Omnibus Deep-Sea Coral Amendment Including a Final Environmental Assessment

Amendment 9 to the Atlantic Herring FMP
Amendment 20 to the Atlantic Sea Scallop FMP
Amendment 8 to the Monkfish FMP
Amendment 24 to the Northeast Multispecies FMP
Amendment 6 to the Red Crab FMP
Amendment 7 to the Skate Complex FMP

June 25, 2019

Prepared by the
New England Fishery Management Council
In consultation with the National Marine Fisheries Service

Final Council action: January 30, 2018
Preliminary submission: December 21, 2018
Final submission: June 25, 2019

COVER IMAGES, CLOCKWISE FROM UPPER RIGHT:

A large black coral and two Paramuricea *corals in Oceanographer Canyon. Image courtesy of NOAA Okeanos Explorer Program, 2013 Northeast U.S. Canyons Expedition.*

Close-up of a sea pen colony at 2,023 meters depth on Retriever Seamount. Sea pens are octocorals and the characteristic eight pinnate tentacles are plainly visible in this image. The dark line running down below the tentacles of each polyp is the pharynx, connecting the mouth to the bag-like digestive cavity. A mysid shrimp ("possum shrimp") is swimming by the colony. Image courtesy of NOAA Okeanos Explorer Program, Our Deepwater Backyard: Exploring Atlantic Canyons and Seamounts.

Cup corals and a sea star a mile underwater in Heezen Canyon. Image courtesy of NOAA Okeanos Explorer Program, 2013 Northeast U.S. Canyons Expedition.

A Paramuricea *coral in Nygren Canyon which 165 nautical miles southeast of Cape Cod, Massachusetts. Image courtesy of NOAA Okeanos Explorer Program, 2013 Northeast U.S. Canyons Expedition.*

1 Executive Summary

1.1 Background and purpose

Deep-sea or cold water corals are attached, benthic animals related to anemones and jellyfish that live in waters at least 50 m (28 fa) deep. They are found in marine habitats worldwide. Offshore New England (section 6.2), the greatest species richness of corals occurs in the canyons south of Georges Bank, as well as on the surrounding continental slope and seamounts. Corals, primarily soft corals and sea pens, also occur in select locations in the Gulf of Maine, both relatively close to shore and in offshore basins. Deep-sea corals come in a diverse range of sizes, shapes and colors. Some types, including sea pens and soft corals, have a flexible structure, while the stony corals have a hard outer covering. Corals occur in both soft sediment habitats and in hard bottom areas. Many types require a hard substrate for attachment, but others including the sea pens and some soft corals anchor in fine sediments.

Deep-sea corals are ecologically important (section 6.4). Deep-sea coral habitats have been noted to have higher associated concentrations of fish than surrounding areas and are believed to serve as nursery grounds and provide habitat for many species of fish and invertebrates at various life stages, including commercially important fish species (Costello et al. 2005; Auster 2007; Foley et al. 2010). Many invertebrate species are directly associated with deep-sea corals. Recent work in the canyons suggests that some of these relationships are very specific. In coral habitats surveyed in the Gulf of Maine, sponges and anemones often occurred in high density patches amongst the more extensive corals on walls and on steep features without corals. Crustaceans such as shrimp, amphipods, krill, and king crab were commonly associated with coral communities along steep walls, and were seen foraging amongst structure-forming organisms, including corals, on the seafloor. At the Gulf of Maine sites, commercially important species were observed in coral habitats, including Acadian redfish, haddock, pollock, cusk, monkfish, cod, silver hake, Atlantic herring, spiny dogfish, squid, and lobster. The fish were observed searching for and catching prey that were also found among the coral, including shrimp, amphipods, krill, and other small fish. The corals seemed to provide refuge from the strong, tidally generated bottom currents.

Purpose and need for this action: Deep-sea corals are vulnerable to anthropogenic impacts (section 6.5). In general, deep-sea corals are slow growing and some species have limited dispersal capability. These features, combined with the branching and sometimes brittle structure of some taxa, make them vulnerable to mechanical disturbance, such as from fishing gear. Given the ecological importance and vulnerability of corals, the overarching objective of this amendment is to identify and protect deep-sea corals in the New England region. Although there are uncertainties in terms of the precise extent of overlap between fishing activities and coral habitats, the problem statement approved for this action affirms the Council's desire to balance coral conservation with commercial fishing usage of coral management zones.

> "The Council is utilizing its discretionary authority under §303(b) in MSA to identify and implement measures that reduce, to the extent practicable, impacts of fishing gear

> on deep-sea corals in New England. This amendment contains alternatives that aim to identify and protect concentrations of corals in select areas and restrict the expansion of fishing effort into areas where corals are likely to be present.
>
> "Deep-sea corals are fragile, slow-growing organisms that play an important role in the marine ecosystem and are vulnerable to various types of disturbance of the seafloor. At the same time, the importance and value of commercial fisheries that operate in or near areas of deep-sea coral habitat is recognized by the Council. As such, measures in this amendment will be considered in light of their benefit to corals as well as their costs to commercial fisheries."

Amendment development: The measures under consideration were developed between 2011 and 2017, initially as part of Omnibus Habitat Amendment 2, but split into a separate coral-focused amendment in 2012. The New England Fishery Management Council (NEFMC), Mid-Atlantic Fishery Management Council (MAFMC), and the South Atlantic Fishery Management Council (SAFMC) have signed a Memorandum of Understanding (MOU) identifying areas of consensus and common strategy related to conservation of corals and mitigation of the negative impacts of fishery interactions with corals. As per the terms of the MOU, the Council developed the alternatives in this document to be applicable only to areas within the NEFMC region as defined in the current regulations (50 C.F.R. §600.105). The Council took final action on various sections of the amendment in two phases, selecting measures for Gulf of Maine coral zones, framework and special program provisions, and research areas in June 2017, and for the continental slope, canyons, and seamounts in January 2018, after review and development of an additional broad zone alternative.

1.2 Alternatives considered

The management alternatives include a range of coral zones (section 4.2) and fishing restriction measures that may be applied within those zones (section 4.3). The No Action alternative (section 4.1) includes management areas that provide some coral conservation benefits, but there are currently no management areas developed under the section 303(b) discretionary authority in the New England region. Special access programs as well as alternatives to modify coral conservation measures via framework adjustment are also being considered in this amendment. The measures proposed in this amendment would affect commercial fisheries operating with bottom-tending fishing gear (i.e., bottom trawls, dredges, bottom longlines, sink gillnets, or pots/traps). Management measures developed under the regulatory authority described in section 3.3 and implemented via this amendment would apply based on gear type and are not limited to fisheries directly managed by NEFMC. Fisheries operating in and around the coral zones are managed by NEFMC, MAFMC, and the Atlantic States Marine Fisheries Commission (ASMFC). Deep-sea coral protection measures were implemented in the Mid-Atlantic region in January 2017. There are many similarities between the NEFMC and MAFMC approaches.

Table 1 – Summary of alternatives considered. Preferred alternatives are bolded and underlined for emphasis.

<table>
<tr><th colspan="3">4.1 No Action</th></tr>
<tr><th>Management areas</th><th>Fishing gear restrictions</th><th>Notes</th></tr>
<tr><td>• Monkfish/Mackerel-Squid-Butterfish closures in Lydonia and Oceanographer Canyons
• Tilefish Gear Restricted Areas in Lydonia, Oceanographer, and Veatch Canyons
• Northeast Canyons and Seamounts Marine National Monument</td><td>• Monkfish/Mackerel-Squid-Butterfish: No fishing by vessels permitted under those plans
• Tilefish: no MBTG
• Monument: no commercial fishing of any kind; lobster and red crab restrictions not in effect until 2023 at the latest</td><td>• Monkfish closures developed jointly with MAFMC
• Mackerel-Squid-Butterfish and tilefish areas managed by MAFMC
• Monument is not subject to modification by the Councils
• These alternatives are not explicitly preferred, but they cannot be changed via this amendment</td></tr>
<tr><th colspan="3">4.2.1 Broad zones
4.3 Fishing gear restrictions</th></tr>
<tr><th>Management areas</th><th>Fishing gear restrictions</th><th>Notes</th></tr>
<tr><td>• Option 1: 300 m zone
• Option 2: 400 m zone
• Option 3: 500 m zone
• Option 4: 600 m zone
• Option 5: 900 m zone
• <u>Option 6: 600 m minimum depth zone</u>
• Option 7: Empirically-derived zone based on coral and fishery data</td><td>• <u>Option 1: Prohibit BTG</u>
  • <u>Sub-option A: exempt red crab</u>
  • Sub-option B: exempt other trap fisheries
• Option 2: Prohibit MBTG</td><td>• Zone options are mutually exclusive (select one or none)
• If a zone is selected, choose either Option 1 or Option 2 gear restrictions. If Option 1, could choose Sub-option A, Sub-option B, Sub-options A and B, or no exemptions.</td></tr>
<tr><th colspan="3">4.2.2.1 Discrete canyon zones
4.3 Fishing gear restrictions</th></tr>
<tr><th>Management areas</th><th>Fishing gear restrictions</th><th>Notes</th></tr>
<tr><td>• Alvin Canyon
• Atlantis Canyon
• Nantucket Canyon
• Veatch Canyon
• Hydrographer Canyon
• Dogbody Canyon
• Clipper Canyon
• Sharpshooter Canyon</td><td>• Option 1: Prohibit BTG
  • Sub-option A: exempt red crab fishery
  • Sub-option B: exempt other trap fisheries
• Option 2: Prohibit MBTG</td><td>• Canyon zones are largely within broad zones, but generally cover additional area in the heads of the canyons, depending on broad zone boundary
• Canyon zones could be adopted in addition to a</td></tr>
</table>

<table>
<tr><td>• Welker Canyon
• Heel Tapper Canyon
• Oceanographer Canyon
• Filebottom Canyon
• Chebacco Canyon
• Gilbert Canyon
• Lydonia Canyon
• Powell Canyon
• Munson Canyon
• Nygren Canyon
• Kinlan Canyon
• Heezen Canyon</td><td></td><td>broad zone, if shallower boundaries or different gear restrictions are desired
• If a zone is selected, choose either Option 1 or Option 2 gear restrictions. If Option 1, could choose Sub-option A, Sub-option B, Sub-options A and B, or no exemptions.</td></tr>
<tr><th colspan="3">4.2.2.2 Discrete seamount zones
4.3 Fishing gear restrictions</th></tr>
<tr><th>Management areas</th><th>Fishing gear restrictions</th><th>Notes</th></tr>
<tr><td>• Bear Seamount
• Mytilus Seamount
• Physalia Seamount
• Retriever Seamount</td><td>• Option 1: Prohibit BTG
  • Sub-option A: exempt red crab fishery
  • Sub-option B: exempt other trap fisheries
• Option 2: Prohibit MBTG</td><td>• Seamount zones are encompassed spatially within the broad zones and the seamount section of the National Monument
• Seamount zones could be adopted in addition to a broad zone if different gear restrictions are desired
• If a zone is selected, choose either Option 1 or Option 2 gear restrictions. If Option 1, could choose Sub-option A, Sub-option B, Sub-options A and B, or no exemptions.</td></tr>
<tr><th colspan="3">4.2.2.3 Gulf of Maine zones
4.3 Fishing gear restrictions</th></tr>
<tr><th>Management areas</th><th>Fishing gear restrictions</th><th>Notes</th></tr>
<tr><td>Gulf of Maine inshore:
• Mount Desert Rock
• Outer Schoodic Ridge

Gulf of Maine offshore:
• WJB - 114 Fathom Bump
• WJB - 96 Fathom Bump</td><td>• Option 1: Prohibit BTG
  • Sub-option A: exempt red crab fishery
  • Sub-option B: exempt other trap fisheries
• Option 2: Prohibit MBTG</td><td>• Gulf of Maine zones are separate and spatially distinct from one another and from canyon/seamount/broad zones.
• There are two sets of boundary options for all</td></tr>
</table>

• WJB - 118 Fathom Bump • Central Jordan Basin • Lindenkohl Knoll		areas except Outer Schoodic Ridge. • If a zone is selected, choose either Option 1 or Option 2 gear restrictions. If Option 1, could choose Sub-option A, Sub-option B, Sub-options A and B, or no exemptions.
4.4 Special fishery programs for coral zones		
• Alternative 1: No Action • Alternative 2: Special access program fishing • Alternative 3: Exploratory fishing • **Alternative 4: Request LOA for research activities in coral zones**		
4.5 Framework provisions for coral zones		
• Alternative 1/No Action: No additional frameworkable coral management measures • **Alternative 2: Add, revise, or remove coral zones** • **Alternative 3: Change fishing restrictions** • **Alternative 4: Allow adoption of or changes to special access or exploratory fishing programs** Notes: Substantial changes could require an amendment regardless of whether these alternatives are adopted.		
4.6 Dedicated habitat research areas		
• Alternative 1/No Action: No new DHRAs • **Alternative 2: Jordan Basin DHRA.** No gear restrictions are associated with Alternative 2 DHRA.		

1.3 Impacts of the alternatives on the ecosystem

The alternatives proposed in this amendment are associated with a range of potential impacts to several Valued Ecosystem Components (VECs), including 1) deep-sea corals, 2) managed resources and essential fish habitat, 3) human communities, and 4) protected resources. These impacts are described in section 6.9.3 and summarized in Table 2 below. Depending on the combination of zones (section 4.2) and restrictions (section 4.3) selected, the amendment outcomes will be more conservative of coral habitat, with a larger degree of fishing activity displaced, or more conservative of fishing activities, with some types of bottom-tending gear permitted in coral zones, and/or smaller areas of coral habitat protected. Some of the coral habitats in New England occur in very deep water beyond the current distribution of fishing activity. These include the deeper portions of the canyons and slope as well as on the seamounts. Coral habitats in the shallower waters of the canyons and slope, as well as the coral habitats in the Gulf of Maine, overlap with fishing grounds.

No Action alternative (section 4.1): The No Action alternative areas are expected to have positive impacts on deep-sea corals and managed species due to gear restrictions that reduce the potential for interactions between coral habitats and fishing gears, and slightly negative impacts on human communities due to costs associated with fishing effort displacement. In terms of protected resources, these alternatives are expected to have negative to neutral impacts on large whales, slightly negative to neutral impacts on small cetaceans, and negative to slightly negative impacts on turtles. No impacts on ESA-listed fishes are expected as these species' distributions have no overlap with the No Action management areas.

Broad deep-sea coral zones (section 4.2.1) and associated fishing restrictions (section 4.3): The broad coral zones are expected to have positive impacts on deep-sea corals and managed species and neutral to negative impacts on human communities. The magnitude of the positive impacts to biological resources and negative impacts to human communities is expected to shrink with deeper zones and if fewer restrictions on fishing are proposed. In terms of protected resources, broad zone Options 1-3, gear restriction Option 1 are expected to have negative to neutral impacts on large whales, and slightly negative impacts on small cetaceans and turtles. Broad zone Options 1-3, gear restriction Option 2, and broad zone Options 4-7, regardless of gear restriction, are expected to have neutral impacts on large whales, small cetaceans, and turtles. No impacts on ESA-listed fishes are expected.

Discrete deep-sea coral zones (section 4.2.2) and associated fishing restrictions (section 4.3): Impacts on deep-sea corals are expected to range from neutral for the seamount zones, which are not currently fished, to positive for the canyon zones, especially if a full range of bottom-tending gears are restricted from the areas. Impacts on human communities are expected to range from negligible in the case of the seamount zones to slightly negative overall impacts for the canyon zones. Impacts are expected to be asymmetrically distributed across fishing business with those that have a higher dependence on fishing in particular areas experiencing more substantial impacts. In terms of protected resources, the canyon zone alternatives are expected to have negative to slightly negative impacts on large whales, depending on redistribution of trap gears, and slightly negative impacts on small cetaceans and turtles. The seamount zones are not expected to have any impacts on protected resources.

The inshore Gulf of Maine discrete zones (Mt. Desert Rock and Outer Schoodic Ridge) are expected to have slightly positive to positive impacts on deep-sea corals and managed species, depending on whether lobster pots are restricted or not, with more positive impacts if lobster pots are prohibited from the zones. These zones are expected to have slightly negative to negative impacts on fisheries and fishing communities, again, depending on lobster trap restrictions, with impacts felt by vessels displaced from the zones. These zones are expected to have neutral impacts on large whales if trap gears are not restricted and may have negative impacts if they are; slight negative to neutral impacts relative to No Action are expected on small cetaceans and sea turtles. Impacts on Atlantic sturgeon and Atlantic salmon are expected to be neutral relative to No Action. The offshore Gulf of Maine zones (Jordan Basin and Lindenkohl Knoll) are expected to have positive impacts on deep-sea corals and managed species, with more positive impacts associated with additional fishing gear restrictions. These zones are expected to have low negative to negative impacts on fisheries and fishing communities, with more negative impacts associated with additional fishing gear restrictions. These zones are expected to have negative to slight negative impacts on large whales, small cetaceans, and sea turtles. No impacts on Atlantic sturgeon are expected for any of the Gulf of Maine discrete zones; there could be slight negative impacts on Atlantic salmon, although effects are likely to be neutral relative to No Action.

Special fishery programs for coral zones (section 4.4): Special fishery programs including special access, exploratory fishing, and requirements that facilitate better tracking of research activities could have negative, neutral, or positive impacts depending on the VEC. Special access and exploratory fishing programs would be carefully designed to manage negative impacts on corals and managed resources, but negative effects of these programs could occur. By extension, socio-cultural impacts on those interested in coral conservation could also be negative. Conversely, such programs would afford flexibility and economic opportunity to fishing community members who take advantage of special access or exploratory fishing programs. Improvements in research tracking as a result of Alternative 4 in this section would likely have indirect positive impacts across a range of VECs.

Framework provisions (section 4.5): Framework adjustments facilitate expedient modifications to certain management measures. This amendment includes alternatives that could edit the list of items in the FMP that could be modified through a framework, to allow for future consideration of deep-sea coral measures through a framework action. In general, the framework alternatives proposed are primarily administrative and intended to simplify and improve the efficiency of future actions related to deep-sea coral protections. Thus, they are not expected to result in any direct impacts to any of the VECs. Indirect impacts are possible from some of the alternatives on some VECs if they allow for more efficient responses to immediate conservation concerns for deep-sea corals or associated habitats.

Dedicated habitat research areas (section 4.6): Dedicated habitat research areas are designed to focus specific types of scientific research into a location thought to be especially well suited to conducting such work. Because the research area proposed in this amendment does not include any restrictions on fishing, the impacts are expected to be indirect and generally positive, as improved knowledge about coral habitats and interactions with fisheries may lead to better management outcomes in the future.

Table 2 – Summary of impacts. 'Neutral' impacts indicate no changes expected relative to current conditions.

No Action				
Alternative	**Deep-sea corals**	**Managed species and EFH**	**Human communities**	**Protected resources**
Existing spatial management measures that have coral conservation implications	Positive	Positive	Slight negative	Negative to neutral for large whales; slight negative to neutral for small cetaceans; negative to slight negative for sea turtles. No overlap with endangered fish distributions.
Broad coral zones				
Alternative	**Deep-sea corals**	**Managed species and EFH**	**Human communities**	**Protected resources**
Option 1 (300 m)	Positive; largest magnitude of impacts of all broad zone options. Similar impacts to options 2, 3, and 7.	Slight positive; largest magnitude of impacts of all broad zone options. Similar impacts to options 2, 3, and 7.	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative for large whales; neutral if lobster traps exempted. Slight negative for small cetaceans and turtles. No overlap with endangered fish distributions. Largest magnitude of all broad zone impacts, and similar to Options 2 and 3.
Option 2 (400 m)	Positive; similar impacts to options 1, 3, and 7.	Slight positive; similar impacts to options 1, 3, and 7.	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative for large whales; neutral if lobster traps exempted. Slight negative for small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 1 and 3.
Option 3 (500 m)	Positive; similar impacts to options 1, 2, and 7.	Slight positive similar impacts to options 1, 2, and 7.	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative for large whales; neutral if lobster traps exempted. Slight negative for small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 1 and 2.

Option 4 (600 m)	Positive; similar impacts to Option 6.	Slight positive; similar impacts to Option 6.	Neutral to slight negative; negative for red crab fishermen under Option 1 without an exemption.	Neutral for large whales, small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 5-7.
Option 5 (900 m)	Positive; smallest magnitude of impacts of all broad zone options.	Slight positive; smallest magnitude of impacts of all broad zone options.	Neutral; no fishing activity with bottom-tending gears is known to occur at these depths.	Neutral for large whales, small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 4, 6, and 7.
Option 6 (600 m minimum; preferred as a closure to all bottom tending gear with a red crab trap exemption)	Positive; similar but slightly fewer positive impacts compared to Option 4.	Slight positive; similar but slightly fewer positive impacts compared to Option 4.	Neutral to slight negative as preferred (Option 1, Sub-option A; negative for red crab fishermen under Option 1 without an exemption (not preferred).	Neutral for large whales, small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 4, 5, and 7.
Option 7 (empirical)	Positive; similar impacts to options 1, 2, and 3.	Slight positive; similar impacts to options 1, 2, and 3.	Neutral to slight negative	Neutral for large whales, small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 4-6.
Discrete coral zones				
Alternative	**Deep-sea corals**	**Managed species and EFH**	**Human communities**	**Protected resources**
Canyons	Positive; less positive than broad zone options 1 and 2; also less positive than options 3-7, but with more complex tradeoffs in terms of depths protected	Slight positive; less positive than broad zone options 1 and 2; similar impacts to options 3-7	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative to slight negative for large whales; slight negative on small cetaceans and turtles. No impacts on listed fishes.
Seamounts	Neutral to slight positive impacts as this would represent a precautionary designation that does not displace current fishing activities.	Neutral to slight positive impacts as this would represent a precautionary designation that does not displace current fishing activities.	Negligible impacts; precautionary designation that does not displace current fishing activities.	Neutral impacts; precautionary designation that does not displace current fishing activities.

Mt. Desert Rock (Option 2 preferred as a closure to all mobile bottom-tending gear)	For boundary option 1 or 2, positive with gear restriction option 1, slight positive with gear option 2	For boundary option 1 or 2, positive with gear restriction option 1, slight positive with gear option 2	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative. More negative impacts on the lobster fishery for boundary option 1 vs. option 2.	For large whales, negative to neutral impacts. Slight negative to neutral impacts on small cetaceans and sea turtles; neutral impacts on Atlantic sturgeon and Atlantic salmon.
Outer Schoodic Ridge (preferred as a closure to mobile bottom-tending gear)	Positive with gear restriction option 1, slight positive with gear option 2, or option 1 sub-option B	Positive with gear restriction option 1, slight positive with gear option 2, or option 1 sub-option B	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	For large whales, negative to neutral impacts. Slight negative to neutral impacts on small cetaceans and sea turtles; neutral impacts on Atlantic sturgeon and Atlantic salmon.
Jordan Basin	Positive regardless of boundary option or gear restriction option selected. Boundary option 1 combined with gear option 1 would have the greatest magnitude of positive impact; gear option 2 combined with boundary option 2 would have the smallest magnitude.	Positive regardless of boundary option or gear restriction option selected. Boundary option 1 combined with gear option 1 would have the greatest magnitude of positive impact; gear option 2 combined with boundary option 2 would have the smallest magnitude.	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative. More negative impacts for boundary option 1 vs. option 2.	Negative to slight negative impacts on large whales, small cetaceans, and sea turtles. Neutral impacts on Atlantic sturgeon, possible slight negative impacts on Atlantic salmon.
Lindenkohl Knoll	Positive regardless of boundary option or gear restriction option selected. Boundary option 1 combined with gear option 1 would have the greatest magnitude of positive impact; gear option 2 combined with boundary option 2 would have the smallest magnitude.	Positive regardless of boundary option or gear restriction option selected. Boundary option 1 combined with gear option 1 would have the greatest magnitude of positive impact; gear option 2 combined with boundary option 2 would have the smallest magnitude.	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative. More negative impacts for boundary option 1 vs. option 2.	Negative to slight negative impacts on large whales, small cetaceans, and sea turtles. Neutral impacts on Atlantic sturgeon, possible slight negative impacts on Atlantic salmon.
Special fishery programs for coral zones				
Alternative	**Deep-sea corals**	**Managed species and EFH**	**Human communities**	**Protected resources**

No Action	Negative to neutral	No impacts	Slight negative to slight positive	No impacts
Special access programs	Slight negative	Slight negative	Positive (fishing communities); negative (those interested in coral conservation)	No impacts
Exempted fishing programs	Slight negative	Slight negative	Positive (fishing communities); negative (those interested in coral conservation)	No impacts
Research activity notification requirements (preferred)	Positive, indirect	Slight positive, indirect	Neutral	No impacts
Framework provisions				
Alternative	**Deep-sea corals**	**Managed species and EFH**	**Human communities**	**Protected resources**
No Action	Slight negative	Neutral	Slight negative, indirect	No impacts
Add, revise, or remove coral zones (preferred)	Slight negative to slight positive	Neutral	Slight positive, indirect	No impacts
Add, revise, or remove fishing gear restrictions (preferred)	Slight negative to slight positive	Neutral	Slight positive, indirect	No impacts
Develop or adjust special fishery programs (preferred)	Slight negative, indirect	Neutral	Slight positive, indirect	No impacts
Dedicated Habitat Research Areas				
Alternative	**Deep-sea corals**	**Managed species and EFH**	**Human communities**	**Protected resources**
No Action	Neutral	Neutral	Neutral	Neutral
Jordan Basin DHRA (preferred)	Positive, indirect	Slight positive, indirect	Slight positive, indirect	Neutral

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3 Background and Purpose

3.1 What are deep-sea corals?

Deep-sea corals, also referred to as cold water corals, can build reef-like structures or occur as thickets, isolated colonies, or solitary individuals, and often are significant components of deep-sea ecosystems, providing habitat (substrate, refuge) for a diversity of other organisms, including many economically important fish and invertebrate species. They are suspension feeders, but unlike most tropical and subtropical corals, do not require sunlight and do not have symbiotic algae (zooxanthellae) to meet their energy needs. Deep corals can be found from near the surface to 6,000 m depth, but most commonly occur between 50-1,000 m on hard substrate (Puglise and Brock 2003), hence their "deep-sea" appellation.

A diversity of coral species live in the northeast region (section 6.2). The characteristics of these corals vary in terms of their size, shape, and flexibility, growth rates and reproductive strategies, preferred depth range, and habitat associations. Some are relatively common, whereas other types are rare. All corals are vulnerable to fishing gear impacts, but the degrees of susceptibility and the rates of recovery vary, depending both on coral biology and on spatial overlap between corals and fishing grounds, which influences the likelihood of gear interactions. In general, coral species richness is greater at deeper depths (Cairns 2007), but there are concentrations of corals at depths where fishing routinely occurs, for example in the Gulf of Maine.

3.2 Need and purpose for action

This action is needed to reduce potential impacts to corals from fishing activity, as allowed under the Council's discretionary authority. The purpose of this action is to consider area-based fishing restriction measures for deep-sea corals occurring in the New England region. The following problem statement was adopted by the Council for this action in April 2016:

> "The Council is utilizing its discretionary authority under §303(b) in MSA to identify and implement measures that reduce, to the extent practicable, impacts of fishing gear on deep-sea corals in New England. This amendment contains alternatives that aim to identify and protect concentrations of corals in select areas and restrict the expansion of fishing effort into areas where corals are likely to be present.
>
> "Deep-sea corals are fragile, slow-growing organisms that play an important role in the marine ecosystem and are vulnerable to various types of disturbance of the seafloor. At the same time, the importance and value of commercial fisheries that operate in or near areas of deep-sea coral habitat is recognized by the Council. As such, measures in this amendment will be considered in light of their benefit to corals as well as their costs to commercial fisheries."

3.3 Management background and authority

There are multiple provisions in the Magnuson Stevens Fishery Conservation and Management Act (MSA) that can be used to justify coral protection. One is the Essential

Fish Habitat (EFH) authority, where corals are considered a component of essential fish habitat, and fishing restrictions are enacted in the context of minimizing, to the extent practicable, the effects of fishing on EFH (§305(b)). In the Northeast region, this authority was used in Monkfish FMP Amendment 2 to protect deep-sea corals and associated habitat features in two offshore canyons, Lydonia and Oceanographer, from fishing activity occurring under a monkfish day at sea. Options for minimizing the adverse effects of fishing on EFH include fishing equipment restrictions, time/area closures, and harvest limits (in this case, direct harvest of corals).

In the Northeast Region, coral distributions extend well beyond the bounds of designated EFH. The §303(b) discretionary provisions found in the 2007 reauthorization of the MSA (below) provide a second and more flexible mechanism by which Councils may protect deep-sea corals from the effects of fishing.

> Any fishery management plan which is prepared by any Council, or by the Secretary, with respect to any fishery, may—
>
> (A) designate zones where, and periods when, fishing shall be limited, or shall not be permitted, or shall be permitted only by specified types of fishing vessels or with specified types and quantities of fishing gear;
>
> (B) designate such zones in areas where deep-sea corals are identified under §408 (this section describes the deep-sea coral research and technology program), to protect deep-sea corals from physical damage from fishing gear or to prevent loss or damage to such fishing gear from interactions with deep-sea corals, after considering long-term sustainable uses of fishery resources in such areas; and
>
> (C) with respect to any closure of an area under this Act that prohibits all fishing, ensure that such closure—
>
> (i) is based on the best scientific information available;
>
> (ii) includes criteria to assess the conservation benefit of the closed area;
>
> (iii) establishes a timetable for review of the closed area's performance that is consistent with the purposes of the closed area; and
>
> (iv) is based on an assessment of the benefits and impacts of the closure, including its size, in relation to other management measures (either alone or in combination with such measures), including the benefits and impacts of limiting access to: users of the area, overall fishing activity, fishery science, and fishery and marine conservation;

In May 2010, the Council received guidance from NMFS NERO (now GARFO) regarding implementation of the discretionary provisions. This guidance was updated by the NMFS Office of Habitat Conservation and distributed to all eight regional fishery management councils in June 2014. Both the 2010 and 2014 guidance documents refer to the deep-sea coral research and technology program (DSCRTP) as a conduit for providing information about coral distributions to the Councils. According to the 2014 guidance, when designating deep-sea coral zones, the following parameters and considerations apply:

1. The authority may only be used for deep-sea coral areas identified by the DSCRTP.
2. Deep-sea coral zones may only be designated within the U.S. Exclusive Economic Zone (EEZ) and within the geographical range of a fishery managed under an FMP. A Council may develop protective measures for such zones that apply to any fishing, not just that managed under the applicable FMP. Thus, measures may apply to fishing that is managed under a different federal FMP or to state-regulated fishing that is authorized in the EEZ.[1]
3. A Council should coordinate with potentially affected Councils, state commissions, and states to ensure that it has sufficient information to support the need for its action and to analyze impacts of the action on other fisheries.
4. Long-term sustainable uses of fishery resources in the deep-sea coral areas must be considered. This consideration informs but does not limit the scope of protective measures that a Council may adopt.
5. Deep-sea coral zones and protective measures may be adopted even if there are no vessels currently fishing at or near the areas or there is no indication that current fishing activities are causing physical damage to deep-sea corals.
6. To ensure the effectiveness of protective measures, deep-sea coral zones may include, as necessary, additional areas beyond the exact locations of the deep-sea corals.

The 2014 guidance suggests the following criteria for identification of coral zones. The NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems (NOAA 2010b) provides similar guidance on selection of coral conservation measures.

