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Framework for ESA Section 7 Evaluation of Aquaculture Projects in the Greater Atlantic Region

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Based on information and deliverables provided by Integrated Statistics, Inc., under contract with NOAA Fisheries

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ABSTRACT

The aquaculture industry is one of the fastest growing food-producing sectors worldwide. This upward trend in commercial marine aquaculture is expected to continue to increase locally in the Greater Atlantic Region (GAR) with more aquaculture operations being proposed for development in offshore marine habitat. Rapid growth in this industry has resulted in an increase in requests for interagency Section 7 consultation with NOAA Fisheries required under the Endangered Species Act (ESA). Many variables and novel engineering factors related to aquaculture activities and gear create challenges in accurately assessing the associated risks and effects to ESA-listed species, particularly in offshore areas beyond three nautical miles from shore. This report documents the recent history of ESA Section 7 consultations on aquaculture activities throughout the GAR. The vast majority of the aquaculture projects we have recently consulted on between 2014 and January 2019, 98% (293/300), are close to shore in shallow depths (less than 10m). Most of the projects (183/300) are shell-on-bottom culturing techniques with minimal gear in the water. However, new and diverse aquaculture methods with unique engineering systems that include floating and/or bottom cages and arrays with vertical and horizontal lines in the water column are being proposed, frequently in open ocean areas beyond three nautical miles from shore. This report describes the associated stressors and risks that are typically analyzed during ESA Section 7 consultation with these different facility designs (e.g. entanglement, habitat modification, vessel interaction, escapement) and how these analyses may be similar or not to those for other activities in the GAR. Finally, the report includes an analytical ESA Section 7 consultation framework for use by ESA Section 7 biologists to guide Section 7 consultation. The framework is an attempt to ensure biologists adequately protect listed species by consistently and comprehensively analyzing the risks and stressors of individual aquaculture projects, while at the same time streamlining and reducing the time taken during the consultation process. The proposed framework has numerous limitations and is a guide that is not intended to replace careful consideration of each unique situation. However, with more research, such a standardized approach will help improve the efficiency of the ESA Section 7 process and will benefit permitting and authorizing of future aquaculture operations, while protecting listed species and contributing to the expected successful and sustainable growth of the aquaculture industry in the GAR.

KEYWORDS

Endangered Species Act, Consultation, Aquaculture, Marine Species, Interactions

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Background

This report was completed through funds provided by NOAA Fisheries' Office of Aquaculture to NOAA Fisheries' Greater Atlantic Regional Fisheries Office's (GARFO). These funds were used by the GARFO's Endangered Species Act (ESA) Section 7 Program to investigate ways to increase the efficiency of the ESA section 7 program on aquaculture activities. One of the main functions of the Section 7 Program is to consult with federal agencies to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat (section 7 consultation is discussed in further detail in Section 1.2). The funds were used to identify challenges that section 7 biologists face when consulting on nearshore and emerging offshore aquaculture and to develop a standardized approach to section 7 analyses to enhance consistency and increase efficiency during consultation. Given the recent arrival of offshore aquaculture in the United States, the lens through which this report evaluates the potential risk and effects from that gear on species listed as threatened or endangered under the ESA (ESA-listed species) is largely informed by a) past aquaculture consultations completed by GARFO section 7 biologists in the nearshore environment; and b) experience evaluating interactions between ESA-listed species and commercial fishing gear.

Offshore aquaculture, as well as some inshore aquaculture proposals, may use novel gear configurations that, among other factors, pose challenges to completing timely and robust risk assessment analyses needed for ESA section 7 consultations. Generally, the ESA section 7 risk assessment for listed species begins with an understanding of the likelihood of an encounter, followed by an analysis of the significance of the encounter should it occur. Therefore, we created a framework for ESA section 7 biologists to use for analysis of aquaculture proposals which will ensure consistency in these analyses and potentially improve the efficiency of the consultation process for aquaculture activities. In time, this report and the framework could be adapted to support applicants in project design and action agencies in conducting their environmental analyses.

Although this report provides useful guidance, it has limitations and does not address all the technical, legal, and policy challenges related to ESA-listed species and aquaculture in the GAR. Many questions remain regarding the best approaches to risk assessment, ocean engineering design, aquaculture site selection, etc. as well as measures to minimize and avoid interactions with listed species.

Here, we summarize ESA section 7 consultation for a wide variety of aquaculture gear categories, discuss the analyses needed to complete those consultations given the diversity of aquaculture gear and the behavioral ecology of our species, describe data gaps and research needs, and offer a potential standardized framework for future consultations. We hope the topics raised lead to further focused research to address the identified data gaps. For example, both the Northeast and Southeast Fisheries Science Centers are beginning to focus on hiring new staff with ocean engineering backgrounds to assist in our agency's understanding of the potential impacts of aquaculture on ESA-listed species.

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1. Introduction

Marine aquaculture refers to breeding, rearing, and harvesting of marine organisms, such as fish, crustaceans, shellfish, and sea vegetables in the marine and estuarine environment. The aquaculture industry is one of the fastest growing food-producing sectors, and it accounts for approximately half of the world's fish used for food (FAO 2018). The upward trend of aquaculture production will likely continue, especially with doctors and nutritionists urging patients to eat more seafood to improve their health (Rubino 2008). In addition to food for human consumption, cultured items support habitat and endangered species restoration, medical research, pharmaceuticals, food additives, ornamentals, and aquarium commerce, among other applications[1].

Similar to countries worldwide, the United States is anticipating rapid growth of commercial marine aquaculture in the coming years. The U.S. federal government has recently taken steps to expand the industry. Specifically, Executive Order 13921 (May 7, 2020) aims to bolster the U.S. seafood industry and increase aquaculture production by streamlining the aquaculture permitting process and removing regulations deemed prohibitive to seafood production. NOAA Fisheries is also working to identify "Aquaculture Opportunity Areas" (AOA), which are small, defined geographic areas that are evaluated to determine their potential suitability for commercial aquaculture. NOAA Fisheries will use a combination of scientific analysis and public engagement to identify areas within the AOA that are environmentally, socially, and economically appropriate for commercial aquaculture. Expanded interest and

[1] NOAA 2019.: https://www.fisheries.noaa.gov/new-england-mid-atlantic/aquaculture/aquaculture-new-england-and-mid-atlantic

investment in commercial marine aquaculture is expected to continue to expand nationwide, including locally in the GAR.

In the GAR, NOAA Fisheries enjoys a long history successfully supporting and consulting on numerous nearshore[2] aquaculture projects, particularly regarding different forms of oyster aquaculture, such as Chesapeake Bay. Nearshore aquaculture has a much longer history of application and data collection, whereas offshore projects are still considered "novel" with many unknown variables (e.g., ocean engineering to withstand environmental factors, effects of open-ocean currents, longevity of in-situ gear). Offshore refers to a location more than 3 nautical miles (nm) away from shore in federal waters, which does not include those areas of bays that are greater than 3 nm from shore. Therefore, as more aquaculture operations are proposed for development in offshore marine habitat in the GAR, new challenges are expected. Challenges in assessing protected species risks from offshore aquaculture operations include: monitoring in the offshore environment, which may require substantial effort, funding, and resources; large whales present in offshore areas where they spend the majority of their feeding and migration time and where risk of interaction with aquaculture gear is not well known; co-occurrence and risks of interactions to sea turtles is also not well understood; lack of detailed historical records and documented accounts of interactions between ESA-listed species and aquaculture gear; and the lack of long-term experience with aquaculture gear types and configurations in the offshore environment.

When assessing marine aquaculture projects, engineering design as well as overlap with ESA-listed species must be considered in order to accurately evaluate the risks of aquaculture activities to ESA-listed species.

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[2] In this report, nearshore refers to quiet waters in enclosed areas with low tidal flux and wave action.

Without a long-term understanding of the effects of marine aquaculture and given the current expansion of this industry, the need for a comprehensive analysis of the industry and its practices is essential in order to improve the ESA consultation process. To enhance the efficiency of the ESA consultation process, both permitting (action) agencies and NOAA Fisheries' (consulting agency) section 7 biologists would benefit from a comprehensive review of a) how the ESA section 7 consultation process has been successfully completed for past marine aquaculture projects (which have been predominantly nearshore); and b) available information on similar gear used by the fishing industry as well as other marine sectors that may inform the consultation process on aquaculture operations, particularly offshore projects. Although differences exist between fishing and aquaculture gear, familiarity with fishing gear can potentially provide a foundation from which to approach risk analysis until further research allows for a better understanding of the risks posed to ESA-listed species from aquaculture activities.

The Section 7 Program of the Protected Resources Division (PRD) in the Greater Atlantic Regional Fisheries Office (GARFO) created an analytical framework to assist section 7 biologists in determining the most appropriate consultation pathway (i.e., no effect, informal consultation, formal consultation) based on the magnitude of anticipated effects associated with aquaculture gear in different spatial and temporal contexts. The framework does not change the current section 7 consultation process or replace the detailed effects and risk analyses currently conducted for aquaculture projects. Rather, the framework is a preliminary support tool to streamline the section 7 process by guiding biologists toward the appropriate consultation pathway.

1.1. Marine Aquaculture

NOAA Fisheries GAR[3] has a vibrant commercial marine aquaculture industry supported by a world-class research and technology sector. Various species of finfish, shellfish, and sea vegetables (e.g., kelp) are farmed in the region. Commercial landings from aquaculture (predominantly consisting of shellfish and American lobster) totaled approximately $1.85 billion in the GAR during 2016[4].

1.1.1. Aquaculture Gear and Growing Techniques

While other forms of aquaculture exist or are in development, there are currently four aquaculture gear/growing techniques used most often in the GAR: shell on bottom, cage on bottom, floating gear, and net pens.

1.1.1.1. Shell on Bottom

"Shell on bottom" refers to shellfish (e.g., oysters, clams) grown on the ocean floor without cages where they can filter and grow in natural conditions. Once the shellfish are of sufficient size, growers harvest them by hand or by mechanical means such as dredging, raking, or other tilling activities. This technique requires minimal to no gear for both distribution of organisms onto the ocean floor and for husbandry work (e.g., feeding the organisms, maintenance of growing location). Some scallop and clam growers use netting to decrease the number of organisms lost through natural processes (e.g., predation; suffocation due to sediment movements; and frost or ice damage on the subtidal substrates).

1.1.1.2. Cage on Bottom

"Cage on bottom" refers a range of techniques, all of which grow shellfish in cages on the ocean floor. Cage on bottom operations analyzed by GARFO section 7 biologists to date

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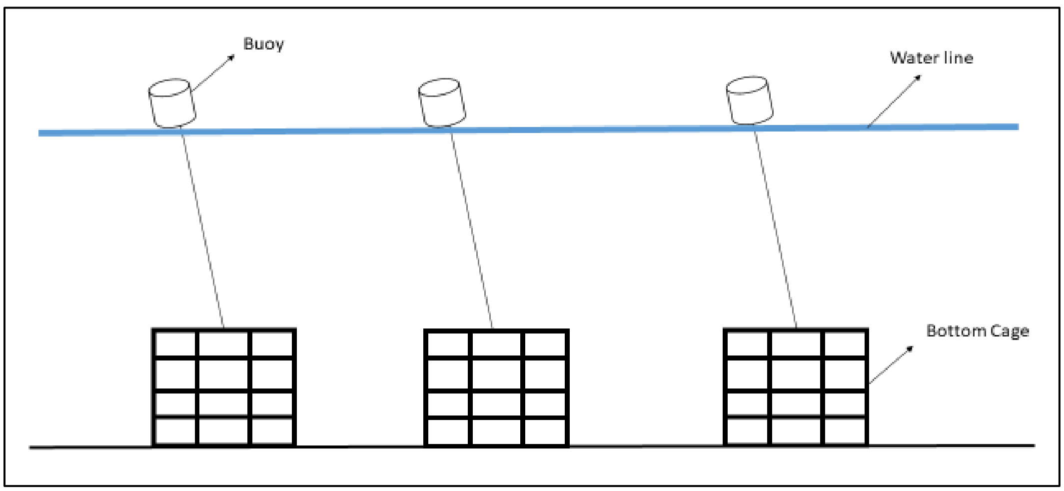
[4] NOAA 2019.: https://www.fisheries.noaa.gov/new-england-mid-atlantic/aquaculture/aquaculture-new-england-and-mid-atlantic

[4] NOAA 2018.: https://www.fisheries.noaa.gov/resource/document/fisheries-economics-united-states-report-2016

have generally occurred in waters less than 40 feet; however, that depth does not reflect a biological or operational limit. In one type of cage on bottom growing technique, each cage on the ocean floor is attached with a vertical line to a floating buoy on the surface (Figure 1.1). Cages can also be trawled together, which increases the number of cages per trawl line and decreases vertical lines and buoys. Typically, cages consist of multiple trays with shellfish on each tray. Growers stack trays on top of one another, insert them into larger cages, and transfer the larger cage to the ocean floor for the shellfish to grow further.

Figure 1.1: Cage on bottom gear used for growing shellfish in Maine. A floating buoy on the surface is attached to each cage (Chi Mori, Integrated Statistics).



Another cage on bottom growing technique uses two floating devices (i.e., pontoons) attached to each cage. Growers place shellfish in High Density PolyEthylene (HDPE) bags, insert the bags into a larger wired cage, and submerge the larger wired cage to the ocean floor. The cages are attached to each other by a trawl line with anchors on both ends of the trawl line. Growers can float this same gear configuration to the surface by lifting the cage out of the water, draining the water from the pontoons, and capping the pontoons closed. In shallow water, sticks or polyvinyl chloride (PVC) pipes/poles at each corner of the site may be used to mark where cages are set on the substrate. Cages on the bottom in water deeper than roughly 6 feet are generally marked with buoys, not poles, at both ends of a group of cages.

1.1.1.3. Floating Gear

Many types of aquaculture gear have floating components and are classified in this report as floating gear. Growers use this technique for a variety of marine organisms, including kelp, mussels, oysters, and scallops. Examples of four sub-types of floating gear are surface longline, submerged longline, rigid catenary array, and raft/docks.

Surface longline gear most often consists of one horizontal longline (i.e., backbone) suspended on/near the surface of the water (depth of the longline depends on the site and project type) with anchor lines and buoys at each end (Figure 1.2). Alternatively, poles are used at the end of longlines instead of anchor lines. Data reviewed suggests growers typically deploy surface longline gear in nearshore[2] waters for growing shellfish. This gear type is vulnerable to surface conditions, such as waves, currents, ice, and accumulation of microorganisms and algae (i.e., biological fouling) (Young 2015). Some growers avoid these vulnerabilities by using a system similar to the cage on bottom configuration with pontoons (see above) that allows for the flexibility to either float the cage on the surface or submerge it (either hanging in the water column or resting on the bottom). When the cage is floated on the surface, the shellfish are exposed to sun and air for short intervals (<12 hours) to reduce biological fouling. When the cage is submerged, the shellfish feed in the water column. In addition to the cages with pontoons, growers culture shellfish in flip bags (Figure 1.3), which can be flipped such that either side is on top, or in hanging baskets on the horizontal longline.

Figure 1.2: Surface longline configuration with cages submerged. Extracted from material provided by USACE to NOAA Fisheries for consultation on the issuance of permit NAE-2015-01735 (NOAA Fisheries).

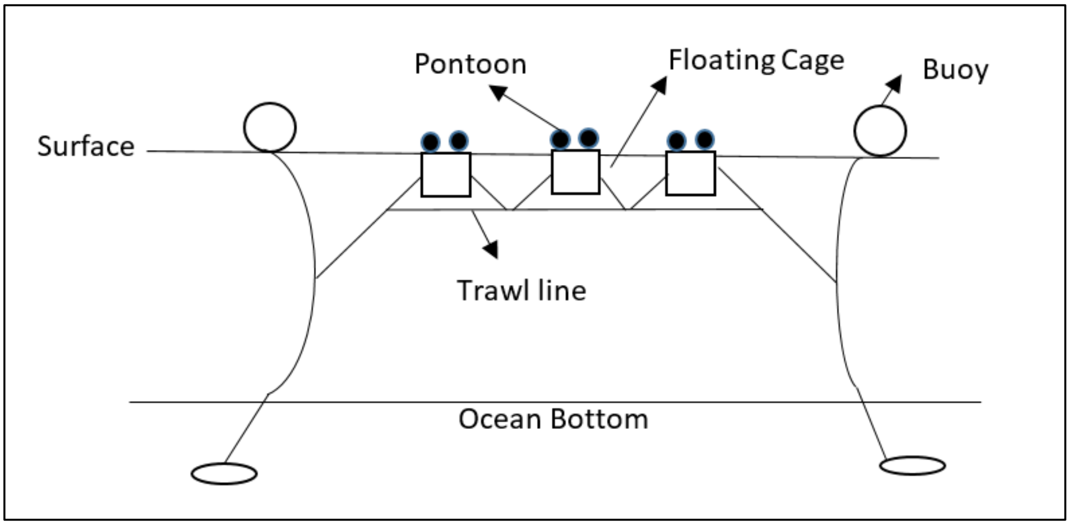


Figure 1.3: Surface longline system using flip bags to grow shellfish (Beth Sanderson, NOAA Fisheries).

To grow kelp, mussels, and scallops, growers often deploy submerged longline gear in the deeper offshore waters with high-energy conditions. Specific details remain dependent on project parameters (i.e., depth of gear), but the design consists of longlines suspended below the surface with a series of buoys, and sometimes weights, to maintain the appropriate depths.

On submerged longlines, organisms can be grown directly on the horizontal lines (Figure 1.4), on vertical lines hung from the longline (e.g., ear-hanging technique) (Figure 1.5), or in various types of hanging nets/cages (Figures 1.6). The type of hanging nets/cages used depends on the type of organism grown (see Table 1.1).

Figure 1.4: Submerged longline configuration with kelp grown directly on horizontal lines. (Mike Stekoll, University of Alaska).

Figure 1.5: Submerged longline configuration with pearl oysters grown using the ear-hanging method (Mark Dixon, NOAA Fisheries).

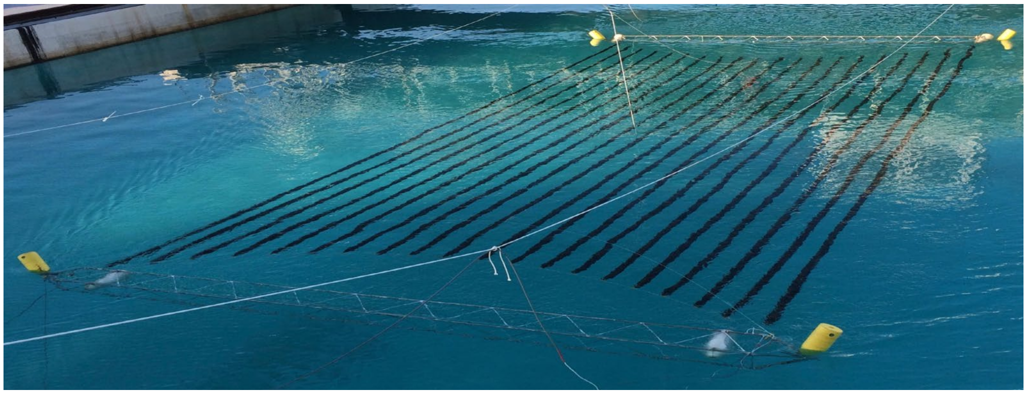
Figure 1.6: Scallops grown in lantern net with submerged longline configuration (Mark Dixon, NOAA Fisheries).

Table 1.6: Submerged longline techniques and organisms grown using each technique.

Submerged Longline Technique	Organisms Grown
Growing directly on longline/headrope	Kelp
Lantern nets	Scallops, oysters
Ear hanging	Scallops, oysters
Vertical sock lines	Mussels, oysters
Looped sock lines	Mussels

Rigid catenary array gear is an experimental longline configuration that minimizes the number of vertical lines compared to a typical submerged longline configuration (Figure 1.7). The rigid catenary array configuration has only two mooring lines, one on each end of the horizontal line, while other submerged longline configurations require at least two vertical lines in addition to any mooring lines and pick-up lines that may be required.

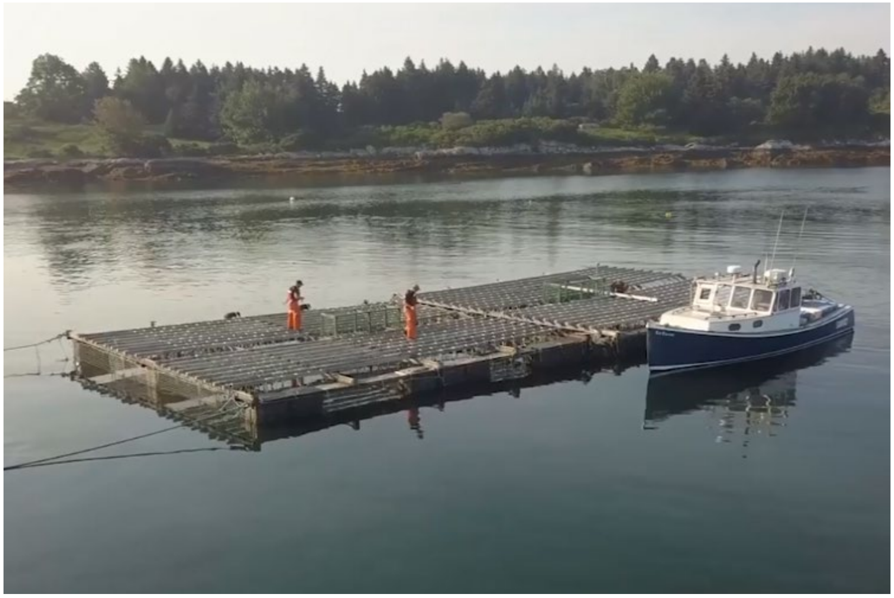
Figure 1.7: Rigid catenary array from WHOI Experimental Kelp Array consultation (NOAA Fisheries).



Raft gear is a type of floating aquaculture gear commonly used to grow mussels in Maine and is generally deployed in bays and harbors. Rafts are typically constructed with floating frames made of steel, wood, or polyethylene (Figure 1.8), and growers can deploy nets around the raft to protect the shellfish from predation. The size and scope of raft gear can vary greatly by location and business operation; however, based on the range of lines proposed in aquaculture consultations in Maine, the GAR has reviewed proposals for raft gear that can support up to 400 vertical lines of 45 feet in length.

A floating upweller system (FLUPSY) has tanks anchored to floats or attached to a dock. The tanks have a motor that pulls water through the system from the bottom. As water enters and circulates through the system, algae (i.e., food for the shellfish) travels up through the layers of shellfish and provides a continuous food supply. The floating downweller system is a similar configuration to the FLUPSY, except water flows through the system in the opposite direction (i.e., water is pumped from the top to the bottom of the system).

Figure 1.8: Raft gear used for growing mussels (NOAA Fisheries).



1.1.1.4. Net Pens

Net pens are cage-like structures typically enclosed by mesh screens (Figure 1.9). Growers generally use net pens for finfish culture, such as salmon and steelhead trout. The structures may consist of layers of nets/meshes: a primary net and a second predator net, fastened to the outside to prevent predation. Floating High Density PolyEthylene (i.e., HDPE) rings often support the net pens. The entire structure does not sit directly on the ocean floor, but is anchored to the ocean floor or attached to a rigid mooring system, which may support multiple net pens.

Figure 1.9: Underwater structure of a net pen (Gilles Lemarchand).

1.1.1.5. Emerging Technologies in Aquaculture

Within the GAR, aquaculture methods and technologies are being developed and tested to meet the changing and growing needs of the industry. Emerging methods and technologies in aquaculture include integrated multi-trophic aquaculture (IMTA), offshore submersible cage systems, mobile fish farms, and ropeless gear.

IMTA is an approach where multiple organisms from different trophic levels are cultivated together. The goal of IMTA is to convert animal waste and uneaten feed into useful resources, which increases sustainability and economic diversification (Buck and Langan 2017). IMTA has been tested in Canada by growing salmon, blue mussels, and kelp together (Buck and Langan 2017). Research studies conducted in Maine grew kelp and shellfish together to study water quality impacts (Buck and Langan 2017). In addition, there is a permitted and deployed project using a raft, multiple net pens, and submerged longlines to grow steelhead trout, blue mussels, dulse, and sugar kelp in the Piscataqua River and a similar proposed IMTA project that will use the same gear to grow steelhead trout and blue mussels roughly 9 miles offshore of New Hampshire that has not yet been authorized by the U.S. Army Corps of Engineers.

Offshore submersible cage systems are another emerging technology in the aquaculture field. In the GAR, there are several submersible cage systems proposals (in various stages of development) that would be located offshore in federal waters. Growers can submerge all of these cages to various depths and the cages are built to withstand offshore conditions.

Mobile fish farms are aquaculture structures that have a ship-like configuration, which allows them to rotate and move to different locations to avoid storms. This configuration is also useful because the structure can move to locations with optimal growing conditions for marine organisms. While this configuration does not yet exist in U.S. waters, there are proposals to use it in international waters off the coast of the U.S. and the product of those operations will likely be imported into the U.S. One of these proposals is off the coast of Maine.

Ropeless gear is another emerging technology for the fishing industry and there may be components that are applicable for use in aquaculture operations. The intent of ropeless gear is to reduce the amount of conventional buoy lines and instead employ remote control technology or timed galvanic releases to locate the aquaculture gear. Two ropeless systems have been successfully tested for application in fisheries: bottom-stowed endline and lift bags. In the bottom-stowed endline technique, endlines are stowed within cages and when triggered remotely, a line releases that is brought to the surface by an attached floatation device. The lift bag technique requires equipping a trap with a compressed air canister linked to an inflatable device. When triggered remotely, the air canister inflates the device and the trap floats to the surface. Testing continues in pot/trap fisheries to reduce whale entanglements. In addition, ropeless gear is currently being used in a few areas outside of the GAR for fishing activities, and similar technology could potentially be used in commercial aquaculture gear in the GAR in the future.

1.2. Aquaculture Permitting Process and ESA Section 7 Consultation

Aquaculture activities (e.g., breeding, growing, and harvesting of farmed species) in the marine and estuarine environment require certain permits and authorizations. Municipal, state, tribal, and/or federal agencies are typically involved during the permitting process (GAO 2019). In the GAR region, the U.S. Army Corps of Engineers is primarily the responsible federal agency for issuing a federal permit for aquaculture deployment and operation under section 10 of the Rivers and Harbors Act of 1899 and section 404 of the Clean Water Act. Generally, in the GAR, the Corps issues permits for activities potentially impacting waterways, including discharge of dredged or fill material into U. S. waters. These permits are required for all activities in navigable waters. The Corps authorizes activities under these permits and must ensure the activities are compliant with other applicable federal laws, such as the ESA, the NPDES program under the Clean Water Act (i.e., EPA or delegated state agencies), and the National Environmental Policy Act (NEPA). Depending on the location, other state and/or local authorizations may also be necessary.

Under section 7 of the ESA, the lead federal action agency (most commonly, the Corps for aquaculture projects) must consult with NOAA Fisheries if a proposed aquaculture activity may affect ESA-listed species, or any designated critical habitat. NOAA Fisheries concludes consultation with a federal action agency with a determination of either a Not Likely to Adversely Affect (NLAA) or Likely to Adversely Affect (LAA) conclusion. If the Corps preliminarily determines that an aquaculture activity is NLAA ESA-listed species and/or critical habitat, they must submit a request for informal consultation to NOAA Fisheries for concurrence. An NLAA determination is the appropriate conclusion when effects on ESA-listed species and/or critical habitat are expected to be insignificant, extremely unlikely to occur, or wholly beneficial. If the Corps preliminarily determines an aquaculture activity is LAA ESA-listed species and/or critical habitat, a formal consultation is necessary. NOAA Fisheries publishes a Biological Opinion (BiOp) which analyzes all consequences of the action and concludes with a determination of whether the proposed aquaculture action(s) is likely to jeopardize the continued existence of an ESA-listed species or destroy or adversely modify critical habitat. If the BiOp concludes with a jeopardy determination, Reasonable and Prudent Alternatives (RPA) will be issued to the action agency as part of the BiOp to remove jeopardy. If the action is reasonably certain to result in the "take" of a listed species, NOAA Fisheries will issue an Incidental Take Statement (ITS) with Reasonable and Prudent Measures (RPMs) and Terms and Conditions (T&Cs) to minimize the impact of the action and exempt a certain amount of "take" of listed species based on the project specifications and analysis.

In 2017, GARFO's Protected Resource Division (PRD) completed an informal ESA Programmatic Consultation with the Corps to streamline the ESA section 7 consultation process for a large number of routine, minor impact, and non-controversial Corps actions that are not likely to adversely affect listed species. Numerous aquaculture projects, utilizing a variety of gear types, fall under the scope of this programmatic consultation.

1.3. Previous Section 7 Consultations on Aquaculture

We compiled data from 300 ESA section 7 consultations conducted by GARFO to gain an understanding of aquaculture practices and trends during that period[5]. The vast majority of

[5] ESA section 7 data used in this report are listed in Appendix A.

these consultations were conducted from 2014 to January 2019 and are nearshore. In addition, we evaluated two consultations in federal waters from 2014. The majority of consultations we reviewed are for nearshore aquaculture operations because almost all previous consultations were for nearshore projects. However, our recent experience with several offshore proposals provides us with some experience to ensure this report, including the section 7 framework, applies to both nearshore and offshore aquaculture. Information compiled includes geographical location where aquaculture gear was deployed; gear type used in each location; organisms grown in each gear type; and seasonality of gear deployment (see Appendix A for detailed information on these parameters and Appendix B for detailed information on the gear configurations). In this report, we discuss projects that have completed consultation and for which the permits have been issued. At that point, many of these projects are deployed for the life of their permit, while others never come to fruition due to external circumstances (e.g., lack of funding). The appendix provides a baseline of past experiences with ESA consultation and a potential database to better understanding possible effects and risks to ESA-listed species in the future (i.e. trends in number or diameter of submerged lines etc). Below, is a summary of information from the appendices.

