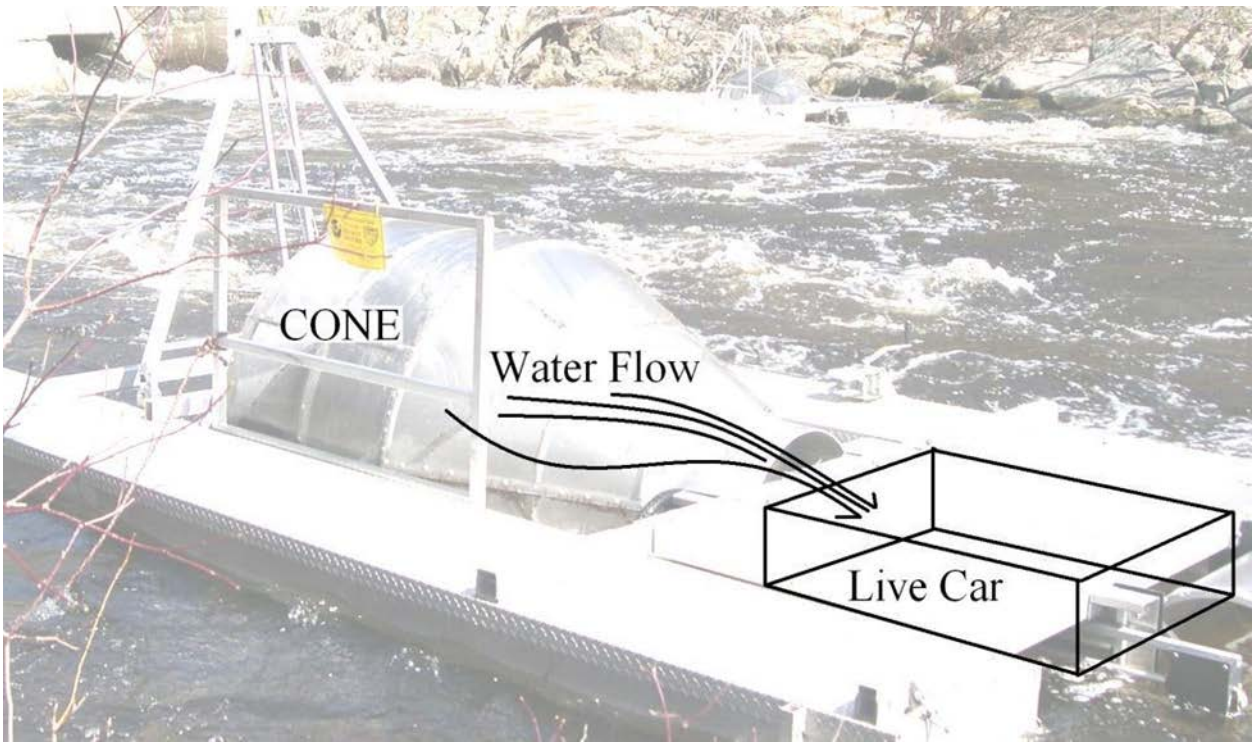

Figure A-16. Rotary screw trap

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).

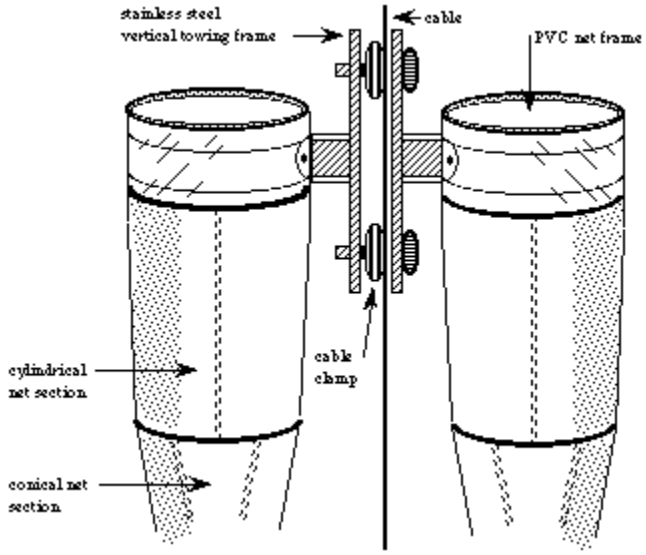

Figure A-17. Bongo net diagram

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.

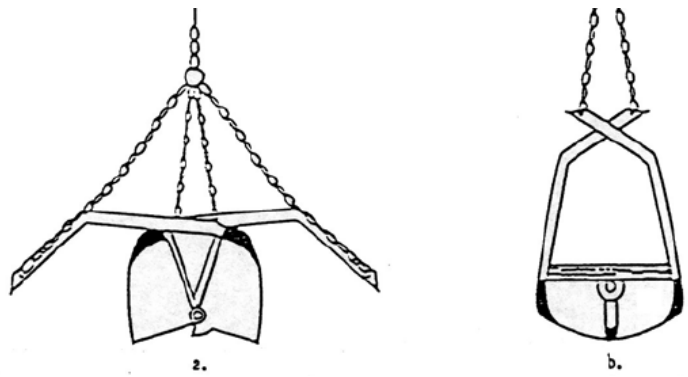

Figure A-18. Van Veen grab sampler: a) cocked position b) closed position

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.