- The size of the reef or coral aggregation, or density of structure-forming deep-sea corals;
- The occurrence of rare species;
- The importance of the ecological function provided by the deep-sea corals as habitat;
- The extent to which the area is sensitive to human-induced environmental degradation;
- The likelihood of occurrence of deep-sea corals in unsurveyed areas based on the results of coral habitat suitability models or similar methods.

Finally, the 2014 guidance suggests that options for protecting corals from fishing gear damage include but are not limited to:

1. Restrictions on the location where fishing may occur. If a closure to all fishing is being considered, it must comply with requirements at MSA §303(b)(2)(C),14

[1] This is different from the 2010 guidance from NERO, which indicated that for coral management provisions to apply to fisheries managed under the Atlantic Coastal Cooperative Fisheries Management Act (ACA), either the ASMFC must take complementary action in their FMP, or there must be a Council FMP for the same resource. The relevant example in our region is the offshore component of the American lobster fishery, which is managed by ASMFC.

which include establishing a timetable for review of the closed area's performance. This review should be conducted in consultation with the DSCRTP. Given the additional requirements and process, a Council may want to consider whether targeted gear restrictions, as opposed to a full fishing closure, would provide sufficient protection.

2. Restrictions on fishing by specified types of vessels or vessels with specified types and quantities of gear. These could include, for example, limits on the use of specified fishing-related equipment, required equipment modifications to minimize interactions with deep-sea coral communities, prohibitions on the use of explosives and chemicals, prohibitions on anchoring or setting equipment, and prohibitions on fishing activities that cause damage to deep-sea corals.
3. Proactive protection by freezing the footprint of current fishing activities of specified types of vessels or vessels with specified types and quantities of gear to protect known or expected locations of deep-sea corals.
4. Limits on the harvest or bycatch of species of deep-sea coral that provide structural habitat for other species, assemblages, or communities.

As noted in the 2014 Office of Habitat Conservation guidance and the NOAA Strategic Plan for Deep-Sea Coral and Sponge Ecosystems, other sections of the MSA may also apply to the protection of deep-sea corals and associated ecosystems:

- MSA §303(a)(7) requires that an FMP describe and identify EFH for the fishery, minimize to the extent practicable adverse effects caused by fishing, and identify other actions to encourage the conservation and enhancement of the EFH. Federal action agencies must consult with NOAA on activities that may adversely affect EFH, and NOAA provides non-binding conservation recommendations to the agencies through that process. If a deep-sea coral area is EFH (e.g., essential for spawning, breeding, feeding or growth to maturity of fish managed under an FMP), then it must be identified as such and the above requirements apply.
- §301(a)(9) requires Councils to include conservation and management measures that, to the extent practicable, minimize bycatch.
- §303(b)(12), authorizes Councils to include management measures in FMPs to conserve target and non-target species and habitats.

3.4 Amendment development process

The coral protection zones included in this amendment were initially developed during 2010 and 2011 as part of the Council's Omnibus Essential Fish Habitat Amendment 2 (OHA2). The Council approved a specific range of alternatives for analysis in April 2012. In September 2012, the Council split the coral protection zones areas and associated management measures out of OHA2 into a separate omnibus amendment. The canyon and seamount Habitat Area of Particular Concern designations, which do not restrict fishing activities but rather serve as a focus for future management efforts as well as EFH consultations, were retained within OHA2. The OHA2 HAPC designations and the coral zones in this action have overlapping but not identical locations and boundaries. The Council took final action on OHA2 in June 2015, including approval of the canyon and seamount HAPCs. OHA2 was implemented on April 9, 2018.

Because Mid-Atlantic and New England-managed fisheries overlap spatially along the shelf break, the two Councils have been coordinating their coral management efforts for years through technical work groups (NEFMC Habitat PDT, MAFMC Coral FMAT) and via the NEFMC Habitat Committee, which currently includes two MAFMC representatives. In June 2013, the New England, Mid-Atlantic, and South Atlantic Fishery Management Councils formalized this coordination via a memorandum of understanding (http://s3.amazonaws.com/nefmc.org/June-2013-Final-DSC-MOU.pdf). Specifically, the purposes of this Memorandum of Understanding (MOU) are:

- To establish a framework for coordination and cooperation toward the protection of deep-sea coral ecosystems; and
- To clarify and explain each Council's role and geographic areas of authority and responsibility with regard to deep-sea coral management.

Under the MOU, each Council develops measures within their respective area of jurisdiction. Inter-council boundaries identifying areas of jurisdiction are specified at 50 CFR §600.105. The boundary between the Mid-Atlantic and New England regions runs diagonally across the shelf from the CT/RI/NY intersection point across Alvin Canyon to the outer EEZ boundary. Thus, one important outcome of the MOU is that Mid-Atlantic region alternatives initially developed in 2010 are no longer included in the NEFMC coral amendment. Prior to and since signing the MOU, the New England and Mid-Atlantic Councils, in particular, have been sharing technical information and monitoring policy approaches to improve consistency in the policies proposed as well as in the use of scientific information.

In addition, the MOU includes a commitment to develop consistent management approaches when possible, and to engage potentially affected stakeholders regardless of which Council manages their fishery. The MAFMC took final action on their coral amendment, which is Amendment 16 to the Mackerel, Squid, and Butterfish FMP, in June 2015. Many of the coral zones selected by MAFMC were initially developed by NEFMC, although the boundaries were subsequently refined by MAFMC using new sources of data and stakeholder feedback, and some additional areas were added. The management measures (e.g., gear restrictions) selected by MAFMC generally fall within the range initially developed by NEFMC and were approved for analysis in 2012. The final MAFMC measures are described below. A proposed rule was published on September 27, 2016 and the final rule went into effect on January 13, 2017.

- MAFMC selected discrete zones in various individual canyons or canyon complexes, specifically Block, Ryan/McMaster, Emery/Uchupi, Jones/Babylon, Mey-Lindenkohl Slope, Spencer, Wilmington, N. Heyes/S. Wilmington, S. Vries, Baltimore, Warr/Phoenix, Accomac/Leonard, Washington, and Norfolk.
    - The MAFMC selected boundaries developed during a workshop held during April 2015. The workshop included input from industry members, conservation organizations, and scientists, and participants reviewed

updated bathymetric data, habitat suitability model outputs, and the locations of direct coral observations prior to and during the meeting.

- MAFMC selected a broad zone with a landward boundary between 400-500 m extending to the outer boundary of the EEZ.
  - The landward boundary line is comprised of straight segments, with the following constraints: minimum depth of 400 m, maximum depth of 500 m, and consistency with discrete boundaries where possible.
  - The north/south extent encompasses the entire MAFMC area of jurisdiction.
  - The discrete zone boundaries take priority in areas of overlap.
- For both broad and discrete zones, MAFMC's amendment prohibits all bottom tending-gear, with an exemption for the red crab fishery. Prohibition would not apply to the American lobster fishery managed by ASMFC. Transit would be allowed, subject to gear stowage requirements.
- Frameworkable measures would include:
  - Boundaries of coral zones,
  - Management measures within zones, including fishing restrictions, exemptions, monitoring, and anchoring,
  - New discrete coral zones, and
  - Special access programs.
- Finally, MAFMC's amendment implements a VMS requirement for all *Illex* squid moratorium vessels, whether they are fishing within or outside of coral zones.

Following final Council action on OHA2 in June 2015, NEFMC refocused attention on this amendment. The PDT reviewed data collected between 2012 and 2015, including the results of the deep-sea coral habitat suitability model, multibeam bathymetry for the slope and canyons as well as the Gulf of Maine, and towed camera and ROV data documenting occurrence of corals in canyon, slope, seamount, and Gulf of Maine sites. The PDT used these data to revise coral zones already under consideration, and in an iterative process with the Habitat Committee and Council, additional coral zones were identified to complete the range of alternatives presented in this document. These included additional Gulf of Maine sites, additional canyons, and an expanded range of broad zone options.

In March 2017, the Council held workshops in New Bedford, MA and Portsmouth, NH to discuss the coral zone boundaries, considering the canyon and slope zones at the first meeting and the offshore Gulf of Maine zones at the second. Following this meeting, the final preferred alternative for the canyons and slope was identified by the Habitat Committee (Option 6: 600 m minimum zone). This was the Council's preferred alternative when public hearings were conducted on the amendment during May 2017. Both the workshop report and public hearing summary are provided as appendices to this document.

During the public hearings, an additional broad coral zone alternative was suggested by a coalition of environmental organizations. The approach was to examine fishing effort and coral data closely and allow the boundary of the zone along the shelf break to vary according to these data. The methods used to develop this zone (referred to as Option 7) are briefly described in section 4.2.1 and detailed in an appendix which also details the approaches used to define the boundaries of other coral zones.

At its June 2017 meeting, the Council took final action on all sections of the amendment with the exception of a coral zone for the canyons, slope, and seamounts. The Council affirmed its general support for Option 7 but asked the Committee and PDT to work on additional adjustments to the boundary along the shelf break using additional data. The PDT refined the zone during the second half of 2017 and presented an updated analysis of the zone to the Habitat Advisory Panel and Committee in December 2017 and January 2018, respectively. In January 2018, the Council took final action on the remaining sections of the amendment, adopting the 600 m minimum depth broad zone (Option 6) as their final preferred alternative.

4 Alternatives Under Consideration

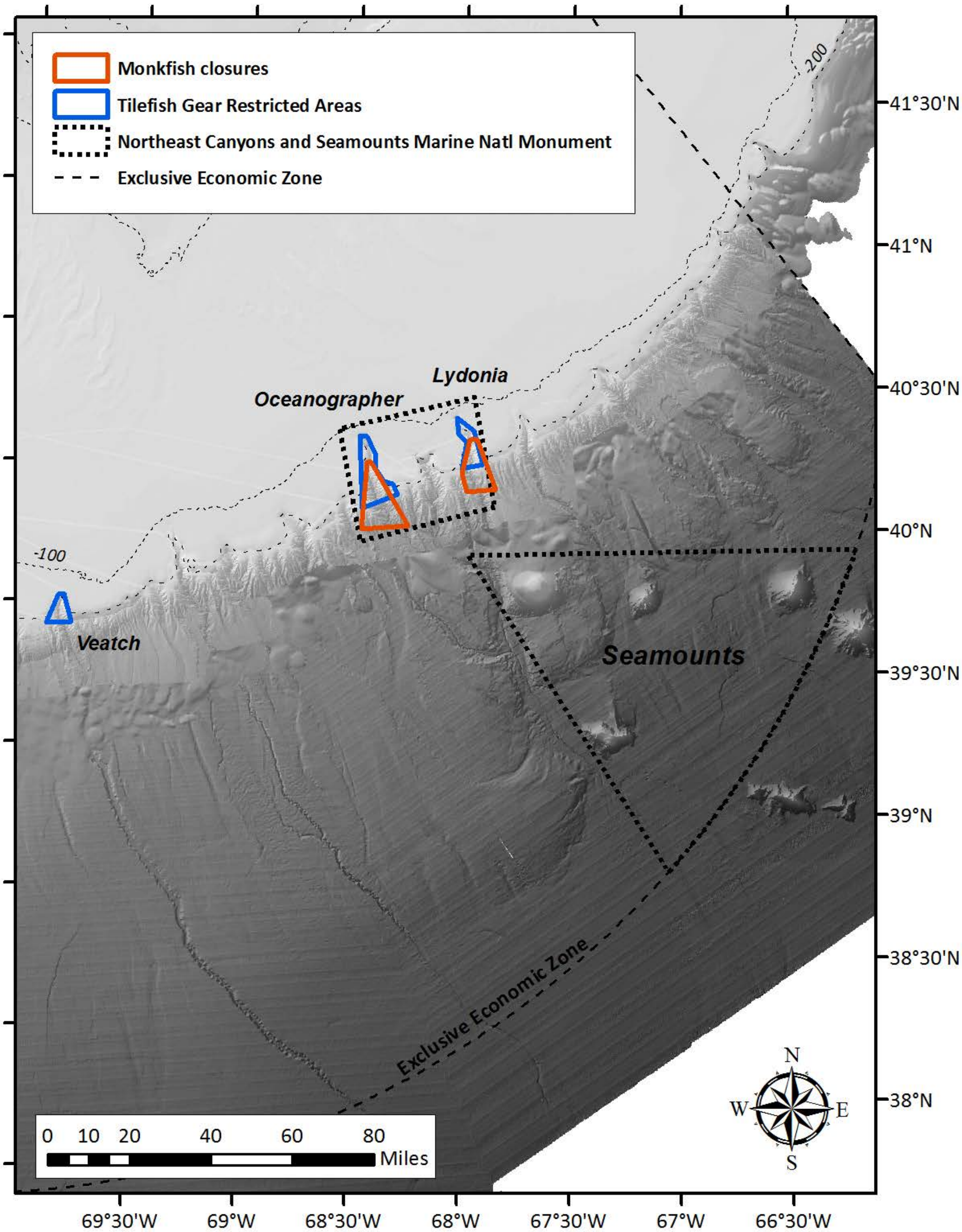
4.1 No Action – existing areas that provide protections for corals

Currently, there are no coral zones designated by the Council under the discretionary authority. However, current area closures offer protection to deep-sea corals in certain locations (Map 1). Because none of these areas are under the sole authority of the New England Fishery Management Council, they cannot be modified via this amendment. They are included for comparative, analytical purposes and because they provide coral conservation benefits.

- **Monkfish/MSB Areas (Joint New England and Mid-Atlantic Councils)**: Monkfish Amendment 2 (implemented 2005) prohibited fishing with any gear type while on a monkfish Day-at-Sea (DAS) in Lydonia and Oceanographer Canyons. The rationale provided in Monkfish Amendment 2 explicitly references protection of deep-water species and habitat in canyons, including deep-sea corals. These areas were developed via the MSA EFH authority, not using the discretionary coral protection provisions. These same two areas were later adopted as mackerel, squid, and butterfish bottom trawling restricted areas via Amendment 9 to that FMP (2008). Under the MSB FMP, no permitted mackerel, squid, or butterfish vessel may fish in the areas with bottom trawl gear on a year-round basis. Vessels fishing with other gear types or under other permits not covered by these provisions are able to fish in these two areas.
- **Tilefish Areas (Mid-Atlantic Council)**: Amendment 1 to the Tilefish FMP (2009) adopted mobile bottom-tending gear restrictions (Gear Restricted Areas, or GRAs) in Lydonia, Oceanographer, and Veatch Canyons. There is also a GRA in Norfolk Canyon, outside the New England region. These apply to any mobile bottom-tending gears regardless of fishery. Note that the Tilefish GRAs are located towards the heads of the canyons, with the boundaries based on those of the Tilefish Habitat Areas of Particular Concern (HAPC). The HAPCs were designed to protect clay outcrop habitats which occur in the heads of the canyons to roughly 300 m, although they cover deeper water areas along the axis of the canyons as well and would therefore have conservation benefits for deep-sea coral occurring deeper than 300 m. As above, these areas were developed via the MSA EFH authority, not using the discretionary coral protection provisions.
- **Northeast Canyons and Seamounts Marine National Monument:** On September 15, 2016, President Barack Obama designated the Northeast Canyons and Seamounts Marine National Monument (Monument), which has two sub-areas. The first encompasses the shelf-slope region from Oceanographer to Lydonia Canyons between about 100 m and 2,000 m, and the second encompasses all four seamounts in the EEZ. Sixty days from designation (November 2016), the areas closed to all commercial fishing as well as to energy exploration and development. The lobster and red crab fisheries will have up to seven years to cease operations within the Monument. Note that the Lydonia and Oceanographer Canyon monkfish and tilefish areas described above are almost entirely encompassed by the canyon section of the Monument. The Veatch Canyon Tilefish GRA is fully outside the Monument. The Monument is currently

under review by the Department of the Interior and modifications could be suggested to the designation. A recommendation from former Secretary Ryan Zinke to President Donald Trump suggests that the boundaries of the area would remain as-is but fishing restrictions in the monument could be rescinded and remanded back to the regional fishery management councils.

Map 1 – No Action alternative – various areas in the New England region that afford protection for deep-sea corals. Depth contours shown are in meters.



4.2 Deep-sea coral zone designations

Two conceptual approaches are considered for designating coral zones. Both would rely on the discretionary coral protection authority provided in the 2007 MSA reauthorization.

The **'discrete areas'** approach would designate more narrowly defined coral zones based on discrete bathymetric/geological features and groupings of corals. These zones include specific locations in the Gulf of Maine, single canyons, and individual seamounts. The boundaries of the discrete coral zones are based on direct observations of corals and other animals, plus inferences about the likely spatial extent of coral habitats, based on terrain data or habitat suitability models. The discrete coral zones were developed to encompass species that attach to hard substrates and are relatively large or have other attributes that make them more susceptible to fishing-related impact. While there is abundant soft substrate in the deep ocean, hard substrate areas are much more limited in their distribution. Because hard substrate areas tend to be patchy in their spatial distribution, some soft sediment areas and associated fauna would be included within the discrete zone boundaries, incidental to the primary conservation target.

The **'broad areas'** approach would designate a coral zone along the entire shelf-slope region between the US/Canada EEZ boundary and the New England/Mid-Atlantic Council boundary. Broad zones are generally intended to cover areas beyond the distribution of currently occurring fishing effort and represent a precautionary approach to management that would prevent the expansion of fishing into additional deep-water habitats. They would encompass coral habitats in the canyons, on the continental slope and on the seamounts. The broad areas do not overlap the coral zones in the Gulf of Maine.

The broad zone alternatives, in addition to encompassing the canyon and seamounts themselves, include additional areas of low-relief mud habitats that harbor other species of corals, including sea pens. Specifically, the white sea pen, *Stylatula elegans*, and the common sea pen, *Pennatula aculeata* possibly have lower susceptibility to fishing disturbance, and are more widely distributed than other types of corals. Other corals fall into the category of lower susceptibility – specifically, the hard coral *Dasmosmilia lymani*. This species was noted as being relatively common, including in shallower depths, is small in size, and is possibly less susceptible to fishing gear impacts. Some larger species such as the bamboo coral *Acanella arbuscula* are also associated with these soft substrates.

Management options for restricting or modifying fishing operations within the deep-sea coral zones include restrictions on mobile bottom-tending gears, restrictions on bottom-tending gears, and authorized exemptions to these restrictions. Different restrictions may be appropriate in broad vs. discrete zones, or among the various discrete zones.

Note that broad areas and discrete areas could be implemented simultaneously. While the individual discrete zones do not overlap one another, the canyon and seamount discrete zones overlap the depth-based broad zone alternatives. In some areas, the landward boundary of the discrete canyon zones is slightly shallower than the landward boundary of the shallowest broad zone, so combining the discrete zones with one of the broad zones would protect additional coral habitats in the heads of the canyons. A combination approach might also be appropriate if different management measures are desired in the discrete vs. broad areas.

To increase flexibility and allow for incorporation of new scientific information, there is an alternative that would allow new coral zones, or new fishing restrictions in designated coral zones, to be implemented via framework action.

4.2.1 Broad deep-sea coral zone designation

This alternative would designate a large area of the slope and abyssal plain out to the outer boundary of the EEZ as a deep-sea coral zone. There are seven overlapping broad zone options under consideration. Options for fishing restrictions in these zones are described in Section 4.3.

The broad zones have their landward/shallow boundaries along the southern flank of Georges Bank, their seaward boundary at the outer boundary of the EEZ, and their western boundary along the New England/Mid-Atlantic intercouncil boundary line. The landward boundaries of Options 1-6 are simplified versions of 300 m, 400 m, 500 m, 600 m, and 900 m depth contours, with line segments connecting waypoints with specific latitude/longitude coordinates. Map 2 shows the full spatial extent of the broad zone alternatives. These simplified contours are shown on Map 2 to Map 4, are being used for analysis, and would be adopted as specific management area boundaries, should one of these areas be selected. The 600 m contour was used to define two separate options. One (Option 4) has an approximate average depth of 600 m, bound by the 550 m and 650 m contours, and one (Option 6) has a minimum depth of 600 m.

Option 7 was developed using a slightly different method. This zone tracks the spatial footprint of coral habitat and fishing effort, within a specified depth range and according to decision criteria specified below.

Rationale

The overall objective of this type of measure would be to prevent the expansion of fishing effort into deep-water coral areas, while limiting impacts on current fishing operations. Progressively deeper broad zones encompass less and less fishing activity.

Methods used to define broad zone options

The depth contours used as the basis for the zone boundaries along the continental slope were derived from a 25 m resolution digital terrain model. To generate Options 1-5, simplified versions of these contours were generated using the simplify line tool in ArcGIS 10.2.2 for Desktop. A 0.5 km tolerance was specified when running the automated line simplify tool. In steeper locations where this tolerance resulted in boundaries outside the +/- 50 m depth tolerance, waypoints were added manually to keep the boundary between the desired depth contours. For example, the landward boundary of the 300 m zone has a minimum depth of 250 m and a maximum depth of 350 m.

The objective was to minimize the number of waypoints and simplify the boundary as much as possible, given the 50 m depth tolerance around each target contour. Given the shape of the contours along the edge of the shelf, the 300 m zone is a somewhat smoother boundary, with the zones becoming increasingly complex as they go deeper. The relationship between the zone boundaries and depth contours is illustrated in Map 3, which shows what these boundaries look like along the western shoulder of Oceanographer Canyon. The broad zones align generally with the discrete canyon zones (section 4.2.2.1) at the heads of the canyons, with some of the discrete canyon zone boundaries approximating the 300 m zone, and others approximating the 400 m zone (Map 4). Four of the discrete canyon zones (Veatch, Hydrographer, Lydonia, and Heezen) include areas shallower than the 300 m broad zone.

The 600 m minimum depth broad zone (Option 6) was also developed using the simplify line tool, but instead of constraining the boundary line to fall between the 550 m and 650 m contours, the boundary was constrained on its shallow side by the 600 m contour. In some areas the boundary crosses the 650 m contour, and Option 6 has fewer vertices and line segments as compared to Option 4. Map 5 shows the two options.

The inshore boundary for Option 7 along the shelf break was developed using a different approach than the other broad zones. The boundary varies in depth, according to the following criteria:

- Boundary follows the 550 m depth contour if the area has evidence of MBTG fishing, but no evidence of coral habitat. This provides the mobile bottom fishing industry with an additional buffer beyond what was identified as the deepest current fishing during the New Bedford workshop.
- Boundary follows the 500 m depth contour if the area has evidence of MBTG fishing and evidence of coral habitat or did not have evidence of MBTG fishing or evidence of coral habitat. This accommodates what the mobile bottom fishing industry identified as the maximum depth of current fishing.
- Boundary follows the spatial footprint of coral habitat, including areas as shallow as the 300 m depth contour if the area did not have evidence of MBTG fishing, but did have evidence of coral habitat. This was done to protect corals in areas where they are known or highly likely to occur and where it is unlikely that current fishing activity would be impacted.

Coral habitat was assessed based on coral presence records, areas identified as highly likely to be suitable soft coral habitat in a predictive model, or presence of steep slopes (> 30°). The coral database includes geo-referenced records dating from the late 1800s to the present of all types of deep-sea corals: soft corals, sea pens, stony corals, and black corals. Locations of recent camera transects and remotely operated vehicle dives were also considered when drawing the boundary. Section 6.2.1 has more information about these data sets.

The coral suitability analysis pools three different soft coral model outputs together and looks for areas estimated to be highly or very highly likely to contain habitats suitable for all types of soft corals combined, non-gorgonian soft corals only, or gorgonian soft corals only. Section 6.3 has more information.

Finally, the high slope area is based on the ACUMEN bathymetry data (section 4.2.2 on discrete zone alternatives). Slope is the rate of change in depth between two adjacent 25 m x 25 m grid cells, calculated in degrees. During 2013-2015 coral dives with remotely operated vehicles and towed cameras, corals were almost always observed where the slope was 30° or greater. Thus, the location of high slope habitats is a reliable indicator of the presence of deep-sea corals. The total area of very high slope is much smaller than the area of predicted suitable habitat.

Fishing with mobile bottom-tending gears (MBTG) was determined based on visual inspection of VMS data, using spatial data sets developed by the PDT during summer and fall 2017. Because the focus of this option was on mobile bottom-tending gears, and trawls are the only gears used at coral habitat depths, the boundary was developed using bottom trawl VMS maps. Two data types were used to create the maps, model-based data from 2005-2012, and speed-filtered data from 2010-2016.

For the 2005-2012 data, VMS polls were matched to observer data to assign a probability of fishing to each poll. Probabilities for polls from non-observed were determined using generalized additive modeling (Records and Demarest 2013; Muench et al 2017) The time elapsed between adjacent polls, which is directly calculated from the VMS data, was multiplied by the probability of fishing at each poll location to generate a value for probability-weighted hours fished for each point. Data were sorted into métiers and separate models were generated for each of two métiers and each year. Specifically, the bottom trawl and squid trawl métiers were used.

A second speed-filtered VMS dataset was developed for 2010-2016 by selecting all trawl gear VTR trips that landed a range of species known to be caught in bottom trawls along the shelf break, and then matching those trips to their VMS polls. The species included were butterfish, silver hake, offshore hake, unclassified hake, red hake, longfin squid, *Illex* squid, summer flounder, scup, black seabass, and monkfish. The VTR data were filtered by this list of species to reduce the number of trips and polls in the dataset, because VMS datasets can be very large files. Data were provided to the PDT by Mike Palmer, Northeast Fisheries Science Center.

Once the VMS polls (points) were collected, the data were converted to heatmaps using point density methods in Arc GIS 10.5. Individual polls were interpolated using the Point Density tool (Spatial Analyst). The resulting point density raster data were natural log transformed (Ln tool, Spatial Analyst), and standardized. All data sets were categorized in the same way, < -1 std dev, -1-0 std dev, 0-1 std dev, 1-2 std dev, > 2 std dev. Reclassified raster data were used for developing map products, and corresponding vector data were used to assess confidentiality. Confidentiality criteria were easily met for all data sets and years. The final step was to evaluate and adjust the draft boundary with respect to the coral and fishing effort data to meet the criteria specified above.

4.2.1.1 Option 1: 300 m broad zone

This option would designate a broad coral zone between the U.S.-Canada EEZ boundary, the boundary between the New England and Mid-Atlantic Council regions, and the seaward boundary of the U.S. EEZ, with the landward boundary based on the 300 m contour. The zone has a minimum depth of 250 m and an area of 67,142 km^2. All fishing restriction options in section 4.3 were analyzed for this zone.

4.2.1.2 Option 2: 400 m broad zone

This option would designate a broad coral zone between the U.S.-Canada EEZ boundary, the boundary between the New England and Mid-Atlantic Council regions, and the seaward boundary of the U.S. EEZ, with the landward boundary at the 400 m contour. The zone has a minimum depth of 350 m and an area of 66,410 km^2. All fishing restriction options in section 4.3 were analyzed for this zone.

4.2.1.3 Option 3: 500 m broad zone

This option would designate a broad coral zone between the U.S.-Canada EEZ boundary, the boundary between the New England and Mid-Atlantic Council regions, and the seaward boundary of the U.S. EEZ, with the landward boundary at the 500 m contour. The zone has a minimum depth of 450 m and an area of 65,838 km^2. All fishing restriction options in section 4.3 were analyzed for this zone.

4.2.1.4 Option 4: 600 m broad zone

This option would designate a broad coral zone between the U.S.-Canada EEZ boundary, the boundary between the New England and Mid-Atlantic Council regions, and the seaward boundary of the U.S. EEZ, with the landward boundary at the 600 m contour. The zone has a minimum depth of 550 m and an area of 65,365 km^2. All fishing restriction options in section 4.3 were analyzed for this zone.

4.2.1.5 Option 5: 900 m broad zone

This option would designate a broad coral zone between the U.S.-Canada EEZ boundary, the boundary between the New England and Mid-Atlantic Council regions, and the seaward boundary of the U.S. EEZ, with the landward boundary at the 900 m contour. The zone has a minimum depth of 850 m and an area of 64,193 km^2. All fishing restriction options in section 4.3 were analyzed for this zone.

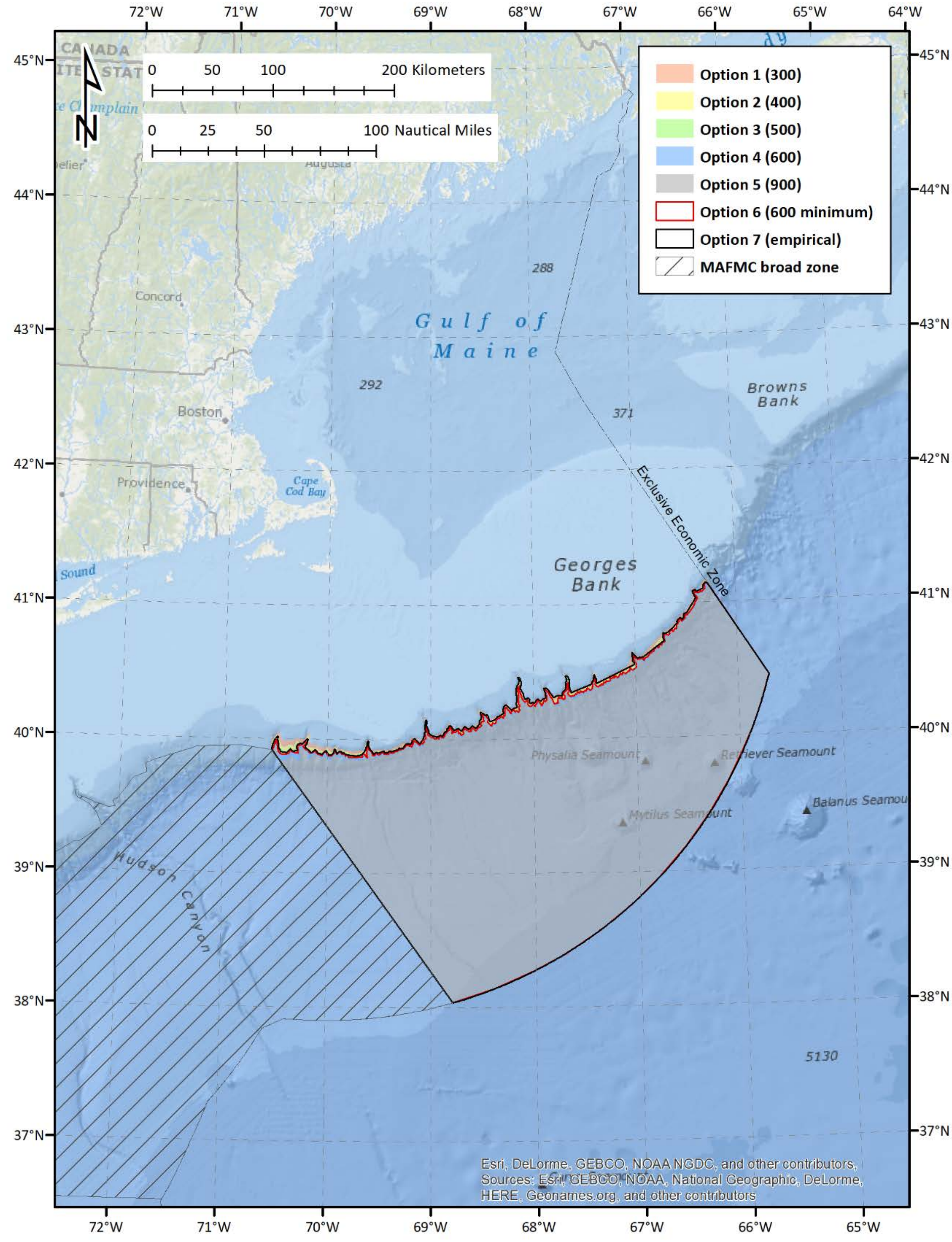
4.2.1.6 Option 6: 600 m minimum depth broad zone (preferred alternative)

This option would designate a broad coral zone between the U.S.-Canada EEZ boundary, the boundary between the New England and Mid-Atlantic Council regions, and the seaward boundary of the U.S. EEZ, with the landward boundary at the 600 m contour. The zone is similar to Option 4, but has a minimum depth of 600 m and an area of 65,147 km^2. The full range of fishing restriction options in section 4.3 are analyzed in this document, but the preferred approach of the Council designates the zone as a closure to all bottom-tending gears, with an exemption for the red crab pot fishery. This is fishing restriction Option 1, Sub-Option A.