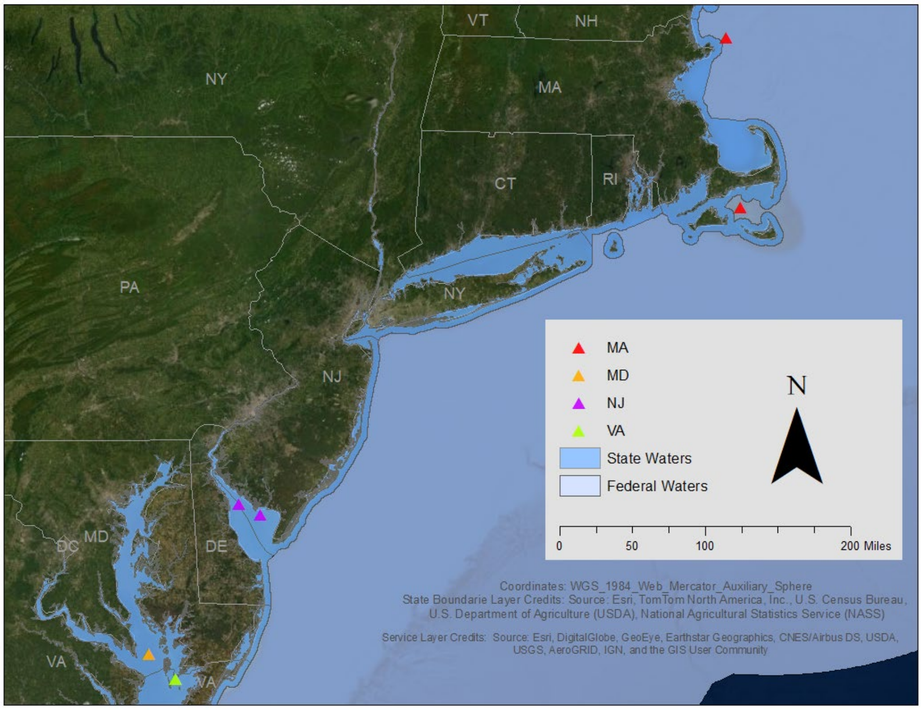
1.3.1. Bathymetry and Distance from the Coastline

We analyzed project location by bathymetry and distance from the coastline to understand possible data trends (Table 1.2). The Corps provided water depths from the U.S. Coastal Relief Model Vol 1 (https://www.ngdc.noaa.gov/mgg/coastal/crm.html) based on the project locations. We mapped the project location to calculate distance from shore. Most currently permitted aquaculture sites in the GAR are close to shore in shallow water. As shown in Table 1.2, 98% of the aquaculture sites (293 of 300) were in waters between 0 to 9.9 m. Six sites were located in waters 10 to 19 m in depth, and one site was located in waters deeper than 80 m. Roughly 75% of the sites (226 of 300) were between 0 and 0.49 nautical miles (nm) from shore. Almost all other aquaculture sites were between 0.5 to 2.99 nm from shore, with the exception of seven sites (Table 1.2). Of these seven sites, five sites were in state waters: two between 3 and 3.99 nm from the New Jersey shoreline in Delaware Bay, using cage on bottom gear at 3 to 6.22 m depth; two 3 to 3.49 nm from the Virginia shoreline in Chesapeake Bay, using shell on bottom techniques between 10 to 19 m depth; one site 5.5 nm is from the Maryland shoreline in Chesapeake Bay using both shell on bottom technique and cage on bottom gear at 6 m depth (Figure 1.10). Only two of the sites, one within Nantucket Sound and one off Rockport, Massachusetts were located in federal waters (i.e., more than 3 nm from shore). Only the Rockport, Massachusetts location currently has gear in the water. The permit holder for the Nantucket Sound, Massachusetts location encountered difficulties keeping the gear afloat and opted to remove it from the site.

Table 1.2: ESA section 7 aquaculture consultations between 2015 and January 2019, in addition to two consultations in 2014, (n=300) categorized by distance from the coastline and depth. An empty cell indicates there were no consultations in that category.

Number of Consultations		**Distance from the Coastline (nautical miles)**														
		0.00 to 0.49	0.50 to 0.99	1.00 to 1.49	1.50 to 1.99	2.00 to 2.49	2.50 to 2.99	3.00 to 3.49	3.50 to 3.99	4.00 to 4.49	4.50 to 4.99	5.00 to 5.49	5.50 to 5.99	6.00 to 6.49	6.50 to 6.99	7.00 to 7.49
Depth (m)	0 to 9.9	223	42	10	9	2	3	1	1	-	-	1	-	-	-	1
	10 to 19	3	-	1	-	-	-	2	-	-	-	-	-	-	-	-
	20 to 29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	30 to 39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	40 to 49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	50 to 59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	60 to 69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	70 to 79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	80 to 89	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Figure 1.10: Seven consultations more than 3 nm away from shore. Two sites are located in federal waters (red triangles), while all other sites are in state waters. The data point (green triangle) in Virginia represents two different consultations as they are in the same area.



1.3.2. Gear Type by State

We also analyzed data from the same 300 aquaculture-related ESA section 7 consultations for information on gear type by state. We identified four growing techniques: shell on bottom, cage on bottom, floating gear, and net pens. If a project used gear from more than one of these categories, we categorized it as "multimode". For example, cage on bottom and floating gear used at one location under the same consultation is considered multimode. These categories are used to analyze gear type by state in the Greater Atlantic Region.

The most prevalent aquaculture growing technique in the GAR is shell on bottom (Figure 1.11 and Table 1.3). More than half (183 of the 300) of the consultations were in this category. Most sites using this technique were in waters off Maryland (115 consultations) and Virginia (59 consultations). Cage on bottom consultations (60 consultations) were the second most prevalent technique and were mainly located off Maryland (33 consultations) and Connecticut (10 consultations) waters. The third most prevalent technique was floating gear, most often used in waters off Massachusetts (11 consultations) and Connecticut (9 consultations).

Figure 1.11: Location and gear type of 300 aquaculture-related ESA section 7 consultations.

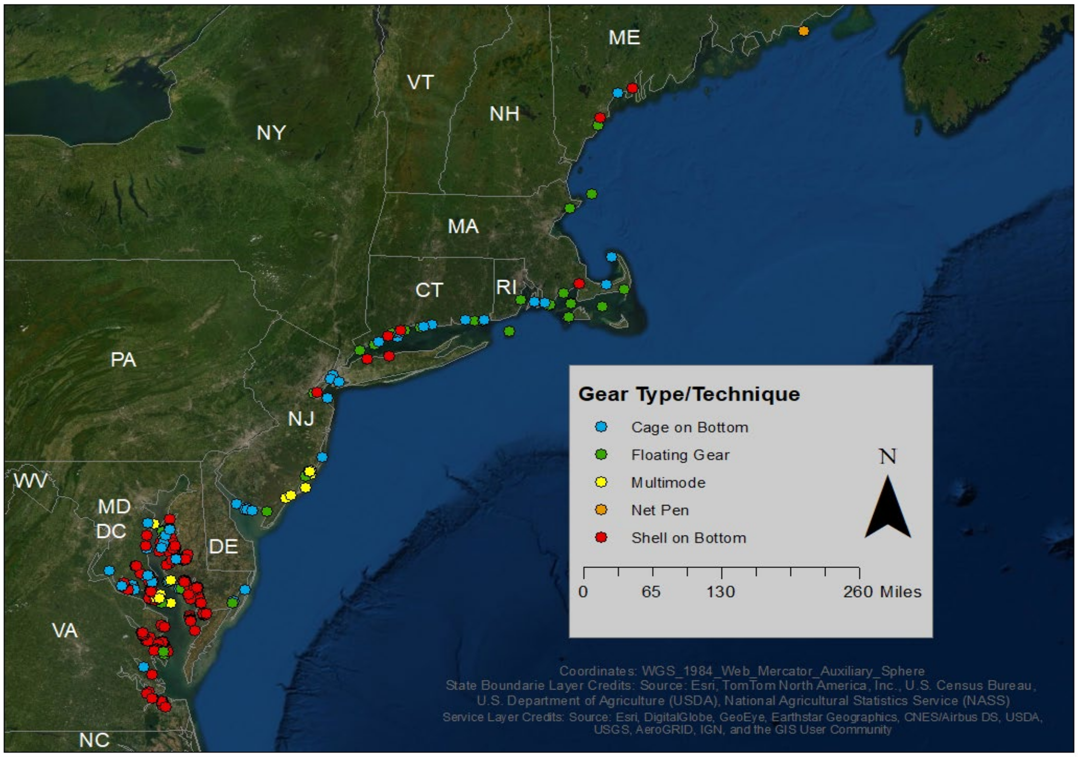


Table 1.3: Aquaculture-related ESA section 7 consultations (n=300) by gear type and state.

State	Type of Aquaculture Gear/Technique					Total Consultations
	Shell on Bottom	Cage on Bottom	Floating Gear	Net Pen	Multimode	
ME	2	1	1	1	0	5
MA	1	3	11	0	0	15
CT	3	10	9	0	0	22
RI	0	1	1	0	1	3
NY	3	3	1	0	0	7
NJ	0	8	3	0	11	22
MD	115	33	7	0	8	163
VA	59	1	2	0	1	63
Total	183	60	35	1	21	300

As there are several subtypes of floating gear, data from the 35 consultations with this gear type were further broken down by subtype and state (Table 1.4). Submerged longline gear (18 consultations) was the most common subtype of floating gear. It is used to grow kelp in Connecticut and Massachusetts (8 and 4 consultations, respectively) and to grow along with cages in Massachusetts (4 consultations). Surface longline (12 consultations) was the second most common floating gear type. Mesh/flip bags were used in nine projects: five in Maryland, two in Virginia, one in Massachusetts, and one in New Jersey. Raft/dock and rigid catenary array were used far less often than surface and submerged longline gear (3 and 2 consultations, respectively).

In addition, 21 out of the 300 consultations analyzed were classified as multimode (Table 1.5). Of these, 20 consultations used floating gear as one of the gear types. The one site that did not include floating gear used cage on bottom and shell on bottom growing techniques in Maryland. One site in Rhode Island used three types of gear including cage on bottom and two types of floating gear: surface and submerged longlines. Other multimode consultations consisted of cage on bottom with either surface longline with mesh/flip bags (5 consultations) or surface longline with cages (14 consultations). The most prevalent gear configuration in the multimode category was the combination of cage on bottom with surface line and hanging cages (13 consultations) and nine of these projects were located in New Jersey waters.

Table 1.4: Subtypes of floating gear by state (n=35).

Floating Gear Type		State	Total Consultations
Surface longline (n=12)	Mesh/flip bags	MA	1
		MD	5
		NJ	1
		VA	2
	Cages	NJ	2
		MD	1
Submerged longline (n=18)	Cages (including hanging socks)	MA	4
	Directly grown for kelp	ME	1
		CT	8
		MA	4
		RI	1
Raft/dock (n=3)		MD	1
		NY	1
		CT	1
Rigid Catenary Array (n=2)		MA	2

Table 1.5: Multimode category classified by technique and state (n=21).

Gear Technique/Type				State	Total Consultations
Cage on Bottom	Shell on Bottom	Floating gear			
Yes	Yes	No		MD	1
Yes	No	Yes; surface longline with cages	Yes; submerged longline	RI	1
Yes	No	Yes; surface longline with mesh/flip bags		MD	3
				NJ	2
Yes	No	Yes; surface longline with cages		MD	4
				NJ	9
				VA	1

1.3.3. Seasonality of Aquaculture Operations

Of the 300 consultations reviewed, a sample subset of 117 that had seasonal data recorded were evaluated to understand if seasonal trends exist by gear type or location

(Appendix C). This review excluded projects that used only shell on bottom technique. Shell on bottom aquaculture activities typically require less gear and vertical lines compared to other aquaculture activities (e.g., cage on bottom, floating gear), reducing the risk of interaction between listed species and the gear. While most ESA section 7 consultations (70 out of 117) did not specify a duration for the activities nor the time of year that aquaculture gear would be deployed, 47 consultations did provide some seasonal information.

Thirteen of the 60 consultations using cage on bottom technique provided seasonal information. In Maryland, there were four aquaculture facilities consistently harvesting between the months of October and April, but it was unclear if the gear was deployed at other times and in which configuration. In Connecticut, some operations ran year-round with no gear removal. However, other operations placed cages only during growing season, between April and winter months, but specific months were not specified. In New Jersey, one consultation mentioned decreased husbandry activity during winter, but specific months were not specified. For the two consultations in Massachusetts, both removed gear during the winter month. One removed all gear, and one left vertical lines in the water, but removed the cages.

Many consultations using floating gear configuration (22 out of 35) provided seasonal information, however, the specificity of information provided was variable. For instance, floating gear was deployed to grow kelp between December and April in one consultation from Massachusetts. During the summer months, the growing line was removed and only the moorings were left. In Rhode Island, one consultation deployed their floating gear between November and April and removed all gear on April 30. Another consultation in Rhode Island deployed gear in April, but did not remove the gear in the summer. Instead, they kept their gear in the water throughout the year, but moved their floating cages to the ocean floor during summer months. Off the coastline of Connecticut, floating gear was deployed for growing kelp during winter months (roughly October through June), and all gear except vertical anchor/buoy lines were removed during the summer. In Maine,[6] cultured sugar kelp are typically grown in the winter months and harvested in the spring. However, whether gear remained in the water during the off-season or not was not specified. Twelve of 21 multimode consultations provided some seasonal information. Some growers sunk their floating cages in the winter, while others removed them entirely.

Other than the seasonal deployment mentioned above for kelp species in different areas, there was no overall consistency observed in the seasonality of gear deployment for the majority of aquaculture gear types. Data show that some aquaculture gear is deployed at certain times of the year, while other gear remains in the water throughout the year. Variability in the timing and duration of gear deployment may be contingent on a) local, state, or federal (Corps) permit conditions; b) growers' preferences based on optimal water temperatures for cultured species, sea state (e.g., avoiding hurricane season); or c) a combination of (a) and (b). Most growers did not specify when they deploy their gear or their growing season.

[6] University of Maine 2019.: https://www.seagrant.umaine.edu/maine-seafood-guide/seaweed

2. ESA-listed Species, Behavior, and Habitat

Existing and proposed aquaculture operations commonly occur in or near areas of the GAR where ESA-listed species, at various stages of their life cycles, forage, rest, breed, and migrate. Aquaculture gear also may co-occur with designated critical habitat for several ESA-listed species[7].

2.1. Large Whales

Five large whale species (fin, sei, sperm, blue, and North Atlantic right whales) are listed under ESA as endangered in the GAR (35 FR 18319, December 2, 1970; 73 FR 12024, March 6, 2008). There is no designated critical habitat for blue, fin, sei, or sperm whales in the GAR. Designated critical habitat for North Atlantic right whale include areas of the Gulf of Maine, Georges Bank, and the Southeast U.S. (81 FR 4837, January 27, 2016)[8].

Adults, juveniles, and/or calves of these large whale species are present year-round in the GAR[9]. The distribution of blue whales in the western North Atlantic generally extends from the Arctic to at least mid-latitude waters. The blue whale is an occasional visitor in the U.S. Exclusive Economic Zone (EEZ) waters, which may represent the current southern limit of its feeding range[9]. Sperm whales feed on larger organisms that inhabit deeper ocean regions[9]. Calving for the species occurs in low latitude waters. The distribution of sperm whales in the U.S. EEZ occurs primarily on the continental shelf edge, over the continental slope and into mid-ocean regions[9]. The range of the Nova Scotia sei whale stock includes the continental shelf waters of the northeastern United States and extends northeastward to south of Newfoundland[9].

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[7] NOAA 2019.: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-endangered-and-threatened-species-new-england-mid

[8] NOAA 2019.: https://www.fisheries.noaa.gov/resource/map/north-atlantic-right-whale-critical-habitat-map-and-gis-data

[9] NOAA 2021.: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-species-presence-table-atlantic-large-whales

Indications are that, at least during the feeding season, a major portion of the Nova Scotia sei whale stock is concentrated in northern waters. The southern portion of the species' range during spring and summer includes the northern portions of the U.S. EEZ – the Gulf of Maine and Georges Bank. Spring is the period of greatest abundance of sei whales in U.S. waters, with sightings concentrated along the eastern margin of Georges Bank, the Northeast Channel area, and along the southwestern edge of Georges Bank in the area of Hydrographer Canyon[9]. Fin whales are common in waters of the U.S. EEZ, principally from Cape Hatteras northward[9]. Fin whales are migratory and move further north into high-latitude feeding areas seasonally. Their overall migration pattern is complex, and specific routes are unknown. However, acoustic recordings from passive-listening hydrophone arrays indicate that a southward "flow pattern" occurs in the fall from the Labrador-Newfoundland region, past Bermuda, and into the West Indies[9]. North Atlantic right whales range primarily from calving grounds in the coastal waters of the southeastern United States to their feeding grounds in New England waters, the Canadian Bay of Fundy, Scotian Shelf, and Gulf of St. Lawrence[8].

There is a long history of large whale interactions with fishing gear, and, as aquaculture develops along the coast and into offshore areas, interactions with aquaculture gear are an emerging concern due to similarities between the gear types (see Section 3.5). Any line in the water column, including line resting on or floating above the seafloor, has the potential to entangle a whale (Hamilton and Kraus 2019, Johnson et al. 2005). Entanglements may involve the head, flippers, or fluke with effects ranging from no apparent injury to death. For example, baleen whales (fin, sei, blue, and North Atlantic right whales) filter feed by opening their mouths and straining prey items from the ocean. This feeding behavior may result in an oral entanglement and damage the baleen plates preventing efficient filter feeding (Cassoff et al.

2011, Hayes S. A et al. 2018). Additionally, large animals, such as whales, with gaping mouths and extending flukes and fins may be at higher risk of entanglement with objects in the water, including aquaculture gear (Price et al. 2017). There are generally three points where gear tend to attach to large whales: the gape of the mouth, around the flippers, and around the tailstock. For example, loose lines with floats/buoys on or near the surface could wrap around flippers or other body parts while animals are migrating, foraging and/or pursuing prey, which may result in tissue injury, drowning, and increased vulnerability to boat collisions (Lutcavage et al. 1997). Moreover, baleen whales rely on visual and audio cues for navigation, rather than echolocation, raising their risk of encountering objects in the water column, since they may not detect aquaculture gear in the ocean compared to animals that use echolocation (Lloyd 2003).

2.2. Sea Turtles

Five species of sea turtles (hawksbill, Kemp's ridley, leatherback, green, and loggerhead) are listed as threatened or endangered in the GAR (35 FR 18319, December 2, 1970; 81 FR 20057, April 6, 2016; 76 FR 58868, September 22, 2011)[10]. Leatherback, Kemp’s ridley, and hawksbill sea turtles are listed at the species level whereas loggerheads and green sea turtles are listed as Distinct Population Segments (DPS). The Northwest Atlantic DPS of loggerhead and North Atlantic DPS of green sea turtles occur in the GAR. In this region, the Northwest Atlantic loggerhead DPS is the only sea turtle to have designated critical habitat, which is located in waters offshore of Maryland and Virginia in the Gulf Stream current[11].

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[10] NOAA 2021.: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-species-presence-table-sea-turtles-greater
[11] NOAA 2019.: https://www.fisheries.noaa.gov/resource/map/loggerhead-turtle-northwest-atlantic-ocean-dps-critical-habitat-map

Four species of sea turtles (loggerhead, green, Kemp's ridley, and leatherback) generally move into marine and estuarine waters of the GAR in the spring as water temperatures rise, and leave the region's waters by the end of November[10] as temperatures fall. Cold stunning of hard-shell sea turtles occurs annually from October to January[10]. Nesting for all species of sea turtles is extremely limited in the GAR, only consistently occurring in Virginia. Typically, juveniles and adults, are present in the GAR[10]. Hawksbill sea turtles are extremely rare in the GAR, most likely because hawksbill sea turtles prefer tropical waters and coral reef habitats[10].

Sea turtles, especially large animals, may entangle, particularly leatherback and loggerhead sea turtles, in low tension lines, such as pot/trap gear vertical lines and marker buoy lines, due to their habitat use (i.e., leatherbacks feeding on jellyfish in the water column), body configuration, and large size. Their presence in the pelagic zone may make them vulnerable to entanglement with aquaculture gear deployed in state waters and offshore. Additionally, their long flippers may also increase the likelihood of entanglement in aquaculture gear. Benthic feeding sea turtles may be attracted to certain types of aquaculture gear, which would also put them at risk of entanglement. Since loggerhead and Kemp's ridley sea turtles feed on a wide variety of food items including mollusks and crabs (NMFS and U.S. Fish Wildlife Service 2008, NMFS et al. 2011), both species may be likely to investigate shellfish farm aquaculture sites. This may increase the risk of entanglement in gear present at the sites and potentially put them at greater risk with collisions with harvesting vessels.

2.3. Fish

Endangered or threatened fish species in the GAR include Atlantic salmon (Gulf of Maine DPS), Atlantic sturgeon (Gulf of Maine, New York Bight, Chesapeake Bay, Carolina and

South Atlantic DPSs), shortnose sturgeon, giant manta ray, and oceanic whitetip shark[12]. Shortnose sturgeon were listed under ESA in 1967 (32 FR 4001, March 11, 1967, Atlantic salmon in 2000 (65 FR 69469, November 17, 2000), Atlantic sturgeon in 2012 (77 FR 5880, February 6, 2012), and both giant manta rays (83 FR 2916, January 22, 2018) and oceanic whitetip sharks (83 FR 4153, January 30, 2018; 83 FR 2916) in 2018. There is no critical habitat designated for shortnose sturgeon, giant manta rays, or oceanic whitetip sharks in the GAR. Select rivers from Maine through Virginia are designated as critical habitat for Atlantic sturgeon (82 FR 39160, August 17, 2017)[13]. For Atlantic salmon, critical habitat was designated in 2009 (74 FR 39903, August 10, 2009)[14]. Atlantic salmon critical habitat includes the Gulf of Maine and connecting perennial rivers, streams, estuaries, and lakes in Maine.

The distribution of Atlantic sturgeon extends from the Androscoggin River in the Southwestern Maine to the Dennys River near the U.S./Canada border. All five DPSs of Atlantic sturgeon occur in marine and estuarine habitat including freshwater reaches of large rivers with access to the sea, from Hamilton Inlet, Canada to Cape Canaveral, Florida[12]. Shortnose sturgeon occur in marine and estuarine habitat, including freshwater reaches of large rivers with access to the sea, from the Minas Basin, Nova Scotia to the St. Johns River, Florida[12]. There have been documented coastal movements between some of the major rivers. The giant manta ray is found worldwide in tropical, subtropical, and temperate oceanic waters and along productive coastlines off the U.S. East Coast as far north as New Jersey[15]. The oceanic whitetip shark is found throughout the world in tropical and sub-tropical waters and are a pelagic species, generally

[12] NOAA 2021.: https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-species-critical-habitat-information-maps-greater#species-tables
[13] NOAA 2020.: https://www.fisheries.noaa.gov/resource/map/atlantic-sturgeon-critical-habitat-map-and-gis-data
[14] NOAA 2021.: https://www.fisheries.noaa.gov/resource/map/atlantic-salmon-critical-habitat-gulf-maine-dps
[15] NOAA 2021.: https://www.fisheries.noaa.gov/species-directory/threatened-endangered

remaining offshore in the open ocean, on the outer continental shelf, or around oceanic islands in water depths greater than 600 feet[15].

Shell on bottom aquaculture projects may convert coastal bottom habitat from soft to hard substrate, potentially reducing foraging habitat for Atlantic and shortnose sturgeon. Conversely, shellfish aquaculture operations may improve water quality, which is important for sturgeon, since shellfish feeding is a form of biofiltering which removes particulates and excess nutrients from the water column (Shumway et al. 2003). Therefore, the net benefit of a shell on bottom operation to sturgeons is uncertain and situationally dependent. There would likely be no effect from marine shell on bottom aquaculture projects on spawning and early life stages of salmon and sturgeon because they spawn and rear in freshwater areas where marine aquaculture activities generally do not occur, unless gear forms an obstruction to passage for upstream spawning in rivers.

Incidents of manta rays entangled in mooring and boat anchor lines has been documented (Deakos et al. 2011). Evidence suggests manta rays entangle when lines make contact with the front of the animal's head between the cephalic lobes. This is because the animal's reflex response is to roll in an attempt to free itself, which can potentially worsen entanglement (Deakos et al. 2011, Heinrichs et al. 2011). Although there are rarely reports of shark entanglements in aquaculture gear, some literature suggests that sharks may be attracted to fish cages (Galaz and De Maddalena 2004, Papastamatiou et al. 2011).(Galaz and De Maddalena 2004, Papastamatiou et al. 2011). Shark attraction to fish cages may increase the risk of entanglement in aquaculture gear.

3. Associated Stressors and Risks of Aquaculture Techniques/Gear

Aquaculture related projects may introduce a number of stressors to ESA-listed species. Potential stressors for ESA-listed species related to aquaculture activities include sound, habitat modification, water quality, vessel strikes, entanglement, and escapement (Table 3.1). Each type of aquaculture growing technique (i.e., shell on bottom, cage on bottom, floating gear, and net pens) may introduce a unique set of stressors, which can vary based on the specifics of a particular operation[16]. For example, hindrance of passage may or not may be an issue for a project with submerged longline gear, since proposed configuration, number of vertical lines, and depth of the gear can vary greatly based on the project. With this variability, the stressors in relation to the behavior and proximity of ESA-listed species must be assessed through the section 7 consultation process to determine the effects to the species, as described in Section 5.

[16] Stressors are any physical, chemical, or biological alteration of resources (i.e., increase, decrease, or introduction) that can induce an adverse response to an organism. Stressors can act directly on an individual or indirectly through impacts to resources (https://www.fws.gov/midwest/endangered/section7/s7process/s7glossary.html).

Table 3.1: Potential stressors generally associated with aquaculture technique/gear type. These may vary depending on the specifics of a particular operation (e.g., location, gear used.).

Stressor		**Type of Aquaculture gear/technique**								
				Floating gear						
		Shell on bottom	**Cage on bottom**	**Surface longline**		**Submerged longline**		**Rigid catenary array**	**Raft/ dock**	**Net pen**
				Flip bags	**Cages/ baskets**	**Cages**	**Directly grown**			
Sound[a]		NP	NP	NP	NP	NP	NP	NP	NP	NP
Habitat modification[b]	Hindrance of passage	NP	P	P	P	P	P	P	P	P
	Shading[c]	NP	NP	P	P	P	P	P	P	P
	Dredging	P	NP	NP	NP	NP	NP	NP	NP	NP
	Habitat conversion[d]	P	NP	NP	NP	NP	NP	NP	NP	NP
Water quality	Effluent	NP	NP	NP	NP	NP	NP	NP	NP	P
	Turbidity[e]	P	P	P	P	P	P	P	P	P
Vessels		P[f]	P	P	P	P	P	P	P	P
Entanglement		NP[g]	P	P	P	P	P	P	P[h]	P
Escapement	Parasite (e.g., sea lice)	NP	NP	NP	NP	NP	NP	NP	NP	P
	Genetic drift	NP	NP	NP	NP	NP	NP	NP	NP	P

Notes: P=Potential; NP=No Potential

[a] Sound is not assessed for aquaculture gear deployment except in the following conditions: 1) acoustic deterrents (e.g., pingers) are used as part of aquaculture operation; and/or 2) pile driving (i.e., requiring a support structure such as a dock).
[b] Prey quantity/quality is an additional stressor included under habitat modification.
[c] Shading refers to an area where the sunlight does not reach the habitat. Whether shading is an associated stressor relevant to type of aquaculture gear/technique will vary depending on depth and water quality of the project area.
[d] Conversion of habitat refers to a permanent change of substrate. A temporary change of substrate, such as cage on bottom technique, are not considered to convert habitat permanently (i.e., only modifies habitat temporarily).
[e] Turbidity refers to water losing its transparency from interacting with soft bottom.
[f] If an operation using shell on bottom technique is located in the intertidal areas, it may be possible that no vessels will be used, in which case this would not be a stressor.
[g] Shell on bottom operations may require boundary marking buoys. If buoys are used, there may be an entanglement risk.
[h] Raft gear has vertical lines and other components (e.g., netting) that could be an entanglement risk (i.e., P); however, docks generally do not have any lines/netting suggesting minimal entanglement risk (i.e., NP).

It should be noted that the potential stressors summarized in Table 3.1 reflect the GAR's experience from consulting on aquaculture projects to date, and do not represent an exhaustive or prescriptive list for how projects should or will be analyzed. Stressors may only become a risk to ESA-listed species under certain circumstances, and are evaluated on a case-by-case basis. Risk is assessed as the likelihood of a stressor occurring multiplied by the severity of the encounter, if an encounter were to happen. Although any of the stressors in Table 3.1 could potentially affect ESA-listed species, previously collected data demonstrate that the most likely risks to ESA-listed species related to aquaculture activities are entanglement, habitat modification, vessel strikes, and escapement and are discussed in more detail below.

3.1. Entanglement

Evaluating risk of entanglement in aquaculture gear is a priority concern of PRD Section 7 staff during the consultation process. To help assess this risk, a review was completed to determine the number, type, severity, and context of aquaculture-related entanglement incidents globally (Table 3.2) (methods used for the search are detailed in Appendix D[17]).

Although reports exist, the majority lack scientific reporting of the severity of resulting injuries, as well as mortality rates associated with interactions (Table 3.2). For example, we learned about the severity of five entanglement incidents in Japan by contacting the authors of the paper, as the published literature did not detail the extent of sustained injuries. This calls attention to the lack of data in tracking entanglement cases at the global scale and the consequences of under-reporting.