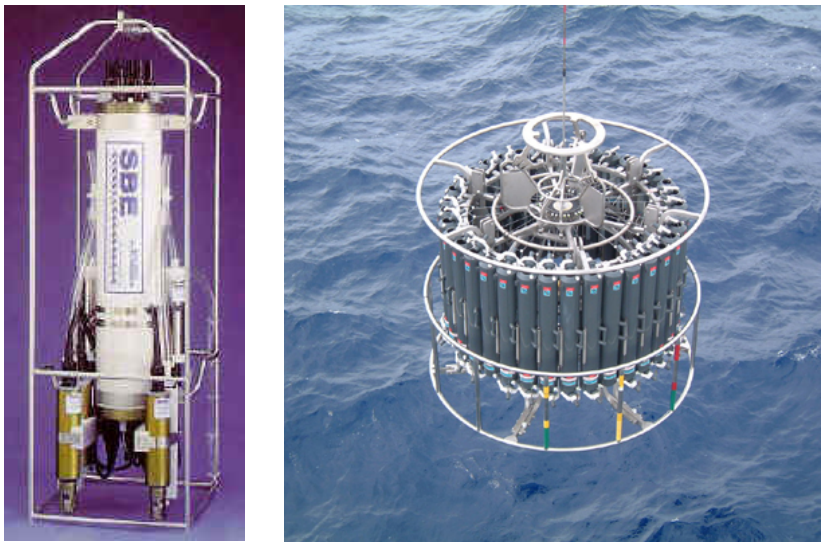

Figure A-19. Sea-Bird 911*plus* CTD profiler and deployment on a sampling rosette

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.

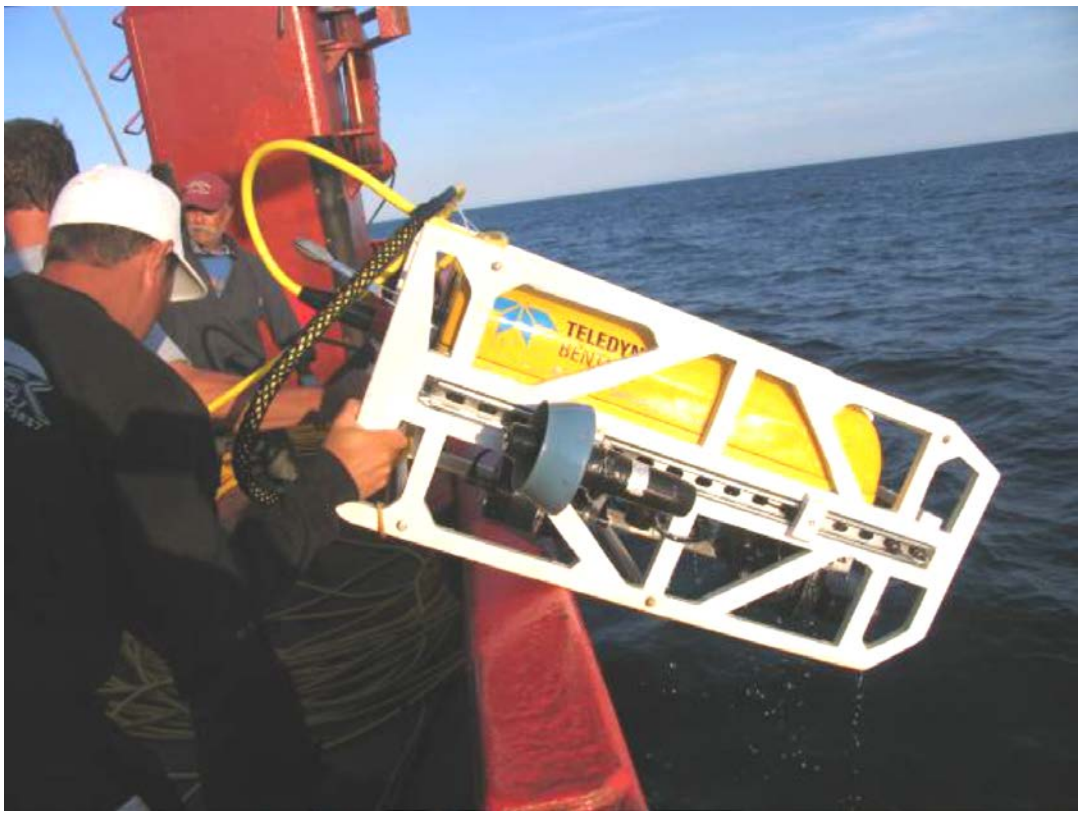

Figure A-20. ROV being deployed from scallop vessel

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).