4.2.1.7 Option 7: Empirically-derived zone based on coral and fishing effort data

This option would designate a single coral zone in the slope/canyon/seamount region south of Georges Bank, with the western boundary along the New England/Mid-Atlantic inter-council boundary line, the eastern boundary at the U.S.-Canada EEZ boundary (Hague Line), and the offshore boundary at the outer limit of the U.S. EEZ (200-mile limit). These boundary limits are the same as for the other broad zone options. The zone would be closed to mobile bottom-tending gears (MBTG), i.e. fixed bottom tending gears would be permitted, as would gears that are not bottom-tending. This is fishing restriction Option 2 in section 4.3.

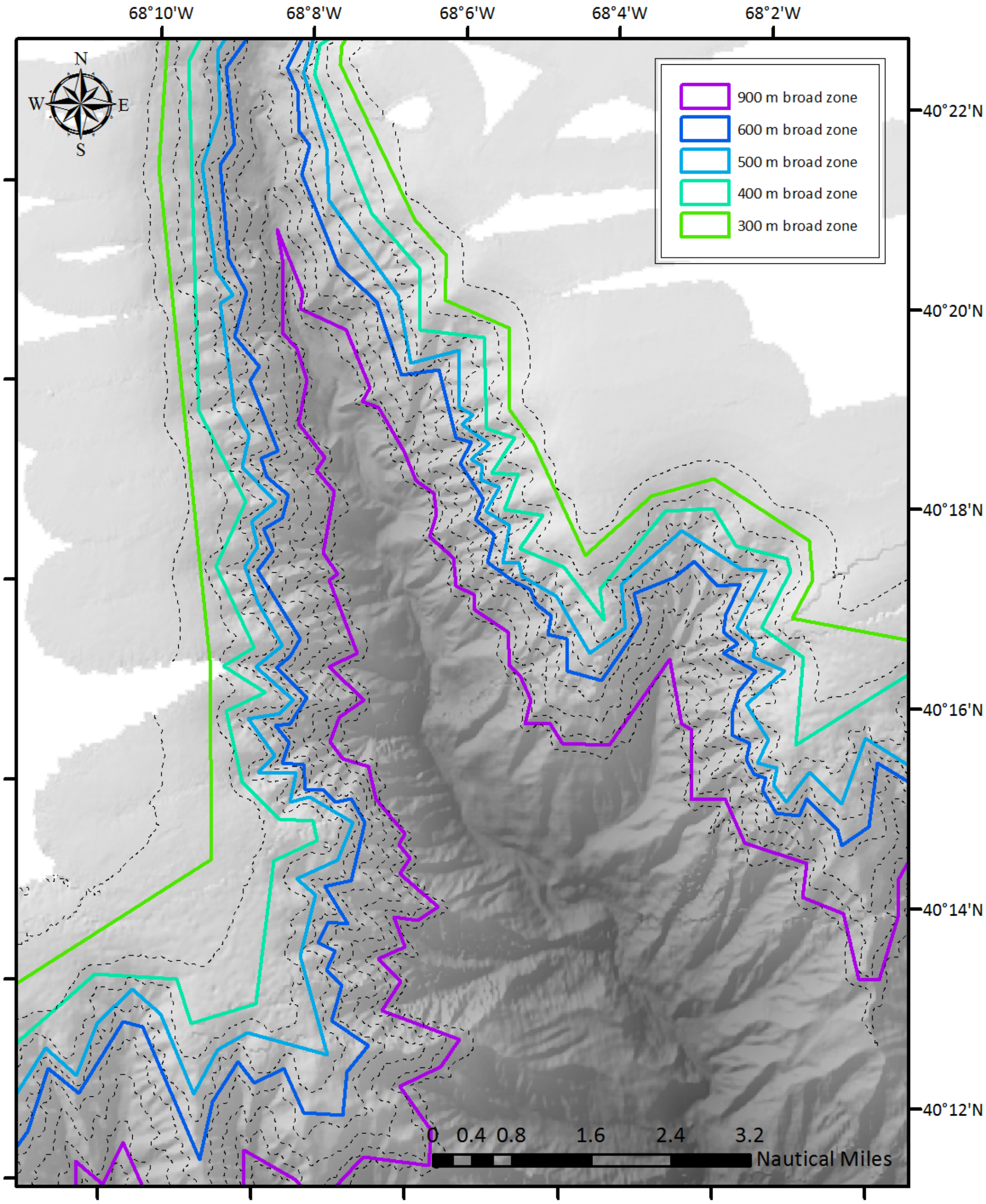
Map 2 – Location of broad coral protection zones.



Coordinate system: WGS 1984 UTM Zone 19N

Map created February 1, 2018

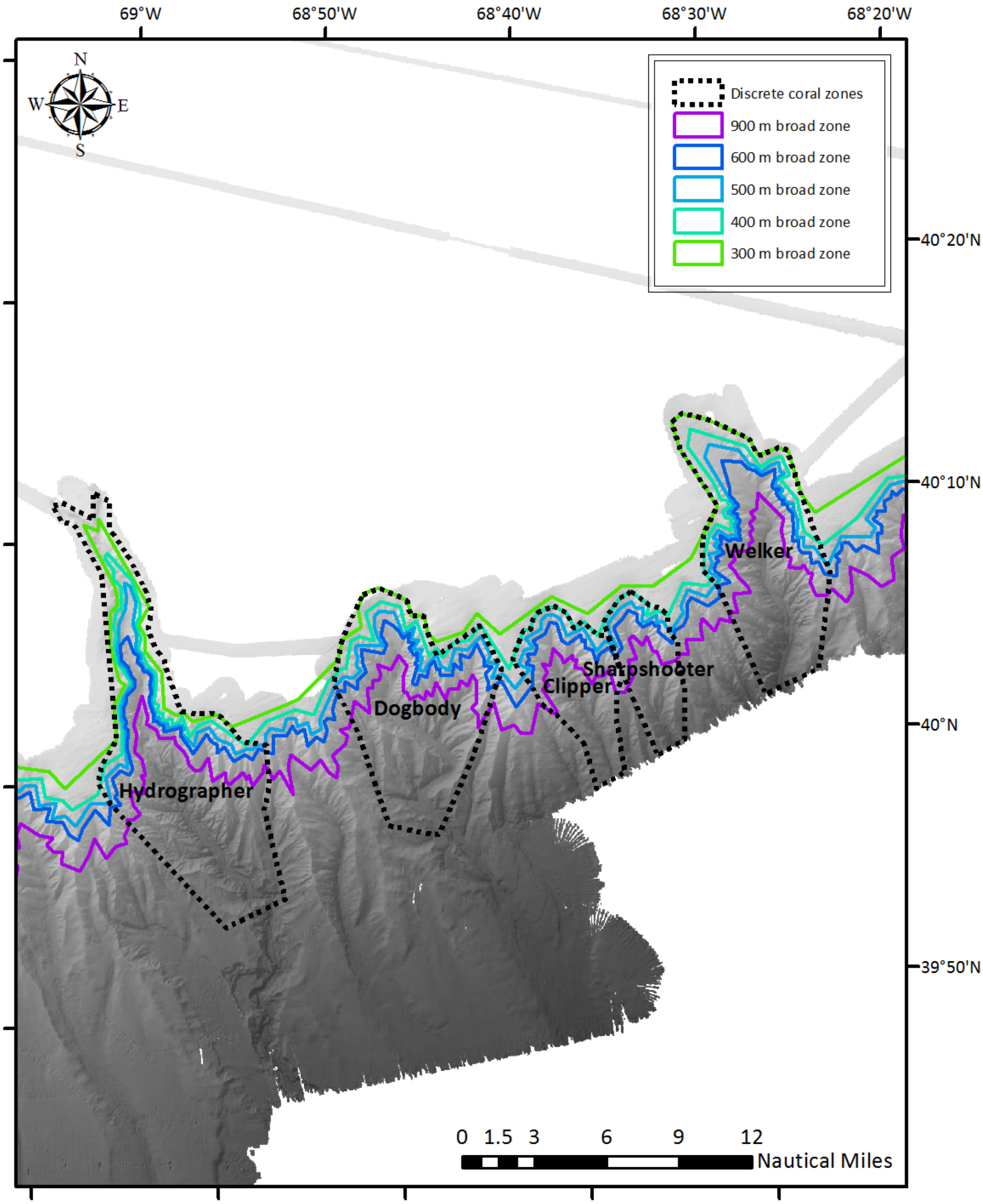
Map 3 – Broad zone Options 1-5 at the shoulder of Oceanographer Canyon showing the relationshiop between depth contours and zone boundaries. Options 6 and 7 are not shown.



Map created November 16, 2016 NEFMC Habitat Plan Development Team

Notes: Heavy colored lines indicate the broad zone boundaries. The black dotted lines indicate the adjacent contours (50 m depth intervals) that serve as upper and lower depth bounds for the broad zones. Grey shading shows the underlying ACUMEN bathymetry surface from which the contours were derived. Because the areas are so steeply sloping, the contours are often only 1-2 km apart between the canyons, and even more closely spaced within the canyons. The deeper boundaries are necessarily more complex than the shallower boundaries.

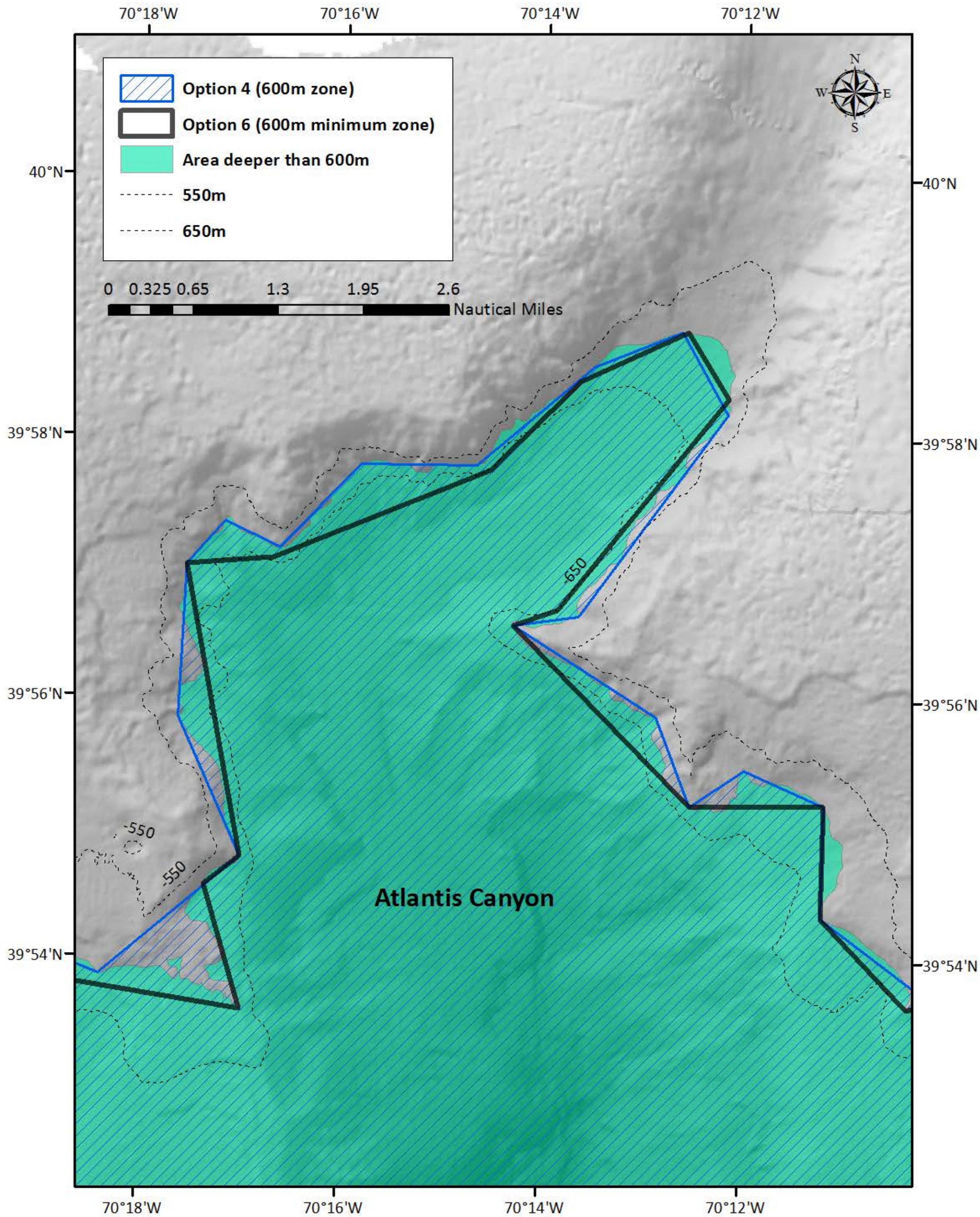
Map 4 – Broad zone boundary options and their relationship with discrete coral zones.



Map created November 16, 2016 NEFMC Habitat Plan Development Team

Notes: Compare Dogbody and Welker, which follow the 300 m zone, with Clipper and Sharpshooter, which follow the 400 m zone. Hydrographer's landward boundary is slightly shallower than 300 m. Grey shading shows the underlying ACUMEN bathymetry surface from which the contours were derived.

Map 5 – Comparison of broad zone Options 4 and 6 within Atlantis Canyon to show difference between boundary constrained by 550 m and 650 m contours (Option 4) and minimum depth approach (Option 6).



Notes: Option 4 is shown in blue hatching, and Option 6 is shown in bold black outline. The shaded area underneath indicates portions of the canyon deeper than 600 m, based on the high resolution depth contour. Option 6 is within this shaded area, but option 4 may extend outside it, to a depth as shallow as 550 m (dotted line). The deeper 650 m contour is also shown.

4.2.2 Discrete deep-sea coral zone designations

Discrete deep-sea coral zones overlap individual canyons, seamounts, or other features. These discrete coral zones are intended to encompass known aggregations of corals, as well as steeply sloping habitats likely to have exposed rock outcroppings that provide suitable attachment sites for corals.

The following sources of data were used to develop a list of recommended deep-sea coral zones, and to generate boundaries for those zones. Available data are similar for the different types of zones (canyon, seamount, Gulf of Maine), with variations as noted below. The major data types include information on the presence, abundance, and locations of various types of corals, terrain data such as depth and slope, and model outputs that predict areas where suitable habitats for particular taxonomic groups of corals are likely to occur. It is important to note the linkages between these datasets, which were generally collected or developed in an integrated, iterative fashion, rather than in an independent or stepwise manner. For example, historical coral distribution records combined with terrain and other environmental data were used in the habitat suitability model, and model outputs were in turn used to direct recent field sampling for coral habitats. Interest in coral habitats based on historical data helped drive collection of high resolution bathymetric data, which in turn informed selection of recent dive sites.

Deep-sea coral observations

Deep-sea coral observations from (1) an historical database and (2) recently conducted remotely operated vehicle (ROV) dives, autonomous underwater vehicle (AUV) dives, and camera tows were used as a starting point to identify areas of conservation interest. Section 6.2 details these data.

Habitat suitability model

Direct observations of corals are only available for a small portion of each area, thus requiring inference about the spatial extent of suitable coral habitats in various locations. A habitat suitability model (Kinlan et al., in review) was developed for the northeast region that predicts areas of lower and higher suitability for various types of corals. The model is described further in section 6.3. The combined high and very high suitability areas for the Gorgonian Alcyonacea and non-gorgonian Alcyonacea combined were used to develop the canyon zones. This model was not used to design the Gulf of Maine coral zones.

Terrain data (bathymetry and slope)

Bathymetry and slope are key data for describing seafloor terrain and identifying areas that may contain deep-sea corals, as many taxa have been found in higher abundances attached to vertical rock walls and other steep terrain. Bathymetry datasets are also referred to as digital elevation models, or DEMs. These bathymetric datasets were used to identify area boundaries, and also to calculate minimum, maximum, and mean depths of candidate management areas.

- The primary source of bathymetry data for the canyons comes from a series of Atlantic Canyons Undersea Mapping Expeditions (ACUMEN) on NOAA's research vessels *Hassler*, *Bigelow*, and *Okeanos Explorer*. These mapping expeditions took place from February 2012 through August 2012. Data were collected at 25 m resolution.
- For the deepest portions of the canyons, the abyssal plain, and the seamounts, 100 m resolution multibeam bathymetry data are available. These data were collected as part of a NOAA-initiated collaboration to fill data gaps identified during an inventory of data holdings to support potential claims under the United Nations Convention on the Law of the Sea (UNCLOS). Data are available for download from the University of New Hampshire Center for Coastal and Ocean Mapping Joint Hydrographic Center (http://ccom.unh.edu/theme/law-sea/law-of-the-sea-data/atlantic).
- In the Gulf of Maine, a 10 m resolution multibeam bathymetric dataset was used for Outer Schoodic Ridge, a 20 m resolution multibeam bathymetric dataset was used in Western Jordan Basin, and a 1/3 arc-second (about 10 m) bathymetric dataset (the Bar Harbor DEM) was used in the Mount Desert Rock area and surrounds. The Outer Schoodic Ridge and Western Jordan Basin data were collected during a fall 2013 ECOMON cruise aboard the *Okeanos Explorer* (Auster et al. 2014). The Bar Harbor DEM is described in Friday et al. 2011.
- A lower resolution 250 m DEM from The Nature Conservancy's Northwest Atlantic Marine Ecoregional Assessment, which is largely based on the Coastal Relief Model, is available in other areas where higher resolution data do not exist.
- A complete 30 arc-second DEM for the entire region was downloaded from the General Bathymetric Chart of the Oceans website, www.gebco.net. The GEBCO 2014 dataset is based on "quality-controlled ship depth soundings, with interpolations between soundings guided by satellite-derived gravity data". When available, additional data sources such as multibeam or Olex are integrated in particular locations.
- Additional mapping was completed by NEFSC in July and August 2017 aboard the NOAA Ship Thomas Jefferson (Cruise TJ 17-03). Areas targeted included Jordan Basin, Lindenkohl Knoll, and the northeastern slope of Georges Bank. These maps were not used to support alternatives development but may be useful in future management updates.

Maps in this document show hill-shaded bathymetry, which allows for the shape of the seafloor to be visualized more easily. Hill-shaded surfaces are generated using Geographic Information System (GIS) software, by simulating what the terrain would look like if a light was shone over the surface from a specific angle and elevation. Values of 315° and 35° with a vertical exaggeration of 3x were used for the maps in this document.

Slope is a measure of the rate of change in bathymetry, and slope surfaces can be derived directly from any digital elevation model. Slope surfaces were also generated for other digital elevation models and high slope areas are highlighted on the maps of each discrete coral zone. The canyons generally contain larger areas of very high slope compared with the seamounts or Gulf of Maine areas. For areas where very steep terrain is less prevalent, including the seamounts and Gulf of Maine areas, slopes greater than 10 or 20° are mapped instead of slopes above 30°.

When interpreting bathymetric data, it is important to recognize the potential for artifacts in the data, which appear as a sudden change in depth. These artifacts can occur at seams, where data collected at different times are joined together to form a single coverage. These visible seams are due to small differences in instrument calibration. These abrupt jumps in bathymetry values can cause false slopes at the seams, which are not reflective of features on the seafloor. Though less probable and less severe, such artifacts can also occur at the boundaries between multibeam swaths collected at different times with the same ship and instrument, especially when data are collected across years. Caution is also needed at the edges of multibeam coverage and in the vicinity of holidays (pixels without valid data), where fewer bottom contacts are averaged and higher statistical noise may be present. These are all common and well-known features of multibeam echosounder data. It is widely accepted that expert interpretation is required to avoid considering such areas as true bottom features, and such expert guidance is standard practice in the hydrographic field. Where such artifacts are present in the maps presented below, they are noted on the maps in the text.

4.2.2.1 Canyon coral zones

This alternative would designate coral zones within 20 submarine canyons off the southern boundary of Georges Bank. From west to east, these canyons include Alvin, Atlantis, Nantucket, Veatch, Hydrographer, Dogbody, Clipper, Sharpshooter, Welker, Heel Tapper, Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia, Powell, Munson, Nygren, Kinlan (previously unnamed), and Heezen. The canyons that overlap the National Monument are Oceanographer, Filebottom, Chebacco, Gilbert, and Lydonia. Options for fishing restrictions in these zones are described in section 4.3.

This alternative assumes that all canyon zones would be selected as a group. The impacts separate results for the groups of canyons that do and do not overlap the Monument. This will allow the Council to more readily understand the additional impacts of designating new canyons, beyond those impacts already associated with the Monument.

Table 3 – Size of each canyon coral zone.

Zone name	*Area (km²)*	*Area (mi²)*
Alvin	210	81
Atlantis	218	84
Nantucket	176	68
Veatch	127	49
Hydrographer	211	82
Dogbody	150	58
Clipper	64	25
Sharpshooter	46	18
Welker	144	55
Heel Tapper	104	40
Oceanographer	236	91

Zone name	*Area (km^2)*	*Area (mi^2)*
Filebottom	56	22
Chebacco	83	32
Gilbert	167	65
Lydonia	179	69
Powell	138	53
Munson	130	50
Nygren	112	43
Kinlan (prev. referred to as Unnamed Canyon)	45	17
Heezen	122	47

Rationale

The discrete canyon zones would protect deep-sea corals from the impacts of fishing throughout the full spatial extent of each canyon. All of these canyons have recent ROV or towed camera dives indicating the presence of coral habitats. Some areas have historical records as well.

Method used to define discrete canyon zone boundaries

Boundaries of these zones are based on the most up to date information on coral observations, high resolution terrain data, and habitat suitability model results. Coral zone boundaries are primarily based on bathymetry and slope, and were designed to encompass the full extent of the canyon feature from the shelf break to the point where the slope begins to flatten out at the edge of continental rise. The 3° slope contour was used to identify the shelf break in previous PDT coral analyses, and this convention is adopted here as well. The 3° slope contour is typically lies somewhere between 200 and 300 meters depth off of New England. Because the shallow edge of the high resolution ACUMEN bathymetry dataset overlaps these contours, this dataset was not suitable for defining a 3° slope contour. Therefore, the slope contour was developed using The Nature Conservancy Northwest Atlantic Marine Ecoregional Assessment digital elevation model. This slope contour roughly approximates the landward coral zone boundary in the shelf incising canyons, and in some of the slope confined canyons as well. The landward boundary of other slope confined canyons begins slightly deeper, which is consistent with the slope and habitat suitability model outputs (more on this below).

Corals have been observed most of the time in high-slope areas of the canyons (>30°) during recent ROV and towed camera surveys. Corals have been found in areas with very high slope (greater than 36°) during all recent dives. Thus, these high and very high slope areas, derived from ACUMEN bathymetry, were useful for defining the width of the canyon zones (west to east dimension), as well as the seaward boundaries of the zones.

The high and very high habitat suitability outputs for Gorgonian Alcyonacea, and Non-Gorgonian Alcyonacea were also considered when developing canyon zone boundaries. These high and very high suitability model outputs often align well with the high and very high slope areas described above. Similar to the slope outputs, the model results were used to help define the width of the canyon zones, and well as their landward and seaward extents. A buffer of 0.4 nautical miles around the high suitability outputs was generated to roughly reflect the degree of spatial uncertainty in the model results. As appropriate, the zones include these buffer areas as well. The PDT prioritized the high resolution bathymetry and slope data over the model outputs when developing boundaries because these high resolution data are best for accurately bounding the spatial extent of the canyon features. The suitability outputs are a useful guide, but are based on a lower resolution dataset. This diverges slightly from the approach used by the MAFMC FMAT. In the MAFMC coral amendment, the FMAT included high and very high habitat suitability areas, plus the buffer, in their initial canyon zone boundary recommendations, but these areas were ultimately scaled back in the heads of the canyons by the time the boundary development process had concluded after their coral workshop. More tightly focused boundaries at this initial stage will hopefully result in the need for fewer changes as these areas make their way through the Council process.

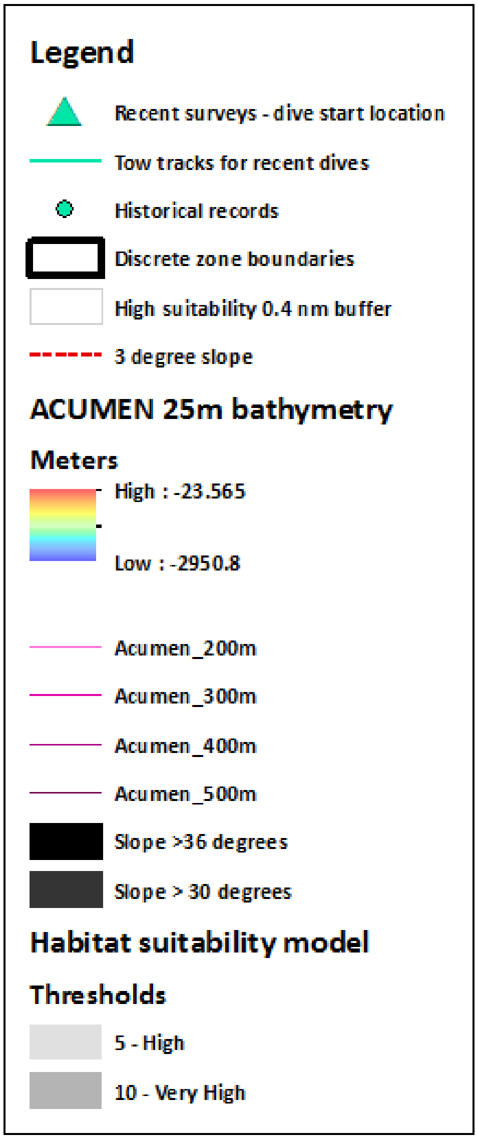
The locations of historic and recent coral observations generally fall solidly within zones developed using bathymetry, slope, and suitability model results, so while they are confirmatory of the presence of coral habitats in a canyon zone, they were not used to define the zone boundaries.

Maps for each canyon shows a draft set of boundaries and the underlying coral distribution, bathymetry, slope, and habitat suitability data layers. The legend in Figure 1 applies to each of the canyon zone maps that follow. It shows locations of recent ROV and towed camera dives (green triangles, with green line tow paths) and coral locations in the historical database (green circles). Coral orders represented in the historical database include stony corals (order Scleractinia); sea pens (order Pennatulacea); soft corals (order Alcyonacea); and black corals (order Antipatharia).

The maps also depict depth, hill-shaded relief (red to blue shading) and contour lines (purple) from the ACUMEN data. Note that the 200 m contour is rather incomplete in the ACUMEN data and is not often depicted fully on the maps. The 3° slope contour (red dotted line) is shown on each map as well. Areas of high slope (> 30°) and very high slope (> 36°) are identified in dark grey and black. The hill-shaded relief indicates the shapes of the canyon and helps to indicate the path of the thalweg, or main axis of the canyon. Seams in the bathymetry data and resulting slope artifacts are noted on the maps.

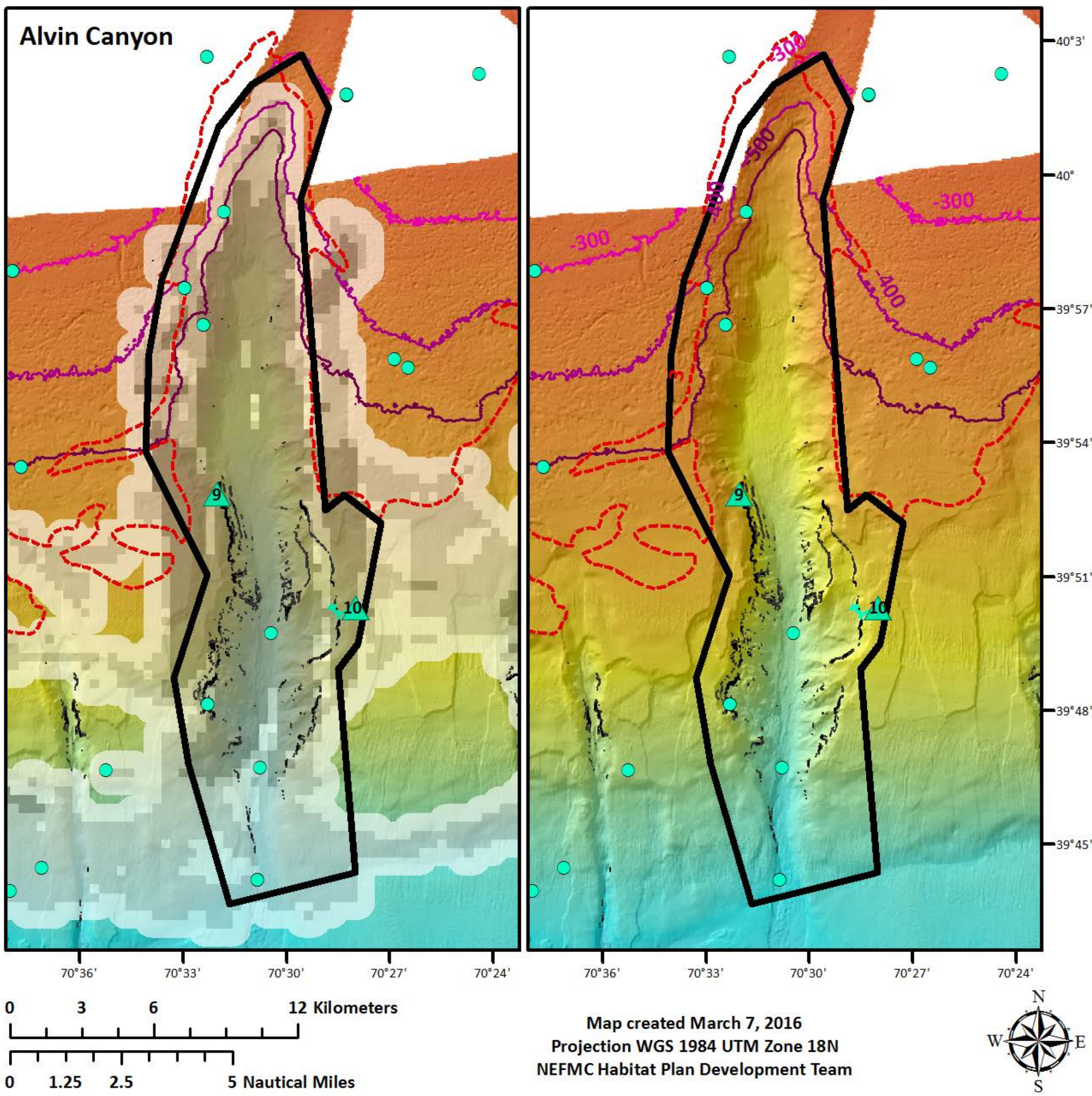
Two sets of maps were prepared for this document, one with the combined Gorgonian and Non-Gorgonian Alcyonacean habitat suitability layers, and one without, because the maps without habitat suitability more clearly show the shapes of the canyons. High and very high habitat suitability areas are shown in transparent grey shading, and a 0.4 nm buffer is shown in white shading.