Additional reasons for under-reporting of entanglement incidents may be difficulty of detection and the postmortem drift of carcasses. Entanglement incidents can be difficult to detect when they occur below the surface of the water. For example, there are no observer(s) present and the incident is less likely to be self-reported. Also, reasons for missing or damaged gear are unknown; if there is no evidence an entanglement occurred, an incident may not be reported. Unobserved and/or undocumented mortalities can occur for any ESA-listed species. For

[17] Only one aquaculture entanglement case was found in the GAR, so the literature search was expanded to cover worldwide.

example, based on experience from entanglements due to fisheries interactions, when entangled whales become emaciated due to the increased energy cost of swimming and impaired feeding ability caused by the gear, emaciated carcasses often sink when the animal dies and are not detected or recovered (Knowlton and Kraus 2001). These unobserved mortalities (i.e., "cryptic mortalities") are challenging to document. Although few entanglement cases related to aquaculture operations have been identified, a better assessment of the entanglement monitoring processes and reliability in aquaculture operations globally is needed to determine if the few recorded events are an accurate representation of the actual number of events.

*Table 3.2: Aquaculture entanglement cases **

Location	Species	Incident Year	Gear Type	Outcome	Source(s)
Argentina	Southern right whale	2011	Unconfirmed aquaculture gear	Unknown	Bellazzi *et al.* 2012; Price *et al.* 2017
Australia	Humpback whale (calf)	2005	Mussel crop line	Released	Clement 2013; Price *et al.* 2017
	Humpback whale	1982-2010	Mussel farm (possibly the same as reported by Clement 2013)	Unknown	Groom and Coughran 2012; Price *et al.* 2017
	Humpback whale		Abalone	Unknown	
	3 Humpback whales		Pearl	Unknown	
	Humpback whale	1993	Tuna feedlot	Released	Kemper *et al.* 2003
	Southern right whale	1987-1990	Salmon pen	Unknown	Pemberton *et al.* 1991
Canada	Humpback whale	2016	Salmon farm	Fatal	P. Cottrell, Fisheries and Oceans Canada (DFO), pers. comm.; Price *et al.* 2017
	Humpback whale	2016	Former salmon farm (mooring buoys)	Mooring buoy anchor line wrapped around the mouth – released	P. Cottrell, Fisheries and Oceans Canada (DFO), pers. comm.; Price *et al.* 2017
	Humpback whale	2013	Fish farm	Fatal	DFO 2019**; Price *et al.* 2017
	Leatherback sea turtle	2009	Mussel farm line	Fatal	Ledwell and Huntingon 2010
	Leatherback sea turtle	2010	Spat line	Fatal	Scott Lindell pers. comm.; Price *et al.* 2017
	Leatherback sea turtle	2013	Mussel farm line	Released	Ledwell *et al.* 2013
	Leatherback sea turtle	2013	Spat line	Released	Scott Lindell pers. comm.; Price *et al.* 2017
Chile	Minke whale	Unknown	Salmon farm	Unknown	Kemper *et al.* 2003
Iceland	Humpback whale (juvenile)	2010	Spat line	Fatal	Young 2015; Price *et al.* 2017
Japan	Humpback whale	1988	Pearl	Alive and released (pending confirmation)	Ishikawa *et al.* 2013**
	Minke whale	2001	Scallop growing facility	Fatal (pending confirmation)	Ishikawa *et al.* 2013**
	Baird's beaked whale	1988	Scallop growing facility	Unknown	Ishikawa *et al.* 2013**
	Most likely fin whale	2013	Rope to grow seaweed	Alive (pending confirmation)	Ishikawa 2014**
	Unidentified whale	2001	Scallop growing facility	Fatal (pending confirmation)	Ishikawa *et al.* 2013**
New Zealand	Bryde's whale	1996	Mussel farm line	Fatal	Lloyd 2003; Baker 2005; Clement 2013; Price *et al.* 2017

	Bryde's whale	Unknown	Unknown	Unknown	Lloyd 2003
South Korea	North Pacific Right Whale	2015	Mussel farm	Released	IWC 2015; Kim *et al*. 2015; Price *et al.* 2017
U.S. (California but unconfirmed)	Gray whale	Unknown	Unknown aquaculture line	Fatal	Lloyd 2003
U.S. – Greater Atlantic Region	Leatherback sea turtle	2014	Shellfish aquaculture gear (vertical line of anchoring system)	Disentangled and released	Price *et al.* 2017

*References listed alphabetically by location

** DFO 2021.: https://open.canada.ca/data/en/dataset/0bf04c4e-d2b0-4188-9053-08dc4a7a2b03

** Information on the outcome/severity of these entanglement events was gained from personal communications between Integrated Statistics and authors of these publications; however, until these outcomes are verified in writing, they should not be included in formal counts of severe interactions/mortalities.

3.2. Habitat Modification

Habitat modification has the potential to affect the conservation function of physical and biological features of designated critical habitat, as well as ESA-listed species' ability to complete essential behaviors and life cycle stages. A few examples are discussed below demonstrating how certain aquaculture techniques (including floating gear, cage on bottom, and shell on bottom) may result in effects to ESA-listed species from habitat modification.

Activities that disturb the sea floor, or even the water column, may affect benthic and pelagic communities. Any reductions in the availability of prey or alterations of the composition of prey species may have an effect on the ESA-listed species' behavior, fitness, or development. For instance, submerged longlines use anchors for the longlines and vertical lines attached to anchors/weights on the seafloor. Previous section 7 consultations show that each longline may have multiple mooring anchors. These anchors and vertical lines may directly disturb benthic habitat and result in the loss of foraging resources for ESA-listed species. Potential impacts from these anchors include localized benthic disturbance, particularly during initial installation of the anchoring system. The placement of anchors may also result in a reduction in available benthic habitat for foraging. Alternatively, anchors may be utilized as habitat by marine invertebrates such as tunicates, sponges, corals, and bryozoans. These species may or may not provide additional foraging opportunities.

In general, the effects of habitat modification from floating aquaculture gear such as raft/docks (i.e., the temporary and/or permanent loss of foraging habitat from the installation of anchors) when added to the existing baseline condition in a given action area, are likely be too small to be meaningfully measured or detected, and effects are usually insignificant. For most lease sites, the size of the lease area in relation to the actual gear footprint (which is typically much smaller) has ensured sufficient suitable habitat remains for ESA-listed species to forage, migrate, or rest in the action area. Shading underneath submerged longline and catenary arrays may reduce benthic prey and forage items (e.g., insects, crustaceans, algae, and seagrasses) that depend on light and photosynthesis for primary production in the aquatic system by limiting their access to light and resources essential to growth.

The cage on bottom technique may also disturb or alter benthic habitat. This may result in reduced availability of prey species and/or alter the assemblage of prey for ESA-listed species. An action area (all areas impacted by the aquaculture action) most often includes a larger area than only the gear (cages, anchors, and any other associated devices). Therefore, the portion of the action area that remains undisturbed is generally larger than the area that is actively utilized for aquaculture activities. Thus, habitat modification effects on the foraging behavior of ESA-listed species when added to the existing baseline conditions at a site, will usually be too small to be meaningfully measured or detected, and are considered insignificant.

Shell on bottom aquaculture varies in scale and by technique. Variables of this gear type include thickness of shell piles; the addition of shell material to an existing shell-on-bottom substrate; or the addition of shell material to areas that were previously not shell on bottom substrate (i.e., soft subtidal substrate, tidal mud flats). In projects where shells are placed in areas that were previously not shell on bottom substrate, conversion of habitat occurs. Alternatively, a temporary, minimal loss of benthic resources will likely result when shell material is placed on areas with existing shell bottom; therefore, in most cases effects would not be able to be meaningfully detected and are insignificant. In scenarios where long-term habitat conversion occurs, impacts may vary in scale and scope depending on the size of the area, the specific location, and the current and potential value of that habitat for ESA-listed species. For example, if an aquaculture activity changes the habitat type of an area and reduces the abundance and/or diversity of infaunal species which use soft sediment habitats, ESA-listed species that rely on those infaunal species as prey will be affected. If large-scale habitat conversion is proposed as part of an individual project, or occurs cumulatively, the ecological effects of the change must be considered in the context of life stage requirements of ESA-listed species in order to determine the level of possible effects.

3.3. Vessel Strikes

Vessel strikes are a well-documented threat to ESA-listed species (e.g., whales, sea turtles, sturgeon) and their recovery[18]. Aquaculture, particularly in the offshore environment, is a new and emerging industry in the United States. Therefore, there is a significant information gap on the extent to which aquaculture vessels may contribute to vessel strike risk for ESA-listed species. With that said, the GAR approaches the analysis of vessel strike risk in a similar way, regardless of industry. Factors considered include: vessel speed, navigational clearance (i.e., depth of draft of the vessel relative to water depth), volume and density of vessels in the action area, number of vessel trips needed to install and tend to gear, and the density of ESA-listed species and their behaviors (e.g., foraging, migrating, or overwintering in the action area) in relation to the activity. These factors, combined with the seasonality of in-water work and any permit conditions that may be imposed by the action agency, help determine how many vessels will be added to the baseline for a given action, the potential effects of the additional vessels, and the associated risk of the aquaculture operation.

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[18] NOAA 2010.: https://repository.library.noaa.gov/view/noaa/4952,
NOAA 2008.: https://repository.library.noaa.gov/view/noaa/3720

In a typical vessel interaction analysis for any new activity, three elements are considered: the existing baseline conditions, the action and what it adds to existing baseline conditions, and new baseline conditions (the existing baseline conditions and the action together). To date, GAR section 7 biologists assessing the effects of one or two project vessels accessing aquaculture facilities have determined that in offshore areas, an extremely small, intermittent, and temporary increase in vessel traffic is highly unlikely to result in a vessel strike due to aquaculture activities in the action area. Furthermore, the risk of a vessel strike is extremely unlikely in offshore environments where listed species are able to disperse widely. Even for offshore operations, the analysis would need to consider strikes closer to shore, as the vessels are transiting from the mooring site to the aquaculture operation. As a result, the risk of a vessel strike in the action area is generally discountable[19].

In cases where the action is occurring in mouths of rivers or areas of high vessel traffic, the addition of project vessels will often be intermittent, temporary, and restricted to a small portion of the overall action area on any given day. As such, past ESA section 7 consultations have determined that any increased risk of a vessel strike caused by an aquaculture project will be too small to be meaningfully measured or detected. As a result, the risk of a vessel strike as a result of the proposed aquaculture project in the action area is insignificant.

While vessel strike analyses for aquaculture projects in the riverine, nearshore, and offshore environments have resulted in insignificant or discountable determinations to date, GAR section 7 biologists evaluate each project individually, and it is possible that a combination of

[19] If the best available information suggests that ESA-listed species are rarely in the action area with any great abundance or frequency, and projects vessels will be limited in both their number and the frequency of their transits, co-occurrence of vessel strikes and ESA-listed species is extremely unlikely, and effects from vessel strikes are discountable.

unique factors in a particular project, when added to existing baseline conditions, could result a conclusion of adverse effects.

3.4. Escapement

Escapement of individuals, as gametes, fertilized eggs, juveniles, sub-adults, or adults, from an aquaculture facility is a potential risk to ESA-listed species. If reared individuals escape, biological interactions between native and reared individuals in the surrounding environment may be impacted, which could result in loss of genetic variability, genetic introgression, or hybridization of the native population. Section 7 biologists consider a number of biological factors during risk assessment of escapement, including the genetic composition of reared individuals compared to native individuals; frequency, seasonality, and duration of escapes; life stages of escaped individuals; and the status of affected, native species. Ecological risks to native, ESA-listed species when escapes occur include increased competition for food, habitat, and during reproduction, in addition to the possibility of disease and pathogen transfer from reared individuals.

3.5. Comparison to Fishing Techniques/Gear

While there is little information on interactions between aquaculture gear and ESA-listed species, there is information available on impacts from various types of fishing gear and other gears that may use vertical lines. For this reason, until further research and experience can fully differentiate the relative risks posed by these gear types, fishing gear can, in certain cases, provide a useful analytical comparison for some types of aquaculture gear. However, there are certain circumstances where, if inappropriate proxies are used, the results might be misleading.

Therefore, the similarities and differences between gears must be carefully considered when comparing fishing gear to aquaculture gear.

Various types of fishing gear may interact with ESA-listed species. The potential effects to these species stem primarily from direct interactions with the gear that result in reduction of fitness, which can result in injury or death of an individual. Atlantic sturgeon have been caught in numerous types of commercial fishing gear in the GAR, including otter trawls, sink gill nets, and drift gill nets (Stein et al. 2004). There are several anecdotal reports of giant manta rays becoming entangled in mooring and anchor lines (C. Horn, NOAA Fisheries, unpublished data), as well as documented interactions reported for reef manta rays (Deakos et al. 2011) . Sea turtles also interact with fishing gear such as trawl, gillnet, sea scallop dredge, vertical fishing lines, and fish trap gear (Seminoff et al. 2015, Upite et al. 2019). Sea turtles are thought to be susceptible to entanglement as a result of their body configuration and behavior. Records of stranded or entangled sea turtles indicate that fishing lines can wrap around the neck, flipper, or body of the sea turtle and severely restrict swimming or feeding (Balazs 1985). Evidence indicates that lines and nets/mesh also have the ability to entangle whales (Johnson et al. 2005). Entanglement cases of right, sei, and fin whales have been documented from a variety of fishing gear types (Hayes et al. 2019).

The effects of entanglement can range from no effect to injury or death in sea turtles and whales (NMFS 2013, NMFS 2014). Entanglement of ESA-listed fish has been documented in net panels of gillnets. For whales and turtles, the animal may react immediately when it physically encounters a line or net/mesh, possibly resulting in an entanglement. Buoy lines can entangle in the animal's mouth, pectoral fin, or some other body part, which suggests that buoys connected to lines creates an additional factor in how the gear can entangle. Determining which part of fixed gear creates the most entanglement risk for ESA-listed species is difficult due to uncertainties surrounding the nature of the entanglement event, as well as unknown biases associated with reporting effort and the lack of information about the types and amount of gear used (Johnson et al. 2005). The vertical and ground lines of several different fisheries entangle ESA-listed species in the region. In some events, animals entangle in more than one set of gear. Type of gear, location, and type of species present may cause varied impacts to species, which could range from insignificant to adverse.

There are measures in place that are designed to reduce the frequency and severity of risk with fishing gear for both sea turtles and whales. For reducing/minimizing risk to sea turtles globally, measures include modifying fishing gear (e.g., altering net mesh size and increasing gear visibility), modifying fishing methods (e.g., changing the depth of gear deployment or daily timing of fishing operations), using acoustic deterrents, and reducing the breaking strength of mesh (Gilman 2009, Price et al. 2017). For large whale interactions with commercial gillnet and pot/trap fisheries, the following are used in the U.S. Atlantic: weak links to connect the vertical line to the buoy system for pot and gillnet gear, weak links between and within gillnet panels, seasonal and gillnet and trap/pot closures, reduction of vertical lines for trap fisheries through traditional trap reduction and trawling up methods[20], and use of sinking groundlines between pots and for gillnet anchoring lines for most east coast U.S. waters except for certain exempted nearshore areas (Van Der Hoop et al. 2013)[21].

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[20] NOAA 2014.: https://www.federalregister.gov/documents/2014/06/27/2014-14936/taking-of-marine-mammals-incidental-to-commercial-fishing-operations-atlantic-large-whale-take

[21] List of mitigation measures implemented as part of the ALWTRT can be found at the following link. NOAA 2021.: https://www.fisheries.noaa.gov/new-england-mid-atlantic/marine-mammal-protection/atlantic-large-whale-take-reduction-plan

As with other projects, the section 7 team must evaluate whether the fishing gear has potential impacts to the ESA-listed species in the action area including hindrance of passage and entanglement risk. The effects may vary depending on the action (e.g., fishing season, gear type and density), action area, and which species/life stages are expected to be present. In the consultation, the severity of effects that may result from potential interaction with the gear must be determined as to whether they are likely to adversely affect or not.

4. Risk Assessment Framework to Assist in ESA Section 7 Consultations

Section 7 biologists must consider the potential for interactions between ESA-listed species in an action area and the components of a proposed aquaculture project. Effects to species vary depending on the action, action area, and species/life stages present. Potential risks from all activities associated with each aquaculture project (e.g., entanglement, habitat modification, and vessel traffic) should be methodically analyzed to ensure adequate protection for ESA-listed species. Section 7 biologists perform this assessment of risk to evaluate first, the likelihood of an interaction and secondly, the severity of that potential interaction with listed species. There is a need for a refined methodology to consistently and efficiently analyze and assess potential risk to ESA-listed species from aquaculture activities. We identified a number of risk assessment methods, both quantitative and qualitative, that could assist with aquaculture-specific section 7 analyses. Existing approaches include a qualitative risk scoring assessment to assess likelihood of salmon infection; risk models to understand North Atlantic right whale entanglement; and simulation models. Ultimately, the development of an analytical framework for risk assessment will allow the section 7 team to conduct consultations for future aquaculture projects more efficiently, consistently, and thoroughly.

4.1 Current Approach to ESA Section 7 Analysis

The section 7 process commences when an action agency determines that an action may affect ESA-listed species and designated critical habitat (i.e., Not Likely to Adversely Affect or Likely to Adversely Affect). The section 7 biologist considers many factors analyzes how effects of a proposed action will impact ESA-listed species before concurrence or non-concurrence with the action agency's determination. The section 7 biologist also analyzes data about seasonal variability of ESA-listed species presence, life stages, and behaviors to understand how the timing of the proposed action will affect species. For example, Table 4.1 depicts the seasons when ESA-listed species could be present in New York waters in relation to the timing of a kelp aquaculture project. In this location, Atlantic sturgeon, shortnose sturgeon, and sea turtles at various life stages are present during most or all of the year, depending on the species (green boxes in Table 4.1). The growing season (when gear is active in the water column) for this project typically runs from October to May (diagonal patterned boxes). The months when both kelp operation and ESA-listed species are present is roughly from January to May and October through December. Therefore, these months will be evaluated for potential effects of the kelp aquaculture operation to the listed ESA-listed species present. This is an example of one of the many analyses conducted by the section 7 biologists to assess potential risk of aquaculture activities to ESA-listed species.

Table 4.7: Life stages of ESA-listed species versus timing of a kelp aquaculture project in Long Island Sound, New York. Green shading indicates that the species may be present in the action area. The diagonal pattern represents the growing season for a kelp aquaculture operation. The green shading with diagonal patterns represents months when ESA-listed species may be present during in-water kelp operation.

Species	**Life Stage**	**Months**											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Atlantic Sturgeon	Adult & Sub-adult												
Shortnose Sturgeon	Adult												
Sea Turtles	Adult & Juvenile												

4.2 Potential Approaches and Models

Many complex variables are considered when assessing aquaculture projects and their potential effects to ESA-listed species during the ESA section 7 consultation process, therefore, there is a need for additional innovative methods to assist section 7 biologists with risk analyses to ensure that they are consistent and efficient. To supplement current analytical methods, we evaluated additional options that can be used to assess risk and complement the existing process. A number of quantitative and qualitative risk assessment approaches, a North Atlantic right whale entanglement model, and simulation models for both turtles and whales were explored for their utility and applicability to aquaculture risk assessment.

Risk assessments are conducted using quantitative methods, qualitative methods, or a hybrid of the two. Quantitative risk assessment methods are typically used when a regulatory standard or an effect level (i.e., exposure thresholds that are likely to be without an appreciable risk of deleterious effects during a lifetime) is available. Qualitative risk assessment is based on qualitative or subjective descriptions rather than numerical or statistical data. This method requires less precise information; it ranks the severity and likelihood of risks using categories such as high, medium, and low. Since no regulatory standard or effect threshold (e.g., number of vertical/horizontal lines, tension values, or space between lines) is currently available for aquaculture gear, quantitative approaches are not an option at this time. However, a qualitative approach may be applicable and useful to section 7 biologists.

A qualitative risk scoring assessment study was conducted on a salmon population to understand infection risk by using categories to describe likelihood (Table 4.2) and severity (Table 4.3) (Mimeault et al. 2017). The risk score is estimated by multiplying likelihood by the severity (Table 4.4). Risk scores were binned as minimal (1-8), moderate (9-18), and high risk levels (20-36),[22] and color-coded to help to visualize the risk (Table 4.4). If a scoring schema can be established for aquaculture projects in this manner, the qualitative method described may be a viable risk assessment method for the ESA section 7 consultation process.

[22] Based on the combination of numbers multiplied, total risk score of 19 does not exist.

Table 4.8: Categories and definitions for describing likelihood of salmon infection (adapted from Mimeault et al. 2017).

Level	Categories	Definitions
1	Extremely unlikely	Event has little to no chance to occur
2	Very unlikely	Event is very unlikely to occur
3	Unlikely	Event is unlikely but might occur
4	Likely	Event is likely to occur
5	Very likely	Event to very likely to occur
6	Expected	Event is expected to occur

Table 4.9: Levels of impact to salmon diversity and abundance from infection (adapted from Mimeault et al. 2017).

Level	Categories	Definitions
1	Negligible	No change in diversity/abundance of salmon
2	Minor	Minor reduction in abundance/diversity
3	Moderate	Moderate reduction in abundance/diversity
4	Major	Major reduction in abundance/diversity
5	Severe	Reduction in abundance/diversity that would result in loss of the salmon conservation unit
6	Extreme	Reduction in abundance/diversity that would result in loss of > 1 salmon conservation unit

Table 4.10: Risk rating matrix. Green, yellow, and red represent minimal, moderate, and high risk, respectively (adapted from Mimeault et al. 2017).

		Consequence					
		1	2	3	4	5	6
Likelihood	6	6	12	18	24	30	36
	5	5	10	15	20	25	30
	4	4	8	12	16	20	24
	3	3	6	9	12	15	18
	2	2	4	6	8	10	12
	1	1	2	3	4	5	6

In addition to qualitative risk assessments, tools used for assessing risk from fishing gear to North Atlantic right whales potentially have the capability to be adapted to assess risk of aquaculture techniques and the associated gear to ESA-listed species. These options include the Woods Hole Oceanographic Institute's (WHOI) entanglement risk model and the Northeast Fisheries Science Center's (NEFSC) North Atlantic Right Whale Decision Support Tool. Both of these models are specific to North Atlantic right whales, but the framework could potentially be tailored to other species.

The WHOI entanglement risk model estimates the entanglement risk to North Atlantic right whales from lobster trap gear off Maine (H. Kite-Powell, WHOI, pers. comm), but could potentially be modified to assess risks to other ESA-listed species from aquaculture gear interactions. This model estimates risk to a North Atlantic right whale as a function of the expected number of physical encounters between North Atlantic right whales and lobster fishing gear. The estimated number of encounters is related to the concept of co-occurrence that is used in fishing gear risk characterizations.

In addition to WHOI's entanglement risk model, the NEFSC's decision support tool, used by the Atlantic Large Whale Take Reduction Team (ALWTRT) for assessing entanglement risk of North Atlantic right whales from fishing gear, could also be applied to risk assessment of aquaculture operations. The ALWTRT used the NEFSC tool to evaluate fishing gear and configuration alternatives to help reduce risk to North Atlantic right whales[23]. Risk is calculated using the following equation:

Risk = [Likelihood] * [Severity]

[23] Further information on the ALWTRT meeting and how the goal of 60% was calculated can be found at the following link. NOAA 2021.: https://www.fisheries.noaa.gov/feature-story/team-reaches-nearly-unanimous-consensus-right-whale-survival-measures

The likelihood of North Atlantic right whale encounters with gear is based on whale density and gear density (i.e., number of vertical lines). Severity refers to the magnitude of impact to North Atlantic right whales (e.g., serious injury, mortality, or sublethal impacts). In developing this tool, the NEFSC recognized that some gear types are likely more dangerous to North Atlantic right whales than other gear types. As such, a severity modifier is used to account for these differences. Therefore, the overall equation can be modified to:

Risk = [Whale density] * [Gear Density] * [Severity of Gear Configuration]

If appropriate severity modifiers were developed for different types of aquaculture gear, the NEFSC risk tool could potentially be adapted to measure risks to ESA-listed species from interactions with aquaculture operations, providing another option for determining risk of aquaculture gear to ESA-listed species.

In addition to the two risk methods developed for North Atlantic right whales, there are two simulation models used to assess entanglement risk of marine animals in fishing gear. Howle et al. (2019) created a virtual representation of a right whale to investigate the severity of interactions with fixed fishing gear with vertical buoy lines. This whale simulator model (WSM) allows users to swim a virtual whale model using a game controller in an attempt to re-create an entanglement scenario. However, this model assumes that the whale will interact with gear if they are present in the same space at the same time. MacNicoll et al. (2017) created a simulation model of a leatherback sea turtle to investigate interactions with vertical lines. Unlike the whale simulator model, the sea turtle model incorporates propulsion through articulated flippers rather than controlled by a gaming operator. However, it only evaluates leatherback sea turtles and risks from interaction with vertical lines. Although both whale and sea turtle simulation models have their limitations (Appendix E and F), they have the potential to be modified to evaluate risks from aquaculture gear to ESA-listed species.

4.3 Ongoing Research

Ongoing research and technological developments related to assessing risks from aquaculture projects to ESA-listed species are vital to mitigation and conservation efforts. NOAA and several partners are currently leading an effort to develop an entanglement simulator. The main objective of the entanglement simulator is to provide resource managers, regulators, and industry with a tool to proactively assess and mitigate the risk of entanglement for protected whale species and leatherback sea turtles in offshore mussel longlines and floating wind turbine configurations. Ground-truthed in detailed whale morphology, meristics, and observed behaviors, and rooted in gear engineering, design, and physics, the simulations will provide descriptive statistics on the expected numbers of scenarios resulting in encounters, near misses, and entanglement out of all possible outcomes.

The Hubbs-Sea World Research Institute (HSWRI) received federal funding in 2018 to monitor and reduce the risk of protected species entanglement with marine aquaculture gear in California. The goal of their project is to review available information, effectiveness of current mitigation measures, and to develop engineering and monitoring tools to reduce entanglement risks. Although HSWRI's project focuses on offshore California waters and geographical differences exist between California and the GAR, information from the HSWRI's project may be useful for understanding risks from aquaculture interaction to ESA-listed species in GAR.

The Hydromechanics Laboratory at the U.S. Naval Academy is quantifying interaction dynamics between whales and aquaculture gear with simplified physical model tests (Wang et al. 2020). Laboratory experiments were conducted to study the flotation and stiffness characteristics of a kelp-growing submerged longline system being used in the Northeast. The aquaculture system consists of a 400-foot line for growing kelp in 50 feet of water. Their effort will help initiate the validation of the whale simulator model previously discussed.

4.4 Research Needs

To bridge knowledge gaps and improve the risk assessment methodology for ESA consultations, more extensive monitoring of existing aquaculture operations would be beneficial. Generally, monitoring schedules that have resulted from completed ESA section 7 consultation vary as part of the Corps' permits. Other monitoring schemes (remote sensing, drones, etc.) may be necessary and useful for future projects. Additionally, the type of data collected from current monitoring reports is not always useful or consistent. It would be beneficial for NOAA Fisheries to participate in development of desired/needed monitoring requirements for aquaculture projects that can be coordinated with permitting agencies, (i.e., Corps and EPA). The suggested monitoring could include detailed information (e.g., sightings of ESA-listed species; proximity of the species to the aquaculture gear; frequency of ESA-listed species interactions with aquaculture gear; and recommendations on types of monitoring equipment at the aquaculture facilities).

Furthermore, in addition to in-person monitoring by aquaculture operators, it may be beneficial for operators to use cameras or other devices (e.g., passive acoustic monitoring, infrared cameras, etc.) that provide for real-time remote monitoring of the aquaculture operation. Some research projects have used underwater cameras to evaluate aquaculture gear. Underwater footage could provide an understanding of marine species behavior around aquaculture gear[24].

[24] NOAA 2021.: https://www.fisheries.noaa.gov/new-england-mid-atlantic/aquaculture/milford-labs-gopro-aquaculture-project

Real-time surface monitoring has also been proposed for use at a potential ITMA project off the coast of New Hampshire. The use of both underwater and surface cameras may allow for near real-time reports of entanglement, which could be beneficial for disentanglement response teams.

Reporting of aquaculture-related incidents on a global scale is not consistent. It would be beneficial to standardize and centralize reporting for each country, starting with countries with high marine production capacities, long marine aquaculture histories, and countries where GAR ESA-listed species also range. In addition, it would be useful to identify valuable monitoring regimes that result in absences/low entanglement reports. These steps would allow increased utility for marine aquaculture interactions assessment worldwide.

Another idea to bridge knowledge gaps includes research on whether entanglement risk differs depending on animal morphology and behavior. For example, research on how body shape and skeletal flexibility affect the likelihood of entanglement could be useful. By investigating these questions, scientists can better understand differences in risk between species based on their morphological features.

A possible research path is tension analysis. Analysis of tension of various components in aquaculture systems could be conducted in a modeling project to answer the question about the threshold of tension that is needed to prevent entanglement for a particular species. In general, research into the effectiveness of technologies available to minimize severity of entanglement to ESA-listed species or report near real-time on possible entanglement events can be areas of further investigation.

Continued research efforts to understand habitat (including migration, reproduction, and foraging patterns) use by ESA-listed species will also be beneficial. Without in-depth knowledge of the possible locations of a species at a given time, it will be challenging to assess possible impacts to ESA-listed species from aquaculture activities.

As part of the section 7 consultation process, action agencies must prepare a Biological Assessment (BA) outlining the effects of the proposed action on ESA-listed species and critical habitat. One area of future research and development for the GAR would be to generate BA templates for action agencies and applicants that outline the information needed, organized by cultured species and gear configuration. Templates could also include recommended best management practices and risk minimization measures that could be built into permit applications. This would enhance transparency and consultation efficiency.

Lastly, for aquaculture projects in close proximity to one another, further discussion with the action agency may be warranted during the technical assistance phase prior to consultation, depending on the situation. Cumulative effects analysis under ESA are only conducted during a jeopardy analysis as part of a formal consultation and not part of preparation of Letters of Concurrence on informal consultation. However, discussions about the potential additive effects of a project are encouraged during the informal process.