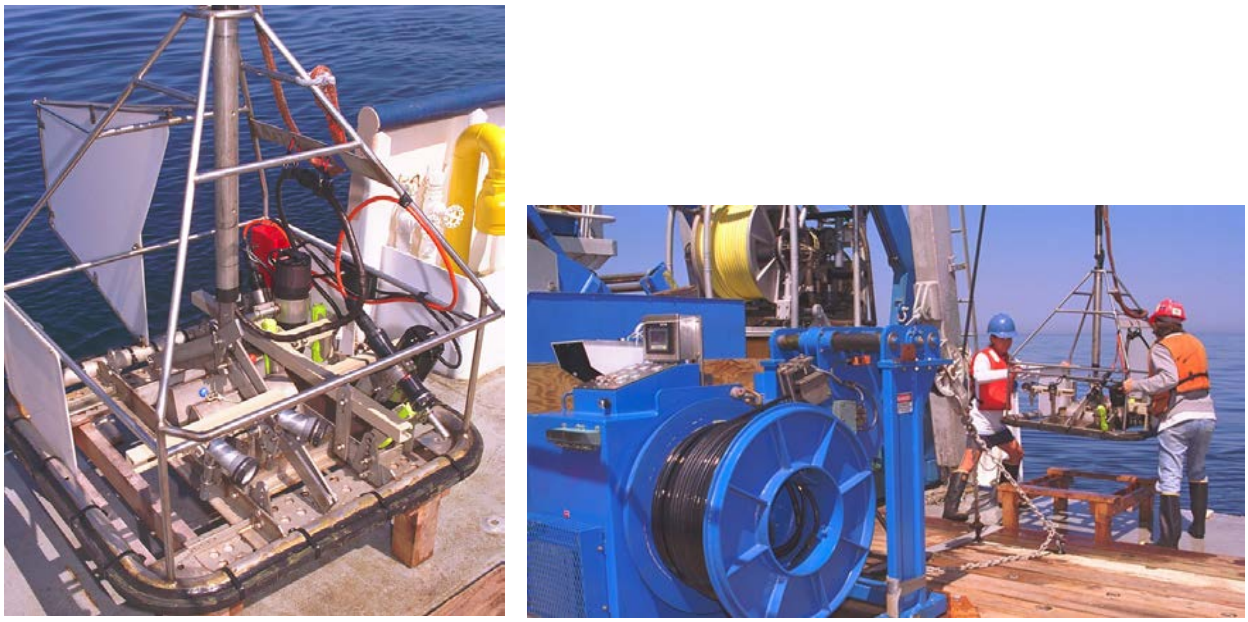

Figure A-21. The SEABOSS benthic observation system

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.

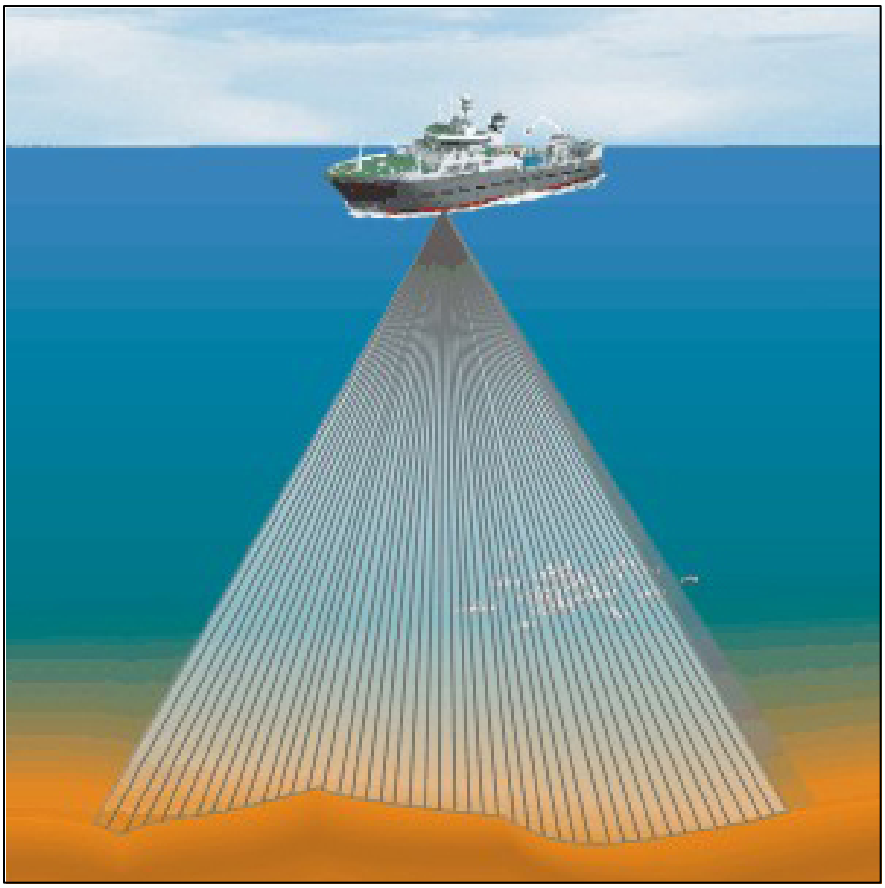

Figure A-22. Multi-beam echosounder

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 *F/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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