Figure 1 – Legend for canyon area maps



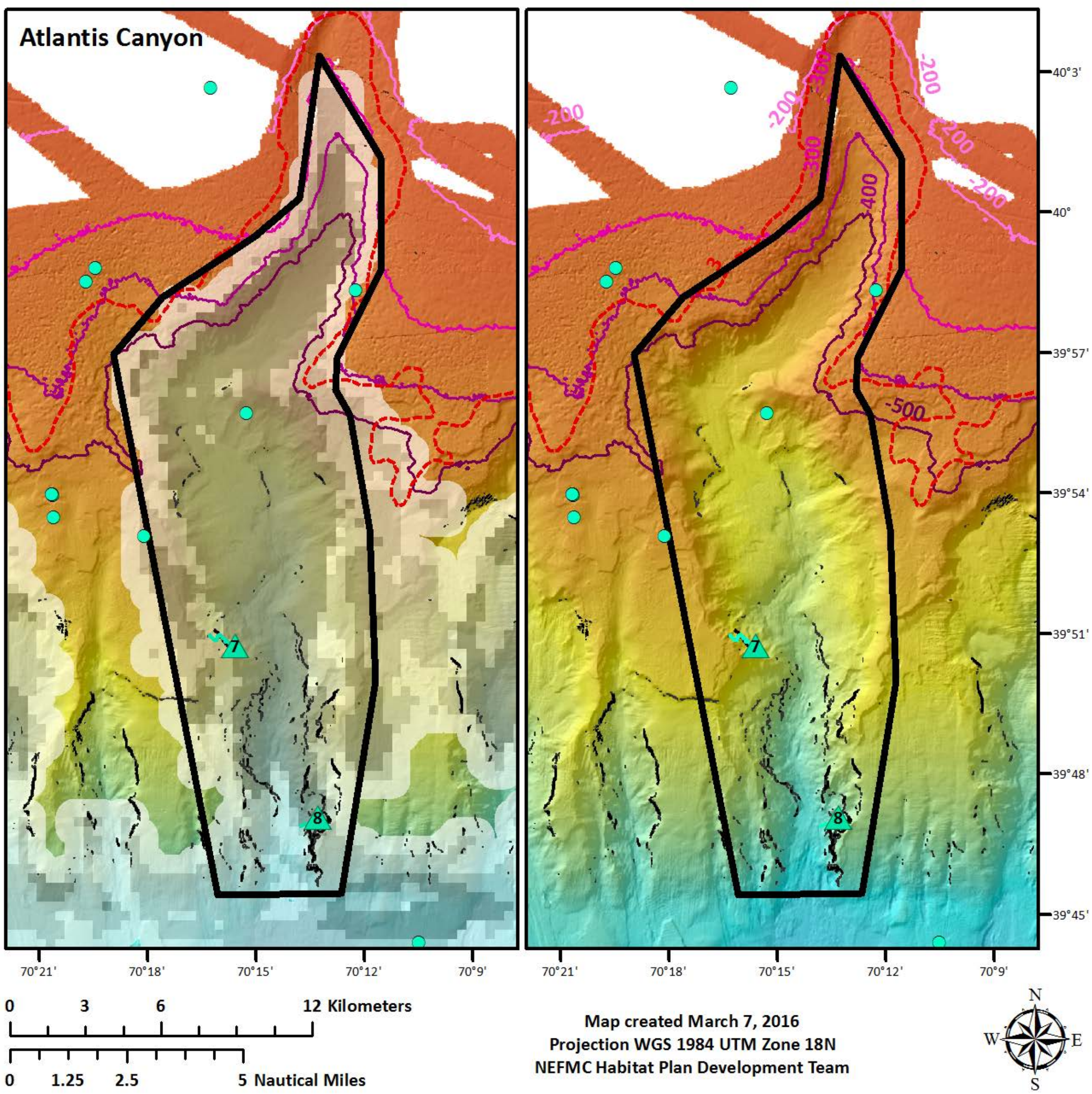
Alvin Canyon incises the continental shelf, encompassing an area of about 200 km^2. The proposed zone follows the 300 m depth contour at the head of the canyon and aligns closely with the 3° slope contour. The proposed zone encompasses areas of high and very high suitability as well as areas of high slope (greater than 30°), which tend to occur in the deeper portion of the canyon. High suitability areas extend beyond the boundaries of the zone to the east and west, but very high suitability areas are mostly confined to the suggested boundaries. There are no issues with seams in the bathymetric data in this canyon. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 6 – Alvin Canyon discrete zone



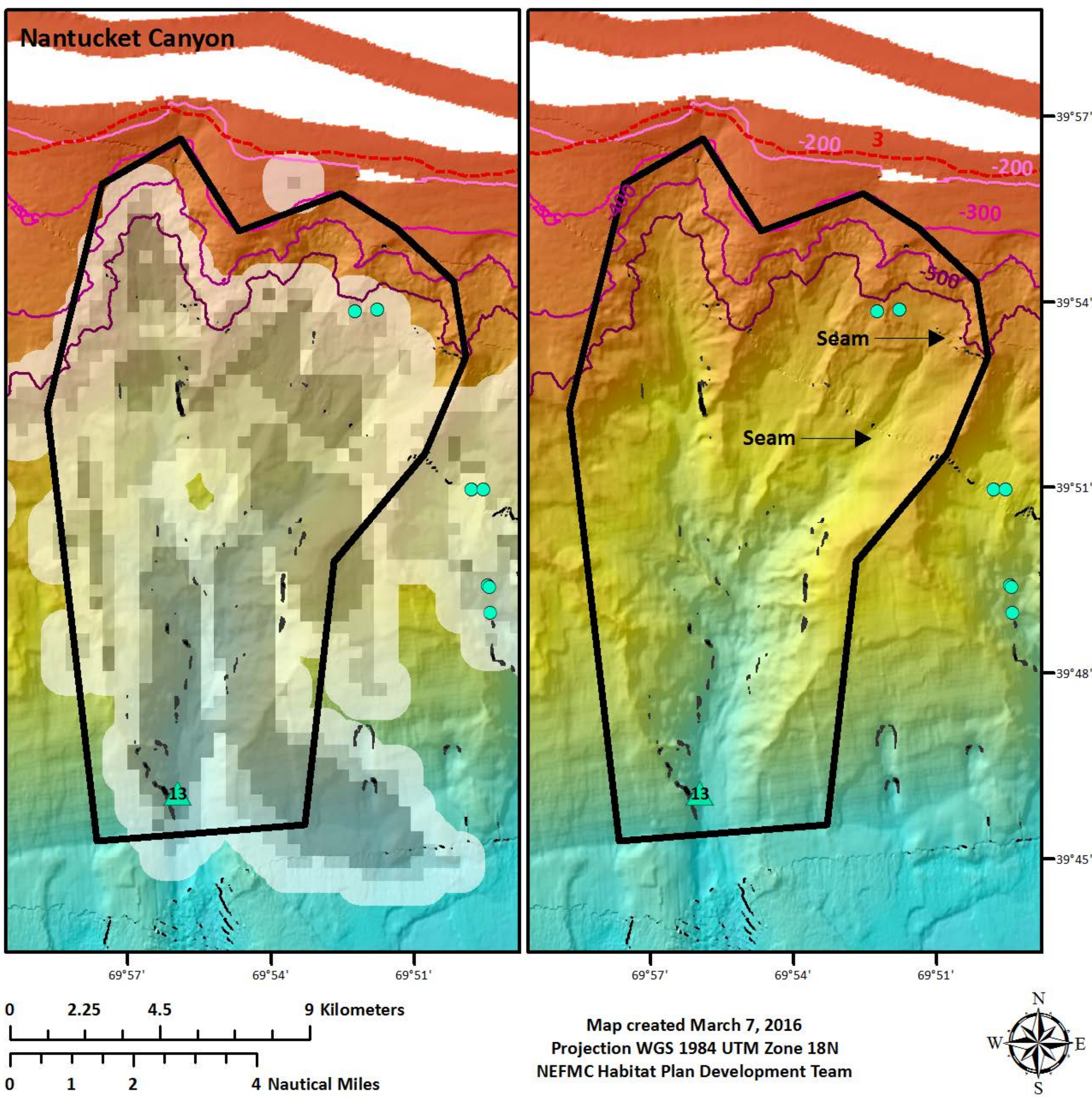
Atlantis Canyon incises the continental shelf break, encompassing an area of about 200 km^2. The proposed zone follows the 300 m depth contour at the head of the canyon and aligns closely with the 3° slope contour. The proposed zone encompasses areas of high and very high suitability as well as areas of high slope (greater than 30°), which tend to occur in the deeper portion of the canyon. There are smaller canyon-type features to the east and west of the proposed zone. There are no issues with seams in the bathymetric data in this canyon. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 7 – Atlantis Canyon discrete zone



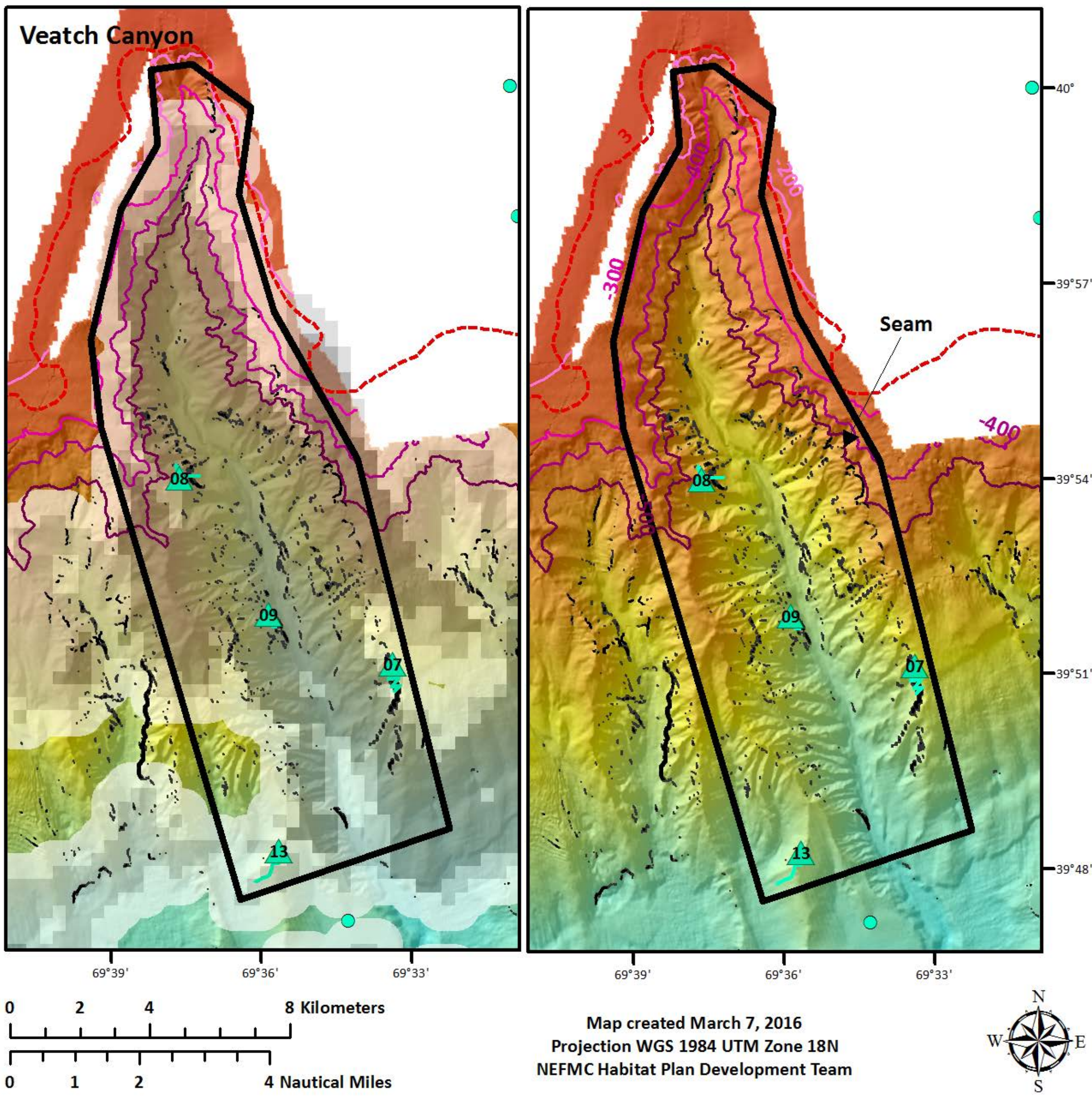
Nantucket Canyon is seaward of the 3° slope contour, with an area of about 200 km^2. It is a dendritic canyon, with three major branches. Although Harris and Whiteway (2011) classify Nantucket as shelf-incising, there is not a substantial curve in the 3° slope contour at the head of the canyon, such that it may more appropriately be classified as slope-confined. The proposed zone roughly follows the 300 m depth contour at the head of the canyon. It encompasses areas of high and very high suitability as well as areas of high slope (greater than 30°), which tend to occur in the deeper portion of the canyon. There are areas to the east of the proposed zone that indicate high likelihood of coral presence. Some apparent high slope areas in the northeastern portion of the zone appear to be artifacts due to seams in the bathymetry data. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 8 – Nantucket Canyon discrete zone



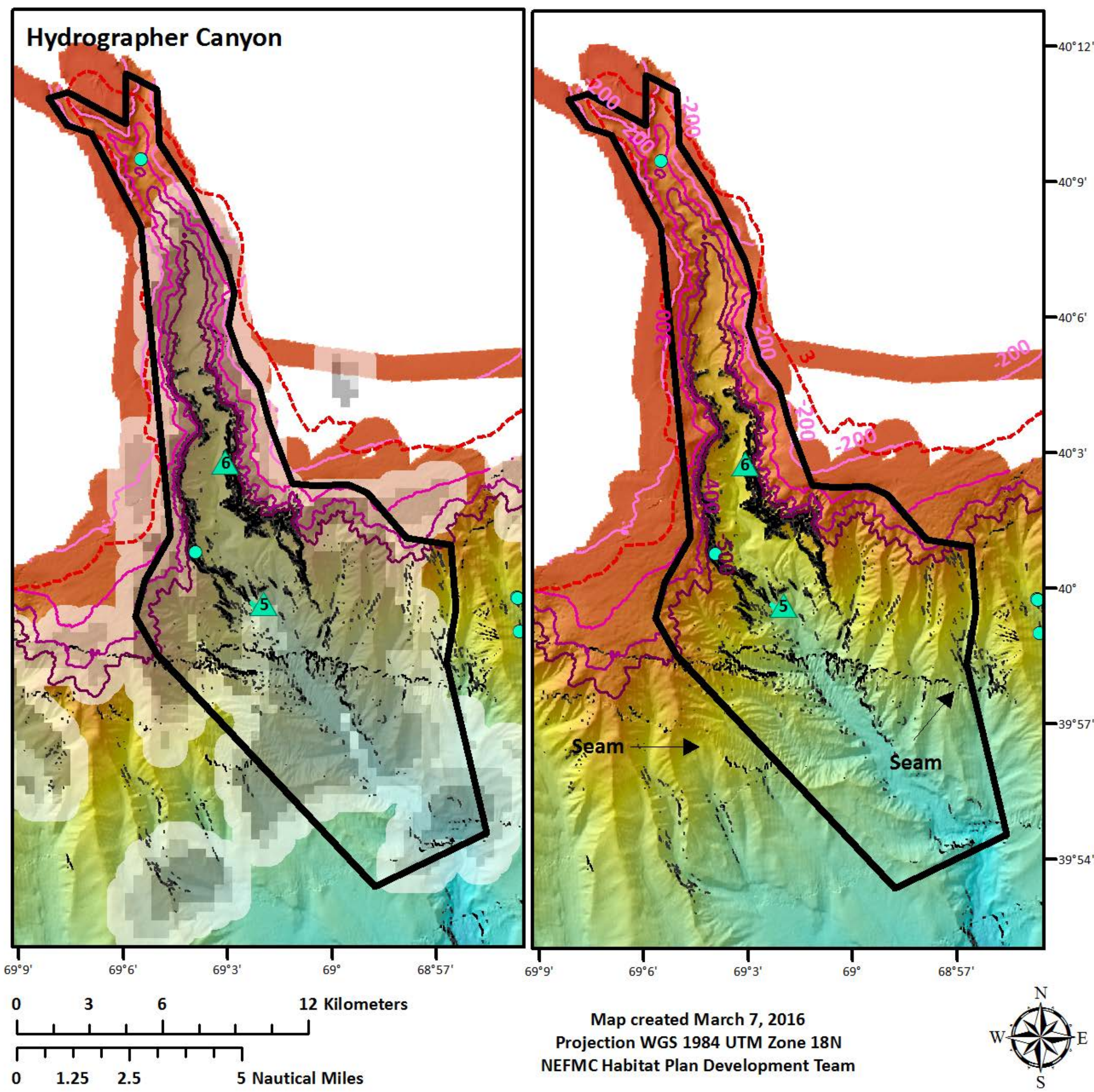
Veatch Canyon incises the continental shelf break. The recommended zone encompasses an area about 125 km^2 and is between 200 m and 300 m in the head of the canyon. The No Action Tilefish Gear Restricted Area encompasses additional areas outside the discrete coral zone. Most of the recommended zone is mapped as very high habitat suitability. High suitability areas extend to the east and west of the boundary, overlapping smaller slope-confined canyons on either side of Veatch. Some apparent high slope areas in the head of the canyon are artifacts due to seams in the bathymetry data. The true high slope areas tend to occur mainly in the deeper portions of the canyon, beyond the shelf break. While there are no historical observations of coral presence in Veatch Canyon area, there have been five recent dives that have documented a range of coral species.

Map 9 – Veatch Canyon discrete zone



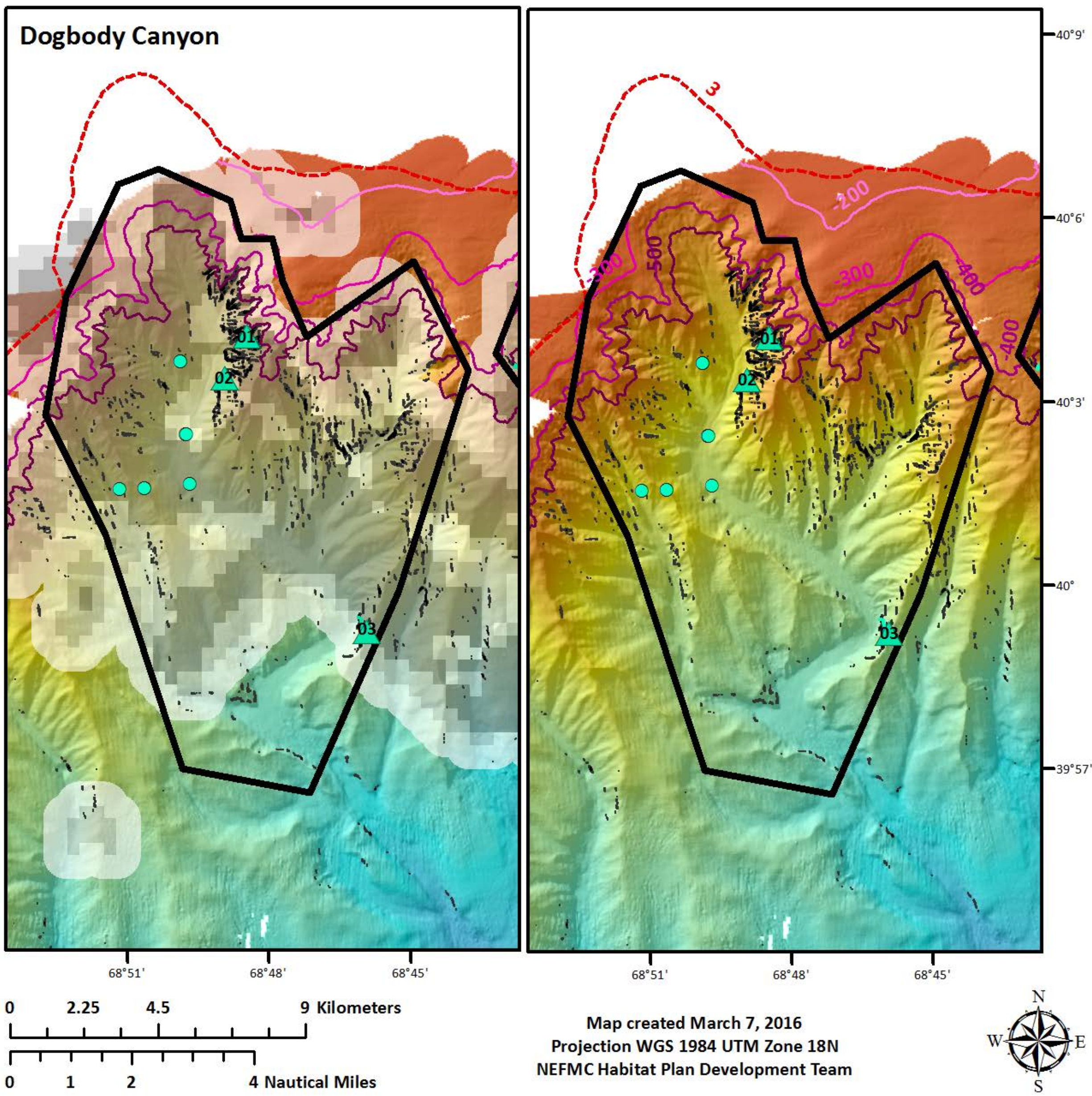
Hydrographer Canyon is a narrow canyon that incises the continental shelf break, encompassing an area about 200 km^2. The proposed zone follows the 200 m depth contour at the head of the canyon. The areas of high slope (i.e., greater than 30º) are found in the narrow portion of the proposed canyon zone, midway between the mouth and foot of the canyon. The zone also encompasses the high and very high habitat suitability output results. The effect of "seams" in the dataset is also visible on the map, and should be ignored. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 10 – Hydrographer Canyon discrete zone



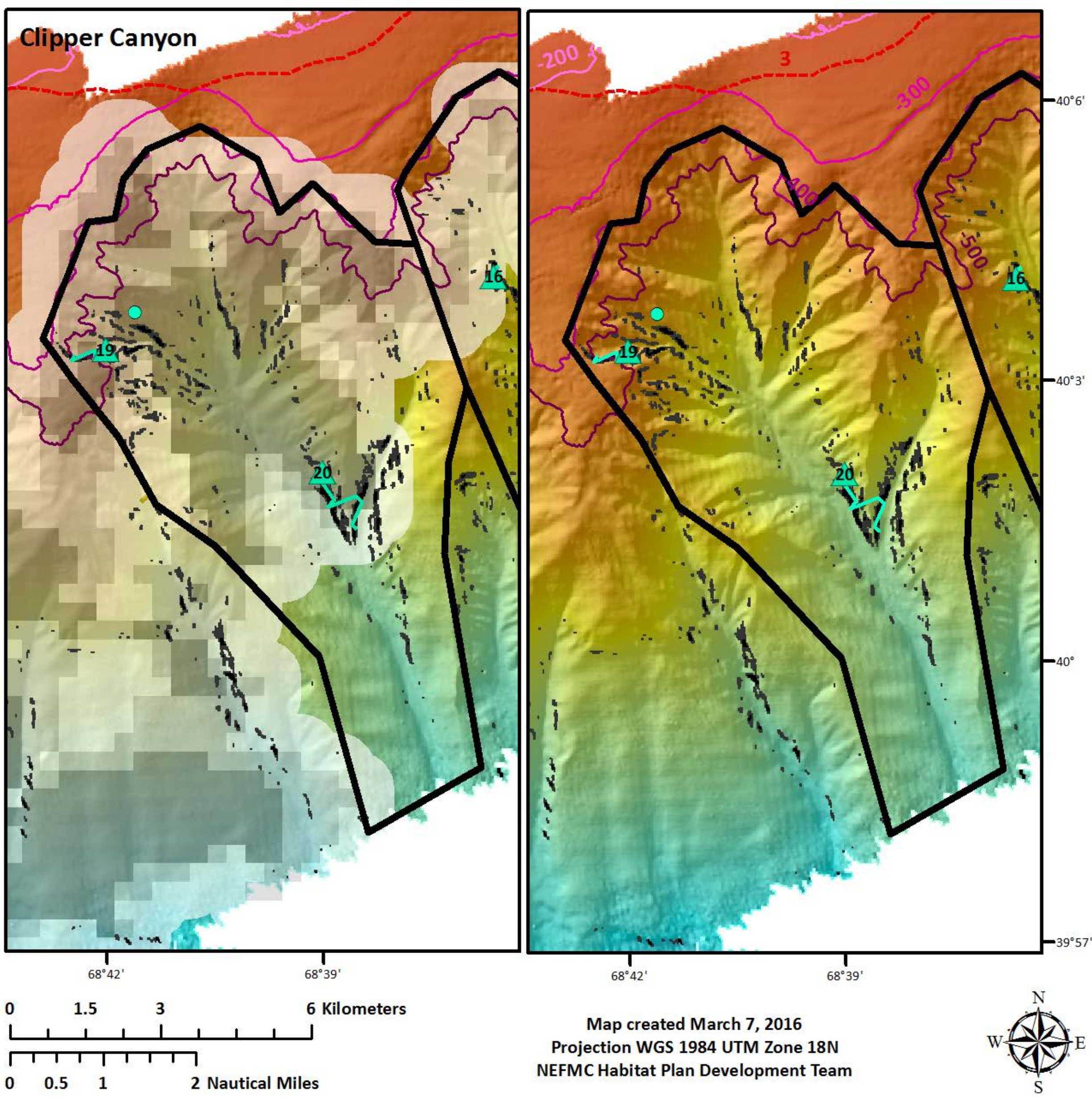
Dogbody Canyon is a dendritic canyon that incises the continental shelf break, encompassing an area about 150 km^2. The proposed zone follows the 300 m depth contour at the head of the canyon and is seaward of the 3° slope contour. The main thalweg is somewhat sinuous with a smaller branch to the east. Most of the canyon is predicted to have high or very high habitat suitability for soft corals, and both branches include large areas of high slope, in relatively shallow water compared with some of the other canyons. There are no issues with seams in the bathymetric data in this canyon. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 11 – Dogbody Canyon discrete zone



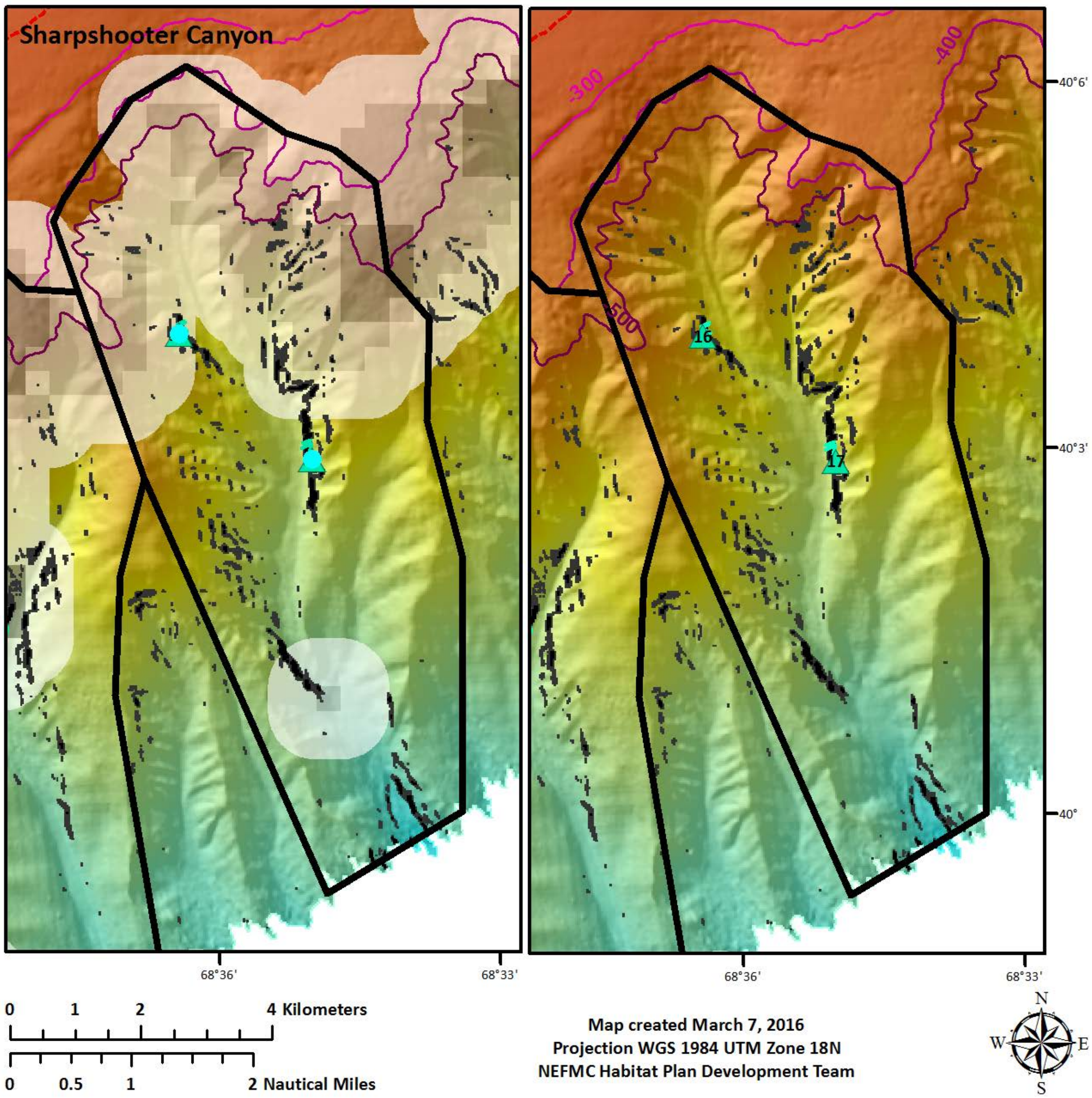
Clipper Canyon is slope-confined, encompassing an area about 50 km^2, and thus among the smaller canyons off the Northeast continental shelf. The proposed zone follows the 400 m depth contour at the head of the canyon. Clipper has one main branch and a smaller branch to the east. The habitat suitability model predicts the shallower portions of the zone as suitable coral habitat. The high/very high suitability footprint coincides spatially with areas of high and very high slope. Areas of high slope are found along both branches of the canyon. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 12 – Clipper Canyon discrete zone



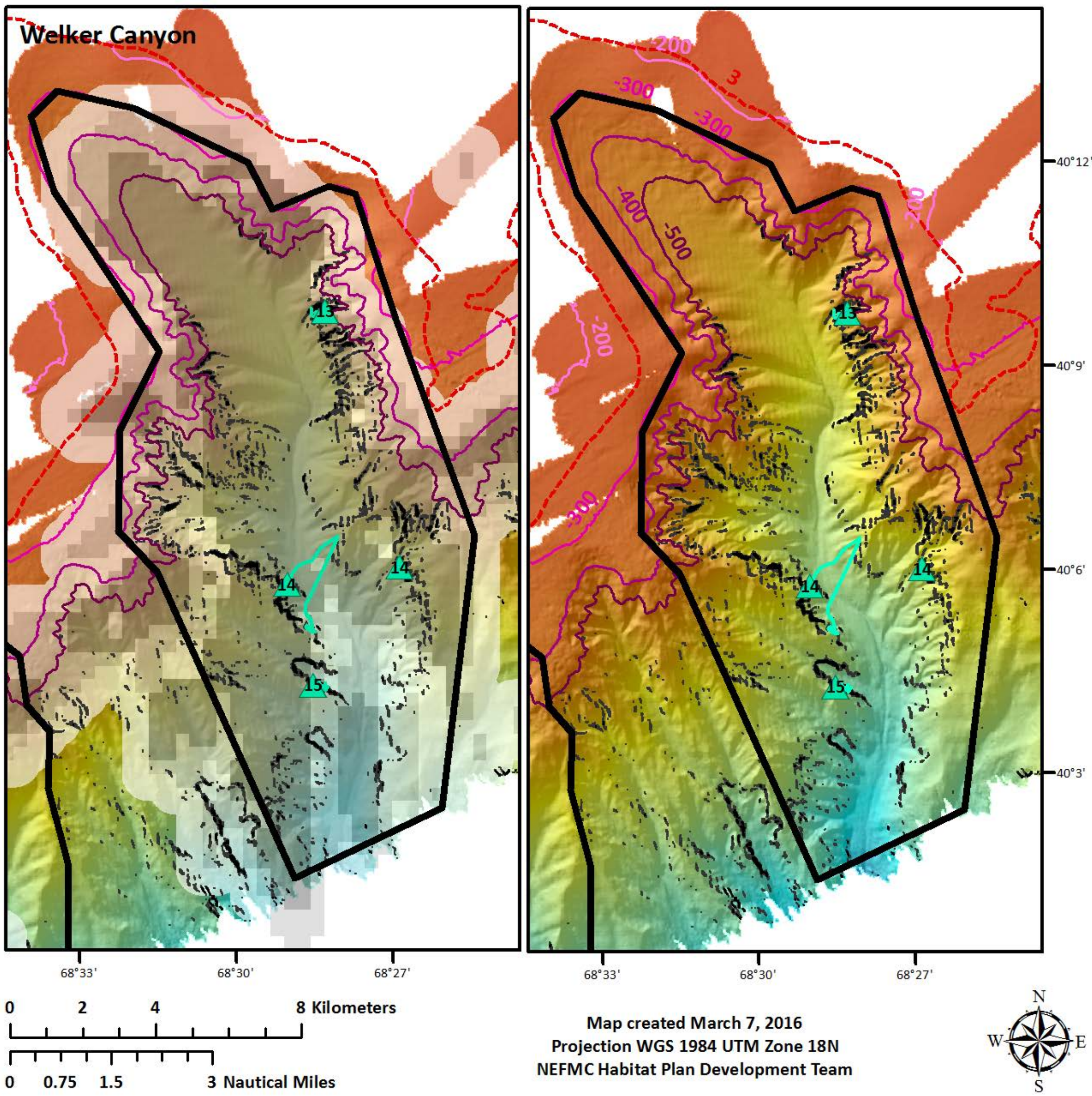
Sharpshooter Canyon is slope-confined, encompassing an area about 50 km^2, and thus among the smaller canyons off the Northeast continental shelf. The proposed zone follows the 400 m depth contour at the head of the canyon. Much of the proposed zone was not identified as high and very high habitat suitability based on the model output results. However, the proposed zone follows the shape of the canyon, and includes areas of high slope at various depths. There are no issues with seams in the bathymetric data in this canyon. Corals have been documented in recent data only (section 6.2.3.1).