4.5 Avoidance and Minimization Measures to Decrease or Avoid Impacts

For coastal and offshore aquaculture activities that use vertical and horizontal lines, anchoring systems, and floats and buoys, the section 7 biologist provides recommendations to project applicants and action agencies to help minimize and even prevent entanglement risk to ESA-listed species. Although aquaculture gear configurations vary significantly and are evaluated individually, many include a vertical anchor/pickup line and a horizontal seaweed/mussel/shellfish growing mainline or backbone. While the absolute risk of some aquaculture gear is unknown and may vary from traditional fishing gear, both vertical and horizontal lines used in aquaculture have the potential to entangle ESA-listed species. Moreover, the larger the aquaculture activity area (i.e., the footprint of the overall aquaculture gear), the higher the likelihood of ESA-listed species encountering the gear which may or may not result in entanglement. A number of risk reduction methods have been previously recommended for inclusion in actions during the section 7 consultation. These methods may reduce the potential risk of entanglement for ESA-listed species and include the following: maintain tension on lines; line sheathing[25]; replacement of lines with PVC pipes or other stiff materials; minimizing the number of lines (e.g., only marking ends of gear rather than along the entire gear array); and use of weak links.

The presence of aquaculture gear, when added to existing baseline conditions, must also be considered in the context of whether the gear is a potential impediment to the movement of ESA-listed species in the action area. If so, methods to minimize the risk should be considered (See Appendix H for a list of potentially useful Avoidance and Minimization Measures).

[25] Adding rigidity to lines may reduce entanglement risks to some ESA-listed species; however, if the measure only takes place on small portion of the line (i.e., partial sheathing), it could increase the risk of lethal entanglement for sea turtles by preventing their ascent to the surface and large whales if disentanglement operations are needed following an entanglement incident. In addition, the material used to sheath the line is also important when considering rigidity. Sheathing with PVC provides more rigid than sheathing with flexible rubber hose.

5. Analytical Consultation Framework

This new analytical framework was designed to assist ESA section 7 biologists with efficiently analyzing the growing number and diversity of aquaculture projects in the GAR and to ensure a consistent approach and methodology. Ultimately, the framework will also help biologists determine the most appropriate consultation pathway during pre-consultation discussions with the action agency and for technical assistance requests from applicants i.e., No effect; Not likely to Adversely Affect (NLAA); or Likely to Adversely Affect (LAA)) based on the magnitude of anticipated effects associated with the and ensure biologists take a consistent analytical approach. This framework is a user-friendly online program that prompts the section 7 biologist for information about the proposed project and produces a recommended consultation pathway for each relevant stressor. Although it is useful, the framework does have limitations. This analytical framework is intended to be useful for initial guidance at the early stages of ESA section 7 consultation on aquaculture projects, but it is not intended to replace the current ESA section 7 consultation process. Ultimately, ESA section 7 biologists will continue to use their best professional judgement and the best available scientific information to analyze the risk of effects of the action to ESA-listed species and designated critical habitat.

Google Forms[26] was the most viable software to develop this analytical framework. The Google Forms format has several major advantages: it enables biologists to evaluate questions discretely; allows for streamlined input of complex data; allows for efficient use of resources (budgeting staff time and resources); is easy to edit, can be adapted as new data become available; allows for real-time monitoring of responses; and records data for future use and analysis.

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[26] https://docs.google.com/forms/d/e/1FAIpQLScHMIiRdJ13VdaeYmBbLt9rIVadFrrG0nMp04m-_cNTQ8euHw/viewform

5.1. Applying the Framework

When an action agency requests technical assistance for an aquaculture permit to determine the possible effects of the project, the section 7 biologist will enter the provided project details into the analytical framework in order to assess if reasonable pathways for effects to ESA-listed species or critical habitat exist. If there are no pathways to effects, the framework guides the section 7 biologist to recommend that the action agency review our “no effect” determination web guidance. Based upon that technical assistance, the action will not require section 7 consultation.

Similarly, based upon data provided by the section 7 biologist, the analytical framework may indicate that the project may affect, but is “not likely to adversely affect” (NLAA) ESA-listed species or critical habitat. In this scenario, several options are available to the section 7 biologist to complete consultation. An option is to proceed with the NLAA consultation using a programmatic Verification Form (VF)[27], with the possibility of including a minor supplemental analysis if not all of the programmatic project design criteria are met. In this option, the section 7 biologist could recommend that the action agency provide a justification in the VF to support their determination that the project is consistent with the effects analysis contained in the North Atlantic Division (NAD) Programmatic Consultation.

Another option the framework offers is “individual NLAA consultation.” In this scenario, the action agency and NOAA Fisheries must proceed with an individual consultation, likely ending with a letter of concurrence. This category of consultation requires the action agency to provide a robust analysis of project impacts that may affect, but are not likely to adversely affect, ESA-listed species. During an individual NLAA consultation, the section 7 biologist and the

[27] https://www.fisheries.noaa.gov/new-england-mid-atlantic/consultations/section-7-take-reporting-programmatics-greater-atlantic#garfo-(prd)---usace-(nad)-nlaa-program

action agency discuss the project elements and potential impacts and may develop or include appropriate avoidance and [28]minimization measures[29] to ensure that effects are insignificant (too small to be detected), discountable (extremely unlikely to occur), or entirely beneficial. When included as part of the action, the avoidance and minimization may reduce the effects to a level at which they are NLAA ESA-listed species or critical habitat, allowing NOAA Fisheries to concur with the action agency's determination that all consequences of the action are NLAA.

The final option the analytic framework may provide is "likely to adversely affect" (LAA) ESA-listed species or critical habitat based on data from the proposed activity/activities and the presence of ESA-listed species. In this circumstance, a formal consultation, concluding a BiOp, is necessary.

Although the analytical framework can assist with determining the potential range of impacts that an aquaculture activity may have, it will only serve as a guide in determining the best path forward. Section 7 biologists and the action agency will still need to perform appropriate analyses to complete the consultation.

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[29] A list of Avoidance and Minimization Measures that have been suggested in literature or used in previous consultations are provided in Appendix H.

Table 5.11: Categories used in the Google Form analytical framework.

Determinations used in the Google Form	**Consultation process recommended as a result of framework determination**
No Effect/No Consultation	Project does not require a consultation.
Not Likely to Adversely Affect (NLAA) using Verification Form (VF)	Proceed with the NLAA designation, using a Verification Form (VF).
NLAA VF with Justification	Proceed with the consultation using the VF and provide a justification.
NLAA – Individual Consultation	Proceed with an individual informal consultation. Avoidance and mitigation measures may be needed to ensure that all effects are insignificant and/or discountable.
Likely to Adversely Affect (LAA)	Proceed with a formal consultation with an LAA designation, by writing a biological opinion (BiOp). RPMs and an ITS will be provided, with the possibility of a jeopardy determination, in which case a Reasonable and Prudent Alternative (RPA) would be drafted.

5.2 Consultation Framework Functionality and Format

The framework presents a series of questions about the proposed aquaculture project to the section 7 biologist. When prompted, the section 7 biologist selects the most appropriate answer for a question based on project specific criteria and proceeds to the next question (see Appendix G for detailed information on the consultation framework). Sets of questions built into the framework vary based on the type of project. The framework will recommend a determination (e.g., No Effect, NLAA, LAA) for each stressor by species relevant to the aquaculture project. Once the section 7 biologist answers all the questions, they then create a table to compile the determinations for each relevant stressor and to select the most appropriate overall determination. Following this determination, the section 7 biologist and the action agency will need to provide appropriate analyses to complete the consultation. The section 7 biologist will always need to use their own judgment and experience to ultimately determine the appropriate ESA consultation process.

Upon receiving the suggested determinations for each stressor, the section 7 biologist assembles the individual determinations to evaluate the overall impact of the entire proposed project. This comprehensive review of the effects of all relevant stressors will inform the ESA determination (Table 5.2). Ultimately, the appropriate consultation pathway is based on the stressor with the greatest impact (ranking of effects listed in Table 5.1). For example, if a single stressor such as entanglement is LAA a listed species, then the entire consultation will be formal, even if the other stressors were independently determined to be NA or NLAA. Alternatively, if all the stressors are NA, VF, or VF with Justification, consultation will be completed informally using a VF.

Table 5.2: Example of the compiled recommendations from the consultation framework. The consultation framework provides a determination for each stressor of the aquaculture project. The user compiles the determinations and uses them to complete the consultation, selecting the path with the highest impact (NA=Not Applicable; VF=Verification Form; NLAA=Not Likely to Adversely Affect; LAA=Likely to Adversely Affect).

Stressor	Individual Determinations by Stressor	Final Determination for Overall Project
Sound	NA	LAA
Hindrance of passage	VF	
Habitat modification	VF	
Dredging	NA	
Vessels	VF	
Entanglement	LAA	
Escapement	NA	

If the section 7 biologist is evaluating an aquaculture project that includes more than one aquaculture gear type/technique (e.g., floating gear and cage on bottom gear), the biologist should assess each gear type individually. Once the section 7 biologist has completed assessments for all aquaculture gear/techniques used in the project, the biologist compiles the determinations for all aquaculture gear types in the proposal to make an overall determination.

5.3 Limitations of the Analytical Consultation Framework

This consultation framework tool is a guide for ESA section 7 biologists to assist them with completing ESA consultation on aquaculture projects with the action agency. The goal of the framework is to provide a consistent analytical approach , regardless of the type of aquaculture project or biologist conducting the analysis.

The framework is also intended to improve efficiency of consultation by ensuring all relevant project and species information is considered early in the consultation process. In its current form, the Section 7 team will use the framework internally, but at a later date, this framework could be adapted for use by action agencies and individual aquaculture applicants. However, it may assist outside entities indirectly if the section 7 biologist provides them with guidance based on the framework's results. At this time, the consultation framework does not support a detailed assessment of the effects generated from aquaculture activities once a consultation is deemed necessary. For instance, the framework may recommend a LAA determination; however, it does not provide details about how to estimate take of listed species or steps needed to complete the formal consultation. In other words, the framework only assists a section 7 biologist in determining what type of consultation may be necessary (i.e., no effect, NLAA, LAA). Once those determinations are recommended, it is up to the section 7 biologist to determine the criteria that are appropriate for proceeding with the consultation (e.g., the number of vertical and/or horizontal lines that may result in entanglement risk, best management practices that may reduce potential risks to ESA-listed species).

With more funding and research, additional functions could be incorporated into the framework to provide GAR section 7 biologists with a standardized approach (tailored by gear type, cultured species, etc.) for a) recommending best management practices and risk minimization measures; and b) once a project design and its operations plan are finalized, assessing risk of gear interactions and if necessary, calculating the anticipated level of take for in Incidental Take Statement (ITS) as part of a Biological Opinion. This development would further reduce any inconsistencies in the evaluation of proposed aquaculture projects, more efficiently convey technical assistance to action agencies, and would likely reduce consultation timelines in the GAR.

A number of emerging stressors may be considered in the future including light and disease transmission. The tool has not incorporated these stressors yet, and others may arise as the framework is used.

While the scope of the analytical framework is currently limited to the GAR Section 7 team, it provides an important first step in improving consultation consistency and efficiency for section 7 biologists.

6. Conclusion

Given industry trends, an increase in federal aquaculture project proposals is likely in the future. ESA section 7 biologists will need to respond to these consultation requests in a methodical, consistent, and timely manner. Therefore, we developed an analytical consultation framework to assist section 7 biologists in identifying the appropriate consultation pathway when assessing risk to listed species and critical habitat from aquaculture projects. Using the framework, each project parameter is evaluated to determine the level of impact from each stressor related to a proposed aquaculture activity. Section 7 biologists then compile the information from the framework to assist in making an appropriate determination and consultation pathway.

Within GARFO, this analytical framework is intended to be used to specifically assist ESA section 7 evaluation of proposed aquaculture activities. If sufficient resources and funding become available, this consultation framework could be updated, modified, or extended to other types of activities. In addition, findings and data from the models discussed previously could be incorporated into this consultation framework to increase its robustness. The consultation framework could also be modified and used in other regions (e.g., including ESA-listed species outside of GAR).

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Appendices

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Appendix A. Aquaculture Gear Locations, Technique Used, Organisms Grown, Distance from Shore, and Depth[1]

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
1	NER-2016-13282	38.2793	-76.8095	MD	Cage on Bottom	Oyster	0.32	-3.7
2	NER-2016-13044	43.4734	-70.3667	ME	Floating Gear	Kelp	0.73	-7.4
3	NER-2016-13247	41.4859	-71.0413	MA	Floating Gear	Oyster	0.04	-2.6
4	NER-2015-12833	38.0717	-76.1944	MD	Multimode	Oyster	5.60	-6
5	NER-2016-13360	37.2231	-76.4499	VA	Shell on Bottom	NA	0.26	-4.2
6	NER-2016-13205	44.4932	-67.5535	ME	Net pen	Atlantic salmon	0.477	-15.2
7	NER-2016-13535	41.2675	-72.6253	CT	Cage on Bottom	Oyster	0.20	-0.7
8	NER-2016-13553	39.7681	-74.1272	NJ	Cage on Bottom	Oyster	0.19	-5.3
9	NER-2016-13597	42.5691	-70.7507	MA	Floating Gear	Kelp	0.16	-8.4
10	NER-2017-14091	38.2423	-76.7875	MD	Shell on Bottom	Oyster	0.25	-1.4
11	NER-2016-13884	43.8742	-69.8977	ME	Shell on Bottom	Clam	0.03	0
12	NER-2016-13869	41.3242	-71.9175	CT	Cage on Bottom	Oyster	0.32	-5.7
13	NER-2016-13895	39.2299	-75.2915	NJ	Cage on Bottom	Oyster	3.55	-6.2

[1] Data compiled from ESA section 7 consultations between 2015 and January of 2019 (in addition to two cases in 2014).

Consultation #	**Tracking #**	**Latitude**	**Longitude**	**State**	**Technique**	**Taxa**	**Distance from Shore (nm)**	**Depth (m)***
14	NER-2017-13989	41.3562	-70.7674	MA	Floating Gear	Kelp	0.05	-2.5
15	NER-2016-13813	39.1812	-75.1719	NJ	Cage on Bottom	Oyster	1.00	-4.7
16	NER-2017-14024	38.0912	-76.3306	MD	Cage on Bottom	Oyster	0.04	0
17	NER-2016-13623	41.1669	-73.0834	CT	Cage on Bottom	Oyster and clam	0.90	-4.2
18	NER-2017-14183	38.0941	-76.3286	MD	Cage on Bottom	Oyster	0.13	-1.2
19	NER-2017-14169	40.4961	-74.2369	NY	Floating Gear	Oyster	0.12	-1.5
20	NER-2017-14167	39.7706	-74.1331	NJ	Cage on Bottom	Oyster	0.29	0
21	NER-2017-14232	41.3122	-71.9462	CT	Floating Gear	Kelp	1.13	-7.1
22	NER-2017-14347	39.1571	-75.1816	NJ	Cage on Bottom	Oyster	2.34	-5.4
23	NER-2017-14330	41.2082	-73.0031	CT	Floating Gear	Kelp	0.26	-1.3
24	NER-2017-14264	41.4947	-71.0277	MA	Floating Gear	Oyster	0.40	-7.8
25	NER-2017-14379	41.4783	-70.3083	MA	Floating Gear	Kelp	7.29	-8.8
26	NER-2016-13598	39.1426	-74.8864	NJ	Floating Gear	Oyster	0.00	-0.2
27	NER-2016-13631	39.1578	-75.1617	NJ	Cage on Bottom	Oyster	1.71	-3.4
28	NER-2018-14998	41.1938	-71.5796	RI	Floating Gear	Kelp	0.24	-1.7

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
29	NER-2017-14518	41.0460	-73.4151	CT	Floating Gear	Kelp	0.17	-9.4
30	NER-2018-14759	40.9854	-73.6098	CT	Floating Gear	Kelp	1.21	-10.1
31	NER-2018-14782	41.5465	-71.4226	RI	Floating Gear	Oyster and kelp	0.15	-0.8
32	NER-2018-15085	41.3151	-71.9459	CT	Floating Gear	Kelp	1.06	-8.2
33	NER-2018-14928	39.5646	-74.2922	NJ	Multimode	Oyster	0.04	-0.5
34	NER-2017-14469	41.3130	-72.0490	CT	Floating Gear	Kelp	0.47	-6
35	NER-2017-14534	41.2428	-72.7956	CT	Floating Gear	Kelp	0.80	-6.1
36	NER-2018-14940	41.6466	-70.108800	MA	Floating Gear	Kelp	0.63	-5.6
37	NER-2018-14997	41.6656	-70.0025	MA	Floating Gear	Kelp	0.22	-2.3
38	NER-2018-15010	40.4390	-74.0612	NJ	Cage on Bottom	Oyster	0.71	-2.8
39	NER-2018-15000	41.5200	-70.7317	MA	Floating Gear	Kelp	0.70	-7.7
40	NER-2018-14762	39.1515	-75.0824	NJ	Cage on Bottom	Oyster	3.04	-3
41	NER-2019-15110	41.3120	-71.9384	CT	Floating Gear	Kelp	1.22	-8.5
42	NAE-2013-1584	41.5112	-70.7317	MA	Floating Gear	Kelp	0.41	-14
43	NAE-2012-1598	42.7270	-70.4500	MA	Floating Gear	Mussel	7.15	-83.3

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
44	NAE-2017-00298	43.8237	-70.0953	ME	Cage on Bottom	Oyster	0.10	-0.1
45	NAE-2015-01601	41.1336	-73.1075	CT	Cage on Bottom	Oyster	1.05	-9.2
46	NAE-2017-867	41.7268	-70.6281	MA	Shell on Bottom	Clam	0.16	-0.2
47	NAE-2011-00882	41.1812	-73.1752	CT	Floating Gear	Oyster	0.00	0
48	NAP-OP-R-2017-0160	39.6081	-74.2897	NJ	Multimode	Oyster	0.06	-0.1
49	NAO-2017-0419	36.9063	-76.3213	VA	Shell on Bottom	Oyster	0.06	0
50	NAO-2017-0141	36.8555	-76.3052	VA	Shell on Bottom	Oyster	0.00	0
51	NAB-2016-01617	38.3167	-76.4521	MD	Cage on Bottom	Oyster	0.29	-0.8
52	NAB-2016-01485	38.1046	-76.4141	MD	Shell on Bottom	Oyster	0.11	-0.1
53	NAB-2016-01609	38.2318	-76.6888	MD	Cage on Bottom	Oyster	0.16	-0.8
54	NAE-2017-00854	41.1467	-73.2356	CT	Shell on Bottom	Oyster	0.00	0
55	NAE-2017-01380	41.1467	-73.2356	CT	Shell on Bottom	Oyster	0.00	0
56	NAO-2010-0922	36.9101	-76.3134	VA	Shell on Bottom	Oyster	0.00	-0.1
57	NAB-2016-01488	38.3842	-76.5390	MD	Cage on Bottom	Oyster	0.04	-1.9
58	NAE-2017-00205	41.3272	-72.1781	CT	Cage on Bottom	Oyster	0.00	-0.2

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
59	NAN-2017-00710-EMI	40.8876	-73.5154	NY	Shell on Bottom	Oyster and clam	0.16	-11.5
60	NAB-2016-01611	38.8612	-76.5185	MD	Shell on Bottom	Oyster	0.13	-2.9
61	NAN-2017-00748-EGR	40.7048	-73.9883	NY	Cage on Bottom	Oyster	0.00	-0.1
62	NAO-2016-01555	37.3185	-76.5679	VA	Cage on Bottom	Oyster	0.00	-0.1
63	NAN-2017-00746-EGR	40.6543	-74.0191	NY	Cage on Bottom	Oyster	0.00	3
64	NAN-2017-00743-EGR	40.6265	-73.9043	NY	Cage on Bottom	Oyster	0.00	-3.1
65	NAN-2017-00749-EGR	40.5125	-74.1994	NY	Shell on Bottom	Oyster	0.00	0
66	NAP-OP-R-2017-00254-83	39.4196	-74.3599	NJ	Multimode	Oyster	0.09	-7
67	NAB-2017-00426	38.5777	-76.0158	MD	Shell on Bottom	Oyster	0.39	-2.5
68	NAB-2017-00429	38.5847	-76.0053	MD	Shell on Bottom	Oyster	0.27	-3.3
69	NAB-2017-00465	38.5678	-76.0368	MD	Shell on Bottom	Oyster	0.26	-3
70	NAB-2017-00625	38.2496	-75.9356	MD	Shell on Bottom	Oyster	0.33	-2
71	NAB-2017-00628	38.3371	-76.0034	MD	Shell on Bottom	Oyster	0.58	-1.2
72	NAB-2017-00467	38.2230	-75.8641	MD	Shell on Bottom	Oyster	0.40	-2.1

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
73	NAE-2017-01345	41.2534	-72.7424	CT	Cage on Bottom	Oyster	0.32	-1
74	NAE-2017-01736	43.5556	-70.3418	ME	Shell on Bottom	Clam	0.03	1
75	NAE-2017-01701	41.2563	-72.7392	CT	Cage on Bottom	Oyster	0.10	-0.1
76	NAB-2017-00466 / LEASE #401	38.1415	-75.8171	MD	Shell on Bottom	Oyster	0.18	-1.3
77	NAB-2016-01230	38.2162	-75.8489	MD	Shell on Bottom	Oyster	0.39	-1.9
78	NAB-2016-01225	38.1645	-75.9563	MD	Shell on Bottom	Oyster	0.28	-2
79	NAB-2014-02262	38.7259	-76.2777	MD	Shell on Bottom	Oyster	0.14	-2.2
80	NAB-2015-00924	38.3919	-76.4906	MD	Shell on Bottom	Oyster	0.05	-2.5
81	NAB-2016-00198	38.7758	-76.2883	MD	Shell on Bottom	Oyster	0.13	-2.9
82	NAB-2016-00655	38.2048	-75.8742	MD	Shell on Bottom	Oyster	0.36	-1.8
83	NAB-2016-01210	38.6667	-76.2061	MD	Shell on Bottom	Oyster	0.50	-4
84	NAB-2016-01212	38.2075	-75.8644	MD	Shell on Bottom	Oyster	0.32	-1.6
85	NAB-2016-01213	38.2471	-76.7875	MD	Shell on Bottom	Oyster	0.09	-1.5
86	NAB-2016-01214	38.2667	-76.7056	MD	Shell on Bottom	Oyster	0.11	-4

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
87	NAB-2016-01220	38.2791	-75.9969	MD	Cage on Bottom	Oyster	0.39	-1.5
88	NAB-2016-01614	38.2481	-75.8386	MD	Shell on Bottom	Oyster	0.10	-1
89	NAB-2016-01615	38.2138	-76.4749	MD	Shell on Bottom	Oyster	0.01	0
90	NAB-2016-01642	38.2459	-76.8144	MD	Shell on Bottom	Oyster	0.61	-5.4
91	NAB-2017-00350	38.2426	-75.8597	MD	Shell on Bottom	Oyster	0.30	-1.4
92	NAB-2017-00433	38.2869	-76.7167	MD	Cage on Bottom	Oyster	0.11	0
93	NAB-2017-00434	38.6001	-75.9883	MD	Shell on Bottom	Oyster	0.33	-3
94	NAB-2017-00435	38.7076	-76.5236	MD	Shell on Bottom	Oyster	0.33	-1.2
95	NAB-2017-00436	38.7089	-76.5233	MD	Cage on Bottom	Oyster	0.32	-1.2
96	NAB-2017-00582	39.0479	-76.2099	MD	Shell on Bottom	Oyster	0.07	-0.3
97	NAB-2017-00626	38.2346	-75.9138	MD	Shell on Bottom	Oyster	0.56	-2.3
98	NAB-2017-00629	38.3298	-76.0027	MD	Shell on Bottom	Oyster	0.74	-2.4
99	NAB-2017-00634	38.1471	-75.8291	MD	Shell on Bottom	Oyster	0.11	-1.1
100	NAB-2017-00637	38.2228	-75.8650	MD	Shell on Bottom	Oyster	0.44	-2.1
101	NAB-2017-00639	38.1140	-76.3961	MD	Shell on Bottom	Oyster	0.02	-2.4

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
102	NAB-2017-00584	38.2227	-76.7371	MD	Shell on Bottom	Oyster	0.49	-1.4
103	NAB-2017-00585	38.2551	-76.8169	MD	Shell on Bottom	Oyster	0.55	-3.3
104	NAB-2017-00586	38.2272	-75.9160	MD	Shell on Bottom	Oyster	0.84	-2.4
105	NAB-2017-01850	38.1227	-76.4151	MD	Shell on Bottom	Oyster	0.04	-0.9
106	NAB-2017-01851	38.1236	-76.4175	MD	Shell on Bottom	Oyster	0.03	0
107	NAB-2017-01129	38.2663	-76.8439	MD	Shell on Bottom	Oyster	0.06	-0.3
108	NAP-OP-R-2017-0771	39.5451	-74.3549	NJ	Floating Gear	Oyster	0.00	-0.1
109	NAB-2016-01482	38.7347	-76.2080	MD	Shell on Bottom	Oyster	0.11	-0.9
110	NAB-2014-01589	38.4158	-76.6122	MD	Shell on Bottom	Oyster	0.06	-1.3
111	NAB-2016-01234	38.1215	-76.3956	MD	Shell on Bottom	Oyster	0.10	-3.6
112	NAB-2016-01199	38.1175	-76.3981	MD	Shell on Bottom	Oyster	0.08	-3.3
113	NAB-2016-01238	38.7734	-76.1699	MD	Shell on Bottom	Oyster	0.11	-2.6
114	NAB-2016-01237	38.8369	-76.1968	MD	Shell on Bottom	Oyster	0.05	-0.9
115	NAO-2015-00100	37.5983	-76.4306	VA	Multimode	Oyster	0.01	0
116	NAB-2017-00186	38.7726	-76.2955	MD	Shell on Bottom	Oyster	0.06	-0.1

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
117	NAB-2017-01893	38.6276	-75.9800	MD	Shell on Bottom	Oyster	0.39	-3
118	NAB-2016-01618	38.2570	-75.8415	MD	Shell on Bottom	Oyster	0.04	-0.9
119	NAB-2017-00589	38.3241	-76.4335	MD	Shell on Bottom	Oyster	0.06	-0.4
120	NAB-2016-01195	38.9217	-76.3053	MD	Cage on Bottom	Oyster	0.08	-1
121	NAB-2016-01612	38.9117	-76.3156	MD	Floating Gear	Oyster	0.10	-0.3
122	NAO-2017-0419_RE	36.9063	-76.3213	VA	Shell on Bottom	Oyster	0.06	0
123	NAB-2016-01218	38.7735	-76.1632	MD	Shell on Bottom	Oyster	0.08	-0.8
124	NAB-2016-01229	38.2135	-75.8559	MD	Shell on Bottom	Oyster	0.41	-1.8
125	NAB-2016-01613	38.1222	-76.4075	MD	Shell on Bottom	Oyster	0.01	-0.4
126	NAB-2016-00653	38.6731	-76.3554	MD	Shell on Bottom	Oyster	0.58	-2.3
127	NAB-2016-01137	38.2540	-75.8243	MD	Shell on Bottom	Oyster	0.11	-1.4
128	NAB-2016-01138	38.2400	-75.8784	MD	Shell on Bottom	Oyster	0.36	-1.1
129	NAB-2016-01216	38.3819	-76.4950	MD	Floating Gear	Oyster	0.07	-1.2
130	NAB-2016-00126	38.9435	-76.2164	MD	Shell on Bottom	Oyster	0.09	-0.3
131	NAB-2017-00391	38.3131	-76.0100	MD	Shell on Bottom	Oyster	0.07	-0.3

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
132	NAB-2018-00089	38.1931	-76.4316	MD	Shell on Bottom	Oyster	0.12	-4.1
133	NAB-2018-00086	38.2127	-76.4612	MD	Shell on Bottom	Oyster	0.01	-2.1
134	NAB-2017-00258	38.0883	-75.3392	MD	Cage on Bottom	Oyster	0.02	0
135	NAB-2016-01240	38.2435	-76.0811	MD	Cage on Bottom	Oyster	0.46	-1.8
136	NAB-2016-01241	38.2420	-76.0796	MD	Cage on Bottom	Oyster	0.41	-1.8
137	NAB-2018-00257	38.2080	-76.4503	MD	Shell on Bottom	Oyster	0.05	-1.5
138	NAB-2017-00431	38.3256	-76.4924	MD	Shell on Bottom	Oyster	0.10	-2.3
139	NAB-2018-00258	38.3316	-76.0174	MD	Shell on Bottom	Oyster	0.07	-0.1
140	NAE-2018-00504	41.1883	-73.0674	CT	Cage on Bottom	Oyster	0.52	-1.2
141	NAO-2018-00276	37.4610	-76.2825	VA	Floating Gear	Oyster	0.06	-1.1
142	NAB-2017-01772	38.3153	-76.2337	MD	Floating Gear	Oyster	0.21	-1.2
143	NAB-2017-01770	38.2434	-76.0482	MD	Floating Gear	Oyster	0.03	0
144	NAB-2016-01610	38.2274	-75.1844	MD	Cage on Bottom	Oyster	0.17	-1.2
145	NAB-2017-00535	38.1132	-76.4739	MD	Floating Gear	Oyster	0.00	-0.1
146	NAB-2017-00252	38.3330	-76.2216	MD	Cage on Bottom	Oyster	0.08	-0.1