Map 13 – Sharpshooter Canyon discrete zone



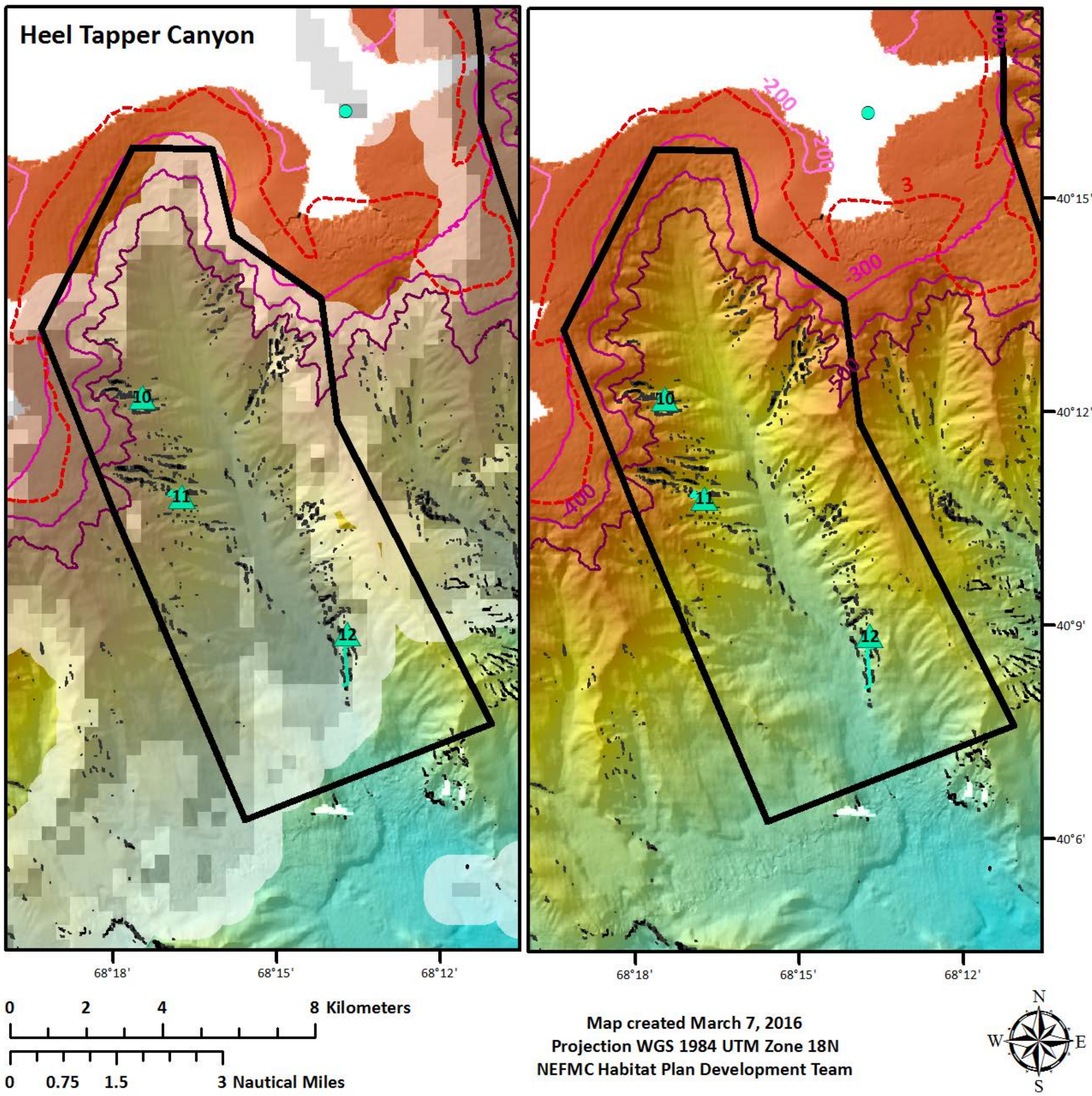
Welker Canyon incises the continental shelf break, encompassing an area about 150 km². The proposed zone follows the 300 m depth contour at the head of the canyon. The head of the canyon is not very steeply sloped, but there are large areas of high slope along both walls. Most of the proposed zone is predicted to be high or very high suitability soft coral habitat, and areas of high slope are found throughout the zone. There are no issues with seams in the bathymetric data in this canyon. Corals have been documented in recent data only (section 6.2.3.1).

Map 14 – Welker Canyon discrete zone



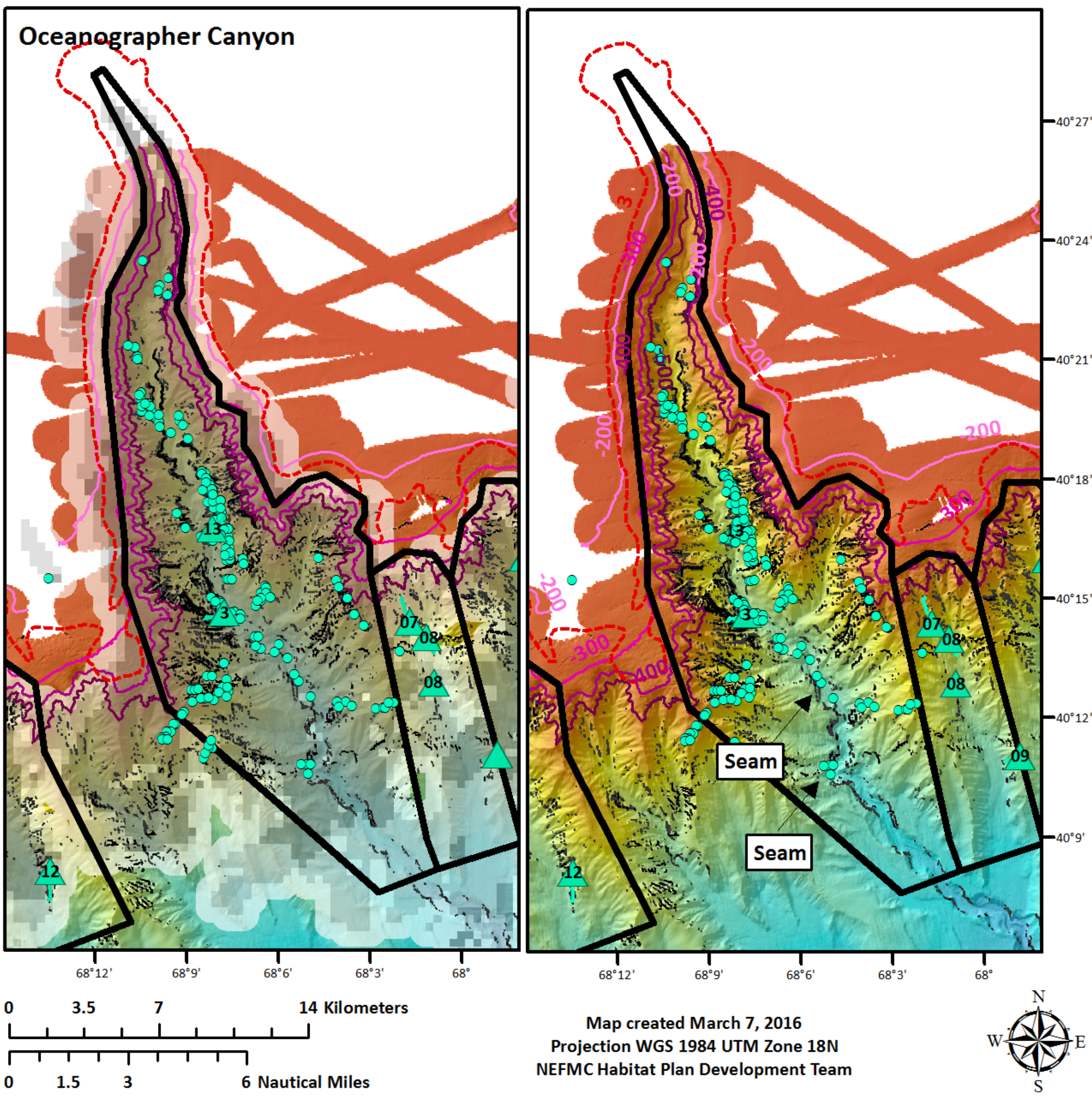
Heel Tapper Canyon incises the continental shelf break, encompassing an area about 100 km^2. The proposed zone follows the 300 m depth contour at the head of the canyon. The areas of high slope are also encompassed in the proposed zone. The area to the west of the proposed zone includes very high habitat suitability model output; however, higher resolution bathymetric data show that the areas of high slope are located within the proposed discrete coral zone. Corals have been documented in recent data only (section 6.2.3.1).

Map 15 – Heel Tapper Canyon discrete zone



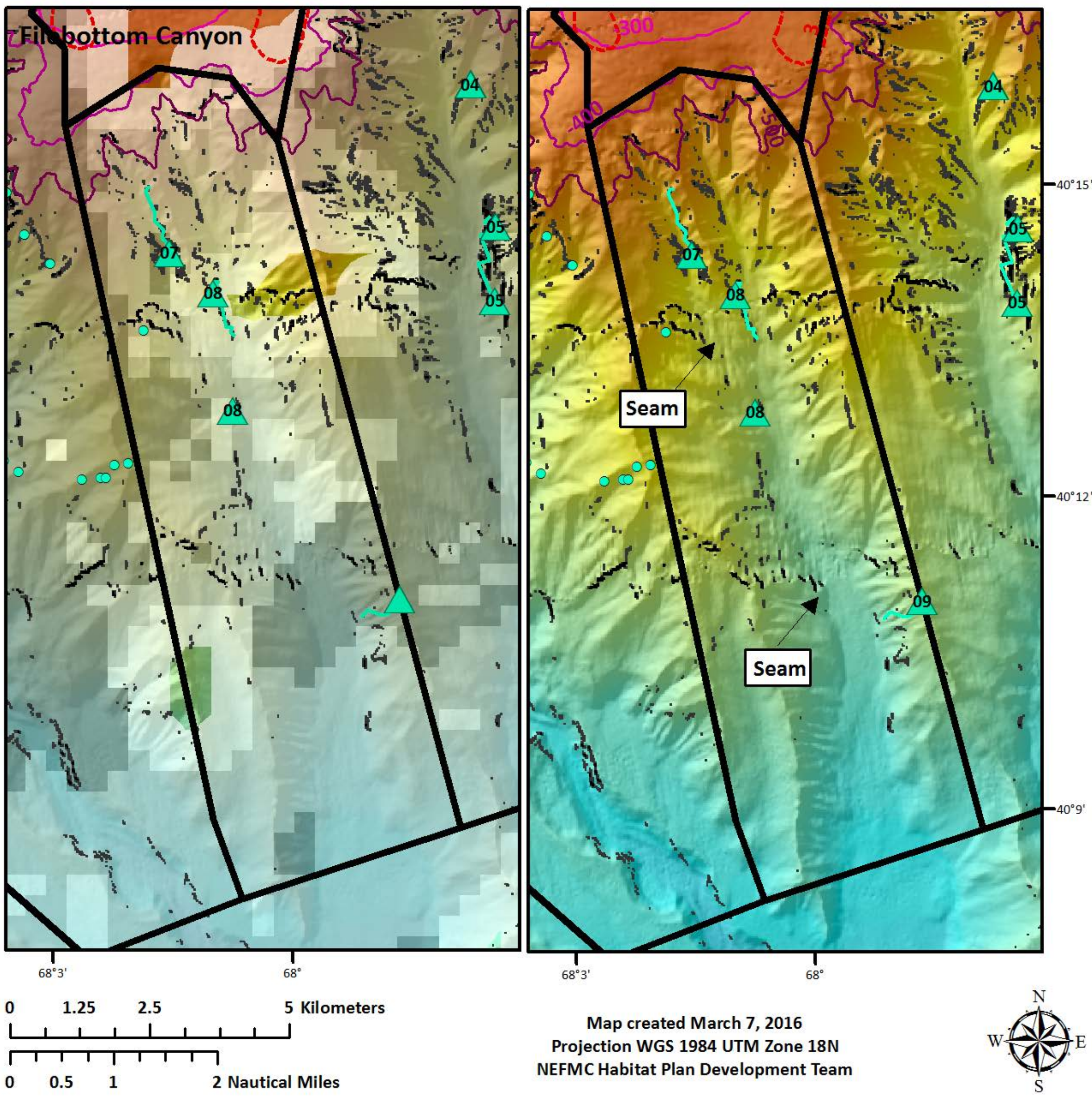
Oceanographer Canyon incises the continental shelf break, encompassing an area of over 200 km^2. It is the largest of the proposed canyon zones. The proposed zone follows the 300 m depth contour at the head of the canyon and the boundary is largely within the 3° slope contour. Oceanographer has a clear main axis with a smaller branch on the eastern side. The areas of high slope and the areas predicted to have high/very high habitat suitability for soft corals are encompassed in the proposed zone. There are a few areas of seams in the bathymetry data that lead to high slope artifacts, but these are difficult to discern amidst the large areas of high slope. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 16 – Oceanographer Canyon discrete zone



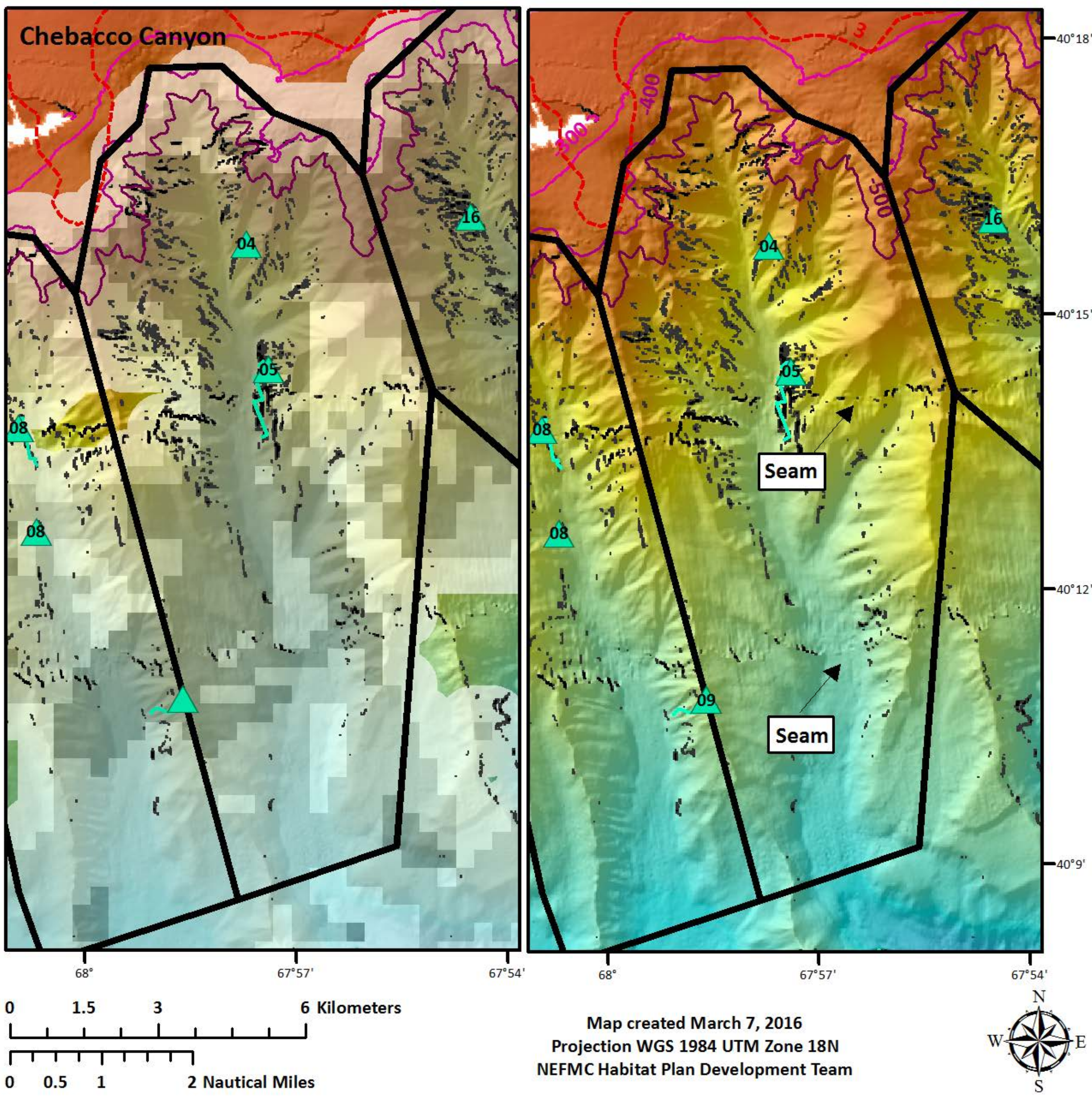
Filebottom Canyon is slope-confined, encompassing an area about 50 km^2. It is immediately adjacent to Oceanographer Canyon to the west and Chebacco Canyon to the east. The proposed zone follows the 300 m depth contour at the head of the canyon. There are fewer areas of high slope compared with some other canyons, and some of the high slope areas shown on Map 17 are artifacts resulting from seams in the data. Much of the zone is predicted to have suitable habitat for corals, although there is less overlap with the very high suitability layer compared with some of the other coral zones proposed. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 17 – Filebottom Canyon discrete zone



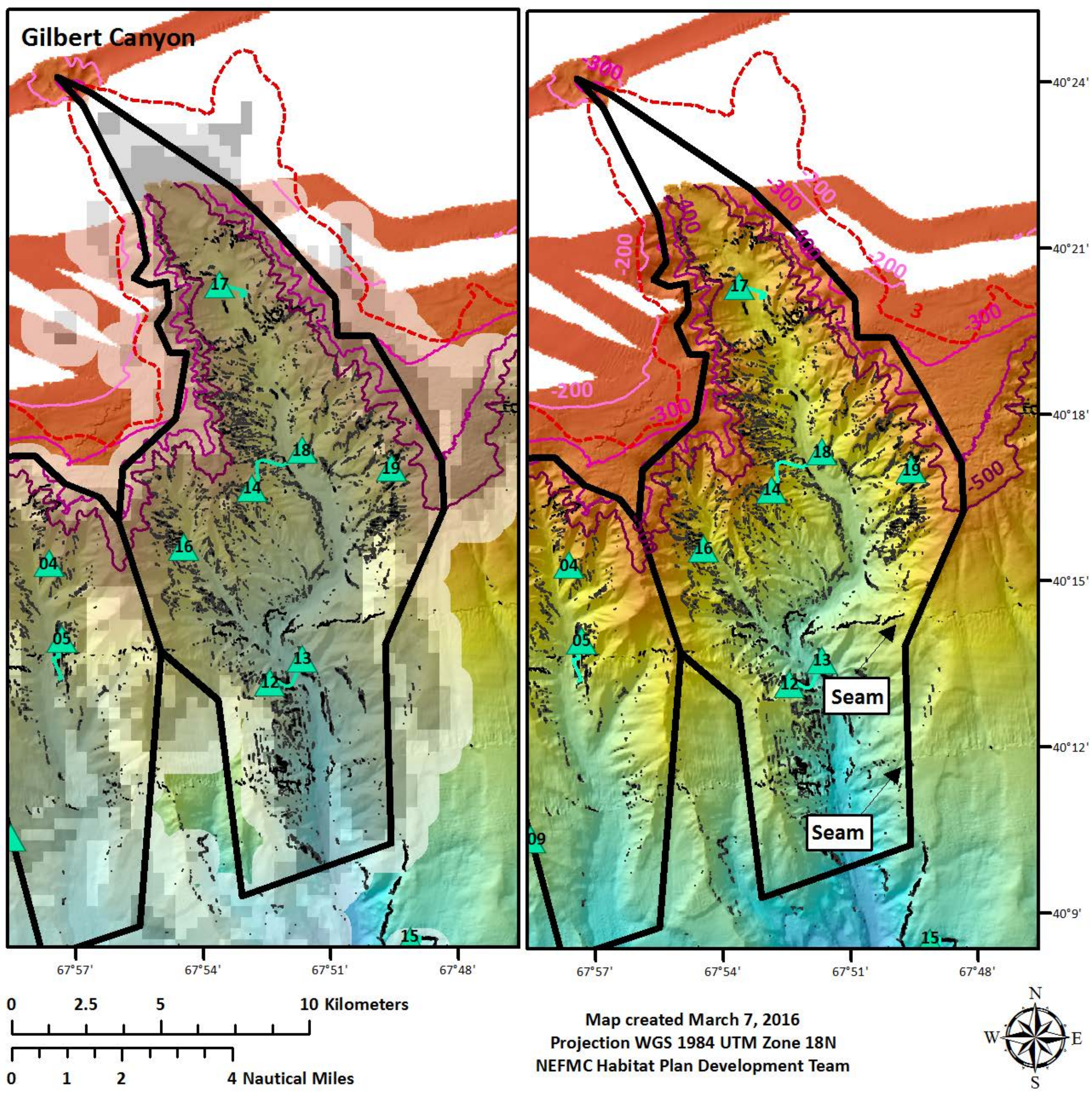
Chebacco Canyon is slope-confined, encompassing an area about 100 km^2. It is larger and steeper than nearby Filebottom. The proposed zone follows the 400 m depth contour at the head of the canyon. Some of the high slope areas shown on Map 18 are artifacts resulting from seams in the data. Much of the zone is high or very high predicted habitat suitability for soft corals. Corals have been documented in recent data only (section 6.2.3.1).

Map 18 – Chebacco Canyon discrete zone



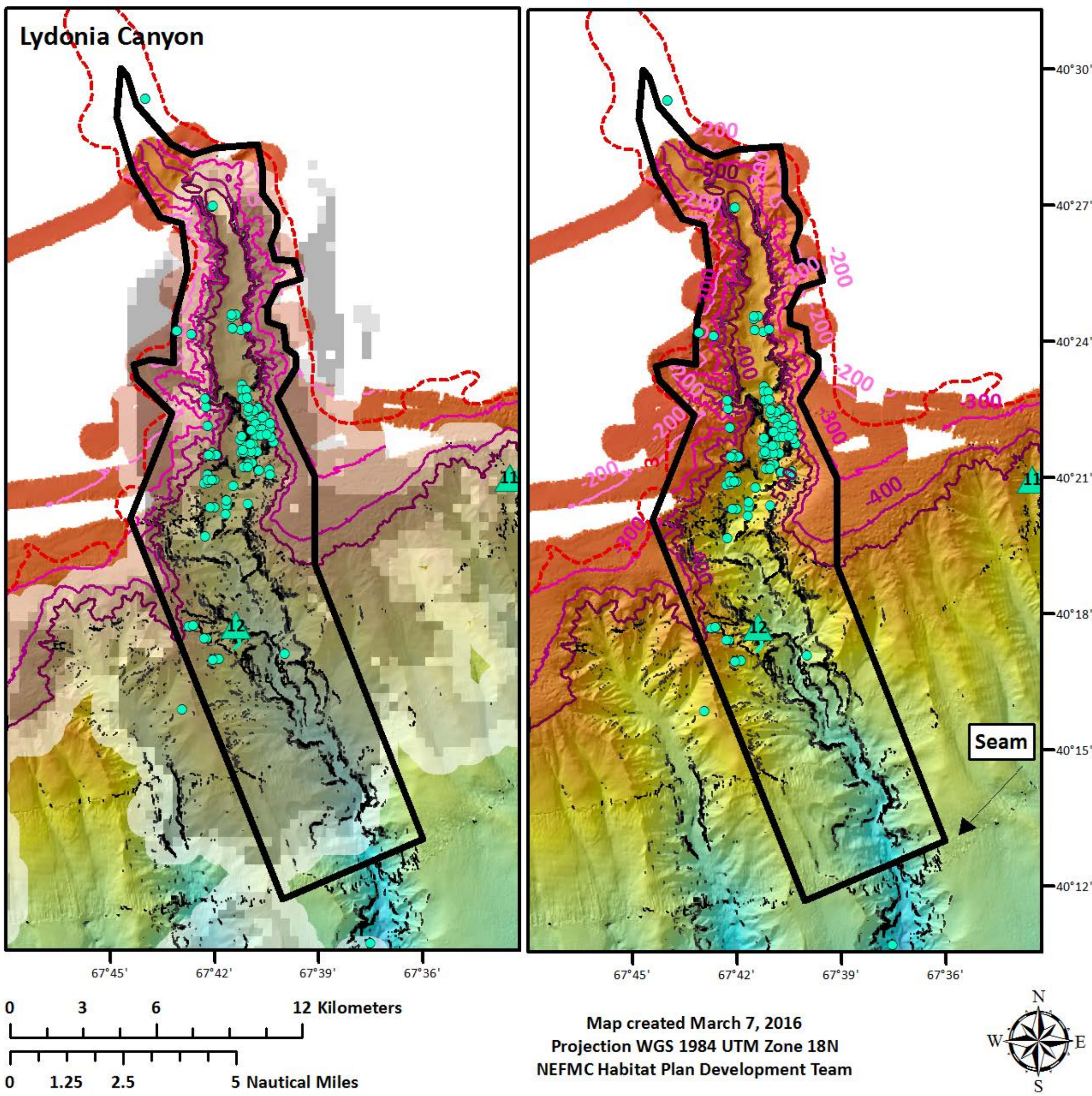
Gilbert Canyon incises the continental shelf break, and has two major branches. The main thalweg is located to the east, and there is another limb to the west. The recommended zone encompasses an area about 175 km^2, following the 300 m depth contour at the mouth of the canyon. The recommended zone is mapped mostly as very high suitability habitat. There are substantial high slope (greater than 30º) areas encompassed within the proposed zone. A few high slope artifacts are observed due to seams in the bathymetry but these are somewhat difficult to discern on the map. Corals have been documented in recent data only (section 6.2.3.1).