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
147	NAN-2018-00316-EHA	40.9196	-73.2137	NY	Shell on Bottom	NA	0.52	-6.1
148	NAB-2018-00263	38.5937	-76.1048	MD	Shell on Bottom	Oyster	0.43	-5.5
149	NAB-2018-00271	38.6350	-75.9718	MD	Shell on Bottom	Oyster	0.27	-2.7
150	NAB-2018-00270	38.5865	-76.0204	MD	Shell on Bottom	Oyster	0.09	-0.3
151	NAB-2018-00269	38.5728	-76.0205	MD	Shell on Bottom	Oyster	0.36	-2.9
152	NAB-2018-00265	38.5437	-76.2121	MD	Shell on Bottom	Oyster	0.14	-2.8
153	NAB-2017-00251	38.2717	-76.8695	MD	Cage on Bottom	Oyster	0.10	-0.3
154	NAB-2016-01526	38.0675	-76.3267	MD	Floating Gear	Oyster	0.17	-0.6
155	NAB-2017-00590	38.3154	-75.9957	MD	Shell on Bottom	Oyster	0.18	-0.4
156	NAB-2016-01110	38.1297	-76.4155	MD	Shell on Bottom	Oyster	0.00	0
157	NAB-2016-01215	38.6959	-76.1329	MD	Shell on Bottom	Oyster	0.02	-0.4
158	NAB-2018-00261	38.2472	-75.9328	MD	Shell on Bottom	Oyster	0.41	-1.8
159	NAB-2018-00655	38.2421	-75.8638	MD	Shell on Bottom	Oyster	0.24	-1.3
160	NAB-2018-00272	38.6382	-75.9642	MD	Shell on Bottom	Oyster	0.18	-3.8
161	NAB-2017-00583	38.0712	-75.3612	MD	Floating Gear	Oyster	0.08	-0.1

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
162	NAB-2018-00793	38.3153	-76.0129	MD	Shell on Bottom	Oyster	0.24	-1.2
163	NAB-2018-00939	38.7226	-76.1485	MD	Shell on Bottom	Oyster	0.04	0
164	NAB-2018-00965	38.7187	-76.1417	MD	Shell on Bottom	Oyster	0.04	-1.3
165	NAB-2018-00964	38.7208	-76.1404	MD	Shell on Bottom	Oyster	0.04	-2.6
166	NAB-2017-00632	38.8040	-76.3140	MD	Multimode	Oyster	0.23	-1.3
167	NAB-2018-60694	38.1911	-76.4311	MD	Shell on Bottom	Oyster	0.03	-1
168	NAB-2018-01356	38.5345	-76.2262	MD	Shell on Bottom	Oyster	0.23	-2.2
169	NAB-2018-01363	38.1563	-76.4714	MD	Shell on Bottom	Oyster	0.06	0
170	NAB-2018-01362	38.1595	-76.4707	MD	Shell on Bottom	Oyster	0.05	-2.7
171	NAB-2018-01365	38.1529	-76.4720	MD	Shell on Bottom	Oyster	0.00	-0.1
172	NAB-2018-01364	38.1554	-76.4686	MD	Shell on Bottom	Oyster	0.01	-2.6
173	NAB-2018-01366	38.1293	-76.4895	MD	Shell on Bottom	Oyster	0.07	-0.6
174	NAB-2018-01367	38.1921	-76.4515	MD	Shell on Bottom	Oyster	0.03	-0.7
175	NAB-2018-01368	38.5203	-76.2559	MD	Shell on Bottom	Oyster	0.20	-1.3
176	NAB-2018-01370	38.5790	-76.0426	MD	Shell on Bottom	Oyster	0.48	-2.7

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
177	NAO-2016-0122	36.9430	-76.4393	VA	Shell on Bottom	Oyster	1.57	-3.3
178	NAO-2000-03926 (Lower Thomas)	37.0206	-76.4880	VA	Shell on Bottom	Oyster	0.98	-2.1
179	NAO-2000-03926 (Ballards Marsh)	36.9909	-76.5184	VA	Shell on Bottom	Oyster	0.54	-1.5
180	NAO-2000-03926 (Nansemond Ridge)	36.9341	-76.4512	VA	Shell on Bottom	Oyster	1.67	-2.1
181	NAO-2000-03926 (Hurley's)	37.9210	-75.9350	MD	Shell on Bottom	Oyster	1.83	-7.2
182	NAO-2000-03926 (#5-H-1)	37.9048	-75.9394	VA	Shell on Bottom	Oyster	2.34	-8.9
183	NAO-2000-03926 (#7-H-1)	37.8734	-75.9301	VA	Shell on Bottom	Oyster	3.07	-11
184	NAO-2000-03926 (#7-H-2)	37.8697	-75.9262	VA	Shell on Bottom	Oyster	3.05	-10.3
185	NAO-2000-03926 (#7-H-3)	37.8653	-75.9267	VA	Shell on Bottom	Oyster	2.86	-9.8

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
186	NAO-2000-03926 (#7-H-4)	37.8613	-75.9243	VA	Shell on Bottom	Oyster	2.81	-7.8
187	NAO-2000-03926 (#7-H-5)	37.8593	-75.9281	VA	Shell on Bottom	Oyster	2.59	-9.2
188	NAO-2000-03926 (27-1 Butler's)	37.6083	-76.3054	VA	Shell on Bottom	Oyster	0.69	-5.7
189	NAO-2000-03926 (27-2 Butler's)	37.6083	-76.3037	VA	Shell on Bottom	Oyster	0.63	-5.6
190	NAO-2000-03926 (53 Butler's)	37.6147	-76.3117	VA	Shell on Bottom	Oyster	0.40	-5.5
191	NAO-2000-03926 (Spike A)	37.5756	-76.2856	VA	Shell on Bottom	Oyster	1.09	-7.9
192	NAO-2000-03926 (Spike)	37.5775	-76.2932	VA	Shell on Bottom	Oyster	1.02	-5.8
193	NAO-2000-03926 (Spike B Offshore)	37.5783	-76.2814	VA	Shell on Bottom	Oyster	1.34	-9.1
194	NAO-2000-03926 (Hogge House Inshore)	37.6351	-76.5417	VA	Shell on Bottom	Oyster	0.66	-5.1
195	NAO-2000-03926 (Hogge	37.6392	-76.5433	VA	Shell on Bottom	Oyster	0.72	-4.9

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
	House Offshore)							
196	NAO-2000-03926 (26 Mosquito Island)	37.6099	-76.3430	VA	Shell on Bottom	Oyster	0.41	-3
197	NAO-2000-03926 (Onancock Rock)	37.7488	-75.8606	VA	Shell on Bottom	Oyster	1.68	-7.2
198	NAO-2000-03926 (#9-H-1)	37.9467	-75.7168	VA	Shell on Bottom	Oyster	0.53	-1.2
199	NAO-2000-03926 (#11-H-1)	37.9236	-75.7461	VA	Shell on Bottom	Oyster	0.61	-2.6
200	NAO-2000-03926 (#10-H-1)	37.9366	-75.7497	VA	Shell on Bottom	Oyster	1.26	-2.1
201	NAO-2000-03926 (#10-H-2)	37.9440	-75.7416	VA	Shell on Bottom	Oyster	1.16	-2.1
202	NAO-2000-03926 (Mill Creek)	37.7935	-76.3076	VA	Shell on Bottom	Oyster	0.19	-2.3
203	NAO-2000-03926 (Fleeton)	37.8111	-76.3211	VA	Shell on Bottom	Oyster	0.00	0

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
204	NAO-2000-03926 (22 Corrotoman)	37.6673	-76.4777	VA	Shell on Bottom	Oyster	0.29	-2.3
205	NAO-2000-03926 (Ingrams South)	37.7937	-76.2870	VA	Shell on Bottom	Oyster	0.45	-3.7
206	NAO-2000-03926 (Lower Edge E)	37.5762	-76.2992	VA	Shell on Bottom	Oyster	0.82	-5.2
207	NAO-2000-03926 (Lower Edge M)	37.5768	-76.3020	VA	Shell on Bottom	Oyster	0.81	-6.4
208	NAO-2000-03926 (Lower Edge W)	37.5770	-76.3050	VA	Shell on Bottom	Oyster	0.80	-6.5
209	NAO-2000-03926 (Broad Creek)	37.5766	-76.3163	VA	Shell on Bottom	Oyster	0.69	-5
210	NAO-2000-03926 (Broad Creek Inshore)	37.5746	-76.3111	VA	Shell on Bottom	Oyster	0.70	-5
211	NAO-2000-03926 (Whiting Creek)	37.6187	-76.5134	VA	Shell on Bottom	Oyster	0.43	-6
212	NAO-2000-03926 (#34 Little Wicks)	37.6905	-76.5720	VA	Shell on Bottom	Oyster	0.83	-4.8

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
213	NAO-2000-03926 (#36-3 Big Wicks)	37.6848	-76.5787	VA	Shell on Bottom	Oyster	0.39	-2.4
214	NAO-2000-03926 (#37 Stove Point)	37.7128	-76.5817	VA	Shell on Bottom	Oyster	0.68	-4.9
215	NAO-2000-03926 (#39-2 Waterview)	37.7253	-76.5880	VA	Shell on Bottom	Oyster	0.65	-7.1
216	NAO-2000-03926 (#35 Little Wicks)	37.6912	-76.5731	VA	Shell on Bottom	Oyster	0.79	-4.1
217	NAO-2000-03926 (#36-2 Big Wicks)	37.6994	-76.5768	VA	Shell on Bottom	Oyster	0.66	-4.2
218	NAO-2000-03926 (#38 Smokey Point)	37.7200	-76.5823	VA	Shell on Bottom	Oyster	0.75	-5.3
219	NAP-2018-00216	39.5999	-74.3018	NJ	Multimode	Oyster	0.15	-1.3
220	NAP-2018-00215-97	39.6005	-74.3029	NJ	Multimode	Oyster	0.09	-1.2
221	NAB-2013-01313	38.1006	-76.3954	MD	Cage on Bottom	Oyster	0.21	-0.5
222	NAB-2013-01496	38.2391	-76.7244	MD	Cage on Bottom	Oyster	0.14	-4.2
223	NAB-2013-02320	38.0991	-76.3977	MD	Cage on Bottom	Oyster	0.32	-3.5

Consultation #	**Tracking #**	**Latitude**	**Longitude**	**State**	**Technique**	**Taxa**	**Distance from Shore (nm)**	**Depth (m)***
224	NAB-2015-001065	38.1002	-76.3962	MD	Cage on Bottom	Oyster	0.24	-1.2
225	NAB-2015-01609	38.2318	-76.6888	MD	Cage on Bottom	Oyster	0.15	-0.8
226	NAB-2016-01485	38.1046	-76.4141	MD	Shell on Bottom	Oyster	0.11	-0.1
227	NAE-2018-00999	41.6272	-70.8417	MA	Floating Gear	Oyster	0.01	-0.1
228	NAB-2018-00262	38.1208	-76.3899	MD	Multimode	Oyster	0.00	-1.7
229	NAO-2018-01095 (North Deep Rock)	37.5175	-76.2463	VA	Shell on Bottom	Oyster	1.74	-7.9
230	NAO-2018-01095 (South Deep Rock)	37.4977	-76.2354	VA	Shell on Bottom	Oyster	1.83	-6.8
231	NAO-2018-01095 (Area 1 Middle)	37.6113	-76.3135	VA	Shell on Bottom	Oyster	0.60	-5.5
232	NAO-2018-01095 (Area 2 Lower)	37.5875	-76.3664	VA	Shell on Bottom	Oyster	0.88	-8.1
233	NAO-2018-01095 (Nansemond Ridge)	36.9377	-76.4512	VA	Shell on Bottom	Oyster	1.65	-2.4
234	NAO-2018-01095 (#12 Hills Bay)	37.5078	-76.3190	VA	Shell on Bottom	Oyster	0.78	-4.3

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
235	NAO-2018-01095 (#13 Island Bar)	37.5337	-76.3844	VA	Shell on Bottom	Oyster	0.28	-3.4
236	NAO-2018-01095 (#14 Cobbs Creek)	37.5289	-76.3949	VA	Shell on Bottom	Oyster	0.11	-2.5
237	NAO-2018-01095 (#16 Thompsons)	37.5190	-76.4084	VA	Shell on Bottom	Oyster	0.06	-4.6
238	NAO-2018-01095 (#17 Doc's View)	37.5115	-76.4189	VA	Shell on Bottom	Oyster	0.10	-2.4
239	NAB-2016-00657-M21	38.2225	-75.8798	MD	Shell on Bottom	Oyster	0.43	-2.1
240	NAB-2017-00260	38.8523	-76.2742	MD	Cage on Bottom	Oyster	0.24	-2.2
241	NAB-2018-00942	38.8589	-76.2676	MD	Multimode	Oyster	0.26	-3.8
242	NAB-2018-00658	38.7239	-76.3171	MD	Cage on Bottom	Oyster	0.21	-0.6
243	NAB-2018-00657	38.2495	-75.8375	MD	Shell on Bottom	Oyster	0.12	-1.2
244	NAB-2018-01842	38.2517	-76.8157	MD	Shell on Bottom	Oyster	0.50	-1
245	NAB-2018-01843	38.2429	-76.8092	MD	Shell on Bottom	Oyster	0.57	-1.3
246	NAB-2018-01844	38.2289	-76.7845	MD	Shell on Bottom	Oyster	0.24	-2.2
247	NAB-2018-01848	38.2128	-76.4562	MD	Shell on Bottom	Oyster	0.00	-1.9

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
248	NAB-2018-01850	38.2072	-76.4666	MD	Shell on Bottom	Oyster	0.06	-0.9
249	NAB-2018-01853	38.1957	-76.4309	MD	Shell on Bottom	Oyster	0.04	-1.4
250	NAB-2018-01633	38.3043	-76.8433	MD	Shell on Bottom	Oyster	0.29	-3.8
251	NAB-2018-01854	38.1894	-76.4426	MD	Shell on Bottom	Oyster	0.03	-0.2
252	NAB-2018-01634	38.9944	-76.4186	MD	Multimode	Oyster	0.02	-0.3
253	NAB-2018-00797	38.1692	-76.3432	MD	Multimode	Oyster	0.04	-0.1
254	NAB-2015-01119	38.3345	-76.1942	MD	Multimode	Oyster	0.41	-1.4
255	NAO-2018-00512 (E)	37.9419	-75.7564	VA	Shell on Bottom	Oyster	1.58	-2.4
256	NAO-2018-00512 (W)	37.9520	-75.7102	VA	Shell on Bottom	Oyster	0.83	-2
257	NAE-2018-01421	41.0846	-73.3526	CT	Cage on Bottom	Oyster	0.94	-2.9
258	NAB-2018-02113	38.3199	-76.4590	MD	Cage on Bottom	Oyster	0.06	-1
259	NAE-2015-01224	41.2125	-73.0528	CT	Shell on Bottom	Oyster	0.00	0
260	NAB-2018-02110	38.2028	-76.4617	MD	Shell on Bottom	Oyster	0.01	-0.9
261	NAB-2018-02111	38.3916	-76.5110	MD	Cage on Bottom	Oyster and clam	0.06	-1.3
262	NAB-2018-02112	38.4470	-77.0412	MD	Cage on Bottom	Oyster	0.08	-1.1

Consultation #	**Tracking #**	**Latitude**	**Longitude**	**State**	**Technique**	**Taxa**	**Distance from Shore (nm)**	**Depth (m)***
263	NAB-2018-02114	38.7735	-76.3416	MD	Shell on Bottom	Oyster	0.37	-1.3
264	NAP-2018-00717-97	39.5982	-74.3076	NJ	Floating Gear	Oyster	0.00	0
265	NAO-2008-03323	36.8378	-76.2626	VA	Shell on Bottom	Oyster	0.00	0
266	NAP-2018-000213-83	39.6024	-74.3041	NJ	Multimode	Oyster	0.00	0
267	NAP-2018-000214-83	39.6020	-74.3035	NJ	Multimode	Oyster	0.00	-0.8
268	NAP-2018-000217-83	39.6024	-74.3029	NJ	Multimode	Oyster	0.00	0
269	NAB-2017-00251	38.2719	-76.8694	MD	Cage on Bottom	Oyster	0.08	-0.3
270	NAB-2017-01130	38.1196	-75.9296	MD	Shell on Bottom	Oyster	0.28	-1.4
271	NAO-2018-00635	37.4922	-76.2990	VA	Floating Gear	Oyster	0.12	-3.5
272	NAB-2017-00432	38.5890	-75.9948	MD	Shell on Bottom	Oyster	0.33	-6
273	NAE-2018-01718	41.7175	-70.2583	MA	Cage on Bottom	Oyster	0.12	-0.1
274	NAB-2017-00587	38.0658	-75.7954	MD	Shell on Bottom	Oyster	0.24	-1.8
275	NAP-2018-00759-96	39.2988	-74.6242	NJ	Multimode	Oyster and clam	0.04	-0.9
276	NAE-2018-02441	42.0327	-70.1868	MA	Cage on Bottom	Oyster	0.39	-0.2
277	NAB-2017-00588	38.0689	-75.7877	MD	Shell on Bottom	Oyster	0.28	-1.8

Consultation #	**Tracking #**	**Latitude**	**Longitude**	**State**	**Technique**	**Taxa**	**Distance from Shore (nm)**	**Depth (m)***
278	NAB-2016-01365	38.8612	-76.5185	MD	Shell on Bottom	Oyster	0.13	-2.9
279	NAB-2018-61751	38.5894	-76.1247	MD	Shell on Bottom	Oyster	0.01	0
280	NAB-2017-00185	38.7756	-76.2950	MD	Cage on Bottom	Oyster	0.06	-1.7
281	NAE-2018-00503	41.3250	-71.9171	CT	Cage on Bottom	Oyster	0.28	-5.2
282	NAB-2017-00265	39.0016	-76.5029	MD	Cage on Bottom	Oyster	0.03	0
283	NAB-2017-00262	38.8623	-76.2623	MD	Cage on Bottom	Oyster	0.20	-2
284	NAB-2017-00256	38.9273	-76.2115	MD	Cage on Bottom	Oyster	0.25	-0.9
285	NAB-2017-00427	38.5744	-76.1754	MD	Shell on Bottom	Oyster	0.04	-0.6
286	NAB-2016-01508	38.7211	-76.3182	MD	Cage on Bottom	Oyster	0.22	-1.9
287	NAB-2018-00463	38.7123	-76.1485	MD	Shell on Bottom	Oyster	0.10	-3.4
288	NAB-2018-00461	38.7098	-76.1738	MD	Shell on Bottom	Oyster	0.07	-0.9
289	NAB-2017-00640	38.5685	-76.1756	MD	Shell on Bottom	Oyster	0.05	-1.2
290	NAB-2017-00592	38.5882	-76.1212	MD	Cage on Bottom	Oyster	0.08	-0.9
291	NAP-2018-01109-83	39.6001	-74.3000	NJ	Multimode	Oyster	0.18	-1.5
292	NAB-2016-01224	38.1676	-75.9568	MD	Shell on Bottom	Oyster	0.37	-3.3

Consultation #	Tracking #	Latitude	Longitude	State	Technique	Taxa	Distance from Shore (nm)	Depth (m)*
293	NAB-2019-00056	38.5012	-76.6765	MD	Shell on Bottom	Oyster	0.28	-1.7
294	NAB-2019-00057	38.5022	-76.6676	MD	Shell on Bottom	Oyster	0.20	-2.3
295	NAB-2018-00938	38.7355	-76.1324	MD	Shell on Bottom	Oyster	0.14	-2.1
296	NAE-2018-02967	41.5179	-71.0918	MA	Cage on Bottom	Oyster	0.16	-0.8
297	NAP-2019-00030	39.3292	-74.5581	NJ	Multimode	Oyster	0.00	0
298	NAE-2017-02377	41.5341	-71.2344	RI	Cage on Bottom	Oyster	0.05	-0.1
299	NAB-2017-00430	38.1232	-76.3561	MD	Multimode	Clam	0.00	0
300	NAB-2019-00053	38.7362	-76.5441	MD	Shell on Bottom	Oyster	0.36	-2.2

* Depth (m) was calculated by applying project coordinates provided by the action agency (USACE) to the US Coastal Relief Model Vol. 1. Values of '0 m' in the Depth (m) column represents either extremely close to shore, in an intertidal zone, or resulted from inaccurate coordinates/strains on the spatial resolution of the topography data used. Negative values represent the depth below sea level.

Appendix B. Detailed Aquaculture Gear Information[2]

Table B.1. Detailed information for consultations using cage on bottom gear.

Consultation #[3]		1	7	8	12	13
Minimum and maximum depth from surface (ft)		13.5 to 15.5	6 to 10	2.5 to 5.5	1.5 to 20.5	20 to 25
# of lease		1	2	12	3	2
Permitted acreage		13.8	N/A	11.8	3.76	391
Total acres used		N/A[4]	0.02	11.8	0.13	0.26
Cages	**Number**	9780	6	400	360	250
	Length (ft)	3	9	4	4	6.75
	Width (ft)	3	9	4	3	6.75
	Height (ft)	1.5	4	2	1.5	3.33
	Material	N/A*	Rebar	Vinyl coated steel mesh	Mesh	N/A
	Space between cages (ft)	15	20	30	1 or 30	100
Vertical lines	**Type**	Buoy line	Buoy line	Buoy line	Sinking buoy line	Buoy line
	Number	160	10	404	138	250
	Diameter (in)	N/A	N/A	0.38	0.63	1
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	Cable, Rope, Bungee	Poly line	Sinking line	Poly steel-braided rope
	Length (ft)	N/A	N/A	3 to 4	30	35

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[2] Data compiled from ESA section 7 consultations on aquaculture, except for ones using the shell on bottom technique, from between 2015 and January of 2019 (in addition to two cases in 2014) were assessed for detailed aquaculture gear information.

[3] Consultation numbers are cross-referenced from the table in Appendix A. The detailed information here was extracted from consultation documents. Discrepancies in depth and measurement units between matching consultations in Appendices A and B can be attributed to the fact that depths in Appendix A were calculated by Integrated Statistics by applying project coordinates provided by the action agency (USACE) to the US Coastal Relief Model Vol. 1; whereas, depths in Appendix B were supplied by the project applicant/USACE as part of the Section 7 consultation (i.e., not just from a single set of coordinates). Therefore, depths in Appendix B are likely more accurate.

[4] N/A indicates the information is not available or not applicable.

Horizontal lines	**Type**	Connecting line	N/A	N/A	Trawl/floating line	N/A
	Number	78	N/A	N/A	729	0
	Diameter (in)	N/A	N/A	N/A	0.38	N/A
	Length (ft)	N/A	N/A	N/A	200	N/A
Anchors	**Type**	N/A	N/A	Helical anchor	Helical screw anchor	Concrete block
	Number	N/A	N/A	8 to 16	18 Helical screw anchor at Elihu Island; 0 at depuration sites	8
	Height (ft)	N/A	N/A	N/A	4	2
	Width (ft)	N/A	N/A	N/A	N/A	2
	Weight (lbs)	N/A	N/A	N/A	N/A	500
Markers	**Type**	Bullet floats, Marker buoy	Buoy	Lease boundary PATON buoy	Lobster pot-style buoy	PVC pipe
	Number	Bullet float: 156, Marker buoy: 4	10	404	138	8
	Material	N/A	N/A	Diamond hazard buoy	N/A	N/A
	Height (in)	Marker buoy: 8	N/A	N/A	12	20
	Width (in)	Marker buoy: 12	N/A	6	6	4

Consultation #		15	16	17	18	20
Minimum and maximum depth from surface (ft)		15 to 21	1 to 2.5	15 to 21	1 to 2.5	2.17 (min); no max
# of lease		2	1	2	N/A	1
Permitted acreage		26	50	136.21	50	0.64
Total acres used		<0.002	N/A	0.06	N/A	N/A
Cages	Number	6	11250	400	11250	150
	Length (ft)	3.83	5.7	3	3.5	4
	Width (ft)	3.25	3.5	2	5.7	4
	Height (ft)	2.5	1.5	1.25	2.5	1.33
	Material	Modified pallentainer	Wire	Mesh	N/A	Vinyl coated steel mesh
	Space between cages (ft)	75	10	30	20	N/A
Vertical lines	Type	Buoy line	Buoy line	Buoy line	Buoy line	Buoy line
	Number	6	790	400	790	154
	Diameter (in)	0.31	N/A	0.38	N/A	0.5
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	Osprey polyester braided sinking/pot line	N/a	Lead sinking line	N/A	Nylon rope
	Length (ft)	30	N/A	4	N/A	4
Horizontal lines	Type	N/A	Connecting line	N/A	Connecting line	N/A
	Number	0	79	N/A	79	N/A
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Anchors	Type	Concrete weight	Screw anchor	0	158	Helical screw anchor

Anchors (continued)	**Number**	8	N/A	N/A	N/A	4
	Height (ft)	2	N/A	N/A	N/A	N/A
	Width (ft)	2	N/A	N/A	N/A	N/A
	Weight (lbs)	500	N/A	N/A	N/A	N/A
Markers	**Type**	PVC pipe, Polyform orange vinyl buoy	Corner marker buoy	400	N/A	Diamond (PATON) hazard buoy
	Number	14	34	N/A	34	154
	Material	Polyform orange vinyl buoy	N/A	Pot-style buoy	N/A	Elliptical yellow styrofoam float
	Height (in)	PVC pipe: 20	11	6	N/A	N/A
	Width (in)	Polyform buoy: 8, PVC pipe: 4	N/A	12	N/A	N/A

Consultation #		22	27	38	40	44
Minimum and maximum depth from surface (ft)		5.5 to 12.5	8.5 to 14.5	2.5 to 11	7 to 20	N/A
# of lease		4	3	1	39	N/A
Permitted acreage		133	70	10.7	1262	0.42
Total acres used		0.17	0.14	0.32	1.05	0.42
Cages	Number	150	150	400	1000	310
	Length (ft)	6.5	6.42	4.25	N/A	N/A
	Width (ft)	6.5	6.42	4.25	N/A	N/A
	Height (ft)	3.5	3.42	3.92	N/A	3.92
	Material	Mesh bag	Steel panel	N/A	N/A	N/A
	Space between cages (ft)	150	30	Cage: 20, Pyramid: 10	30	N/A
Vertical lines	Type	Buoy line	Buoy line	Buoy line	N/A	N/A
	Number	150	150	525	5000	N/A
	Diameter (in)	0.75	1	N/A	N/A	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	Poly-steel braided sinking line	N/A	N/A	N/A	N/A
	Length (ft)	35	30	N/A	N/A	N/A
Horizontal lines	Type	N/A	N/A	N/A	N/A	N/A
	Number	0	N/A	80	N/A	N/A
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Anchors	Type	Concrete block	N/A	N/A	Concrete block	Wood stake
	Number	12	N/A	N/A	156	24
	Height (ft)	2	N/A	N/A	2	N/A
	Width (ft)	2	N/A	N/A	2	N/A
	Weight (lbs)	500	N/A	N/A	500	N/A

Markers	**Type**	PVC pipe, 8" Polyform orange vinyl buoy	Buoy, PVC pipe	Buoys, PVC pipe	N/A	N/A
	Number	162	312	Buoy: 525, PVC pipe: 160	1156	N/A
	Material	8" Polyform orange vinyl buoy	White buoy, PVC pipe	N/A	N/A	N/A
	Height (in)	20	9	N/A	N/A	N/A
	Width (in)	Pipe: 4, Buoy: 8	Buoy: 16, PVC pipe: 4	N/A	N/A	N/A

Consultation #		45	51	53	57	58
Minimum and maximum depth from surface (ft)		25 to 33	1 to 2.5	4 to 5	N/A	0.25 to 4.33
# of lease		1	1	1	1	1
Permitted acreage		3.8	7.5	4.3	5.8	1.14
Total acres used		0.004	N/A	N/A	N/A	0.46
Cages	Number	50	1688	970	1250	102
	Length (ft)	4	4	4	4	8
	Width (ft)	4	4	4	6	3
	Height (ft)	3	1.5	1.5	0.33	1
	Material	Wire mesh	N/A	N/A	Wire mesh	High PVC coated steel mesh wire
	Space between cages (ft)	35	10	10	N/A	Tray with feet: 3, Tray: 1
Vertical lines	Type	Buoy line	Buoy line	Buoy line	Buoy line	Mooring line
	Number	60	188	988	100	8
	Diameter (in)	0.38 to 0.5	N/A	N/A	N/A	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	Sinking line	N/A	N/A	N/A	N/A
	Length (ft)	15 to 40	N/A	N/A	N/A	N/A
Horizontal lines	Type	Ground line	Connecting line	Longline	Longline	N/A
	Number	10	47	138	50	N/A
	Diameter (in)	0.5	N/A	N/A	N/A	N/A
	Length (ft)	140	N/A	200 to 600	N/A	N/A

Anchors	**Type**	N/A	Screw auger	N/A	N/A	N/A
	Number	N/A	32	276	N/A	N/A
	Height (ft)	N/A	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A	N/A
Markers	**Type**	Buoy	Buoy	Float buoy, Bullet float, Marker buoy	Marker buoy	8
	Number	10	31	1250	104	N/A
	Material	N/A	N/A	N/A	N/A	N/A
	Height (in)	11	N/A	N/A	N/A	N/A
	Width (in)	8	11	6 to 9	N/A	N/A

Consultation #		61	62	63	64	73
Minimum and maximum depth from surface (ft)		Below mean low water (MLW)	N/A	N/A	N/A	2.83 to 8.83
# of lease		N/A	N/A	N/A	N/A	1
Permitted acreage		N/A	N/A	N/A	N/A	0.21
Total acres used		0.003	0.01	0.01	0.002	N/A
Cages	Number	6	N/A	96	5	25
	Length (ft)	10	2	1.67	10	3
	Width (ft)	2	2	2	2	2
	Height (ft)	2	1.67	2	2	1.17
	Material	Rebar	Concrete	N/A	Rebar	N/A
	Space between cages (ft)	N/A	N/A	N/A	N/A	15
Vertical lines	Type	N/A	N/A	N/A	N/A	Buoy line
	Number	N/A	N/A	N/A	N/A	9
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Horizontal lines	Type	N/A	N/A	N/A	N/A	Trawl line
	Number	N/A	N/A	N/A	N/A	5
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Anchors	Type	N/A	N/A	N/A	N/A	N/A
	Number	N/A	N/A	N/A	N/A	9
	Height (ft)	N/A	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A