Map 19 – Gilbert Canyon discrete zone



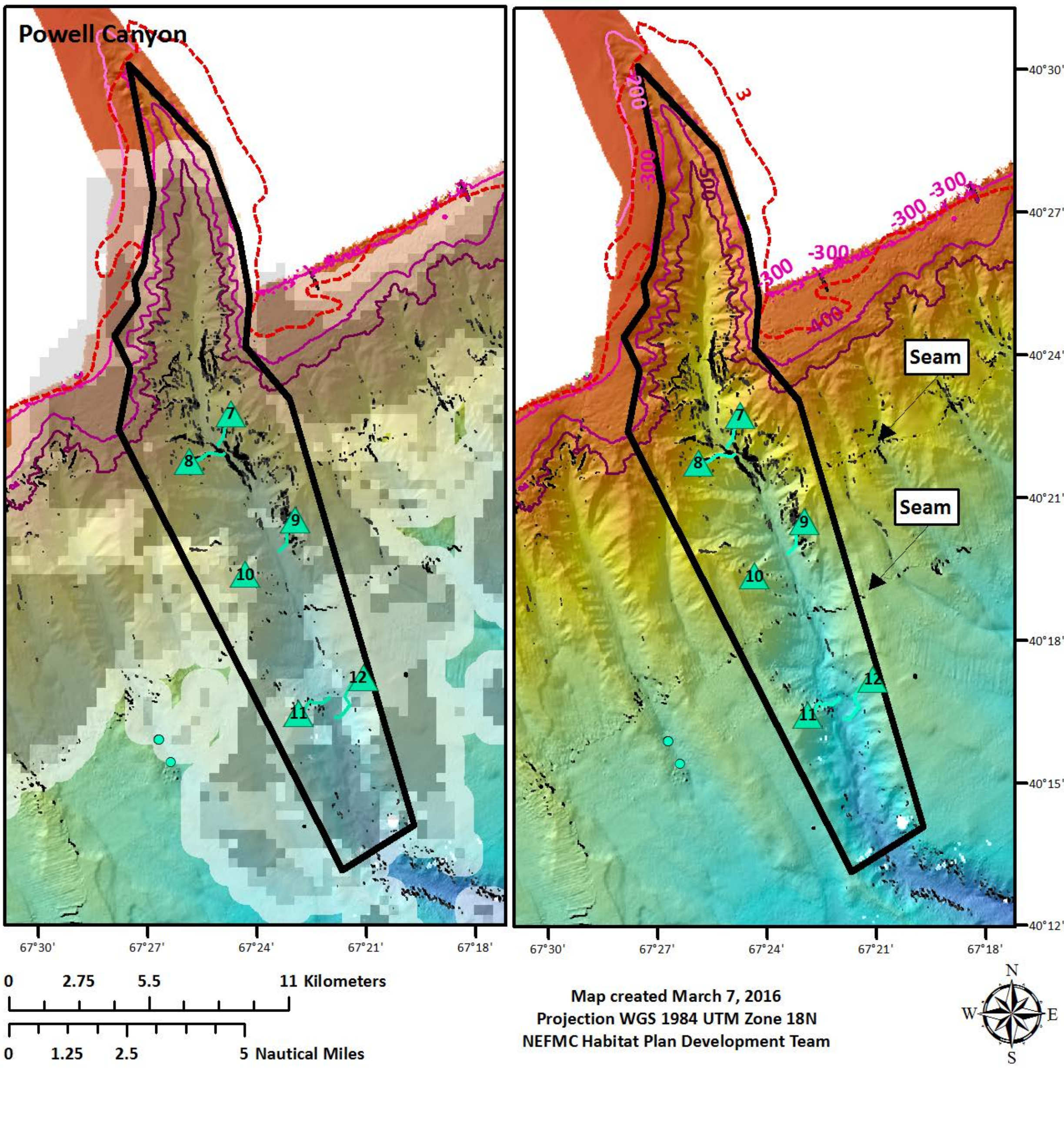
Lydonia Canyon incises the continental shelf break, encompassing an area of over 200 km^2, second in size only to Oceanographer Canyon. The proposed zone follows the 200 m depth contour at the head of the canyon. Based on the ACUMEN bathymetric data, the proposed zone has a depth range of 142 to 2,249 m below sea level. Much of the zone is predicted to be highly or very highly suitable habitat for soft corals. In addition, there are areas to the west and east of the boundary which are also predicted to be suitable coral habitat. However, most of the areas of high slope are encompassed within the proposed zone, including within the head of the canyon. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 20 – Lydonia Canyon discrete zone



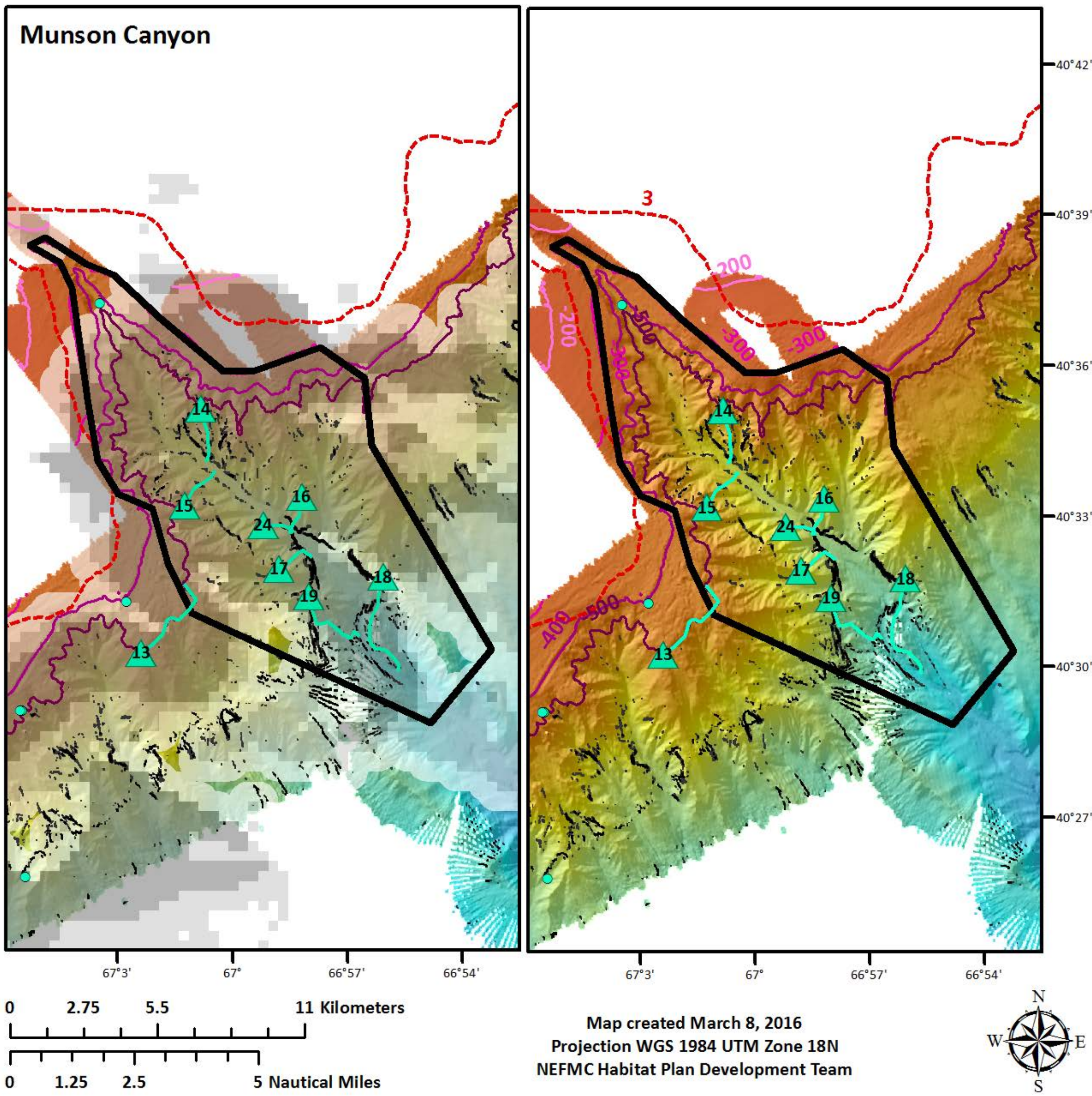
Powell Canyon incises the continental shelf break, encompassing an area about 200 km^2. The proposed boundary follows the 300 m depth contour along the head of the canyon. The areas predicted to have a high likelihood of coral presence based on the habitat suitability model are also encompassed in the zone, along with the areas identified as high slope areas. The areas of high slope are concentrated just beyond the shelf break and in the deepest parts of the canyon. There is an east-west seam in the data in the middle of the zone. Corals have been documented in recent data only (section 6.2.3.1).

Map 21 – Powell Canyon discrete zone



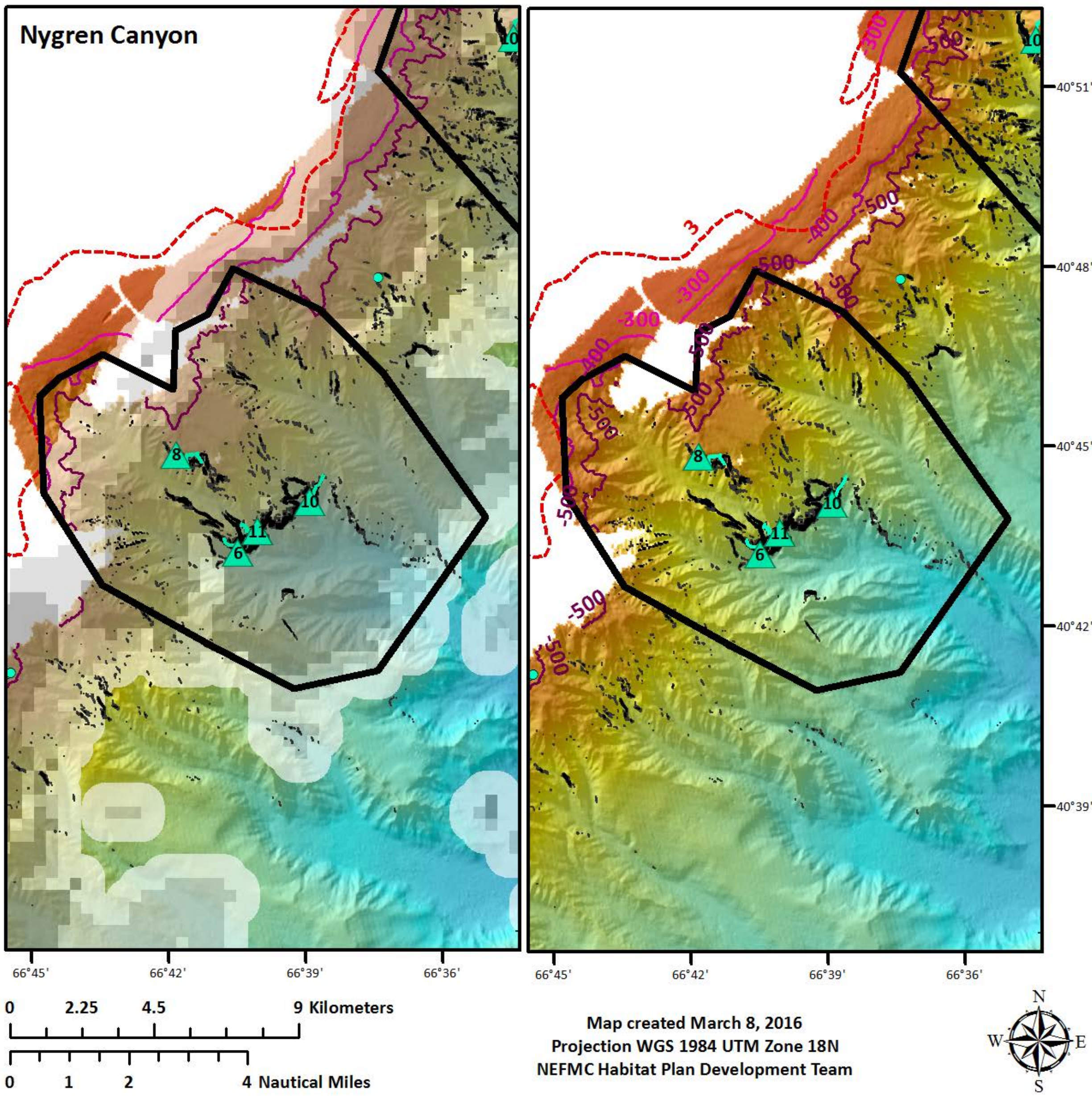
Munson Canyon incises the continental shelf break, encompassing an area about 100 km^2. The proposed boundary follows the 300 m depth contour along the head of the canyon. Munson has one main branch and a smaller branch to the east. Most of the canyon is identified as having high and very high likelihood of coral presence based on the habitat suitability model. Areas of high slope can be found throughout the zone, except in the shallowest portion of the canyon. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 22 – Munson Canyon discrete zone



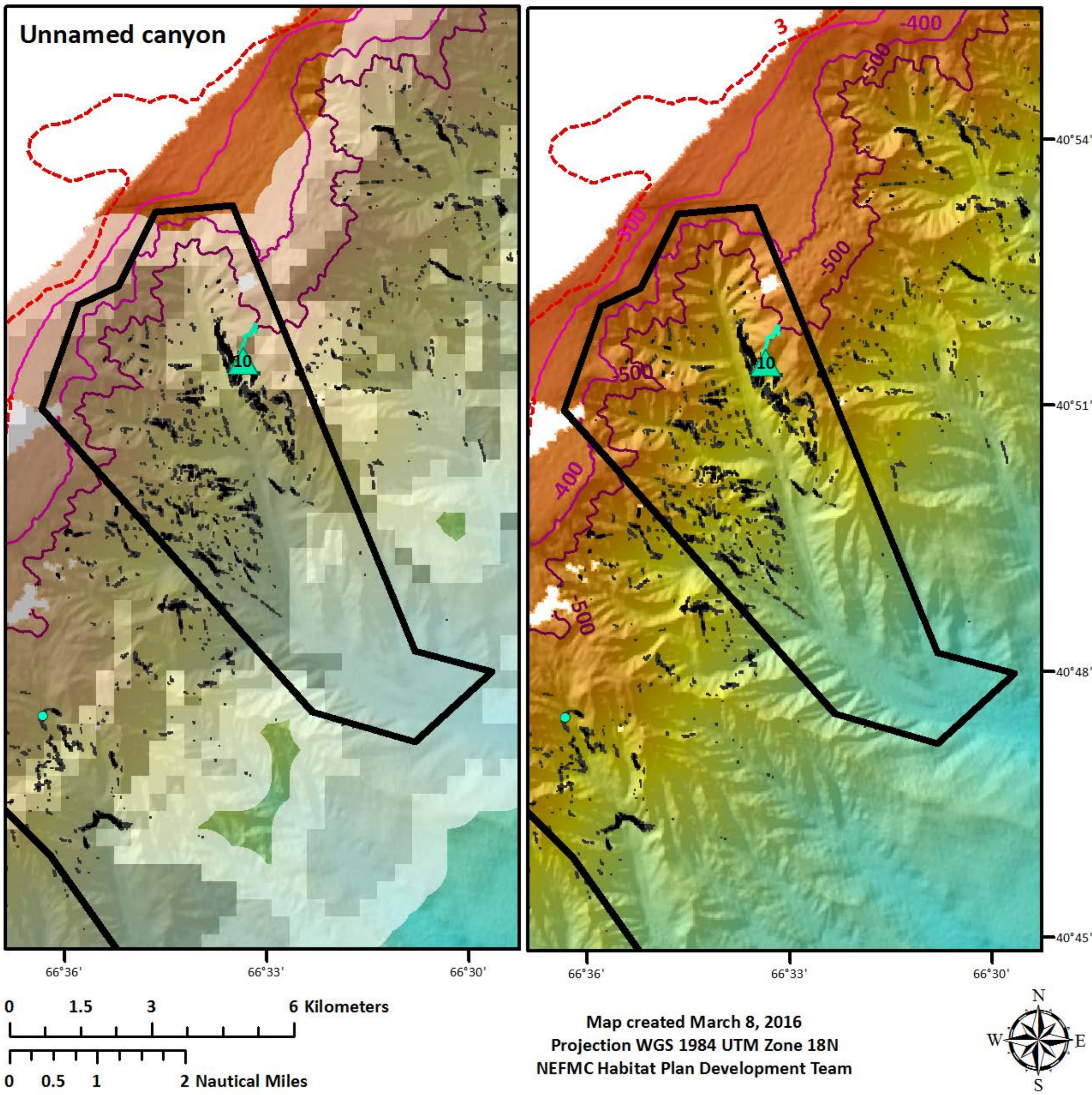
Nygren Canyon is a dendritic, slope-confined canyon that encompasses an area about 100 km^2. The recommended zone follows the 400 m depth contour along the head of the canyon. Most of the canyon is identified as having high and very high likelihood of coral presence based on the habitat suitability model. Areas of high slope are concentrated in the middle of the proposed zone, but can be found on all major branches of the canyon. The very high suitability areas coincide with the very high slopes. Both the landward and seaward depths of the recommended zone were developed to correspond with the habitat suitability results. Corals have been documented in recent data only (section 6.2.3.1).

Map 23 – Nygren Canyon discrete zone



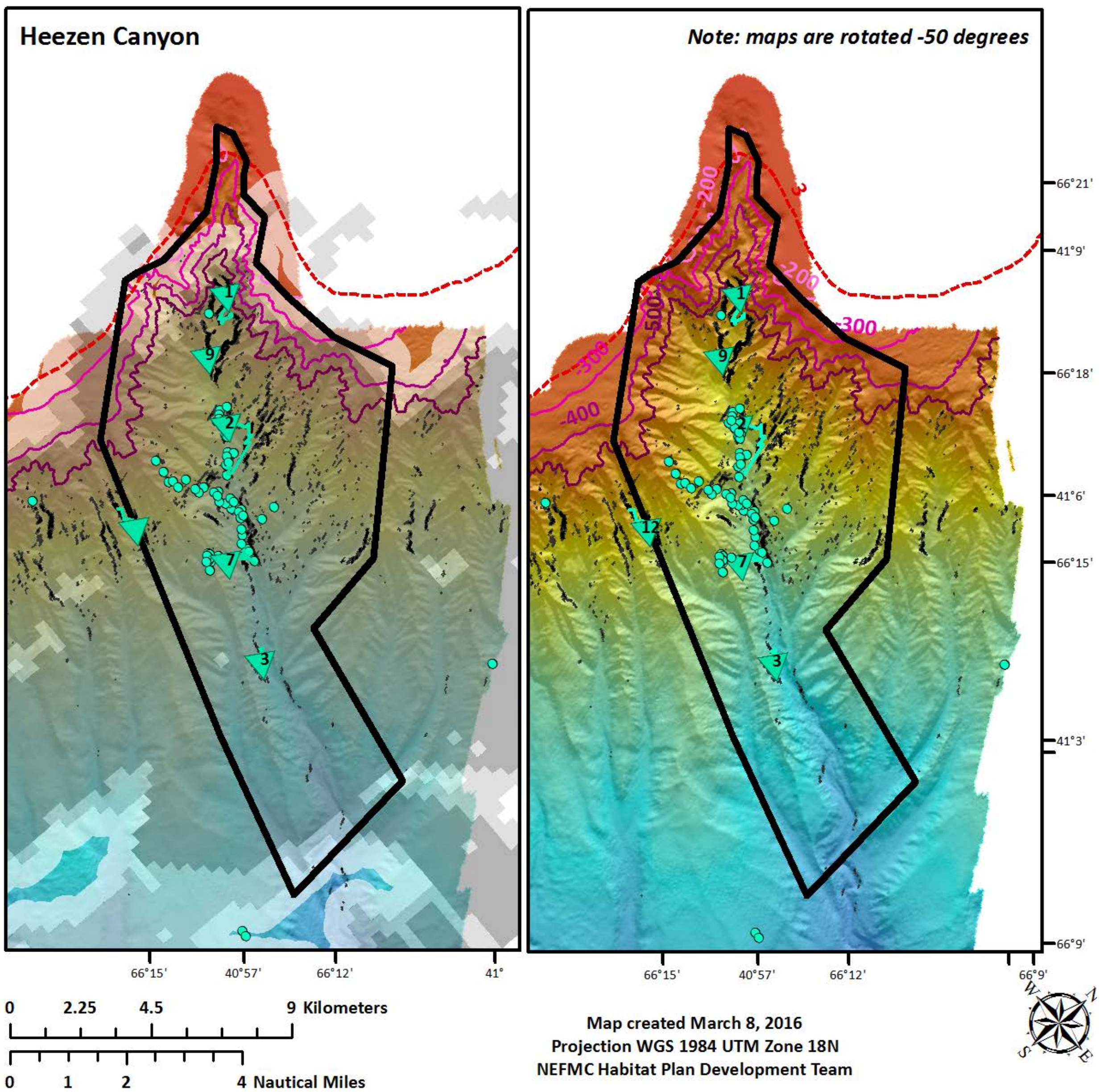
Kinlan Canyon (previously referred to as an unnamed canyon) is relatively small, encompassing an area about 50 km^2. The recommended zone follows the 400 m contour along the head of the canyon. Most of the canyon is identified as having high or very high likelihood of coral presence based on the habitat suitability model. Areas of high slope can be found throughout the zone, and generally coincide with areas of very high habitat suitability. Corals have been documented in recent data only (section 6.2.3.1).

Map 24 – Discrete zone in Kinlan Canyon



Heezen Canyon incises the continental shelf break, encompassing an area about 125 km^2. The proposed zone follows the 200 m contour at the head of the canyon. Most of the recommended zone is identified as having high and very high likelihood of coral presence based on the habitat suitability model. Areas of high slope can be found throughout the zone, except in the shallowest and deepest portion of the canyon. Corals have been documented in both the historical and recent data (section 6.2.3.1).

Map 25 – Heezen Canyon discrete zone



4.2.2.2 Seamount coral zones

This alternative would designate coral zones around the four seamounts within the U.S. EEZ. All of the seamounts combined are shown on Map 40. Options for fishing restrictions in these zones are described in section 4.3.

All four of the discrete seamount zones are fully encompassed within the Northeast Canyons and Seamounts Marine National Monument and are also fully contained within each of the broad zone alternatives. The seamount zones were developed during 2011-2012, in conjunction with the original set of broad zones and discrete canyon and Gulf of Maine zones. The concept behind designating the seamount zones in conjunction with a broad zone was that the Council might adopt more comprehensive fishing restrictions within the seamount zones as compared to the larger surrounding broad zones. The monument, designated in September 2016, has fishing restrictions that are more comprehensive than what the Council is considering in these areas. The bottom-tending gear restrictions imposed by the Council would have no additional conservation benefit beyond those established by the monument. The only difference is that under the monument designation, restrictions on red crab and lobster pots could take effect as late as 2023, depending on the timing of the management plan, and Council regulations prohibiting these gears from fishing on the seamounts could take effect sooner, potentially during 2019. As a practical matter, even prior to monument designation, fishing was not known to occur on the seamounts.

This alternative assumes that all seamount zones would be selected as a group.

Rationale

Deep-sea corals are known to occur on the seamounts on the basis of ROV and AUV surveys (section 6.2.3.2). This alternative would protect corals occurring on seamounts from the negative impacts of fishing activity, should fisheries expand to include any of the four seamounts within the U.S. EEZ at some time in the future.

Method used to define discrete seamount zone boundaries

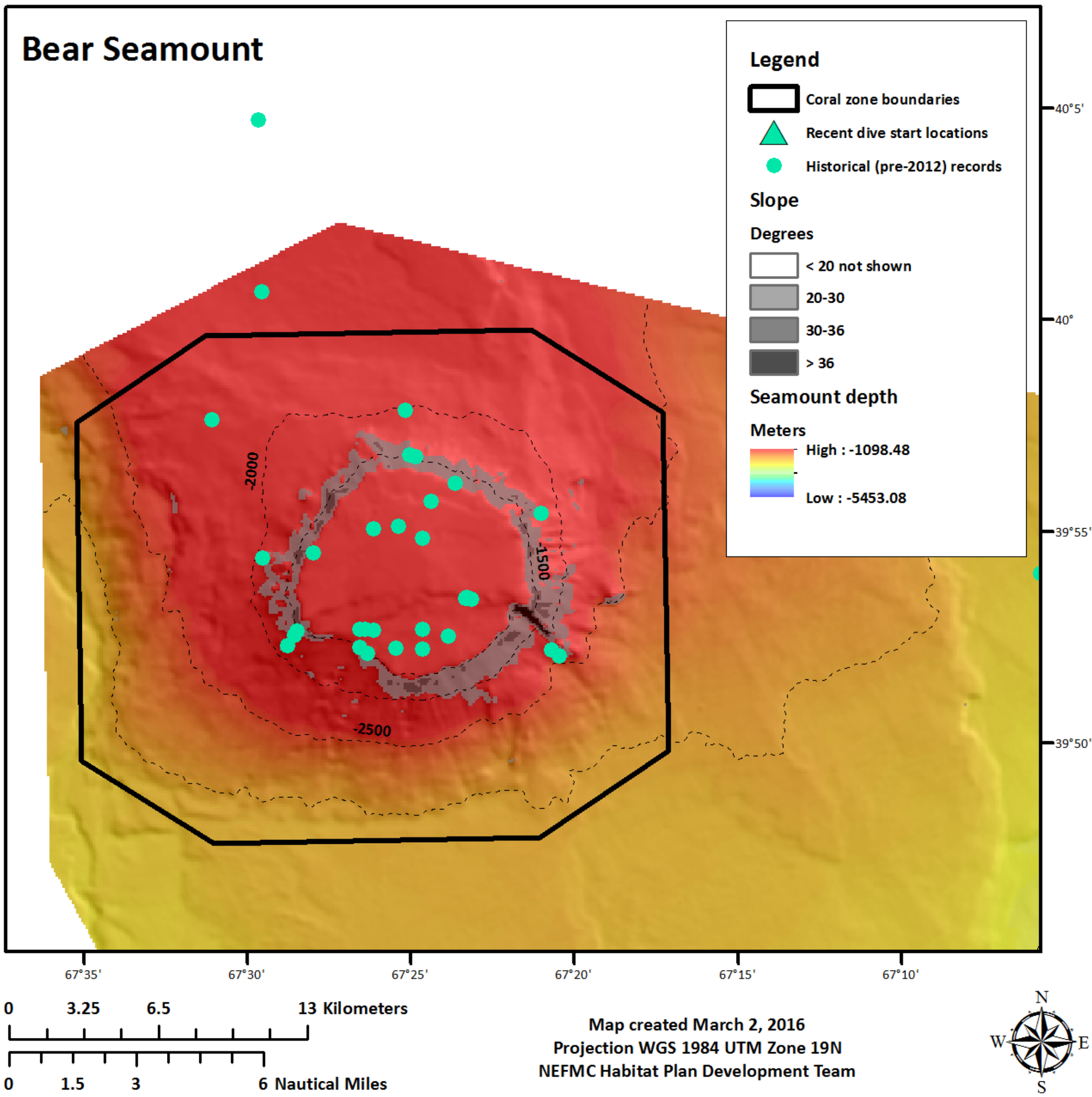
The four seamounts vary in size, depth range, and slope. The seamount bathymetry data are lower resolution than the canyon data (100 m vs. 25 m), but nonetheless provide a clear indication of the spatial extent of each seamount. The boundaries were drawn based on these bathymetry data and are intended to encompass the full extent of each seamount. Areas of high slope are also shown on the maps. In general, there are fewer areas of slope greater than 30° than in the canyons, so areas with slopes greater than 20° are shown. Overall, the seamount zones are somewhat larger than the canyon zones, about 200-500 km^2. Contours are shown in 500 m intervals. Note that while the depth color shading uses the same coloration as the canyon maps, it is on a different scale.

Table 4 – Coordinates and area sizes for seamount coral zones

Zone	Coordinates	Size (km^2)
Bear Seamount	-67°21', 40°00' -67°17', 39°58' -67°17', 39°50' -67°21', 39°48' -67°31', 39°48' -67°35', 39°50' -67°35', 39°58' -67°31', 40°00'	527
Mytilus Seamount	-67°08', 39°26' -67°00', 39°22' -67°03', 39°18' -67°10', 39°18' -67°16', 39°21' -67°16', 39°26'	258
Physalia Seamount	-66°58', 39°54' -66°53', 39°54' -66°50', 39°50' -66°53', 39°46' -66°58', 39°46' -67°01', 39°50'	169
Retriever Seamount	-66°18', 39°54' -66°12', 39°54' -66°08', 39°51' -66°08', 39°46' -66°12', 39°44' -66°18', 39°44' -66°22', 39°46' -66°22', 39°51'	317

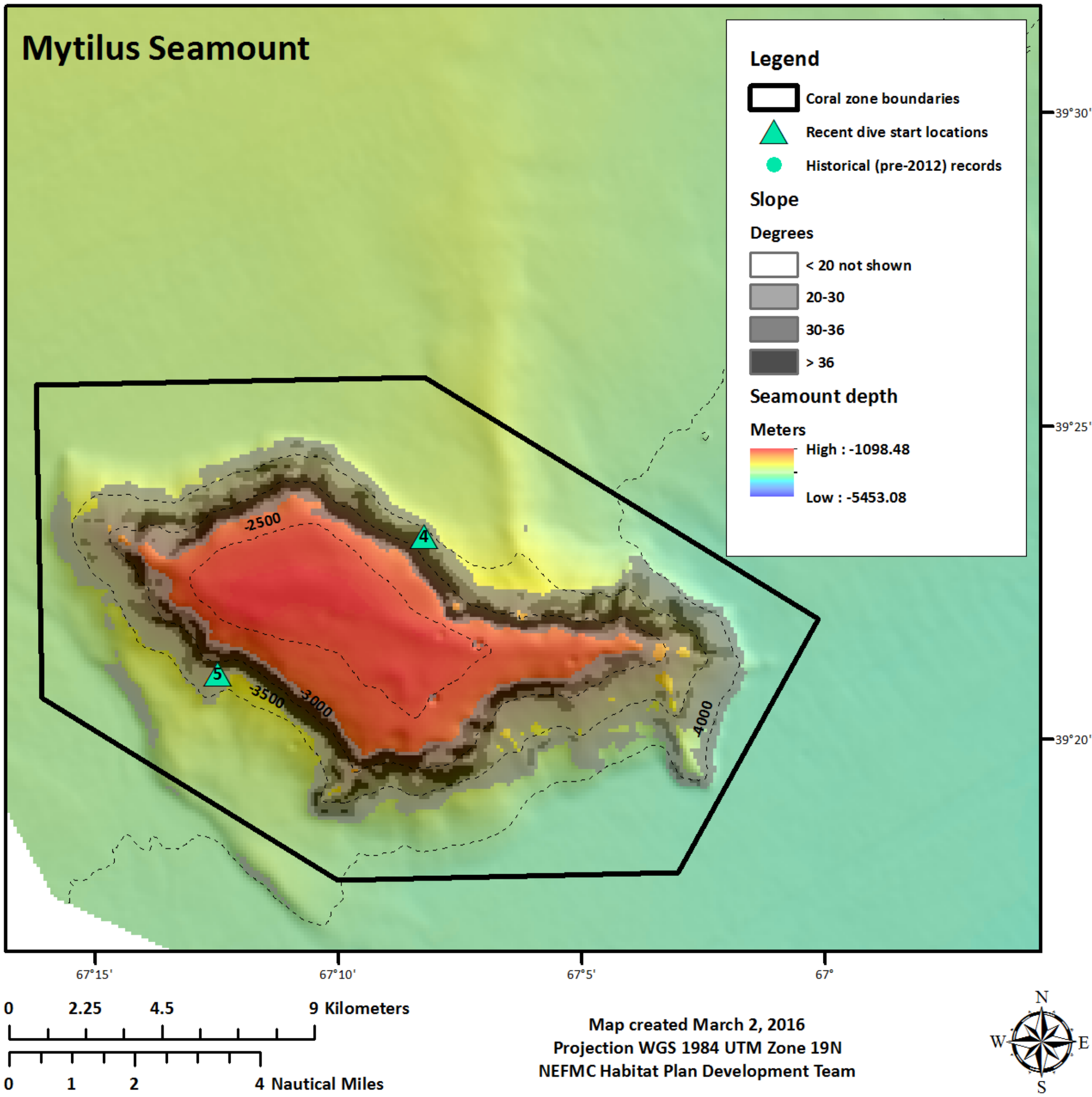
Bear is the largest of the New England seamounts. The summit is about 1,100 m below sea level, and the base of the seamount is at over 3,000 m. While it was not visited during recent (2012-2015) cruises, all four groups of corals (soft, stony, sea pens, and black corals) had been previously documented in the area.

Map 26 – Bear Seamount coral zone boundary



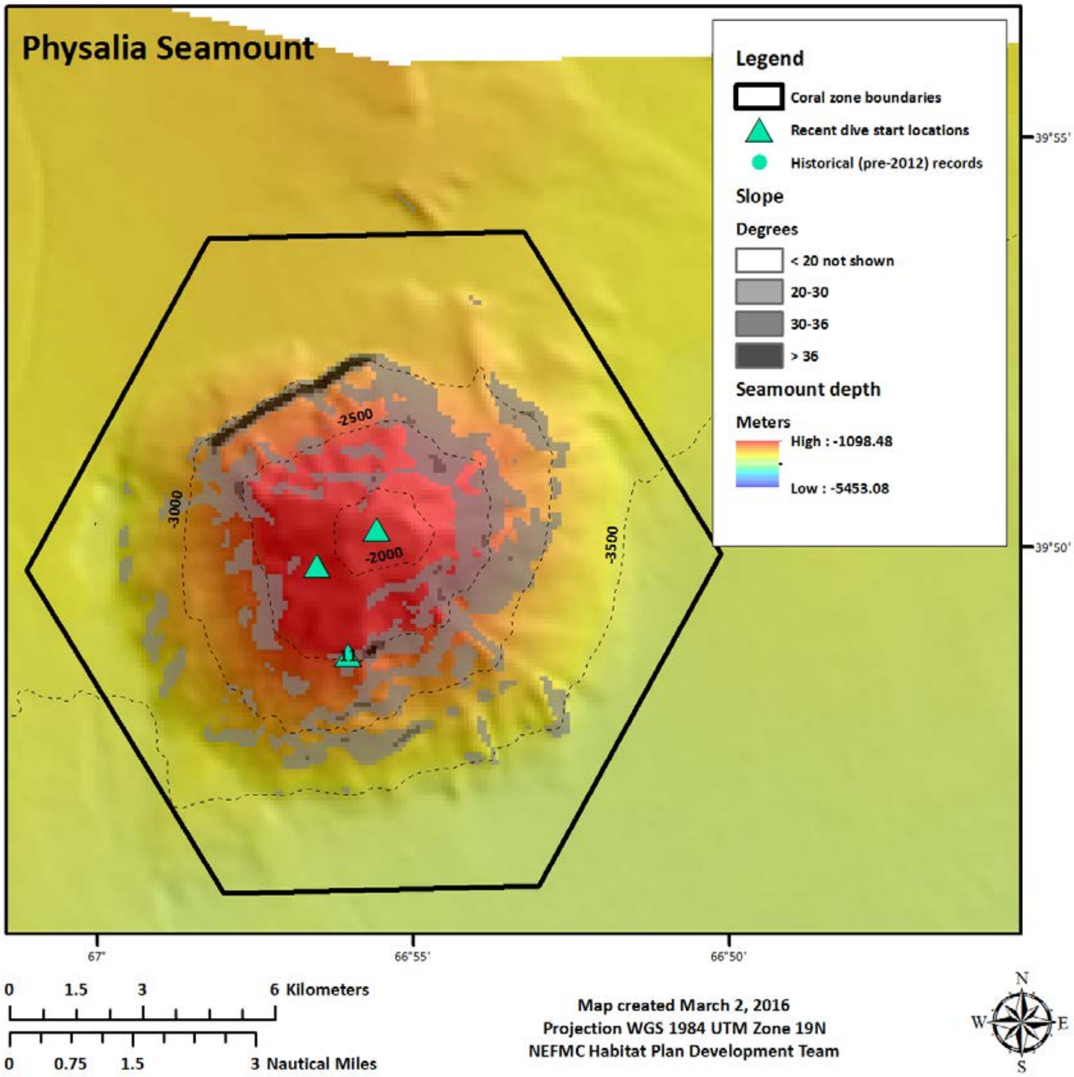
Mytilus is the deepest of the four seamounts, with a minimum depth of 2,396 m and a maximum depth within the proposed coral zone boundary of 4,183 m. Corals have been documented in recent data only (section 6.2.3.1).

Map 27 – Mytilus Seamount coral zone boundary



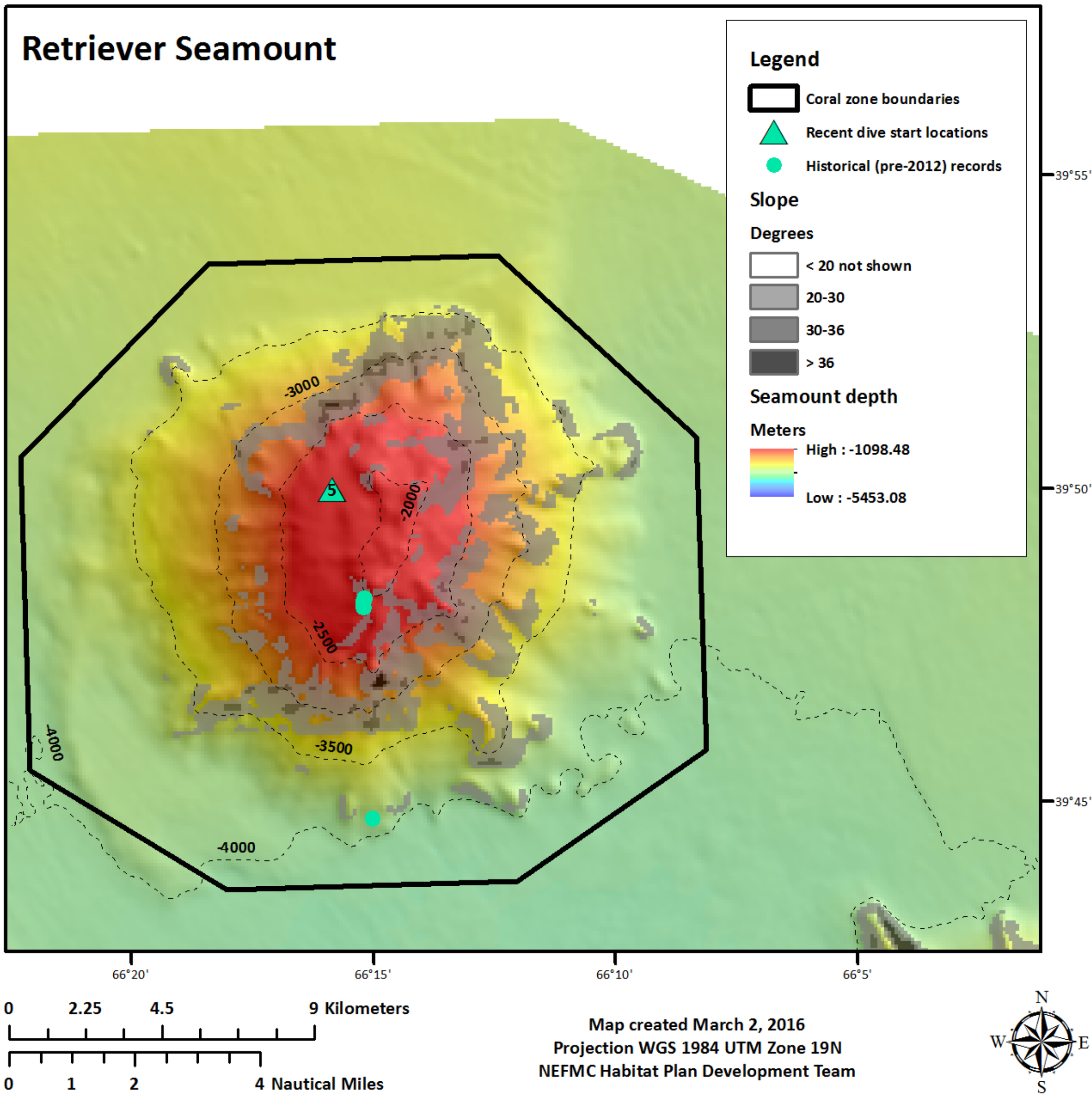
Physalia and Retriever seamounts have similar minimum and maximum depths. The summit of Physalia is at about 1,900 m, and the deepest part of the proposed zone is at over 3,700 m. Physalia was surveyed for the first time in 2012 using AUV technology (Kilgour et al. 2014) and was also observed during a 2014 *R/V Okeanos Explorer* cruise (section 6.2.3.2).

Map 28 – Physalia Seamount coral zone boundary



The summit of **Retriever Seamount** is at about 1900 m, and the deepest part of the proposed zone is at depths of over 4,000 m. Corals have been documented in recent data only (section 6.2.3.2).

Map 29 – Retriever Seamount coral zone boundary



4.2.2.3 Gulf of Maine coral zones

Deep-sea corals have been known to occur in the Gulf of Maine since the 19th century (Watling and Auster 2005), but targeted camera surveys to assess coral distribution have been conducted only in the last fifteen years, with most of this type of survey activity occurring since 2013. Recent activities include both towed camera and ROV dives in various locations throughout the Gulf (see Auster et al. 2014, Auster et al. 2014 for details on 2013 and 2014 cruises). Coral habitats observed during 2002, 2003, and 2013-2015 surveys were classified as either low density corals or coral gardens. A density of 0.1 colonies per m^2 is the threshold that the International Council for the Exploration of the Sea (ICES) used to define coral garden habitat (ICES 2007). Coral habitats in some areas of the Gulf of Maine exceed the coral garden threshold density (see sections below for details), although coral management zones are recommended in areas with both classifications. The recommended zones are Outer Schoodic Ridge, Mount Desert Rock, three sites in Western Jordan Basin, one site in Central Jordan Basin, and Lindenkohl Knoll, which is in Georges Basin. All sites with multiple dive observations, specifically Outer Schoodic Ridge, Mount Desert Rock, the 114 Bump site in Western Jordan Basin, Central Jordan Basin, and Lindenkohl Knoll, had at least one dive where coral garden habitats were found.

In general, the boundaries of the coral zones were developed to encompass dive sites where corals were positively identified. Other recently collected data that inform the delineation of coral zones include high resolution multibeam bathymetry in the Outer Schoodic Ridge and Western Jordan Basin regions. Because the spatial extent of high resolution bathymetric data is limited, it is impossible to delineate zone boundaries based on full spatial extent of specific terrain features, as is the case with the canyon and seamount sites. However, the bathymetric data confirm the presence of similar terrain at sampled locations and nearby unsampled locations, such that suitable habitat can be inferred beyond the dive sites.

4.2.2.3.1 Mount Desert Rock (Option 2 preferred)

This alternative would designate a coral zone southwest of Mount Desert Rock, a small, rocky island off the eastern Maine coast, about 20 nm south of Mount Desert Island (Map 30). Options for fishing restrictions in this zone are described in section 4.3.

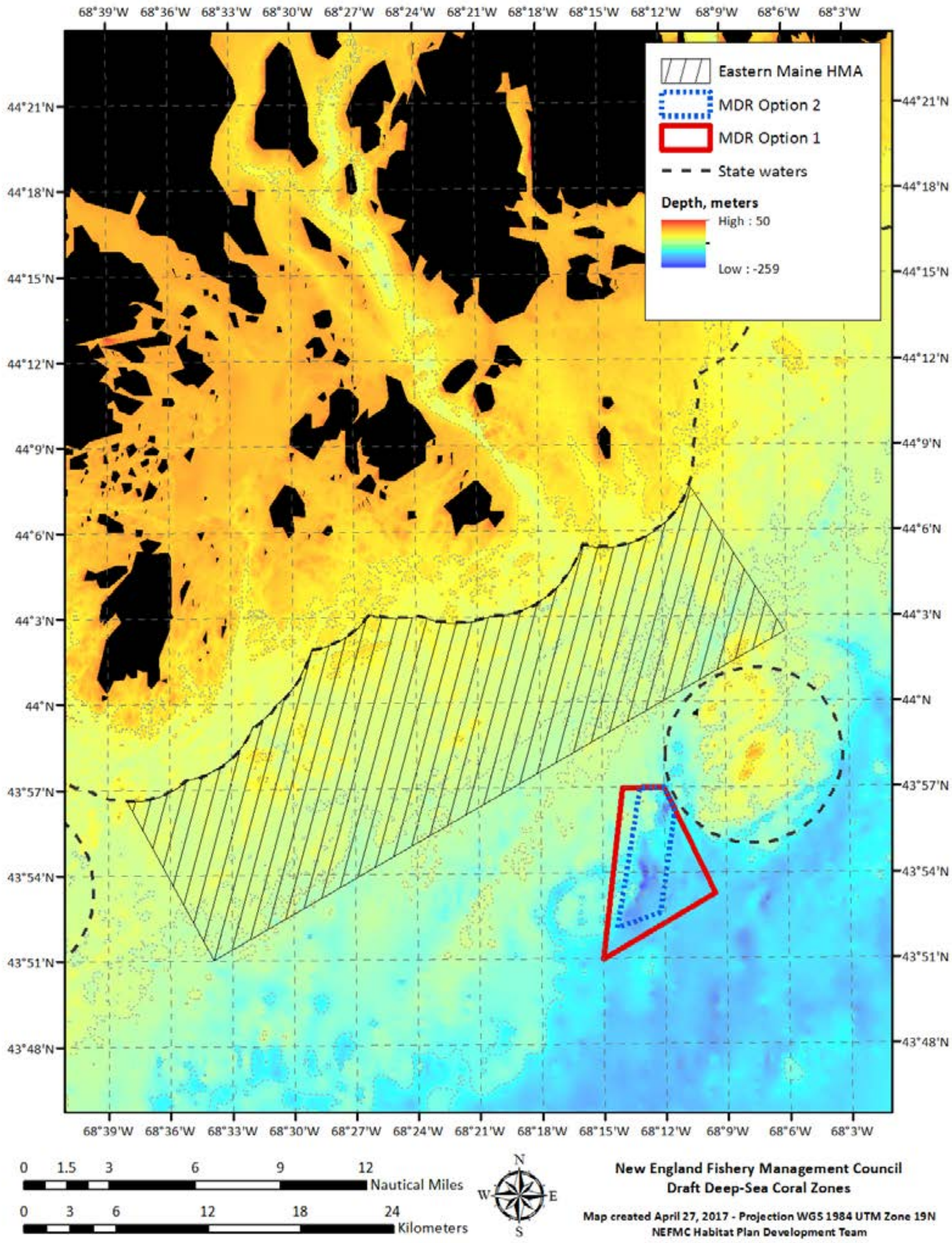
There are two boundary options for the Mt. Desert Rock zone (Table 5, Map 31). **Option 1** is the larger of the two and encompasses an area of about 47 km^2/18 mi^2. **Option 2** lies within Option 1, a smaller area about 21 km^2/8 mi^2. Both options encompass depths of 100-200 m. Boundary Option 2 is the preferred alternative, designated as a closure to mobile bottom-tending gears (gear restriction option 2).

Table 5 – Coordinates for the Mt. Desert Rock coral zone options

MDR Option 1 coordinates	MDR Option 2 coordinates
-68°09'34", 43°53'17"	-68°14’19”, 43°52’06”
-68°15'00", 43°51'00"	-68°13’10”, 43°56’59”
-68°14'00", 43°57'00"	-68°12’00”, 43°57’00”
-68°12'00", 43°57'00"	-68°11’27”, 43°56’10”
	-68°12’13”, 43°52’37”

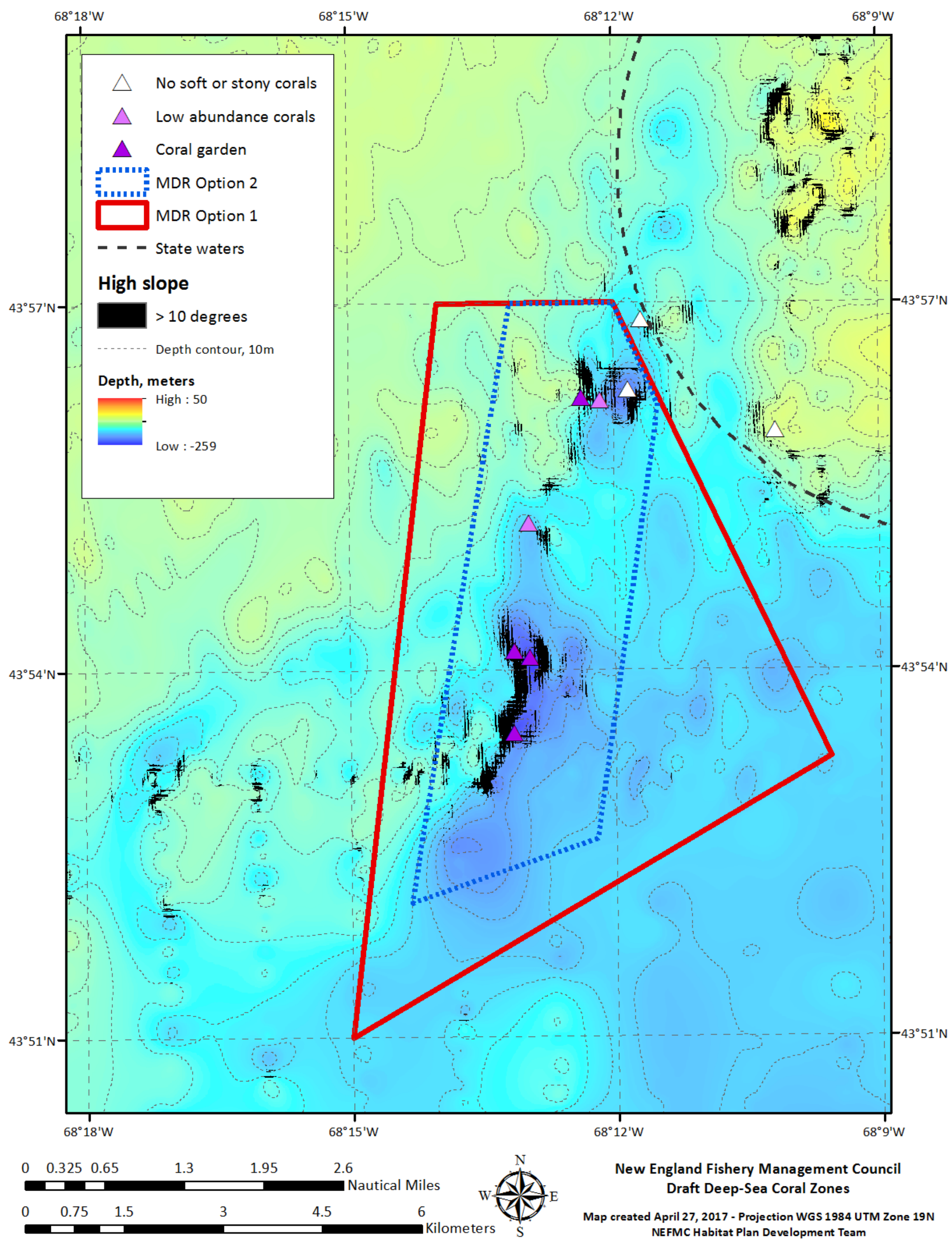
Rationale: This alternative would protect corals in the Mt. Desert Rock region from fishing impacts. Corals have been documented in both the historical and recent data (section 6.2.3.3).

Map 30 – Regional siting of Mount Desert Rock Coral Zone



Option 1 shown in heavy red outline, Option 2 in dotted blue. The hatched area is the Eastern Maine Habitat Management Area adopted via Omnibus EFH Amendment 2 as a mobile bottom-tending gear closure. State waters are outlined in dotted black outline.

Map 31 – Mount Desert Rock Coral Zone options



Map includes recent dive locations and relative abundance of corals. Contours are in 10 m intervals and areas of high slope are shown in black.

4.2.2.3.2 Outer Schoodic Ridge (preferred)

This alternative would designate a coral zone on the Outer Schoodic Ridge, roughly 25nm southeast of Mt. Desert Island (Table 6, Map 32), within Statistical Area 511 and Maine Lobster Management Zone A. The coral zone encompasses a portion of the ridge that has been recently mapped with multibeam and surveyed using ROV. Recent high resolution bathymetric mapping details the complex, slot canyon terrain in the area. These data indicate that depths in the zone range from 104 m to 248 m, with a mean depth of 174 m. The coral zone is about 79 km^2/31 mi^2. Options for fishing restrictions in this zone are described in section 4.3. This is a preferred alternative, designated as a closure to mobile bottom-tending gears (gear restriction option 2).

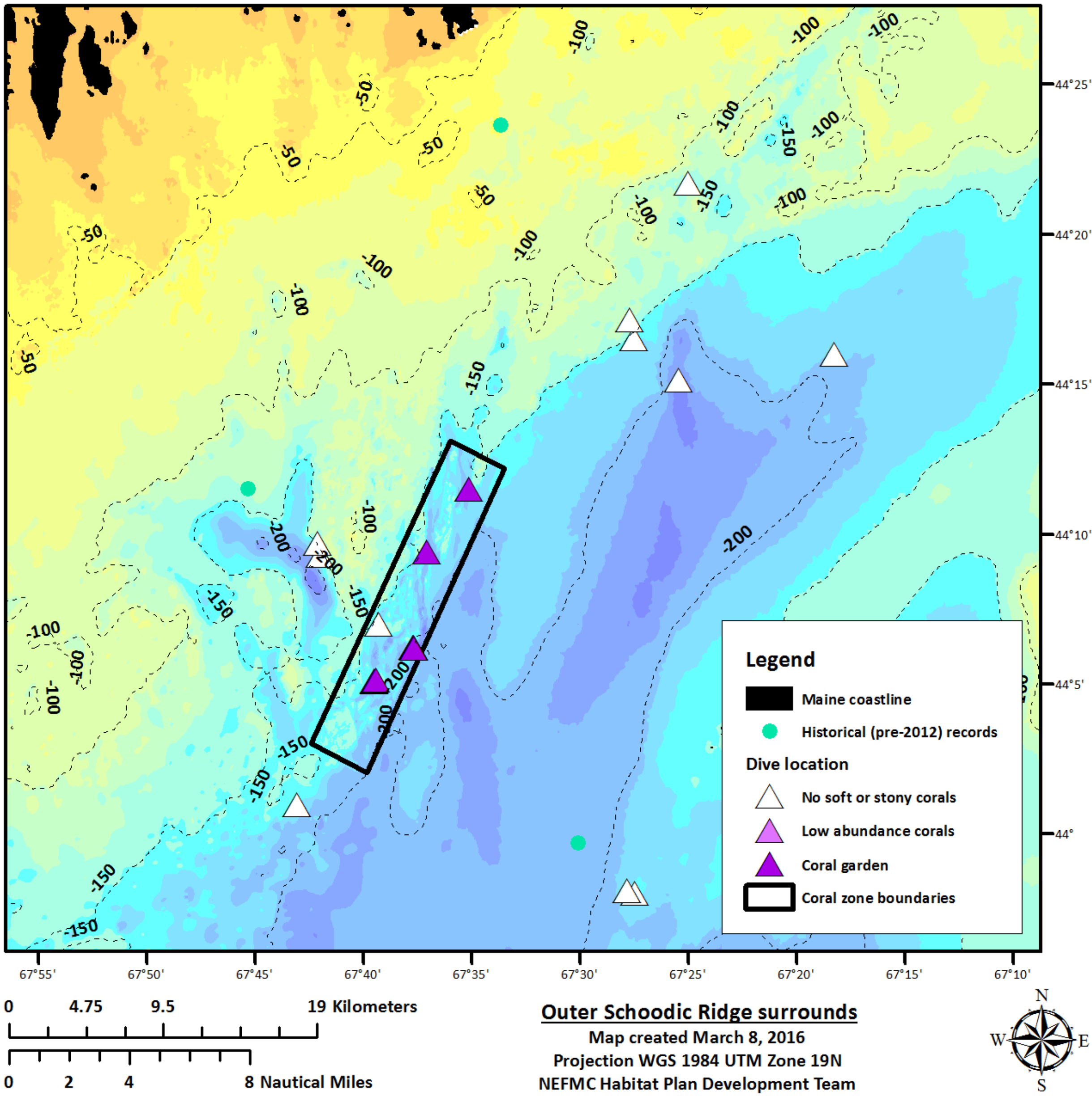
Table 6 – Coordinates for the Outer Schoodic Ridge coral zone

Outer Schoodic Ridge coral zone coordinates
-67°35'36", 44°13'29"
-67°33'06", 44°12'34"
-67°39'42", 44°02'29"
-67°42'17", 44°03'29"

Rationale

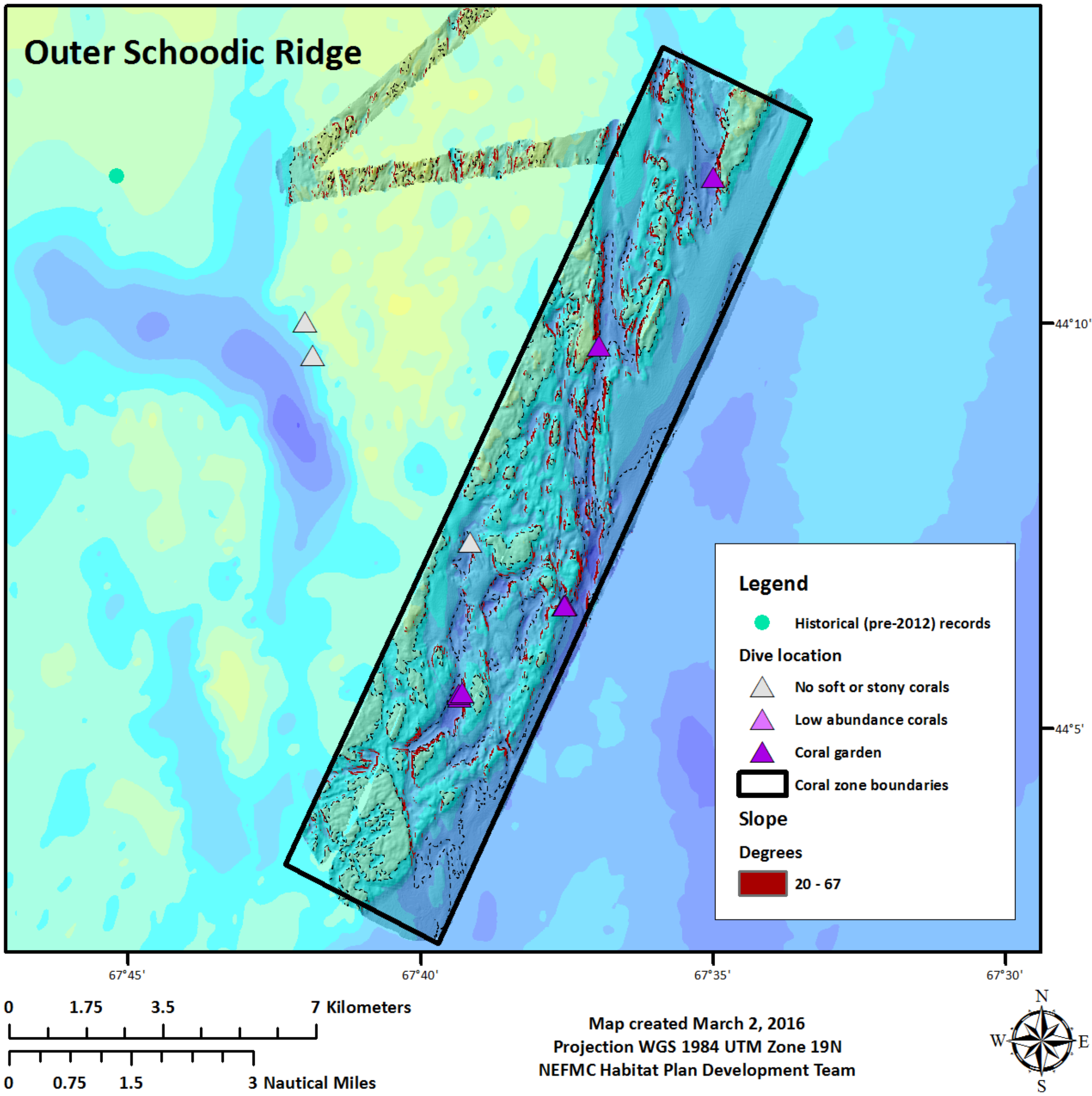
This alternative would protect corals in the Outer Schoodic Ridge region from fishing impacts. Corals have been documented in both the historical and recent data (section 6.2.3.3). Corals at this location were studied during eight ROV dives and two camera tows during 2013, 2014, and 2015. Steeply sloped features that are likely to provide suitable attachment sites for corals are found in the vicinity of the dive sites, throughout the area with high resolution bathymetry data. Based on the presence of steep terrain, the entire footprint of this dataset, aside from a small amount of data to the west of the area in shallower waters, is recommended as a coral zone. It is possible that there are additional corals outside the recommended zone boundaries, but corals were not observed during dives at similar depths nearby (Map 32).

Map 32 – Area surrounding the Outer Schoodic Ridge Coral Zone



Contours are at 50 m intervals. Relative coral densities during recent dives are shown in purple shading.

Map 33 – Outer Schoodic Ridge Coral Zone and high resolution bathymetry



Areas of high slope are shown in red. Relative coral densities during recent dives (triangles) are shown in purple shading.

4.2.2.3.3 Jordan Basin

This alternative would designate coral zones in Jordan Basin. Jordan Basin straddles the EEZ boundary, with depths of about 175-250 m. Deep-sea corals have been observed on shallower rocky features within the basin, which are named for their charted depths: 98 Fathom Bump (179m), 114 Fathom Bump (208m), and 118 Fathom Bump (216m). A site in Central Jordan Basin encompasses depths of about 220-235m. All four features are shown on Map 34. The 114 Fathom Bump and its immediate surrounds is the best mapped of these four sites and has the greatest number of coral exploratory survey dives (Map 35).

The intent is to adopt multiple zones as a group. **Option 1** is comprised of four zones, one zone for each feature. **Option 2** includes subsets of these four zones: four areas at 114 Fathom Bump, two areas in Central Jordan Basin, and one area each at the 96 Fathom and 118 Fathom Bumps (Table 7). Options for fishing restrictions in these zones are described in section 4.3.

Coral zone designation is Jordan Basin is not a preferred alternative.

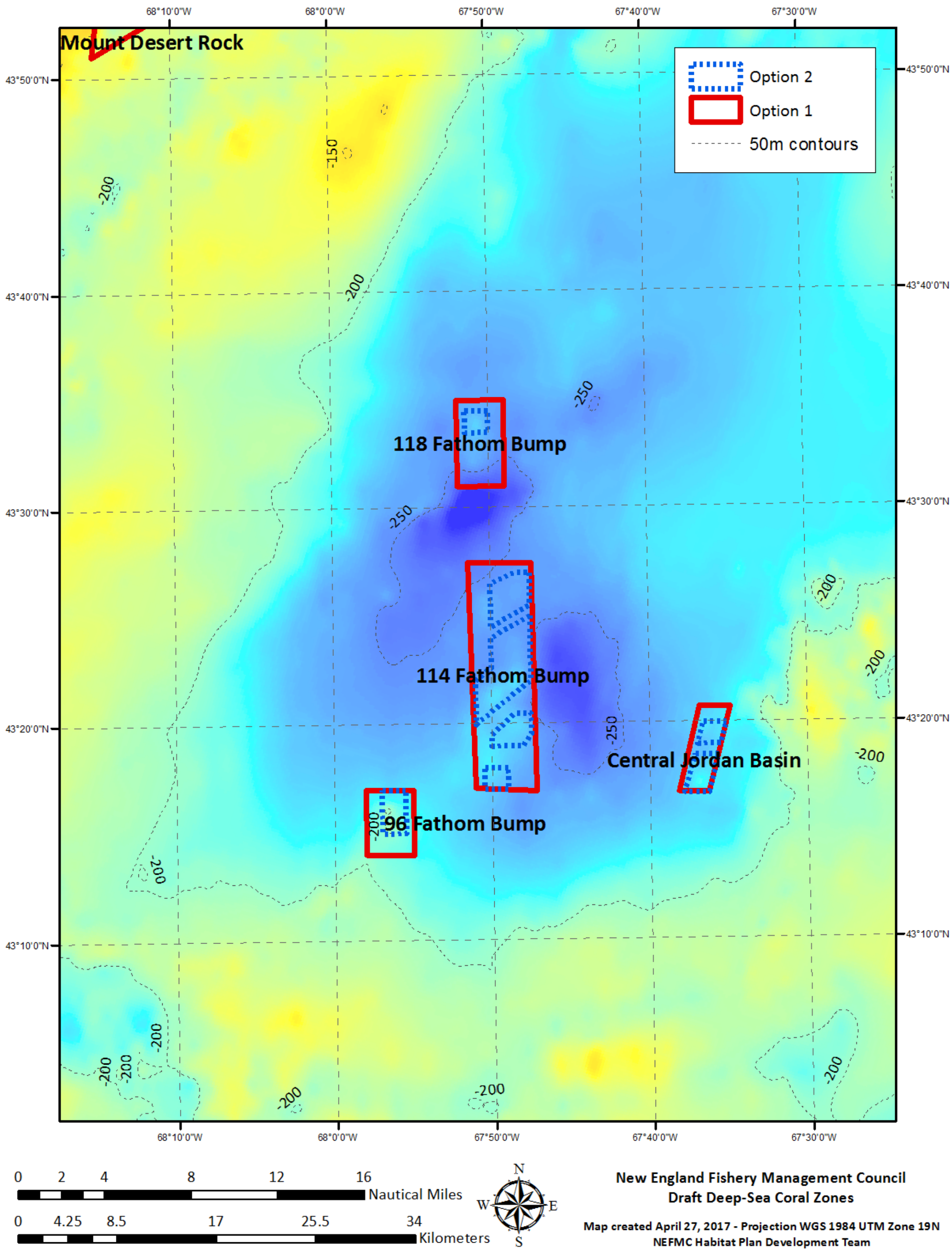
Rationale

This zone would protect coral habitats in Jordan Basin from the impacts of fishing gear.