Anchors (continued)	**Weight (lbs)**	N/A	N/A	N/A	N/A	N/A
Markers	**Type**	N/A	N/A	N/A	N/A	Vertical pick up buoy
	Number	N/A	9	N/A	N/A	9
	Material	N/A	Timber	N/A	N/A	N/A
	Height (in)	N/A	N/A	N/A	N/A	N/A
	Width (in)	N/A	8	N/A	N/A	N/A

Consultation #		75	87	92	95	120
Minimum and maximum depth from surface (ft)		5 to 11	5 (min); no max	5.83 (min); no max	10 (min); no max	0.58 (min); no max
# of lease		1	1	1	1	1
Permitted acreage		2	5	0.7	5	0.5
Total acres used		N/A	N/A	N/A	N/A	N/A
Cages	Number	100	N/A	N/A	N/A	255
	Length (ft)	3	N/A	N/A	N/A	N/A
	Width (ft)	1.5	N/A	N/A	N/A	N/A
	Height (ft)	0.33	N/A	N/A	N/A	N/A
	Material	Repurposed lobster pot	N/A	N/A	N/A	N/A
	Space between cages (ft)	N/A	N/A	N/A	N/A	N/A
Vertical lines	Type	Buoy line	N/A	N/A	N/A	N/A
	Number	25	4	N/A	4	15
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Horizontal lines	Type	Short line	N/A	N/A	N/A	N/A
	Number	100	N/A	N/A	N/A	5
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A

Anchors	**Type**	N/A	N/A	N/A	N/A	N/A
	Number	N/A	N/A	N/A	N/A	N/A
	Height (ft)	N/A	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A	N/A
Markers	**Type**	Buoy	Buoy, PVC pipe	PVC pipe	PVC pipe, buoy	Buoy
	Number	25	4	N/A	8	15
	Material	N/A	N/A	N/A	N/A	N/A
	Height (in)	N/A	N/A	N/A	N/A	48
	Width (in)	N/A	N/A	N/A	2	9

Consultation #		134	135	136	140	144
Minimum and maximum depth from surface (ft)		N/A	N/A	N/A	7 to 20	0
# of lease		1	1	1	N/A	1
Permitted acreage		7	5	5	303	2.968
Total acres used		N/A	N/A	N/A	0.003	N/A
Cages	Number	1300	600	600	10	200
	Length (ft)	5	4	4	4	3
	Width (ft)	7.5	3	3	3	3
	Height (ft)	2.5	1	1	2	0.5
	Material	N/A	N/A	N/A	N/A	N/A
	Space between cages (ft)	N/A	10	10	232.94	N/A
Vertical lines	Type	N/A	N/A	N/A	Sinking lead buoy line	Buoy line
	Number	2600	120	120	14	12
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	Lead-core poly line	N/A
	Length (ft)	N/A	N/A	N/A	25	N/A
Horizontal lines	Type	N/A	N/A	N/A	N/A	N/A
	Number	N/A	60	60	N/A	N/A
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Anchors	Type	N/A	N/A	N/A	N/A	N/A
	Number	260	120	120	N/A	N/A
	Height (ft)	N/A	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A	N/A
Markers	Type	Corner marker buoy, PVC marker	Marker buoy	Marker buoy	Pot-buoy	Bullet float, Corner marker
	Number	2655	124	124	14	12

Markers (continued)	**Material**	N/A	Styrofoam	Styrofoam	N/A	N/A
	Height (in)	15	N/A	N/A	N/A	12
	Width (in)	6	N/A	N/A	N/A	Corner marker: 8

Consultation #		146	153	221	222	223
Minimum and maximum depth from surface (ft)		N/A	0.5 (min); no max	N/A	N/A	N/A
# of lease		1	1	1	1	2
Permitted acreage		7.798	7.9	3.2	1.3	35.5
Total acres used		N/A	N/A	N/A	N/A	N/A
Cages	**Number**	2500	160	N/A	286	7988
	Length (ft)	0.67	4	4	5.75	5.7
	Width (ft)	2	3	3	3.5	3.5
	Height (ft)	0.42	0.67	0.92	1.5	1.5
	Material	N/A	N/A	N/A	N/A	N/A
	Space between cages (ft)	12	8 to 10	N/A	7 to 9	10
Vertical lines	**Type**	Buoy line	Buoy line	N/A	N/A	Buoy line
	Number	75	160	N/A	557	889
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Horizontal lines	**Type**	Longline	Longline	N/A	Longline	Longline
	Number	50	10	N/A	557	72
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Anchors	**Type**	N/A	N/A	N/A	N/A	N/A
	Number	100	20	N/A	N/A	144
	Height (ft)	N/A	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A	N/A
Markers	**Type**	Marker buoy, Stake with sign	Small buoy, Marker buoy, PVC pipe	N/A	Corner marker buoy	Crab pot buoy, Corner marker buoy

Markers (continued)	**Number**	Buoy: 179, Stake: 4	Small buoy: 160, Corner marker buoy: 4, PVC pipe at corner: 4	N/A	224	753
	Material	N/A	N/A	N/A	N/A	N/A
	Height (in)	Marker buoy: 12	PVC pipe: 4	N/A	N/A	N/A
	Width (in)	Buoy: 5	N/A	N/A	N/A	N/A

Consultation #		224	225	240	242	257
Minimum and maximum depth from surface (ft)		0.83 (min); no max	2.6 (min); no max	N/A	1.67 (min); no max	13 to 20.5
# of lease		1	1	1	1	1
Permitted acreage		2.5	4.3	2.875	4.93	11.2
Total acres used		N/A	N/A	N/A	N/A	0.01
Cages	Number	6053	970	2103	1100	50
	Length (ft)	5.7	3.83	4	4	3
	Width (ft)	3.5	3.42	3	3	2.5
	Height (ft)	1.5	1.5	1.25	0.33	0.5
	Material	N/A	N/A	Wire mesh	N/A	N/A
	Space between cages (ft)	10	10	N/A	N/A	30
Vertical lines	Type	Buoy line	N/A	N/A	N/A	Acorn buoy line
	Number	67	988	102	34	10
	Diameter (in)	N/A	N/A	N/A	N/A	0.38
	Tension (lbs)	N/A	N/A	N/A	N/A	0.38
	Material	N/A	N/A	N/A	N/A	Lead poly sinking line/chain
	Length (ft)	N/A	N/A	N/A	N/A	20
Horizontal lines	Type	Longline	Longline	N/A	N/A	Ground line
	Number	36	138	N/A	17	10
	Diameter (in)	N/A	N/A	N/A	N/A	0.38
	Length (ft)	N/A	N/A	N/A	N/A	150
Anchors	Type	N/A	N/A	N/A	N/A	N/A
	Number	N/A	N/A	N/A	34	N/A
	Height (ft)	N/A	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A	N/A
Markers	Type	Crab pot float, Corner marker buoy	Float buoy, Corner marker buoy	BB buoy, Corner marker buoy	Small buoy, Marker buoy	Acorn buoy line

Markers (continued)	**Number**	Small crab pot float: 63, Corner marker buoy: 54	Float buoy: 970, Corner marker buoy: 4	Small BB buoy: 98, Corner marker buoy: 4	Small buoy: 34, Marker buoy: 4	10
	Material	N/A	N/A	N/A	White marker buoy	N/A
	Height (in)	N/A	Float buoy: 6, Corner marker buoy: 11	N/A	Marker buoy: 60	N/A
	Width (in)	N/A	N/A	N/A	Marker buoy: 12	N/A

Consultation #		258	261	262	269	273
Minimum and maximum depth from surface (ft)		2.5 (min); no max	1.7 (min); no max	1.75 (min); no max	0.5 (min); no max	0 to 11
# of lease		1	1	1	1	1
Permitted acreage		3.979	5	13.8	7.9	3
Total acres used		N/A	N/A	N/A	N/A	N/A
Cages	Number	400	4500	375	160	330
	Length (ft)	N/A	1.5	5.83	4	4
	Width (ft)	N/A	1.5	3.42	3	3
	Height (ft)	N/A	3	1.25	0.67	N/A
	Material	N/A	N/A	N/A	N/A	Wire mesh
	Space between cages (ft)	5	N/A	N/A	8 to 10	4
Vertical lines	Type	N/A	Buoy line	Buoy line	N/A	N/A
	Number	80	36	385	160	4
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Horizontal lines	Type	Longline	Longline	Longline	Longline	N/A
	Number	40	12	5	10	N/A
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Anchors	Type	N/A	N/A	N/A	N/A	N/A
	Number	80	N/A	N/A	N/A	N/A
	Height (ft)	N/A	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A	N/A
Markers	Type	Small buoy, Corner marker pole	Buoy, Bamboo pole	Small buoy, Placard	Marker buoy, Small buoy, PVC pipe	Floating buoy

Markers (continued)	**Number**	Small buoy: 80, Corner marker pole: 4	Buoy: 36, Bamboo pole: 4	Small buoy: 385, Placard: 4	Marker buoy: 4, Small buoy:160, PVC pipe: 4	4
	Material	Pine pole	Bamboo pole	N/A	N/A	N/A
	Height (in)	N/A	N/A	N/A	N/A	N/A
	Width (in)	N/A	Plastic marker: 18, Bamboo pole: 2	1	N/A	N/A

Consultation #		276	280	281	282	283
Minimum and maximum depth from surface (ft)		0 to 7.33	2.75 to 7.75	14 to 17	0.4 to 11.83	2.75 to 5.17
# of lease		1	1	1	1	1
Permitted acreage		1	3.8	2.66	6.4	4.278
Total acres used		N/A	N/A	0.06	N/A	N/A
Cages	Number	N/A	504	150	1000	2745
	Length (ft)	3.42	4	4	4	4
	Width (ft)	3.83	3	3	3	3
	Height (ft)	2	1.33	2	1.5	1.25
	Material	Rebar rack	N/A	N/A	N/A	N/A
	Space between cages (ft)	N/A	15	25	10	15
Vertical lines	Type	N/A	Buoy line	Buoy line	Buoy line	Buoy line
	Number	N/A	76	42	15	90
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	Lead-core sinking line/chain	N/A	N/A
	Length (ft)	N/A	N/A	25	N/A	N/A
Horizontal lines	Type	Longline	Weighted sinking longline	Ground line	Weighted longline	Weighted longline
	Number	N/A	24	12	17	45
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	250	N/A	N/A
Anchors	Type	N/A	N/A	0	N/A	N/A
	Number	N/A	48	0	7	90
	Height (ft)	N/A	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	5	N/A
Markers	Type	N/A	Buoy	Acorn/pot buoy	Corner marker buoy	Buoy

Markers (continued)	**Number**	N/A	76	54	12	Small buoy: 90, Corner marker buoy: 4
	Material	N/A	N/A	Styrofoam	N/A	N/A
	Height (in)	N/A	12	N/A	12	49
	Width (in)	N/A	8	N/A	8	9

Consultation #		284	286	290	296	298
Minimum and maximum depth from surface (ft)		2.25 to 4.58	4.33 (min); no max	1.33 (min); no max	3.5 (min); no max	N/A
# of lease		1	1	1	1	1
Permitted acreage		3.374	3.8	5	1	3
Total acres used		N/A	N/A	N/A	N/A	N/A
Cages	Number	2200	1536	500	N/A	120
	Length (ft)	4	N/A	4	4	2
	Width (ft)	3	N/A	3	3	3.5
	Height (ft)	1.25	N/A	0.5	1.5	3
	Material	N/A	Wire mesh	N/A	Mesh	N/A
	Space between cages (ft)	15	50	5 to 10	N/A	20
Vertical lines	Type	Buoy line	Buoy line	Buoy line	N/A	N/A
	Number	88	96	24	N/A	N/A
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Horizontal lines	Type	Weighted longline	Longline	Longline	Weighted longline	Trawl/lateral line
	Number	44	16	10	N/A	Trawl line: 10, Lateral line: 1
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A
Anchors	Type	N/A	N/A	N/A	Screw anchors	N/A
	Number	132	N/A	N/A	N/A	4
	Height (ft)	N/A	N/A	N/A	1.5	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A	N/A
Markers	Type	Buoy	Marker buoy	Crab pot buoy, Corner marker buoy	N/A	Lobster pot buoy

Markers (continued)	**Number**	Small buoy: 176, Corner marker buoy: 4	4	Small crab pot buoy: 20, Corner marker buoy: 4	N/A	4
	Material	N/A	N/A	N/A	N/A	N/A
	Height (in)	49	N/A	Crab pot buoy: 6, Corner marker buoy: 12	N/A	N/A
	Width (in)	9	12	8	N/A	N/A

Table B.2. Detailed information for consultations using floating gear for growing shellfish.

Consultation #		**3**	**19**	**24**	**26**
Depth from surface (ft)		5	N/A	5	1.67
# of lease		1	1	1	1
Permitted acreage		25	0.2	25	50
Total acres used[5]		N/A	N/A	N/A	1.25
Floating gear	**Type**	Longline with cage	Floating nursery, Floating oyster tray	Longline with cage	Longline
	Number	Longline: 32	2	Longline: 32	30
	Length (ft)	726	300	726	N/A
	Width (ft)	N/A	10	N/A	N/A
	Height (ft)	N/A	N/A	N/A	N/A
	Diameter (in)	1	N/A	1	N/A
	Material	N/A	N/A	N/A	Stainless steel
	Space between lines (ft)	50	N/A	50	N/A
Subordinate gear[6]	**Additional gear type used**	Cage	N/A	Cage	Cage
	Number of subordinate gear	100 per longline	N/A	100 per longline	600
	Length (ft)	2	N/A	2	7.42
	Width (ft)	2	N/A	2	3.17
	Height (ft)	4	N/A	4	1.67
	Material	Rubber coated with one inch wire mesh	N/A	Rubber coated with one inch wire mesh	Mesh
Vertical lines	**Type**	Polysteel headrope, Anchor line	N/A	Polysteel headrope, Anchor line	Stainless steel cable
	Number	N/A	N/A	N/A	N/A
	Diameter (in)	0.5	N/A	0.5	0.32
	Tension (lbs)	440	N/A	440	N/A

[5] Total acres used for floating gear types (i.e., floating gear, multimode) refers to the anchor footprint and/or the size of the disruption on the ocean floor.
[6] Subordinate gear refers to any additional gear (e.g., cages, nets, lines, bags, trays) attached to the main gear type (i.e., floating gear in Table B.2).

	Material	N/A	N/A	N/A	Stainless steel cable
	Length (ft)	N/A	N/A	2	N/A
Horizontal lines	**Type**	Longline	N/A	Longline	Stainless steel cable
	Number	32	N/A	32	30
	Diameter (in)	1	N/A	1	0.24
	Tension (lbs)	21300	N/A	21300	N/A
	Material	Polysteel composite line	N/A	Polysteel composite line	Stainless steel cable
	Length (ft)	726	N/A	726	N/A
Anchors	**Type**	Helical anchor	N/A	Helical anchor	Helical screw/shaft anchor
	Number	64	N/A	64	60
	Height (ft)	48	N/A	48	N/A
	Width (ft)	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A
Markers	**Type**	Buoy	N/A	Buoy	Navigation buoy
	Number	208	N/A	208	12
	Material	N/A	N/A	N/A	N/A
	Height (in)	N/A	N/A	N/A	N/A
	Width (in)	36	N/A	36	N/A

Consultation #		31				42				43		
Depth from surface (ft)		Oyster: 3, Kelp: 7				26.25				N/A		
# of lease		1				1				1		
Permitted acreage		3				28.5				33		
Total acres used		0.11				N/A				N/A		
Floating gear	**Type**	Kelp longline	Oyster floating gear	Oyster bottom cage		Mussel, Kelp longline array				Longline		
	Number	N/A	300	15		N/A				3		
	Length (ft)	N/A	4.83	3		N/A				400		
	Width (ft)	N/A	0.5	4		N/A				N/A		
	Height (ft)	N/A	0.92	2		N/A				40		
	Diameter (in)	N/A	N/A	N/A		N/A				N/A		
	Material	N/A	N/A	Coated wire cage		N/A				N/A		
	Space between lines (ft)	25	10	N/A		0				75		
Subordinate gear	**Additional gear type used**	N/A	Mesh grow out, Fine mesh seed bag	Mesh grow out bag, Fine mesh seed bag		N/A		N/A	N/A	N/A	N/A	N/A
	Number of subordinate gear	N/A	Mesh grow out bag: 1500, Fine mesh seed bag: 300	Mesh grow out bag: 1500, Fine mesh seed bag: 300		N/A		N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Height (ft)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Vertical lines	**Type**	Sinking line				Buoy line		Anchor line	Center pick-up vertical line	Counter-buoyancy buoy line	Spat collection rope	N/A
	Number	319				6		6	3	270	N/A	315
	Diameter (in)	0.63				1		N/A	N/A	N/A	2 to 3	N/A
	Tension (lbs)	N/A				N/A		660	22	N/A	N/A	N/A
	Material	Anchor attached to shackle, Shackle attached to chain, Chain attached to nylon rope				Polysteel		N/A	N/A	N/A	N/A	N/A
	Length (ft)	30			N/A	N/A	N/A	45.93	N/A	N/A	9.84	N/A
Horizontal lines	**Type**	Kelp longline	Trawl line			Polysteel longline		N/A	N/A	N/A	N/A	Longline
	Number	9	30			3		N/A	N/A	N/A	N/A	3
	Diameter (in)	0.75	N/A			1		N/A	N/A	N/A	N/A	1
	Tension (lbs)	N/A	N/A			440		N/A	N/A	N/A	N/A	21300
	Material	Polysink rope	Polysink rope			Polysteel		N/A	N/A	N/A	N/A	Esterpro sinking line
	Length (ft)	100	100			475.7		N/A	N/A	N/A	N/A	400
Anchors	**Type**	Pyramid weight	Screw anchor			Block anchor		Helical anchor		N/A		
	Number	N/A	60			2		2		12		
	Height (ft)	N/A	N/A			N/A		N/A		N/A		
	Width (ft)	N/A	5			N/A		13.12		N/A		
	Weight (lbs)	1500	N/A			4000		N/A		N/A		
Markers	**Type**	Trawl line buoy	Safe boating marker	Round white buoy	Green buoy	Highflyers or buoy	High flyer	Corner buoy	Center buoy	Counter-buoyancy buoy	N/A	
	Number	60	4	2	3	4	2	6	3	270	N/A	
	Material	Polyform	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
	Height (in)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	

Markers (continued)	**Width (in)**	24	N/A	24	12	N/A	N/A	16 to 24	16 to 24	N/A	N/A

Consultation #		**47**	**108**			**121**	**141**
Depth from surface (ft)		6	12			2 to 4	N/A
# of lease		1	1			1	1
Permitted acreage		0.14	2.25			2.05	13.8
Total acres used		N/A	N/A			N/A	4.81
Floating gear	**Type**	Upweller float	OysterGro, Floating cage			Oyster float, Floating cage	Oyster bag/tray suspended from anchored line
	Number	Upweller float: 13	140			486	Bag per line: 144 to 780
	Length (ft)	20	5.67			N/A	1.67
	Width (ft)	8	3.33			N/A	3.25
	Height (ft)	N/A	0.75			N/A	N/A
	Diameter (in)	N/A	N/A			N/A	N/A
	Material	N/A	Vinyl-coated wire mesh			N/A	HDPE plastic bag with foam float
	Space between lines (ft)	N/A	28			30	15 to 20
Subordinate gear	**Additional gear type used**	Floating Bag	Bag			N/A	HDPE plastic tray with foam float
	Number of subordinate gear	450	6 per cage			N/A	N/A
	Length (ft)	2.67	1.5			N/A	3
	Width (ft)	1.33	2.92			N/A	3
	Height (ft)	N/A	0.25			N/A	N/A
	Material	N/A	Vexar oyster bag			N/A	HDPE
Vertical lines	**Type**	N/A	Lead rope	Anchor line	Line between anchor/lead rope	N/A	Nylon rope
	Number	N/A	280	28	28	72	N/A
	Diameter (in)	N/A	N/A	N/A	N/A	N/A	0.38

Vertical lines (continued)	**Tension (lbs)**	N/A	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A	N/A	Nylon
	Length (ft)	N/A	8	60	17	N/A	N/A
Horizontal lines	**Type**	Polyline	Regular rope			N/A	Nylon longline
	Number	25	14			18	23
	Diameter (in)	N/A	0.38			N/A	1
	Tension (lbs)	N/A	N/A			N/A	N/A
	Material	N/A	N/A			N/A	Nylon rope
	Length (ft)	40	160			N/A	200 to 1300
Anchors	**Type**	N/A	N/A			N/A	Helix anchor
	Number	N/A	28			N/A	48
	Height (ft)	N/A	N/A			N/A	N/A
	Width (ft)	N/A	N/A			N/A	N/A
	Weight (lbs)	N/A	N/A			N/A	N/A
Markers	**Type**	N/A	Polyball buoy			Buoy	N/A
	Number	N/A	14			4	N/A
	Material	N/A	Yellow polyball buoy			N/A	N/A
	Height (in)	N/A	18			9	N/A
	Width (in)	N/A	N/A			48	N/A

Consultation #		142	143	145	154
Depth from surface (ft)		0.33	0.67	0.33	1 to 7
# of lease		1	1	1	1
Permitted acreage		3.12	2.78	2	10.9
Total acres used		N/A	N/A	N/A	N/A
Floating gear	Type	Oyster float	Oyster basket	Mesh bag with high density polyurethane float	Oyster float/floating cage
	Number	816	Hexcyl oyster basket: 4028	Mesh bag: 6460	1000
	Length (ft)	4.5	2.75	2.83	N/A
	Width (ft)	1.5	1	1.58	N/A
	Height (ft)	1.67	0.67	N/A	N/A
	Diameter (in)	N/A	N/A	N/A	N/A
	Material	N/A	N/A	Compounded HDPE	N/A
	Space between lines (ft)	N/A	10	8	28
Subordinate gear	Additional gear type used	N/A	FLUPSY	N/A	N/A
	Number of subordinate gear	N/A	10	N/A	N/A
	Length (ft)	N/A	20	N/A	N/A
	Width (ft)	N/A	8	N/A	N/A
	Height (ft)	N/A	1.5	N/A	N/A
	Material	N/A	N/A	N/A	N/A
Vertical lines	Type	N/A	Marker buoy line	Anchor line	N/A
	Number	330	8	62	200
	Diameter (in)	N/A	N/A	N/A	N/A

Vertical lines (continued)	**Tension (lbs)**	N/A		N/A			N/A		N/A	
	Material	N/A		N/A			Galvanized steel wire rope		N/A	
	Length (ft)	N/A		N/A			N/A		N/A	
Horizontal lines	**Type**	N/A		Longline			Longline		N/A	
	Number	82		76			95		100	
	Diameter (in)	N/A		N/A			N/A		N/A	
	Tension (lbs)	N/A		N/A			N/A		N/A	
	Material	N/A		Monofilament line sheathed with plastic			UV treated polyester		N/A	
	Length (ft)	N/A		150			110		N/A	
Anchors	**Type**	N/A		N/A			Mushroom anchor		N/A	
	Number	N/A		N/A			62		N/A	
	Height (ft)	N/A		N/A			N/A		N/A	
	Width (ft)	N/A		N/A			N/A		N/A	
Markers	**Type**	Small buoy	Marker buoy	A-2 buoy	A-1 buoy	Marker buoy	Anchor buoy	Marker buoy	Small buoy	Corner pole
	Number	326	4	156	1092	8	62	5	200	4
	Material	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Height (in)	N/A	5	N/A	N/A	5	28	48	N/A	N/A
	Width (in)	N/A	18	N/A	N/A	18	16	9	N/A	N/A

Consultation #		161	227	264	271
Depth from surface (ft)		2 to 3	10	0	0
# of lease		1	1	1	1
Permitted acreage		6.4	1	2	5.5
Total acres used		N/A	0.0002	N/A	N/A
Floating gear	Type	Flip floating bag	Floating bag	Floating cage	Floating cage
	Number	700	78	200	714
	Length (ft)	4	N/A	5.63	4
	Width (ft)	4	N/A	3.38	3
	Height (ft)	10	N/A	1.92	2
	Diameter (in)	N/A	N/A	N/A	N/A
	Material	N/A	N/A	OysterGro	Wire mesh cage
	Space between lines (ft)	10	10 to 12	20	25
Subordinate gear	Additional type used	Clam bag	N/A	Bag	Mesh bag
	Number of subordinate gear	250	N/A	Bag per cage: 6, Bag total: 1200	Plastic mesh bag: 2856
	Length (ft)	1	N/A	N/A	N/A
	Width (ft)	0.83	N/A	N/A	N/A
	Height (ft)	0.67	N/A	N/A	N/A
	Material	N/A	N/A	N/A	Plastic
Vertical lines	Type	N/A	N/A	Chain anchor	N/A
	Number	200	N/A	34	55
	Diameter (in)	N/A	N/A	0.38	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A
Horizontal lines	Type	N/A	N/A	Sink line	N/A
	Number	50	16	10	N/A
	Diameter (in)	N/A	N/A	0.5	N/A
	Tension (lbs)	N/A	N/A	N/A	N/A
	Material	N/A	N/A	Sink line	N/A

	Length (ft)	50	N/A		200		200	
Anchors	**Type**	N/A	Mushroom mooring		Pyramid anchor		Screw anchor	
	Number	100	4		34		51	
	Height (ft)	N/A	N/A		N/A		12	
	Width (ft)	N/A	N/A		N/A		N/A	
	Weight (lbs)	N/A	N/A		50		N/A	
Markers	**Type**	Buoy	Buoy	Corner marker	Anchor float	Corner lease marker	Bullet nose buoy	Regulatory buoy
	Number	100	24	4	30	4	51	4
	Material	N/A	N/A	N/A	N/A	N/A	N/A	N/a
	Height (in)	N/A	N/A	N/A	N/A	N/A	11	N/A
	Width (in)	N/A	N/A	N/A	16	N/A	5	9

Table B.3. Detailed information for consultations using floating gear for growing kelp.

Consultation #		**2**	**9**			**14**	**21**
Depth from surface (ft)		7	7			6 to 11	22
# of lease		1	1			1	1
Permitted acreage		2.75	1			N/A	3
Total acres used		N/A	0.001			N/A	N/A
Floating gear	**Type**	Kelp longline	Kelp longline			Kelp longline	Kelp longline
	Number	1	N/A			N/A	N/A
	Length (ft)	600	N/A			N/A	N/A
	Width (ft)	200	N/A			N/A	N/A
	Height (ft)	N/A	N/A			N/A	N/A
	Diameter (m)	N/A	N/A			N/A	N/A
	Material	N/A	N/A			N/A	N/A
	Space between lines (ft)	N/A	50			N/A	40
Vertical lines	**Type**	N/A	Control line with buoy/ weight	Line hold on mooring chain	Flexible anchor rode	Line with buoy/anchor line	Anchor line
	Number	6	4	4	4	3	N/A
	Diameter (in)	N/A	N/A	0.75	N/A	1.08	0.38
	Tension (lbs)	22	440.9	440.9	440.9	30 to 100	1,000
	Material	Grow line with PVC wrap	N/A	N/A	N/A	Poly-steel rope	N/A
	Length (ft)	N/A	5	N/A	30 to 50	6 to 18	N/A
Horizontal lines	**Type**	Kelp grow line	Controlled depth longline			Seeded kelp line	Longline
	Number	4	2			1	4
	Diameter (in)	0.63	0.44			N/A	N/A
	Tension (lbs)	22	21,300			50	50
	Material	Poly composite	Poly line			N/A	N/A
	Length (ft)	400 to 1600	150			50	500

Anchors	**Type**	Perimeter line mooring block, Anchor chain	Helix anchor, Mooring chain	Plow-type anchor	Mushroom anchor	
	Number	10	4	2	12	
	Height (ft)	N/A	N/A	N/A	N/A	
	Width (ft)	N/A	N/A	N/A	N/A	
	Weight (lbs)	1500 to 4000	1000	250	250	
Markers	**Type**	Moored surface buoy, Mooring block	Polyform buoy	N/A	Anchor buoy	Safe boating marker
	Number	6	4	N/A	3	6
	Material	N/A	Polyform	N/A	N/A	N/A
	Height (in)	N/A	36	N/A	24	12
	Width (in)	N/A	N/A	N/A	N/A	N/A

Consultation #		**23**		**25**	**28**		**29**	
Tracking #		NER-2017-14330		NER-2017-14379	NER-2018-14998		NER-2017-14518	
Depth from surface (ft)		5		10 to 40	4 to 23		N/A	
# of lease		1		1	1		3	
Permitted acreage		2.9		1.61	2.3		18.9	
Total acres used		0.008		0.008	0.006		0.01	
Floating gear	**Type**	Kelp longline		Kelp longline	Kelp longline		Kelp longline	
	Number	N/A		1	N/A		N/A	
	Length (ft)	N/A		360	N/A		N/A	
	Width (ft)	N/A		108	N/A		N/A	
	Height (ft)	N/A		N/A	N/A		N/A	
	Diameter (m)	N/A		N/A	N/A		N/A	
	Material	N/A		N/A	N/A		N/A	
	Space between lines (ft)	40		N/A	20		50	
Vertical lines	**Type**	Sinking lead line	Lines attaching buoy	N/A	Sinking buoy line	Sinking line	Lines between buoy and anchor	Line between seed line and counter float buoy
	Number	18	45	N/A	12	72	72	
	Diameter (in)	0.63	0.378	N/A	0.63	0.5	0.38	
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A	N/A	
	Material	Sinking leadline	N/A	N/A	N/A	N/A	Lead-core sinking line	
	Length (ft)	N/A	5	N/A	N/A	N/A	N/A	
Horizontal lines	**Type**	Seaweed seed line		N/A	Kelp seeded sinking line		Lead-core sinking line	
	Number	9		N/A	8		24	
	Diameter (in)	0.38		N/A	0.5		0.38	
	Tension (lbs)	N/A		N/A	N/A		N/A	
	Material	Lead-core sinking line		N/A	Sinking poly line		Lead-core sinking line	
	Length (ft)	200		N/A	500		500	

Anchors	**Type**	Mushroom anchor, Block or screw anchor	N/A	Mushroom anchor			Mushroom anchor, Block or screw anchor	
	Number	36	N/A	16			144	
	Height (ft)	N/A	N/A	N/A			N/A	
	Width (ft)	N/A	N/A	N/A			N/A	
	Weight (lbs)	250 to 300	N/A	200			200 to 300	
Markers	**Type**	Chain anchored boat marker	N/A	Mooring buoy	Floatation buoy	Hazard buoy	Counter float surface buoy	Navigation hazard buoy
	Number	6	N/A	12	72	4	384	8
	Material	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Height (in)	36	N/A	N/A	N/A	N/A	N/A	N/A
	Width (in)	12	N/A	N/A	N/A	N/A	N/A	N/A

Consultation #		**30**		**32**		**34**		**35**	
Depth from surface (ft)		6		5		3 to 6		5	
# of lease		1		1		2		1	
Permitted acreage		4.7		3.97		84		8.3	
Total acres used		0.01		0.01		N/A		0.01	
Floating gear	**Type**	Kelp longline		Kelp longline		Kelp longline		Kelp longline	
	Number	N/A		N/A		N/A		N/A	
	Length (ft)	N/A		N/A		N/A		N/A	
	Width (ft)	N/A		N/A		N/A		N/A	
	Height (ft)	N/A		N/A		N/A		N/A	
	Diameter (m)	N/A		N/A		N/A		N/A	
	Material	N/A		N/A		N/A		N/A	
	Space between lines (ft)	40		20		50		40	
Vertical lines	**Type**	Line between anchor/ buoy	Line between counter float surface buoy/ longline	Line between anchor/ buoy	Line between counter floatation surface buoy /longline	Sinking buoy line	Counter floatation buoy line	Buoy line	Lines betwee longline and counter-flotat surface buoy
	Number	21	112	20	90	108	720 to 864	42	119
	Diameter (in)	0.38		0.63	0.63	0.75 to 1	0.75 to 1	0.63	0.38
	Tension (lbs)	N/A		N/A	N/A	N/A	N/A	N/A	N/A
	Material	Lead-core sinking line		Lead-core sinking line	Lead-core sinking line	N/A	N/A	Lead core sinking line	Lead core sinking line

Vertical lines (continued)	**Length (ft)**	N/A		42			36 to 40.5	N/A		N/A		5	
Horizontal lines	**Type**	Lead-core sinking line		Poly long line with lead-core sinking line or chain			Poly line with lead-core sinking line or chain			Lead core sinking line			
	Number	7		10			36			7			
	Diameter (in)	0.38		0.5			0.5			0.38			
	Tension (lbs)	N/A		N/A			N/A			N/A			
	Material	Lead-core sinking line		Poly line with lead-core sinking line or chain			Sinking line			Lead core sinking line			
	Length (ft)	500		500			500			500			
Anchors	**Type**	Mushroom anchor		Mushroom/pyramid anchor			Mushroom anchor			Mushroom, block or screw anchor			
	Number	42		42			108			42			
	Height (ft)	N/A		4			N/A			3			
	Width (ft)	N/A		4			N/A			3			
	Weight (lbs)	200 to 300		500			250			250			
Markers	**Type**	Anchor buoy	Surface buoy	Navigation buoy	Anchor buoy	Surface buoy	Navigation buoy	Anchor buoy	Surface buoy	Safe boating marker	Anchor buoy	Surface buoy	Ch an bu
	Number	21	112	6	20	90	6	108	720 to 864	24	42	119	8
	Material	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/
	Height (in)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/
	Width (in)	18 to 24	12	N/A	16	12	N/A	18 to 24	10 to 12	12	18 to 24	12	N/

Consultation #		36		37		39		41	
Depth from surface (ft)		7 to 8		7		10		5	
# of lease		1		1		1		1	
Permitted acreage		N/A		49		2.5		3.86	
Total acres used		0.003		0.2		0.01		0.01	
Floating gear	Type	Kelp longline		Kelp longline		Kelp longline		Kelp longline	
	Number	N/A		N/A		N/A		N/A	
	Length (ft)	N/A		N/A		N/A		N/A	
	Width (ft)	N/A		N/A		N/A		N/A	
	Height (ft)	N/A		N/A		N/A		N/A	
	Diameter (m)	N/A		N/A		N/A		N/A	
	Material	N/A		N/A		N/A		N/A	
	Space between lines (ft)	N/A		20		3.28		20	
Vertical lines	Type	Line between anchor/buoy	Line between longline/ counter-flotation buoy	Anchor line	Line between kelp line /floatation buoy	Catenary line	Anchor/ mooring line	Buoy/ anchor line or chain	Line between grow surface buoy
	Number	6	12	2 anchor line per kelp line	2 floatation buoy per kelp line	N/A	N/A	20	140
	Diameter (in)	0.75	0.5	N/A	N/A	1	1.5	0.63	0.63
	Tension (lbs)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A	Braided poly	Braided poly	Lead-core line or chain	N/A
	Length (ft)	N/A	5	N/A	N/A	198.5	N/A	31.5	N/A

Horizontal lines	**Type**	Sinking line			N/A			Polysteel "Esterpro" sink rope	Lead-core sinking line		
	Number	3			15 to 350			33	10		
	Diameter (in)	0.5			N/A			0.38	0.5		
	Tension (lbs)	1,100			1100			N/A	N/A		
	Material	N/A			N/A			Polyester 12-strand braid	Lead-core sinking line		
	Length (ft)	250			200			216.5	500		
Anchors	**Type**	Concrete, cylindrical, mushroom, screw anchor			Mooring anchor			Stockless anchor	Pyramid anchor		
	Number	12			2 per line			2	42		
	Height (ft)	N/A			N/A			N/A	4		
	Width (ft)	N/A			N/A			N/A	4		
	Weight (lbs)	160 to 300			250 to 300			8000	500		
Markers	**Type**	Mooring buoy	Floatation buoy	Navigation buoy	Anchor buoy	Floatation buoy	Navigation buoy	Steel truss-supported corner buoy	Anchor buoy	Flotation buoy	Naviga buoy
	Number	6	12	8	2 per kelp line	2 per kelp line	N/A	4	20	140	6
	Material	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Height (in)	N/A	N/A	N/A	N/A	N/A	N/A	144	N/A	N/A	N/A
	Width (in)	18 to 24	12	12	24 to 30	12	N/A	24	24	12	N/A

Table B.4. Detailed information for consultations using multiple modes of gear (i.e., multimode).

Consultation #		**4**	**33**	**48**	**66**
Gear types		Cage on bottom, Shell on bottom	Cage on bottom, Floating gear	Cage on bottom, Floating gear	Cage on bottom, Floating gear
Depth from surface (ft)		7.7 to 10.7	0	3	N/A
# of lease		1	5	1	1
Permitted acreage		18.4	9.29	1	6.28
Gear type details	**Dominant gear type**	Bottom cage	Oyster flip bag	Floating cage, Cage on bottom (OysterGro)	Floating oyster cage, Cage on bottom
	Number	3500	13880	50 to 100	1800
	Length (ft)	3	3	36.67	Floating: 45, Bottom: 40
	Width (ft)	4	2	36.33	Floating: 20, Bottom: 45
	Height (ft)	1.5	3	2	Floating: 6, Bottom: 18
	Material	N/A	Vinyl-coated wire mesh	Wire mesh	PVC coated wire mesh
	Space between cages (ft)	5	3	10	4
Subordinate gear	**Additional gear type used**	N/A	Oyster cage	N/A	UV resistant mesh aquaculture bag
	Number of subordinate gear	N/A	N/A	Mesh bag: 200-400	N/A
	Length (ft)	N/A	4	N/A	N/A
	Width (ft)	N/A	3	N/A	N/A
	Height (ft)	N/A	0.67	N/A	N/A
	Material	N/A	N/A	Mesh vexar	Polyurethane
Vertical lines	**Type**	Buoy line	Crab line	Tether between float/ bottom cage	N/A
	Number	160	228	36	144
	Diameter (in)	N/A	0.38	0.5	0.5
	Material	N/A	Polypropylene	Nylon rope	Braided nylon line
	Length (ft)	N/A	1	4	N/A
Horizontal lines	**Type**	Connecting line	Mainline	Sinking mainline	Longline
	Number	20	347	3 to 10	20 to 30

Horizontal lines (continued)	**Diameter (in)**	N/A	0.31	0.63	0.5
	Material	N/A	Stainless steel cable	Strand nylon	N/A
	Length (ft)	N/A	170	100	75
Anchors	**Type**	N/A	D helical anchor	Mushroom anchor	Galvanized steel screw anchor
	Number	40	694	6 to 20	Twice the number of horizontal line
	Height (ft)	N/A	N/A	N/A	2.5
	Width (ft)	N/A	0.05	N/A	N/A
	Weight (lbs)	N/A	N/A	75	N/A
Markers	**Type**	Buoy	Crab pot float	Styrofoam float, Corner marker	Buoy
	Number	160	Crab pot float: 228, Cedar post: 2082	Styrofoam float: 36, Corner marker: 4	4
	Material	N/A	N/A	Elliptical yellow styrofoam float	N/A
	Height (in)	9	10	N/A	4.5
	Width (in)	4	N/A	N/A	3.5

Consultation #		115	129	166	219
Gear types		Cage on bottom, Floating gear	Cage on bottom, Floating gear	Cage on bottom, Floating gear	Cage on bottom, Floating gear
Depth from surface (ft)		N/A	N/A	N/A	0
# of lease		1	1	1	1
Permitted acreage		9.96	4.6	5	0.2
Gear type details	**Dominant gear type**	SEAPA basket	Stacked cage, Pod	Wire mesh cage	Floating cage, Bottom cage, Bag
	Number	34560	Stacked cage: 3116	2000	100 to 150
	Length (ft)	0.67	4	3	4
	Width (ft)	0.5	3	4	4
	Height (ft)	2	2	1.5	2
	Material	Mesh basket	Wire mesh	Wire mesh	Marine grade vinyl coated wire mesh
	Space between cages (ft)	N/A	N/A	N/A	25
Subordinate gear	**Additional gear type used**	N/A	SEAPA pod	N/A	Mesh bag with 2 plastic float
	Number of subordinate gear	N/A	10800	N/A	Mesh bag: 50, Plastic float: 2
	Length (ft)	N/A	3	N/A	N/A
	Width (ft)	N/A	1	N/A	N/A
	Height (ft)	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A
Vertical lines	**Type**	N/A	N/A	N/A	Retrieval line
	Number	N/A	310	12	20
	Diameter (in)	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A
Horizontal lines	**Type**	Black monofilament line	N/A	N/A	Sinking mainline
	Number	288	122	6	10
	Diameter (in)	0.43	N/A	N/A	0.5

Horizontal lines (continued)	**Material**	Monofilament	N/A	N/A	N/A
	Length (ft)	300	N/A	N/A	200
Anchors	**Type**	N/A	N/A	N/A	N/A
	Number	N/A	N/A	N/A	N/A
	Height (ft)	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A
Markers	**Type**	Composite pole, Strainer post	Small buoy, Corner marker buoy	PVC marker, Small buoy	Piling, Hazard marker
	Number	Composite pole: 8928, Strainer post: 144	Small buoy: 300, Corner marker buoy: 4	PVC marker: 4, Small buoy: 12	Piling: 20, Hazard marker: 4
	Material	N/A	N/A	N/A	Vinyl coated timber piling
	Height (in)	N/A	N/A	N/A	Piling: 20, Timber: 10
	Width (in)	2	N/A	N/A	10

Consultation #		220	228	241	252
Gear types		Cage on bottom, Floating gear	Cage on bottom, Floating gear	Cage on bottom, Floating gear	Cage on bottom, Floating gear
Depth from surface (ft)		0	2	N/A	N/A
# of lease		1	1	1	1
Permitted acreage		2	2.6	5.08	2
Gear type details	Dominant gear type	Floating cage, Bottom cage, Bag	Oyster grow-out cage with floats	Oyster cage	Hanging basket
	Number	100 to 150	200	1664	100
	Length (ft)	4	3	4	4
	Width (ft)	4	4	3	2
	Height (ft)	2	2	1.25	0.5
	Material	Marine grade vinyl coated wire mesh	N/A	N/A	N/A
	Space between cages (ft)	25	5	20	4
Subordinate gear	Additional gear type used	Mesh bag, Plastic float	N/A	Float	Oyster bottom cage
	Number of subordinate gear	Mesh Bag: 50, Plastic float: 2	N/A	N/A	20
	Length (ft)	N/A	N/A	4	3.5
	Width (ft)	N/A	N/A	3	3.5
	Height (ft)	N/A	N/A	0.58	0.33
	Material	N/A	N/A	N/A	Mesh
Vertical lines	Type	Retrieval line	N/A	N/A	N/A
	Number	20	20	64	12
	Diameter (in)	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A
Horizontal lines	Type	Sinking mainline	N/A	N/A	N/A
	Number	10	20	32	5
	Diameter (in)	0.5	N/A	N/A	N/A

	Material	N/A	N/A	N/A	N/A
	Length (ft)	200	N/A	N/A	50
Anchors	**Type**	N/A	Anchro stake	Steel anchor	Screw anchor
	Number	N/A	20	68	12
	Height (ft)	N/A	N/A	N/A	2.08
	Width (ft)	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A
Markers	**Type**	Piling, Hazard marker	Sapling, Float	Small buoy	Cage float buoy, Longline buoy, Corner marker buoy, Stake, Spacer buoy between floats
	Number	Piling: 20, Hazard marker: 4	Sapling: 6, Float: 200	Small buoy: 64, Marker buoy: 4	Cage float buoy: 18, Longline buoy: 12, Corner marker buoy: 4, Stake: 4
	Material	Vinyl coated timber piling	N/A	N/A	N/A
	Height (in)	Piling: 20, timber: 10	N/A	48	18
	Width (in)	10	N/A	9	6

Consultation #		253	254	266	267
Gear types		Cage on bottom, Floating gear	Cage on bottom, Floating gear	Cage on bottom, Floating gear	Cage on bottom, Floating gear
Depth from surface (ft)		N/A	N/A	0	0
# of lease		1	1	1	1
Permitted acreage		13.9	14	2.24	2.12
Gear type details	Dominant gear type	Oyster cage	SEAPA basket	Floating wire cage	Floating bay cage/bottom cage
	Number	500	14000	288	204
	Length (ft)	4	2	N/A	N/A
	Width (ft)	6	1	N/A	N/A
	Height (ft)	2	0.5 to 0.75	N/A	N/A
	Material	N/A	N/A	N/A	N/A
	Space between cages (ft)	5	N/A	N/A	25
Subordinate gear	Additional gear type used	N/A	Wire mesh cage	Mesh bag	Mesh bag
	Number of subordinate gear	N/A	4200	50	1224
	Length (ft)	N/A	4	N/A	N/A
	Width (ft)	N/A	3	N/A	N/A
	Height (ft)	N/A	1.17	No Info	N/A
	Material	N/A	Wire mesh	N/A	N/A
Vertical lines	Type	N/A	N/A	Retrieval line	Retrieval line
	Number	104	1124	32	32
	Diameter (in)	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	N/A	N/A
Horizontal lines	Type	N/A	N/A	Mainline	Mainline
	Number	50	1520	16	16
	Diameter (in)	N/A	0.5	0.5	0.5
	Material	N/A	N/A	N/A	N/A

	Length (ft)	N/A	Float: 100, Cage: 600	185	185
Anchors	**Type**	N/A	N/A	N/A	N/A
	Number	N/A	N/A	N/A	N/A
	Height (ft)	N/A	N/A	N/A	N/A
	Width (ft)	N/A	N/A	N/A	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A
Markers	**Type**	Buoy, Marker buoy	Small buoy, Corner marker buoy	Vinyl coated timber piling	Vinyl coated timber piling
	Number	Buoy: 100, Marker buoy: 4	Small buoy: 280, Corner marker buoy: 4	Piling: 32, Hazard marker: 4	Piling: 32, Hazard marker: 4
	Material	N/A	N/A	N/A	N/A
	Height (in.)	1	N/A	8	8
	Width (in)	8	N/A	N/A	N/A

Consultation #		268	275	291	297	299
Gear types		Cage on bottom, Floating gear	Cage on bottom, Floating gear, Shell on bottom	Cage on bottom, Floating gear	Cage on bottom, Floating gear	Cage on bottom, Floating gear
Depth from surface (ft)		0	0 to 8	0 to 6.5	0 to 2	0
# of lease		1	1	1	1	1
Permitted acreage		1.99	2	2	1.96	0.12
Gear type details	Dominant gear type	Floating bay cage, bottom cage	Oyster cage floating/bottom	Oyster cage floating/bottom	Floating bags, Bag on bottom	Oyster cage
	Number	216	420	150	1500 to 2640	120
	Length (ft)	N/A	3	3	3	3
	Width (ft)	N/A	6	3	1.67	10
	Height (ft)	N/A	1.5	0.67	N/A	1
	Material	N/A	PVC-coated welded wire aqua-mesh	Gauge wire mesh	HDPE float	N/A
	Space between cages (ft)	25	25	5	15	2
Subordinate gear	Additional gear type used	Mesh bag	Bag	Mesh bag	N/A	Clam bag
	Number of subordinate gear	1224	3360	300	N/A	3
	Length (ft)	N/A	N/A	N/A	N/A	3
	Width (ft)	N/A	N/A	N/A	N/A	0.33
	Height (ft)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	PVC	N/A	N/A
Vertical lines	Type	Retrieval line	PVC-sheathed anchor line	Line between anchor/boundary marker	N/A	Anchor line/tether line for clam bag
	Number	32	72	14	N/A	116
	Diameter (in)	N/A	N/A	N/A	N/A	N/A
	Material	N/A	N/A	N/A	N/A	N/A
	Length (ft)	N/A	N/A	7	N/A	N/A

Horizontal lines	**Type**	Mainline	Sinking mainline	Mainline	Mainline	N/A
	Number	16	36	7	22	N/A
	Diameter (in)	0.5	0.63	0.38	N/A	N/A
	Material	N/A	100	N/A	N/A	N/A
	Length (ft)	185	N/A	120	180	16
Anchors	**Type**	N/A	Helical anchor	Auger anchor	Helix screw anchor	N/A
	Number	N/A	72	14	44	N/A
	Height (ft)	N/A	N/A	5	4	N/A
	Width (ft)	N/A	0.5	N/A	0.5	N/A
	Weight (lbs)	N/A	N/A	N/A	N/A	N/A
Markers	**Type**	Vinyl coated timber piling	Anchor buoy, Boundary buoy, Boundary stake	Marker buoy, Mainline buoy	PVC stake	Bamboo pole corner marker
	Number	Piling: 32, Hazard marker: 4	Anchor buoy: 72, Boundary buoy: 14, Boundary stake: 6	Marker buoy: 4, Mainline buoy: 14	4	N/A
	Material	N/A	N/A	N/A	PVC	N/A
	Height (in.)	8	N/A	N/A	N/A	N/A
	Width (in)	N/A	N/A	N/A	N/A	N/A

Table B.5. Detailed information for consultations using net pen gear.

Consultation #		6
# of lease		1
Permitted acreage		28
Gear type details	**Dominant gear type**	Circular floating fish net pens connected together to form a three pen by six pen grid system
	Number	18
	Diameter (m)	100
	Material	High Density Polyethylene circular tubes filled with foam for added buoyancy which support a primary containment net and predator net
	Space between cages (ft)	N/A
Additional gear type used		Containment/Predator net: The primary containment net is secured to the inside floating ring which bears the weight of the net, a jump net or skirt is sewn into the net above the water line and is attached to a support structure and hand rail. An avian predator net is attached to the handrail and is placed above the entire net pen and is supported in the middle by a floating structure to keep it above the water line. Another predator net is attached to the outer ring of the net pen and is deployed below the water line to deter seals from tearing the primary containment net. This net is usually spaced several feet from the primary containment net and is held in place with a HDPE ring or weighted collar filled with cement to keep it taut and to help maintain its shape when exposed to tidal current.
Vertical lines	**Type**	Buoy/mooring line securing cage to moorings and fastened to compensator buoy to maintain tension in the line and terminates with a 1 in. diameter chain, shackle and connector plate.
	Number	18
	Diameter (in)	1.625
Anchors	**Type**	Mooring system directly on seafloor. Danforth-style anchors and/or concrete block.
	Number	18
	Weight (lbs)	2,200 to 6,000
Markers	**Type**	Boundary marker around lease area and structures will be placed according to Coast Guard regulations.

Appendix C. Seasonal Information from ESA Section 7 Consultations Evaluated by Gear Type[7]

Appendix C.1. Seasonal information evaluated for consultations using cage on bottom (n=13).

Seasonal Trend by State			
Connecticut	**Maryland**	**New Jersey**	**Massachusetts**
Cages placed for six weeks or more at a time and will be removed seasonally (months not specified).	Harvest: October to April. Gear removal not specified.	Husbandry activities become less frequent in winter months (months not specified). Gear removal not specified.	All equipment removed between December and March.
Cages will be moved from grow out to depuration around October. Gear will be removed seasonally from March to November.	Harvest: October to April. Gear removal not specified.		From February 1 to April 30, all floating gear are sunk or removed. Remaining vertical lines attached to bottom gear will be reduced, kept under tension, and attached with a 600lb breakaway link or ropes of appropriate breaking strength.
Year round project. No gear removal.	Harvest: October to April. Gear removal not specified.		
Growing season: April until early winter. Harvest: late fall/early winter. Gear removal not specified.	Harvest: October to April. Gear removal not specified.		
Cages removed between January and April. Farming season between May and December.			
Gear installed seasonally from June to October. Gear removal not specified.			

[7] Projects that did not include seasonal information are not included.

Appendix C.2. Seasonal information evaluated for consultations using floating gear (n=22).

Seasonal Trend by State				
Connecticut	**New Jersey**	**Massachusetts**	**Rhode Island**	**Maine**
Gear removed November to May.	Cages float during growing season and flipped and sunk during the winter (months not specified).	Annual restocking of oysters occur June to September. Gear removal not specified.	Growing season: April to November. After harvest, cages rest on the bottom and stay year round. Kelp season is between November and March.	Buoys, moorings and grow line deployed in October until May. Gear removal not specified.
Harvest: May and/or June. Gear removal not specified.		Annual restocking of oysters occur June to September. Gear removal not specified.	Harvest: April. Growing season: November to April. Gear removal not specified.	
Growing season: November to April. Harvest: April. Longlines removed for the summer/fall season leaving only the vertical mooring lines in place.		Mussels harvested once per year. After harvest, only bare tensioned headrope and anchor lines left. No months specified. Kelp planted in November, and monthly harvests during March to May. Gear removal not specified.		
Growing season: October to June. Longlines removed in June but anchors, anchor lines, and buoys will remain in place.		The gear will remain in the water for the duration of the project (6 growing seasons; 3 years). After, all in water will be removed.		
Growing season: November to June. After harvest, horizontal/floatation lines removed but terminal vertical anchor lines and buoys left in place.		Growing season: December to April. Harvest: April. Horizontal longlines removed after harvest. All other gear remain in the water throughout year.		

Growing season: October to June. Harvest: May to June. Horizontal longlines and flotation lines/buoys removed after harvest but terminal vertical anchor lines/buoys left in place.		Growing season: December to April/May. All gear removed in May 2019 after project is complete. Gear removal not specified.		
Growing season: October to June. Harvest: May to June. Gear removal not specified.		Growing season: October to November. Harvest: May to June 15. Horizontal lines removed after harvest.		
Growing season: November to May. Harvest: April 30. Horizontal longlines and flotation lines/buoys removed after harvest but terminal vertical anchor lines/buoys left in place.		Growing season: October to May. Gear removal not specified.		
Growing season: October to June. Harvest: May to June. Horizontal longlines and flotation lines/buoys removed for the summer/fall season but terminal vertical anchor lines/buoys left in place.		Growing season: late October/early November to April/May. Harvest: May to early June. Everything except for anchors removed after harvest.		

Appendix C.3. Seasonal information evaluated for consultations using combination of cage on bottom and floating gear (n=12), which are categorized as multimode in this report.

Seasonal Trend by State	
Maryland	**New Jersey**
Cages float between March and October and sunk to bottom November to February.	Use of bags during warmer months and cages during colder months (months not specified). Gear removal not specified.
Floating cages sunk during storm events and winter weather (months not specified).	Bottom cages deployed December to February/March. Gear removal not specified.
	Floating cages deployed April to November. Floating gear removal: December to March. Bottom cages used year round.
	Floating cages and bags sunk to the bottom during the winter (months not specified).
	Floating cages and bags sunk to the bottom during the winter (months not specified).
	Floating bags and cages sunk in the winter (months not specified).
	Floating bags and cages sunk in the winter (months not specified).
	Floating bags and cages sunk in the winter (months not specified).
	Floating bags and cages sunk in the winter (months not specified).
	Floating gear sunk in the winter or during storm events (months not specified).

Appendix D. Methods for Searching Literature on Entanglement with Aquaculture Gear

Table D.1. Key words used in the literature search[8].

Entanglement	Interaction	Disturbance	Predation	Avoidance
Aquaculture	Gear	Cage on bottom	Shell on bottom	Floating gear
FLUPSY	Aqua trays	Lantern net	Submerged longline	Headrope
Net pen	Fish pen	Longline	Raft	Predator net
Surface longline	Kelp	Clams	Shellfish	Oyster
Mussels	Mariculture	Macroalgae	Seaweed	Suspended culture
Atlantic salmon	Shortnose sturgeon	Atlantic sturgeon	Blue whale	Fin whale
North Atlantic Right Whale	Sei whale	Sperm whale	Green sea turtles	Hawksbill turtle
Kemp's Ridley turtle	Leatherback turtle	Loggerhead turtle	Salmon	Sturgeon
Whale	Turtle	Abalone	Baleen whales	Sea turtles

For literature most relevant to the topic, citations listed in those references were searched for additional relevant findings. Moreover, new literature that cited those relevant papers were searched for through Web of Science. A gray literature search was also conducted throughout the Web using key words and phrases listed above. Due to the limited findings of relevant literature, the librarians did not restrict their literature search effort by year of publication. As a result of previous successful collaborative efforts, information on known marine mammal entanglement cases with aquaculture gear were requested from collaborators in Japan. As noted in the report, the severity of those entanglement events are pending confirmation and until the outcomes are verified in writing, they should not be included in formal counts of severe interactions/mortalities. Several databases/tools were used to search for literature on entanglement cases with aquaculture gear (see Table D.2.).

[8] Librarians from NOAA Headquarters conducted a literature search for up-to-date information about entanglements in aquaculture gear involving ESA-listed species. A combination of keywords, exact phrase, and Boolean search techniques were used when conducting the literature search. Depending on the database or tool used, database thesauri and full-text searching were also used.

Table D.2. List of databases/tools used for literature search.

Clarivate Analytics' Web of Science	EBSCO: Academic Search Complete and Environment Complete	Science Direct
BioDiversity Heritage Library	BioOne Complete	JSTOR
ProQuest Aquatic Sciences and Fisheries Abstracts	NOAA Institutional Repository	NOAA library network catalog

Appendix E. Simulation Model for Right Whales

Although entanglement with fixed fishing gear is one of the known causes of mortality of North Atlantic right whales, there remains little documentation of how whales interact with fishing gear. To better understand how entanglements occur, an interactive simulator was developed that allows users to swim a virtual whale model using a game controller in an attempt to re-create an entanglement scenario (Howle *et al.* 2018). The game controller with the virtual right whale was developed to interact with physics software to represent the fishing or aquaculture gear. The interaction mechanism within the simulator consists of a surface of convex "primitives"[9] surrounding the body of the virtual whale that detects when a collision with a gear component in the physics model occurs (Figure E.1.). The physics model then applies an equal and opposite force to both the virtual whale and the gear component and includes friction. The Howle *et al.* (2018) description does not include the mass or kinetic energy associated with the virtual whale, which may affect the collision response dynamics.

[9] The primitive equations are a set of nonlinear differential equations that are used to approximate global atmospheric flow and are used in most atmospheric models.

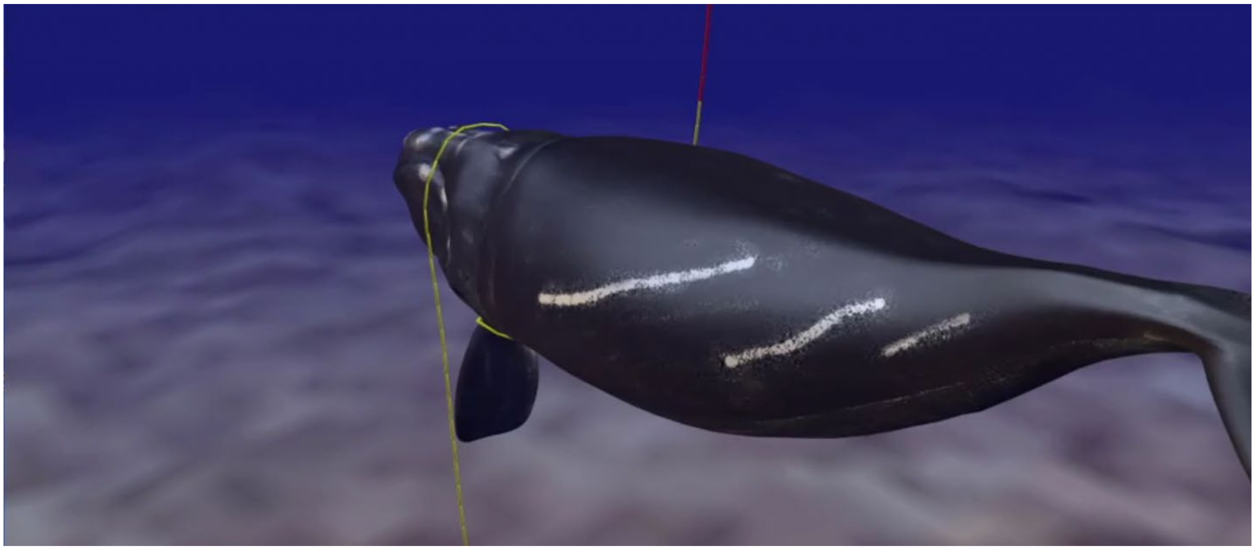

Figure E.1. A virtual representation of the Whale Simulator model. This model incorporates a virtual representation of a North Atlantic right whale coupled with a physics engine to calculate response of ocean deployed gear (Howle et. al., 2018 and https://www.andersoncabotcenterforoceanlife.org).

The simulator model incorporates the geometric morphology of a 10 meter right whale. The whale model produces swimming motions, including pectoral fin motions in response to user input, but not actual propulsion. Some whale swimming behaviors (e.g., ascend/descend, turn left/right, etc.) can be manually controlled and others (e.g., tail fluke motion, body roll) can be programmed for automated model runs. Various factors are incorporated into this model and are listed in Table E.1.

Table E.1. Factors incorporated into the right whale simulation model. Three categories are listed, but no specific relationship/correlation exists between these categories.

Gear properties	Whale behavior	Consequence of interaction
Tension of lines	Swimming speed	Thrashing behavior
Friction of gear	Swimming movements	Gear force on whale
Gear configuration		Rolling behavior
		Drag of gear

The whale simulation could be useful to aid scientists, fisheries experts, fishing gear designers, and bycatch reduction scientists in understanding entanglement dynamics and testing potential new aquaculture gear configurations; however, validation needs to be pursued. For example, this model assumes that the whale will interact with gear if they are present in the same space and time. The “swimming” behavior of the whale is maneuvered by the user not the model. In real life, the whale may avoid the gear entirely (i.e., swimming away but had the opportunity to interact) which would result in an insignificant effect. Assuming interaction between the whale and the gear does occur, the model does not allow one to predict the consequence to the whales since there is not sufficient data to be certain of whales’ behavior after encountering a gear. For instance, the whale may interact with the gear, but bounce off the line and result in insignificant impacts.

Although this model has limitations, it has potential to adjust its parameters to include aquaculture gear and a variety of types of animals (with varying ages/size). Thus, it would be a good option to pursue when there are more data to incorporate into the model (e.g., animal behavior before and after interaction).

Appendix F. Simulation Model for Sea Turtles

To better understand how entanglement of sea turtle cases occur, MacNicoll *et al.* (2017; see also Figure F.1.) developed a computer simulation model to mimic the behavior of adult leatherback sea turtle as they become entangled in a mooring lines.

The sea turtle model incorporates a wireframe representation in a commercially available program called MSC Adams. MSC Adams is a software (www.mscsoftware.com/product/adams) used to analyze moving parts that connect. A difference in the sea turtle model, compared to the whale simulator, is that the sea turtle model has actual propulsion through articulated flippers rather than being controlled by a gaming operator. The contact elements in the modelled gear (i.e., rope and buoys) are constructed with cylindrical shell elements, which are segmented with ball joints and torsion springs for the rope components. Similar to the whale simulator model, it also incorporates friction within the contact elements.

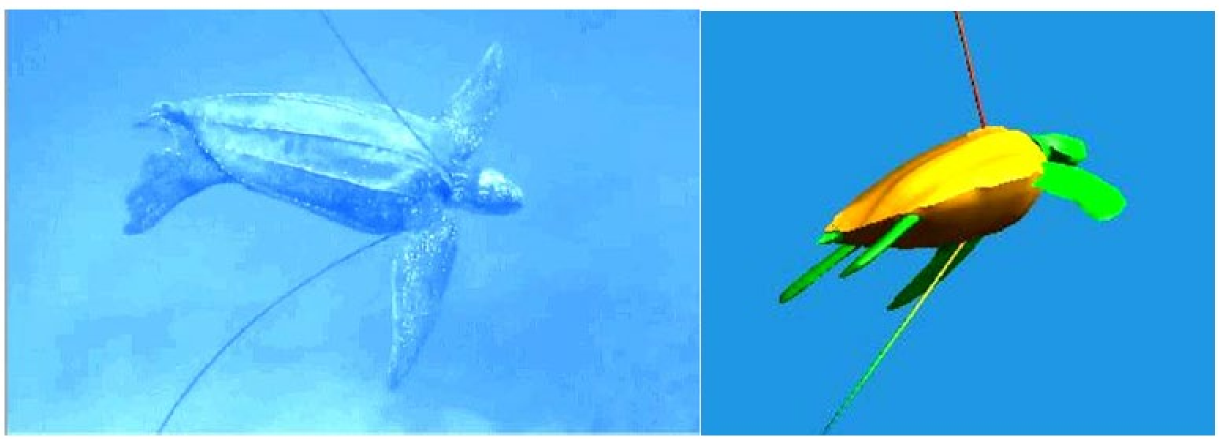

Figure F.1. Image of a leatherback turtle interacting with a vertical line (left). Simulation of a turtle interacting with a vertical line (right).

MacNicoll *et al.* (2017) believe this simulation model can assist designers to develop and advance mooring and fishing gear to reduce the number of leatherback turtle entanglement events. However, as with any model, this model also has limitations. For example, it only evaluates leatherback sea turtles. The model would have to be updated to measure risks of other species (e.g., other sea turtle species, manta rays, sharks, sturgeons, etc.). Moreover, it only evaluates risks from interaction with vertical lines. Aquaculture gear is complex, and in addition to vertical lines, other features (e.g., horizontal lines, hanging socks, etc.) need to be incorporated to better understand the overall risk of aquaculture gear to ESA-listed species.

Appendix G. Data Used in the Google Form Consultation Framework

The data included in the framework created in Google Form is detailed below. The Home Table is the starting point of the framework, providing the essential questions that will determine if a consultation is necessary. If a consultation is necessary, responses to the Home Table questions prompt the user to select applicable stressors. Subsequent tables provide a series of questions pertaining to each stressor evaluated for aquaculture projects. The GAR Section 7 team intends to update and adapt this framework (update frequency will be contingent on funding) as new information becomes available and when errors in the question sequencing/logic become apparent. Therefore, the data below is an example of the questions and logic included at the time this report was drafted (2020).

Notes: Y=Yes; N=No; Cells in Green= Recommendation on path forward

Home Table

Step	Question	Answer	Recommendation
1	Does project have in water effects?	Y	Go to Step 2
		N	No effect
2	Which species and critical habitat (CH) are in the project area? (Use ESA Section 7 Mapper[10])	(Add relevant information)	Go to Step 3
3	Is there any overlap with species and/or CH within the action area (spatially and temporally: identify when and duration of action below)?	Y	Go to Step 4
		N	Go to Step 4
4	What gear type/technique is used? Once selected, provide detailed gear information	Shell on bottom (SB)	Go to Step 5
		Cage on bottom (CB)	

[10] https://www.fisheries.noaa.gov/resource/map/greater-atlantic-region-esa-section-7-mapper

4 (continued)	(#Acres (footprint); # of horizontal/vertical lines; lines sheathed/loose?; tensile strength; line tension; breakaway "weak" links; distance between horizontal lines; water depth where gear will be deployed (total tidal range); distance from shore; distance from grow lines to seafloor)	Floating gear (FG)	
		Net pen (NP)	
5	What are the stressor(s) associated with the action?	Sound	Go to Sound Table
		Hindrance of passage	Go to Hindrance of Passage Table
		Habitat modification (e.g., shading, conversion of habitat, prey quality/quantity, water quality)	Go to Habitat Modification Table
		Dredging	Go Dredging Table
		Vessels	Go to Vessels Table
		Entanglement	Go to Entanglement Table
		Escapement (parasite/genetic drift)	Go to Escapement Table
		None of the above apply	No effect

Stressor: Sound

Step	Question	Answer	Recommendation
1	Does your action area include critical habitat (CH) of North Atlantic right whale or other areas where other ESA-listed species are present?	Y	Go to Step 2
		N	Go to Step 3
2	Could your action result in underwater noise exceeding the behavioral threshold for marine mammals (120 dB RMS or 160 dB RMS for non-pulse and pulse noise, respectively) and/or physiological/injury noise threshold for other ESA-listed species?	Y	Go to Step 6
		N	Go to Step 3
3	Does your project involve pile driving during a time when ESA-listed species may be present?	Y	Go to Step 4
		N	NLAA/VF
4	Is the pile driving occurring during a time when ESA-listed species may be present and the anticipated noise is above behavioral noise threshold?	Y	NLAA/VF with justification
		N	Go to Step 5
5	Does your project involve underwater noise that may disrupt any essential behaviors (migrations, foraging, spawning, overwintering)?	Y	Go to Step 6
		N	NLAA/VF with justification
6	Does your project overlap with ESA-listed whales?	Y	Go to Step 7
		N	Go to Step 8
7	Does the sound pressure (underwater noise) from the project have the potential to exceed injurious levels of noise and/or create a behavioral disturbance that would deter/diminish essential behaviors (e.g., foraging, migration)?	Y	Recommend use of OPR's tool[11] ;Go to Step 9
		N	NLAA/individual consultation
8	For ESA-listed fish and turtles, are they likely to be exposed to injurious levels of noise?	Y	Go to Step 9
		N	NLAA/individual consultation
9	Are there available/achievable BMPs or time of year (TOY) restrictions that could make effects of sound pressure on ESA-listed species insignificant or discountable?	Y	NLAA/individual consultation
		N	LAA

[11] OPR's tool: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance

Stressor: Hindrance of Passage

Step	Question	Answer	Recommendation
1	Does your action area include Critical Habitat (CH) for Atlantic sturgeon, Atlantic salmon, or North Atlantic right whales?	Y	Go to Step 2
		N	Go to Step 3
2	Is gear in shallow water (too shallow to be used for passage) and accessed by foot at low tide?	Y	NLAA/VF
		N	Go to Step 5
3	Are the ESA-listed species (a) likely to pass through the action area at the time of year when project activities occur; and/or (b) the project will create an obstruction to passage when in-water work is completed, then a zone of passage (~50% of water body) with appropriate habitat for ESA-listed species (e.g., depth, water velocity, etc.) must be maintained (i.e., physical or biological stressors such as turbidity and sound pressure must not create barrier to passage)?	Y	NLAA/VF
		N	Go to Step 4
4	Are there any sensitive life stages of species present and/or important behaviors (e.g., spawning, migration) taking place?	Y	Go to Step 6
		N	Go to Step 5
5	What is the likelihood/frequency of co-occurrence between listed-species and the portion of the action area where passage may be limited due to gear/aquaculture activity?	Temporary (gear) & Rare and/or Transient (species)	NLAA/VF with justification
		High likelihood/frequency of co-occurrence	Go to Step 6
6	Is project in critical habitat (CH) of Atlantic sturgeon or Atlantic salmon?	Y	LAA
		N	Go to Step 7
7	Is the project in NARW CH?	Y	Go to Step 8
		N	Go to Step 9
8	Is the obstruction temporary and avoid important times of the year (spawning/breeding/foraging) such that	Y	NLAA/individual consultation
		N	LAA

Stressor: Hindrance of Passage

	none of the essential behaviors are prevented or obstructed in multiple seasons?		
9	Can TOY and BMPs be used to reduce or eliminate exposure of species to the stressor causing the hindrance of passage?	Y	NLAA/individual consultation
		N	LAA

Stressor: Habitat Modification

Step	Question	Answer	Recommendation
1	Does your project include CH for Atlantic sturgeon, Atlantic salmon, or North Atlantic right whale?	Y	Go to Step 2
		N	Go to Step 6
2	Does your project include CH for Atlantic sturgeon?	Y	Go to Step 3
		N	Go to Step 4
3	Is the gear in water that is too shallow to be frequented by the ESA-listed species in your action area (e.g., intertidal zone)?	Y	NLAA/VF
		N	Go to Step 5
4	Is the gear in water that is too shallow to be frequented by the ESA-listed species in your action area (e.g., intertidal zone)?	Y	No effect
		N	Go to Step 5
5	Will your project potentially result in a long-term modification of habitat (e.g., conversion to shell on bottom in a previously soft bottom habitat)?	Y	Go to Step 8
		N	NLAA/VF
6	Is the habitat subject to long term modifications (multi-seasonal impacts that may last longer than a year) located in an area where listed species are known to occur regularly or are any sensitive life stages of the species present and/or important behaviors (e.g., spawning migration, foraging, overwintering) occurring within the project area?	Y	Go to Step 10
		N	Go to Step 7
7	Are listed species in the action present only temporarily and use the habitat transiently and/or opportunistically where in-water work/gear or aquaculture gear components will be deployed?	Y	NLAA/VF with justification
		N	NLAA/VF without justification
8	Is the proposed action expected to adversely affect critical habitat?	Y	LAA
		N	Go to Step 9
9	Any adverse effects to species from removal of habitat (e.g., reduce fitness of species, reduce fecundity)?	Y	LAA
		N	NLAA/individual consultation
10	Is the habitat modification expected to be long-term, likely to prevent listed species from completing an important behavior (e.g., accessing documented/preferred foraging habitat, spawning/breeding grounds,	Y	LAA
		N	NLAA/individual consultation

Stressor: Habitat Modification

10 (continued)	overwintering grounds, etc.), and are these listed species present in the action area majority of their lifetime (i.e., non-transitory)?		

Stressor: Dredging

Step	Question	Answer	Recommendation
1	Does your project involve dredging in water that is likely too shallow to be frequented by the ESA-listed species in your action area (e.g., intertidal zone)?	Y	NLAA/VF
		N	Go to Step 2
2	Does your project include "new" dredging within the Atlantic salmon or sturgeon critical habitat?	Y	Go to Step 5
		N	Go to Step 3
3	Are any of the ESA- listed species likely to be present when in-water work is occurring, particularly during sensitive life stages and/or important behaviors (e.g., spawning migration) are taking place?	Y	Go to Step 4
		N	NLAA/VF
4	Is the co-occurrence of ESA-listed species and dredging activity temporary and only expect infrequent transient individuals to migrate/forage in the project area?	Y	NLAA/VF
		N	Go to Step 7
5	Is dredging occurring in an area/time of year when sensitive life stages/important behaviors of any listed species are occurring (e.g., spawning/breeding migration, overwintering fish, etc.)?	Y	LAA
		N	Go to Step 6
6	Does the dredging project result in a long-term modification of habitat that will likely change essential sturgeon/salmon behavior and/or affect their overall fitness (permeant loss of prey items from an important foraging area)?	Y	LAA
		N	NLAA/individual consultation
7	Can any of the ESA-listed species in areas of proposed action (e.g., oyster reefs) be affected from dredging activities?	Y	Go to Step 8
		N	NLAA/individual consultation
8	Are there any BMPs or TOY restrictions to avoid affecting injury to ESA-listed species from dredging activities?	Y	NLAA/individual consultation
		N	LAA

Stressor: Vessel Traffic

Steps	Questions	Answers	Recommendation
1	Does your project take place in CH for Atlantic sturgeon, Atlantic salmon or North Atlantic right whale?	Y	Go to Step 2
		N	Go to Step 3
2	Does your project have potential impacts on the CH from vessel traffic interactions?	Y	Go to Step 7
		N	NLAA/VF
3	Do vessels used for in-water gear deployment and/or regular gear maintenance co-occur with listed species and the habitat they use to migrate, rest, forage, and/or reproduce?	Y	Go to Step 4
		N	NLAA/VF
4	Are more than 2 vessels expected to be added to the existing vessel traffic baseline?	Y	Go to Step 5
		N	NLAA/VF
5	Is the occurrence of ESA-listed species in the project area expected to be rare/transient?	Y	NLAA/VF with justification
		N	Go to Step 6
6	Are any sensitive life stages of ESA listed species present and/or important behaviors (e.g., spawning, migration, foraging) occurring within the project area?	Y	Go to Step 7
		N	NLAA/VF with justification
7	Does the aquaculture project avoid critical times of year (e.g., spawning/breeding migrations, overwintering, foraging aggregations) and early life stages?	Y	NLAA/individual consultation
		N	Go to Step 8
8	Are vessel interactions likely to prevent a species from completing an important behavior (e.g., accessing documented/preferred foraging habitat, spawning/breeding grounds, overwintering grounds, etc.).	Y	LAA
		N	NLAA/individual consultation

Stressor: Escapement

Steps	Questions	Answers	Recommendation
1	Does your project involve rearing of finfish within a fish pen configuration?	Y	Go to Step 2
		N	"Not Applicable" (Not relevant to escapement stressor)
2	Does your project culture domestic Atlantic salmon?	Y	LAA
		N	NLAA/individual consultation

Stressor: Entanglement

Step	Question	Answer	Recommendation
1	Is the gear in shallow enough water to be accessed by foot at low tide or within a mostly enclosed/protected harbor?	Y	Go to Step 3
		N	Go to Step 2
2	Does the project area include areas of ESA-listed whales or NARW CH?	Y	Go to Step 5
		N	Go to Step 3
3	Does your project include culturing of species besides shellfish or submerged horizontal longline configuration?	Y	Go to Step 5
		N	Go to Step 4
4	Does your project include culturing of shellfish and meet the guidelines below (CAUTION: Use ONLY as a guideline)?	Y	NLAA/VF
	Shell on bottom <50 acres with maximum of 4 corner marker buoys;	N	NLAA/VF with justification
	Cage on bottom with no loose floating lines <5 acres and minimal vertical lines (1 per string of cages, 4 corner marker buoys);		
	Floating cages in <3 acres in waters and shallower than -10 feet MLLW with no loose lines and minimal vertical lines (1 per string of cages, 4 corner marker buoys);		
	Any in-water lines, ropes, or chains must be made of materials and installed in a manner to minimize or avoid the risk of entanglement by using thick, heavy, and taut lines that do not loop or entangle. Lines can be enclosed in a rigid sleeve.		
5	Does your project include areas that overlap critical habitat (CH) of NARW?	Y	Go to Step 6
		N	Go to Step 8
6	Is there a likely presence/behavior of right whales in your action area and high likelihood of right whales interacting with the proposed action that could result in entanglement risk (also recommend using risk models (e.g., whale simulator, entanglement risk model) if available)?	Y	Go to Step 7
		N	NLAA/individual consultation
7	Can TOY and/or BMPs be used to reduce or eliminate exposure of species to the stressor causing the entanglement?	Y	NLAA/individual consultation
		N	LAA
8	Does your project include areas where ESA-listed whale species are present?	Y	Go to Step 9
		N	Go to Step 11

Stressor: Entanglement

9	Is the presence of whales extremely unlikely?	Y	NLAA/individual consultation
		N	Go to Step 10
10	Is there a likely presence/behavior of ESA-listed whales in your action area and high likelihood of whales interacting with the proposed action that could result in entanglement risk (also recommend using risk models (e.g., whale simulator, entanglement risk model) if available)?	Y	Go to Step 7
		N	NLAA/individual consultation
11	Is the presence of ESA-listed sea turtles/fish extremely unlikely in the action area?	Y	NLAA/individual consultation
		N	Go to Step 12
12	Is there a likely presence/behavior of ESA-listed sea turtles/fish in your action area and high likelihood of these animals interacting with the proposed action that could result in entanglement risk (also recommend using risk models (e.g., simulator model for sea turtles) if available)?	Y	Go to Step 7
		N	NLAA/individual consultation

Appendix H. Potential Avoidance and Minimization Measures Previously Suggested in Completed Consultations

In the Greater Atlantic Region, aquaculture projects range broadly and may include activities such as nearshore shellfish aquaculture, offshore kelp aquaculture, and a variety of other culturing techniques. Given the diversity of operations and marine environments, a variety of potential impacts to listed species may occur. It is important to note that ***we do not prescribe required management measures applicable to all aquaculture activities***. Each project is unique, so we evaluate them on a case-by-case basis, taking into account the geographic area that the project may affect (e.g., the project's action area), the species that are present and may be affected (e.g., frequency of occurrence, pathways to effects), and what we know about the proposed gear types (e.g., tension, tensile strength, length of lines, distance between lines). Therefore, this list of Avoidance and Minimization Measures (AMMs) is meant solely for consideration during project design and/or NOAA's feedback on mitigation options to reduce the level of potential risk to ESA-listed species. Having this list of previously used methods and measures provides section 7 biologists with a reference document that may be updated depending on effectiveness and accessibility of usage in practice, and is not exhaustive, nor is it prescriptive.

Stressor	GARFO General Guidance on Avoidance and Minimization Measures	Examples of Specific Avoidance and Minimization Measures Included as USACE Permit Conditions and/or Part of ESA Section 7 Consultations
General	Monitor site on a regular basis. Intervals may vary depending on project location and duration. Biweekly monitoring has been used in the past, but more frequency may be justified depending on the project.	Site monitoring may include: • Check for presence of marine animals in the vicinity of aquaculture operation • Check whether the gear is secured and under tension as initially installed • Monitor gear configuration changes (e.g., depth of headrope, tangles with cages/buoys, location of gear) and address what needs to be corrected • Buoys added/removed as needed to maintain proper buoyancy for longline configurations

		• Ensure waste material and debris are collected and disposed of correctly
	Minimize the number of vertical buoy lines for bottom cages and avoid the loss/conversion of sea floor foraging habitat from bottom cages.	• Use multi-cage trawl lines with only one vertical buoy/pick-up line, rather than one buoy/line on each end
Entanglement	Maintain constant tension/increase tension of lines at all tide levels (demonstrate/explain how this will be achieved), as feasible with the gear design.	• For submerged longlines, check for warp, proper head line depth, and proper buoyancy of the lines to keep the tethered structures rigid and under tension, etc.
	Adequate space will be kept between each aquaculture system and its adjacent neighbors and between the gear and the bottom, so that protected species are free to maneuver around, through, and/or under gear.	The following were all included as part of USACE New England District Endangered Species Act Aquaculture Best Management Practices (2019). While GARFO agrees that spacing gear is important, the preferred spacing distances are dependent on the site conditions, likelihood of ESA species presence, their anticipated behavior, etc. Therefore, we would not recommend prescribing a set distance at this time until further research is completed. • minimum of 5 feet kept between vertical floating gear (droplines) and the bottom • minimum of 50 feet between each aquaculture system (longline, trot, or individual cages) and its adjacent neighbors • the length of the vertical buoy pick-up line shall not exceed 10 percent of the maximum water depth at MHHW
	Utilize features to increase gear visibility.	Potential ways to increase gear visibility include: • Glow rope (UV illumination) • Bird-scaring device • Lightsticks • Reflective/colored buoys
	Seasonal seed lines, buoys, and associated gear shall be removed during the off- season.	Remove gear from the water and store in upland areas to minimize opportunity for potential entanglement, seasonal impediment, and to reduce the effects of habitat exclusion, loss, or alteration.
	Utilize features for escape mechanisms upon contact with protected species.	Potential escape mechanism features include: • Turtle Excluder Device (TEDs): Two-dimensional net inserts with large escape openings • Breakaway lines • Time tension line cutter • Buoy line trigger release • Stiff Rope • Medina panel • Alternative net filaments • Galvanic release • Lipid soluble rope

	Add rigidity to gear to reduce entanglement risks to some ESA-listed species.	Potential ways to increase line rigidity are: • line sheathing (note: partial sheathing could increase the risk of lethal entanglement for sea turtles by preventing their ascent to the surface and large whales if disentanglement operations are needed following an entanglement incident) • replace lines with PVC pipes or other stiff materials • use of weak links
Vessel Strike	Consider vessel size based on project needs and speed of vessels operated.	• Vessels maintain a cruising speed of no more than 10 knots when transiting between the dock and the aquaculture lease/gear field • onboard staff maintain vigilant watch for sea turtles and sturgeon during transit
Sound	If ESA-listed species may be present and the anticipated noise is above the behavioral noise threshold, a "soft start" is recommended at the start of each day and after breaks in work (e.g., 30 minutes of longer) to allow animals an opportunity to leave the project vicinity before sound pressure levels increase.	• For impact pile driving: pile driving commences with an initial set of three strikes by the hammer at 40% energy, followed by a one minute wait period, then two subsequent 3-strike sets at 40% energy, with one-minute waiting periods, before initiating continuous impact driving. • For vibratory pile installation: pile driving is initiated for 15 seconds at reduced energy followed by a one-minute waiting period. This sequence of 15 seconds of reduced energy driving, one-minute waiting period will be repeated two additional times, followed immediately by pile-driving at full rate and energy • To assess potential noise-induces **physiological impacts** on ESA-listed cetacean species: Please refer to NOAA's 2018 Marine Mammal Acoustic Technical Guidance document and user spreadsheet for assessing whether or not a project creates underwater noise that exceeds the permanent threshold shift (PTS) or temporary threshold shift (TTS) limits for listed cetaceans: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance
Hindrance of Passage	Reduce sound and/or turbidity generating activities that create hindrance of passage	• Work behind cofferdams, turbidity curtains, or other methods to block access of animals to the project setup's footprint when operationally feasible or beneficial and ESA-listed species are likely to be present. • For those activities that are likely to create turbidity levels that can potentially represent a barrier to normal fish behaviors Total Suspended Sediments (TSS) levels should remain **below 1000 mg/L**, as these are the levels shown to have adverse effects on fish species. • If the proposed activity is likely to cause turbidity and/or sound barriers to normal behaviors, the activity should take place outside those time windows when important spawning, breeding or foraging activities are likely to occur in the project area.
Water Quality	Utilize controls for solids from hatcheries.	Potential ways to control solids include: • Employ efficient feed management and feeding strategies that limit feed input to the minimum amount reasonably necessary to achieve production goals and sustain targeted rates of aquatic animal growth in order to minimize potential discharges of

		uneaten feed and waste products. • In order to minimize the discharge of accumulated solids from settling tanks, basins and production systems, identify and implement procedures for routine cleaning of rearing units and settling tanks, and procedures to minimize any discharge of accumulated solids during the inventorying, grading and harvesting of aquatic animals in the production system. • If any material is removed from the rearing units and/or settling tanks, describe where it is to be placed and the techniques used to prevent it from entering the surface waters from any on-site storage. If the material is removed from the site, describe who received the material and its method of disposal and/or reuse. • Remove and dispose of aquatic animal mortalities properly on a regular basis to prevent discharge to receiving waters, except in cases where EPA and the applicable state agency authorizes such discharges in order to benefit the aquatic environment.
	Employ biological controls for hatcheries.	• Describe in detail the precautions used by the facility to prevent aquatic organisms that are neither indigenous nor naturalized to State waters from becoming established in the local waters. • Provide a description of any storage and/or treatment strategies designed to prevent biological pollution (non-indigenous organisms including fish parasites and fish pathogens and dead or dying fish) from entering the receiving water when the cultured fish population or a portion thereof are showing signs of stress.
	Maintain proper materials storage for hatcheries.	• Ensure proper storage of drugs, pesticides, and feed to prevent spills that may result in the discharge of drugs, pesticides, or feed to receiving waters. • Implement procedures for properly containing, cleaning, and disposing of any spilled material.
	Ensure proper structural maintenance for hatcheries.	• Inspect the production system and the wastewater treatment system on a routine basis in order to identify and promptly repair any damage. • Conduct regular maintenance of the production system and the wastewater treatment system in order to ensure that they are properly functioning.
	Maintain accurate recordkeeping for hatcheries.	• Maintain records documenting the feed amounts and estimates of the number and weight of aquatic animals for each rearing unit to show how representative feed conversion ratios (i.e., efficiency of fish feed used) were calculated. • Maintain records by outfall of the approach/analysis used to determine the elapsed time from its application to its maximum (peak) effluent concentration to show how the maximum concentration in discharge was derived. • Keep records that document the frequency of cleaning, inspections, repairs and maintenance. In addition, records of all medicinal and chemical usage (i.e., for each occurrence) shall be recorded, including the dosage concentration, frequency of application (hourly, daily, etc.) and the duration (hours, days) of treatment, and the method of application. For further information, see the EPA's website:

		https://www.epa.gov/eg/concentrated-aquatic-animal-production-complianceguide-and-reporting-forms
	Implementation of training programs for hatchery staff.	• Adequately train all relevant facility personnel in spill prevention and how to respond in the event of a spill to ensure the proper clean-up and disposal of material. • Train staff on the proper operation and cleaning of production and wastewater treatment systems including training in feeding procedures and proper use of equipment.
	Measures to ensure proper use of aquaculture disease control and/or prevention drugs and chemicals for hatcheries.	• List all aquaculture drugs and chemicals, including all INAD and extra-label drugs and for each, identify: i. Product name and manufacturer; ii. Chemical formulation; iii. Purpose/reason for its use; iv. Dosage concentration, frequency of application (hourly, daily, etc.) and the duration (hours, days) of application; v. The method of application; vi. Material Safety Data Sheets (MSDS), Chemical Abstracts Service Registry number for each active therapeutic ingredient; vii. The method or methods, if any, used to detoxify the wastewater prior to its discharge; viii. Information on the persistence and toxicity in the environment; ix. Information on the USFDA approval for the use of said medication or chemical on fish or fish related products used for human consumption; x. Available aquatic toxicity data (vendor data, literature data, etc.); Lethal Concentration to 50 percent test organisms (LC50) at 48 and/or 96 hours and No Effect Level (NOEL) concentrations for typical aquatic organisms (salmon, trout, daphnia, fathead minnow, etc.).
	Optimization of nitrogen removal for at hatcheries.	• Complete an assessment of alternative AMMs or improvements to current AMMs implemented to optimize the removal of nitrogen to minimize the annual average mass discharge of total nitrogen. Subsequently, submit a report to EPA and the applicable state agency documenting this evaluation and presenting a description of recommended operational changes. Following an assessment by EPA and applicable state agencies, the permittee can implement the recommended operational changes. • Submit an annual report to EPA and the applicable state agency that summarizes activities related to optimizing nitrogen removal, documents the annual nitrogen discharge load from the facility, and tracks trends relative to the previous year. If the facilities discharge of TN on an average annual basis has increased, include a detailed explanation of the reasons why TN discharges have increased.