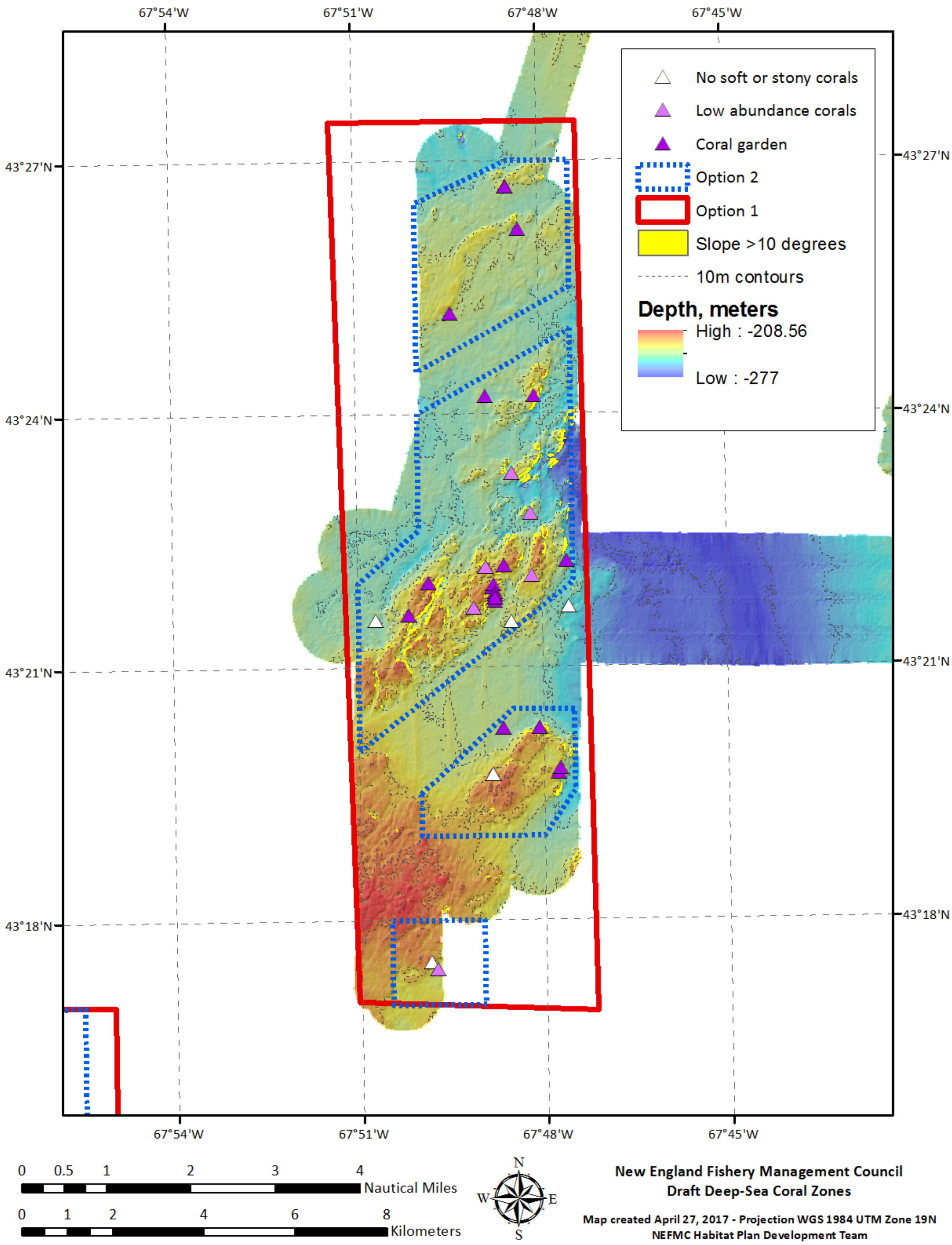
Table 7 – Summary of coordinates and sizes for the Jordan Basin coral zone options

		Option 1		Option 2	
		Coordinates	**Size (km^2)**	**Coordinates**	**Size (km^2)**
Feature	**96 Fathom Bump**	-67°58'0", 43°14'0" -67°58'0", 43°17'0" -67°55'0", 43°17'0" -67°55'0", 43°14'0"	22.5	-67°57'00", 43°17'00" -67°55'30", 43°17'00" -67°55'30", 43°15'00" -67°57'00", 43°15'00"	7.5
	114 Fathom Bump	-67°47'22.9", 43°27'27.8" -67°47'10.6", 43°16'55.2" -67°51'2.9", 43°17'2.8" -67°51'22.9", 43°27'28.2"	103.1	-67°49'60", 43°26'30" -67°48'30", 43°27'00" -67°47'30", 43°27'00" -67°47'30", 43°25'30"	11.5
				-67°47'30", 43°25'00" -67°47'30", 43°22'00" -67°51'00", 43°20'00" -67°50'59.2", 43°21'59.7" -67°49'60", 43°22'37.2" -67°49'60", 43°24'00"	25.1
				-67°49'60", 43°19'30" -67°48'30", 43°20'30" -67°47'30", 43°20'29.6" -67°47'30", 43°19'32.5" -67°48'0", 43°19'0" -67°49'60", 43°19'0"	7.2
				-67°50'30", 43°18'00" -67°48'60", 43°18'00" -67°48'60", 43°17'00" -67°50'30", 43°17'00"	3.8
	118 Fathom Bump	-67°49'0", 43°35'0" -67°49'0", 43°31'0" -67°52'0", 43°31'0" -67°52'0", 43°35'0"	29.9	-67°51'30", 43°34'30" -67°49'60", 43°34'30" -67°49'60", 43°33'30" -67°51'30", 43°33'30"	3.7
	Central Jordan Basin	-67°34'53.9", 43°20'43.7" -67°36'16.7", 43°16'47" -67°38'10.9", 43°16'47.8" -67°36'51.2", 43°20'43.8"	19.0	-67°36'36.7", 43°20'00" -67°35'09.0", 43°20'00" -67°35'29.6", 43°19'00" -67°36'58.0", 43°19'00"	3.7
				-67°37'07.5", 43°18'30" -67°35'40.0", 43°18'30" -67°36'16.7", 43°16'45" -67°37'50.9", 43°16'45"	6.6

Map 34 – Discrete coral zone options in Jordan Basin.



Map 35 – Larger scale image of the high-resolution bathymetry at 114 fathom bump



This map uses a different color scale than the previous map of the Jordan Basin region.

4.2.2.3.4 Lindenkohl Knoll

This alternative would designate a coral zone or zones at Lindenkohl Knoll within Georges Basin (Map 36). Georges Basin is just north of Georges Bank, and includes the deepest waters in the Gulf of Maine (about 200fa, over 360 m). Lindenkohl Knoll is a somewhat shallower feature on the western side of Georges Basin, roughly 25 miles north of the northern edge of Georges Bank. Corals have been documented in recent data only (section 6.2.3.3). Options for fishing restrictions in this zone are described in section 4.3.

Two boundary options are under consideration. **Option 1** consists of a single zone. The eastern boundary of Option 1 is just over two nautical miles from the Hague Line. **Option 2** lies within Option 1 and consists of three smaller zones centered on locations where corals have been observed (Table 8).

Coral zone designation at Lindenkohl Knoll is not a preferred alternative.

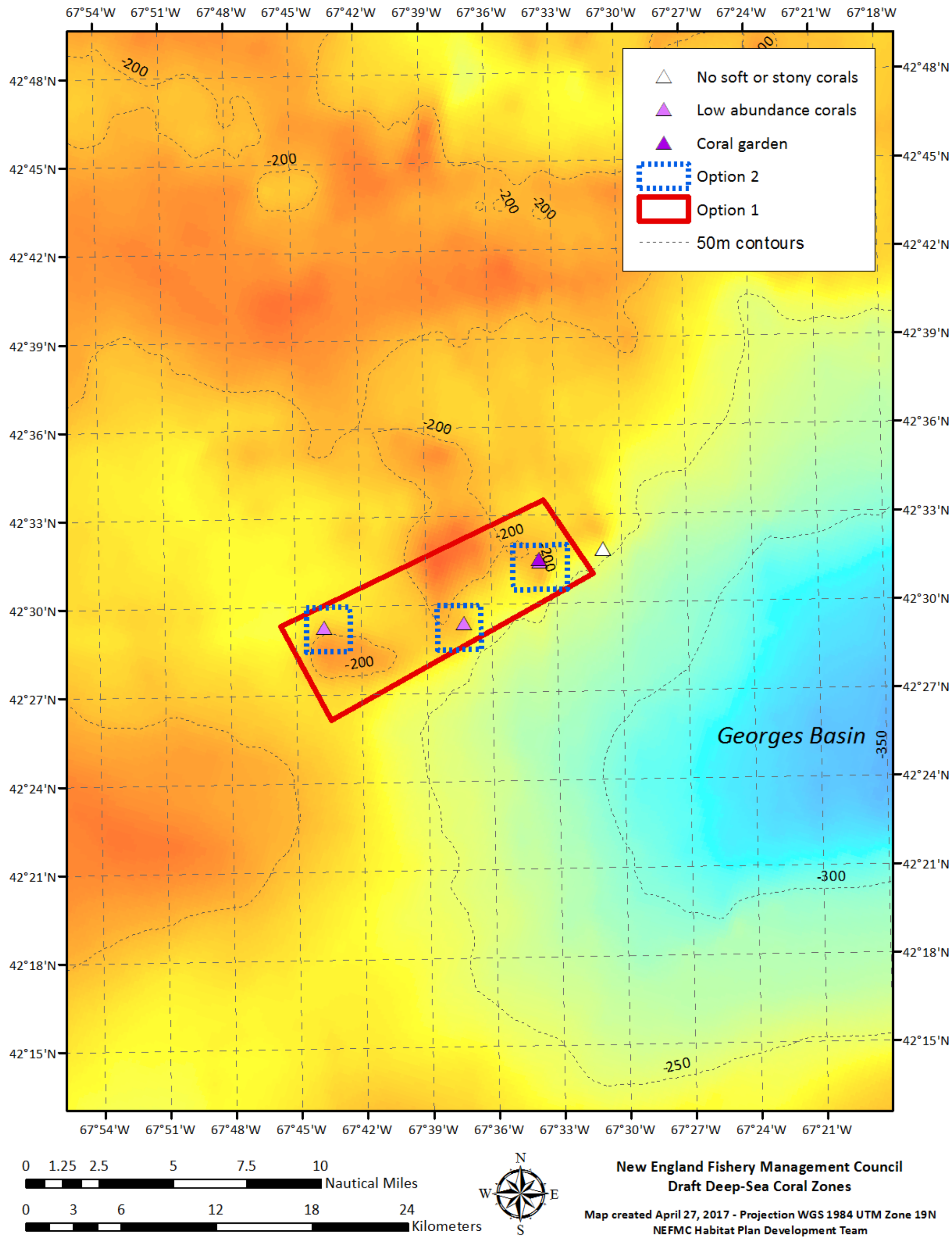
Table 8 – Summary of coordinates and sizes for the Lindenkohl Knoll coral zone options

Option 1		Option 2	
Coordinates	Size (km²)	Coordinates	Size (km²)
-67°45'40.5", 42°29'23.3" -67°33'34.3", 42°33'30.8" -67°31'19.7", 42°30'59.8" -67°43'24.5", 42°26'09.8"	114	-67°44'30", 42°30'00" -67°42'30", 42°30'00" -67°42'30", 42°28'30" -67°44'30", 42°28'30"	7.6
		-67°38'30", 42°30'00" -67°36'30", 42°30'00" -67°36'30", 42°28'30" -67°38'30", 42°28'30"	7.6
		-67°34'60", 42°32'00" -67°32'30", 42°32'00" -67°32'30", 42°30'30" -67°34'60", 42°30'30"	9.5

Rationale

This zone would protect coral habitats at Lindenkohl Knoll from the impacts of fishing gear.

Map 36 – Discrete coral zone options at Lindenkohl Knoll.



4.3 Fishing restrictions for coral zones

The following range of fishing restriction alternatives are under consideration for the coral zones described above. Different measures could be used in broad vs. discrete zones, or in different discrete zones, depending on the fisheries that occur there and the degree of protection desired. Note that broad and discrete zones could be used in combination, with different types of measure applied in each.

4.3.1 Option 1: Prohibit all bottom-tending gears (preferred for broad zone)

Option 1 would prohibit the use of all bottom-tending fishing gears in deep-sea coral zones but would allow the use of gears that do not contact the seabed. Restricted gear types would include bottom-tending otter trawls, bottom-tending beam trawls, hydraulic dredges, non-hydraulic dredges, bottom-tending seines, bottom-tending longlines, sink or anchored gillnets, and pots and traps. This list is intended to be comprehensive, but some of these gears may not be currently active in any particular coral zone being considered. Pots and traps could be exempted from this restriction by adopting one or both of the sub-options listed below in combination with this alternative.

Note that recreational bottom-tending gears are not included in the restriction. The PDT investigated whether party charter recreational bottom-tending fishing trips have occurred in the coral zones during the analysis time period and found only a small handful of trips (12) out of over 80,000+ trips in the database reporting fishing locations within the coral zones. This suggested that bottom-tending recreational fishing gear is used very little in the coral zones being considered and does not need to be regulated. Recreational fishing activity is also exempt from restrictions associated with the Mid-Atlantic Fishery Management Council's (MAFMC) coral management zone.

Vessels may transit the coral zones provided bottom-tending trawl nets are out of the water and stowed on the reel and any other fishing gear that is prohibited in these areas is onboard, out of the water, and not deployed. Fishing gear would not be required to meet the definition of "not available for immediate use" in 50 CFR §648.2. These transit provisions are consistent with those selected by the MAFMC for their coral zones, which went into effect on January 13, 2017.

4.3.1.1 Sub-option A: Exempt the red crab fishery from coral zone restrictions (preferred for 600 m minimum broad zone)

Sub-option A would exempt the red crab trap fishery from bottom-tending gear restrictions. This exemption would be limited to vessels fishing under a limited access red crab permit (Category B or C).

4.3.1.2 Sub-option B: Exempt other trap fisheries from coral zone restrictions

Sub-option B would exempt vessels in all other pot and trap fisheries from coral zone gear restrictions. This exemption would cover vessels fishing for lobster and Jonah crab with federal lobster permits, as well as any other vessels fishing with traps or pots.

4.3.2 Option 2: Prohibit use of mobile bottom-tending gears (preferred for inshore GOM zones)

Option 2 would prohibit the use of mobile bottom-tending fishing gears in deep-sea coral zones, including bottom-tending otter trawls, bottom-tending beam trawls, hydraulic dredges, non-hydraulic dredges, and bottom-tending seines. This list is intended to be comprehensive, but some of these gears may not be currently active in any particular coral zone being considered. This option would allow fishing with fixed gears (bottom-tending longlines, sink or anchored gillnets, and pots and traps) and any gear that does not contact the seabed. The rationale for treating fixed and mobile gears differently is that while both mobile and fixed bottom tending gears can negatively impact corals, mobile gears are understood to have more substantial impacts. See section 6.5.2.

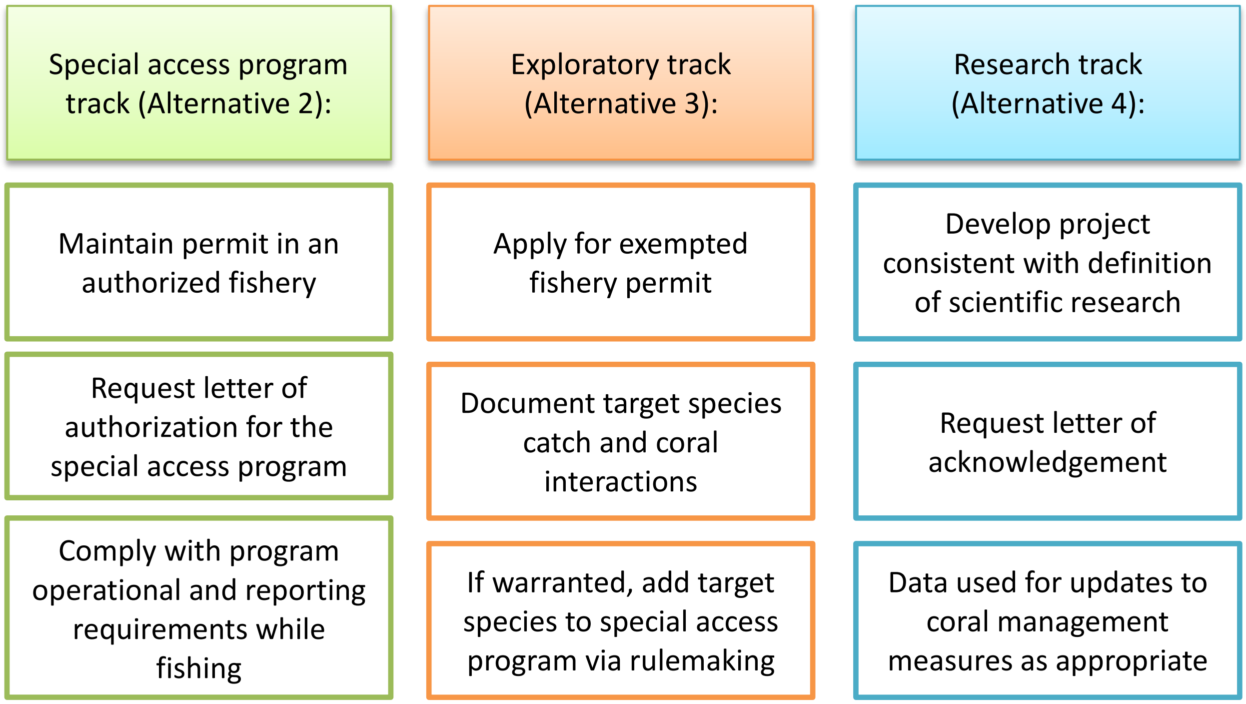
Vessels may transit the coral zones provided bottom-tending trawl nets are out of the water and stowed on the reel and any other fishing gear that is prohibited in these areas is onboard, out of the water, and not deployed. Fishing gear would not be required to meet the definition of “not available for immediate use” in 50 CFR § 648.2. As above, these transit provisions are consistent with those adopted through the MAFMC action.

This option is the preferred alternative for Mt. Desert Rock (boundary option 2) and Outer Schoodic Ridge.

4.4 Special fishery programs for coral zones

The alternatives in this section would create programs to allow special access fishing, exploratory fishing, and/or research activities within coral zones (comparison in Figure 2). The concepts in these alternatives come from existing special access programs in the groundfish, scallop, and herring fisheries, the exempted fishing permit process, and the Northwest Atlantic Fishery Organization exploratory fishing program. One or more of the action alternatives could be selected, in any combination, or Alternative 1/No Action.

Figure 2 – Major elements of special access and exploratory fishing programs within coral zones. Alternative 1 (not shown) is no action, with none of these programs implemented.



4.4.1 Alternative 1/No Action: No special programs for access, exploratory fishing, or research tracking requirements

Under Alternative 1/No Action, the Council would not develop any new programs for special access or exploratory fishing and would not request that researchers ask for a letter of acknowledgement.

4.4.2 Alternative 2: Coral Zone Fishery Access Program

This alternative would implement a fishery access program within some or all of the deep-sea coral zones. The objectives of the program would be as follows:

(1) To allow for continued fishery access to some or all coral areas
(2) To ensure that such fishing does not conflict with coral conservation objectives

This program would generate sufficient data to understand fishing distributions in coral zones, as well as interactions between fishing and corals. The intent is to specify the possible operational requirements for a vessel to fish within a coral zone.

The main distinction between this program and a general exemption from gear restrictions for the red crab fishery (section 4.3.1.1) or other trap fisheries (section 4.3.1.2) is that this program could have additional reporting requirements and/or spatial restrictions, while fisheries that are generally exempt from restrictions in the coral zone would operate under current restrictions with no additional reporting requirements.

Which vessels?

A program to allow fishing activities in specified deep-sea coral zones could potentially apply to any vessel that is restricted from operating in a particular coral zone according to the measures selected in section 4.3 (fishing restrictions for coral zones). This could include vessels fishing with any type of bottom tending gear, or only those fishing with mobile bottom-tending gear, depending on the alternative selected. Alternatively, the Council could restrict participation in special access programs to vessels participating in specific fisheries, based on permit type.

Which areas?

The Council would need to determine where access program fishing would be allowed. Such activities could be authorized in all designated coral zones, or only in certain coral zones. Areas authorized for a special access fishery could vary by fishery to include only those areas fished currently or in the recent past. Sub-areas of broad zones might also be appropriate.

Operational requirements

When fishing in a coral zone fishery access program, vessel operators could be subject to additional requirements. These might include:

1. *Gear requirements:* The Council may wish to specify gear restrictions that are different from what is currently authorized under the various FMPs in order to better protect corals from fishing impacts. This could include limits on rollers or rockhoppers, for example.
2. *Seasonal requirements:* This is an element of some existing special access programs and is listed for completeness but would probably not be necessary here. Corals are almost certain to be equally vulnerable to fishing impacts year-round.
3. *Total amount of effort or target species landings:* The Council could specify the number of trips allowed for each vessel authorized in the fishery access program in order to limit the total amount of fishing that could occur in coral areas. Or, the Council could consider exemptions from certain fishery regulations when operating in coral zones. For example, trip limits might be counterproductive to conservation objectives if discarding occurs and additional bottom time is therefore required to land the same amount of the target species. Ensuring coral protection should remain the focus though. In the case of corals, effort limitation might not be a useful tool because the impact/recovery relationship is such that the initial impact is most damaging, such that any effort occurring in locations with lots of corals could be problematic from a conservation standpoint. This underscores the importance of only allowing special access fishing to occur in locations where interactions between that type of fishing and the coral types known or thought to occur would be minimal to begin with.
4. *Move-along provision if any corals are caught:* This type of provision would require the vessel to stop fishing if corals are encountered and move to a new location. The Council could specify a zero or non-zero threshold of coral bycatch

that would trigger a move-along clause. While the Northwest Atlantic Fisheries Organization (NAFO) has advanced the use of such approaches, these types of thresholds are difficult to develop because coral catch rates vary by coral species, gear and area (Auster et al. 2011). Whether the threshold is zero or non-zero, this type of provision would require the vessel operator to be able to identify corals in the catch.

5. *Coral retention requirement:* Would require any corals caught to be retained and brought back to shore for analysis, to determine the species caught.
6. *Reporting requirements:*
    a. For vessels that are equipped with one as a requirement of a fishery they participate in, use of a vessel monitoring system with half-hourly polling
    b. Enhanced documentation of fishing location and catch. For each tow of mobile gear or set of fixed gear:
        i. Start and end location and depth of all tows
        ii. Catch weights by species, including target and non-target fishes and invertebrates identified to the lowest taxonomic level possible
        iii. Alternatively, use an observer.
    c. File fishing vessel trip reports as usual. Note that federal lobster permit holders only file VTRs if they hold another federal permit. It might be appropriate to require a VTR as a condition of the program.

Letter of authorization

A special access program would likely require a letter of authorization. The fishing that would occur under the letters of authorization typically needs to meet a range of requirements. These types of information could be included in the request:

1. Vessel identifying information and point of contact
2. Must be filed by the application deadline. A deadline would need to be specified so that vessel owners would know how far in advance they need to request a letter of authorization. In the case of research-related exempted fishing permits, the project proponents are asked to apply 60 days before the permit is to be used. Requests could be submitted on a rolling basis, similar to research-related applications, or only within a certain window each year. If the latter option is selected, the deadline could be 60 days before the start of a particular fishing year, or the deadline might be the same for all fisheries (e.g., November 1 to take effect January 1 of the following year).
3. Target and incidental species expected to be harvested and discarded:
    a. For species regulated under a federal FMP, it is assumed all size limits, possession limits, and trip limits would still apply. The vessel would need to have a permit to fish under that FMP and comply with any limitations associated with the category of permit held, unless the special access program rules are different.
    b. For non-target/incidental species including corals and protected species, the application would need to specify a list of species that might be encountered and how catch of those species would be monitored and documented.

4. The vessel would need to be in good standing at the time the request is made. This means no open violations, must be current with reporting requirements, etc.
5. A description of any fishing gear to be used would be required. This would include roller gear or other sweep attachments on trawl vessels, number and size of traps in a string, type of line connecting traps in a string, etc. All gear would need to comply with existing regulations for use outside of coral areas.

4.4.3 Alternative 3: Exploratory fishing

This alternative would implement an exploratory fishing program within some or all of the deep-sea coral zones. The objectives of an exploratory program would be as follows:

(1) To allow for exploration of the feasibility (technological, economic) of new fisheries
(2) To collect data that indicate whether the new fishery conflicts with coral conservation objectives

Steps in the exploratory fishing process would be as follows:

1. Apply for an exempted fishing permit and letter of authorization to conduct research/exploratory fishing
2. Document feasibility of the fishery including evidence that the fishery does not compromise coral conservation objectives
3. Longer term, as appropriate, add the target species to the list of special access program species via rulemaking

Which vessels?

Presumably, any vessel could apply for an exploratory fishing permit, whether they were currently permitted to operate in regional fisheries or not.

Which areas?

As above, the Council would need to determine where exploratory fishing activity would be allowed. Such activities could be authorized in all designated coral zones, or only in certain types of coral zones. For example, distinctions might be made between whether or not exempted/exploratory fishing is authorized in broad zones, discrete zones based on coral data and habitat suitability, and/or discrete zones based on habitat suitability only.

Operational requirements

When fishing under an exploratory fishing permit in a coral area, vessel operators could be subject to requirements, similar to those for special access fisheries, above. The Regional Administrator would have the discretion to grant exempted permits as he or she saw fit, but the Council could provide guidance as to the types of activities that they would consider appropriate.

1. Gear requirements
2. Seasonal requirements (again, probably not necessary)

3. Total amount of effort permitted
4. Move-along provision if any corals are caught
5. Coral retention requirement
6. Reporting requirements:
    a. Vessel monitoring system if equipped
    b. Scientific personnel or NEFOP observer
    c. Enhanced documentation of fishing location and catch. For each tow of mobile gear or set of fixed gear:
        i. Start and end location and depth of all tows
        ii. Catch weights by species, including target and non-target fishes and invertebrates identified to the lowest taxonomic level possible

Permit requirements

An application for an exempted fishing permit to conduct market research/exploration could include the following elements. Additional details about these elements are provided above in the special access program section. The Regional Administrator would maintain final discretion regarding the approval of exempted fishing permits. Table 9 contains additional information about exempted fishing permits and other types of research documents. While exploratory fishing activities would not constitute scientific research, some of the requirements of an exempted fishing permit application are appropriate to an exploratory fishing program within deep-sea coral zones.

1. Vessel identifying information and point of contact.
2. Must be filed by the application deadline.
3. Target and incidental species expected to be harvested and discarded:
    a. Species regulated under a federal FMP
    b. Non-target/incidental species including corals and protected species
    c. For target exploratory species not regulated under a federal FMP, the application would need to summarize all available information about the distribution of the species, provide a brief rationale as to why the species is of exploratory fishing interest, and whether or not the species would be retained for sale.
4. The vessel would need to be in good standing
5. A description of any fishing gear to be used

4.4.4 Alternative 4: Research activities (preferred)

This alternative requests that individuals and organizations seek a letter of acknowledgement when conducting scientific research (see definition below) in coral zones, acknowledging that such letters are not required. A letter of acknowledgement would be useful to help NMFS and the Council keep track of research activities that may be occurring in coral zones, the results of which could benefit future management decisions. Letters of acknowledgement are distinct from letters of authorization.

Presently, four types of documents are issued by the Northeast Regional Office to vessels participating in scientific research projects: an exempted fishing permit, a temporary possession permit, an exempted educational activity authorization, and/or a letter of acknowledgement (Table 9). This alternative would not change requirements for exempted fishing permits, temporary possession permits, or exempted educational activity authorizations.

Table 9 – Types of research documents issued by GARFO

Exempted Fishing Permit: Authorizes a fishing vessel of the United States to conduct fishing activities that would be otherwise prohibited under the regulations at 50 CFR part 648 or part 697. Generally issued for activities in support of fisheries-related research, including seafood product development and/or market research, compensation fishing, and the collection of fish for public display. Anyone that intends to engage in an activity that does not meet the definition of scientific research but that would be otherwise prohibited under these regulations is required to obtain an EFP prior to commencing the activity. **Temporary Possession Permit:** Temporary Possession Permits authorize a federally permitted fishing vessel that is accompanied by an eligible research technician to temporarily retain fish that are not compliant with applicable fishing regulations for the purpose of collecting catch data. Example regulations include minimum fish sizes, species under quota closures, and fish possession limits. All non-compliant fish are returned to the sea as soon as practicable following data collection. **Exempted Educational Activity Authorization:** An EEAA is a permit issued to accredited educational institutions that authorize, for educational purposes, the target or incidental harvest of species managed under an FMP or fishery regulations that would otherwise be prohibited. **Letter of Acknowledgement:** An LOA is a letter that acknowledges certain activities as scientific research conducted from a scientific research vessel. Scientific research activities are activities that would meet the definition of fishing under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), but for the statutory exemption provided for scientific research. Such activities are exempt from any and all regulations promulgated under the Magnuson-Stevens Act, provided they continue to meet the definition of scientific research activities conducted from a scientific research vessel. Although the LOA is not required for scientific research, obtaining an LOA serves as a convenience to the researcher, the vessel(s), NMFS, the NOAA Office of Law Enforcement, and the U.S. Coast Guard, to establish that the activity is indeed exempt from the provisions of the Magnuson-Stevens Act. To meet the definition of a scientific research vessel, the vessel must be conducting a scientific research activity and be under the direction of an appropriate group (e.g., a government agency, university or accredited educational institution, etc.). Scientific research activity includes, but is not limited to sampling, collecting, observing, or surveying the fish or fishery resources within the EEZ. Research topics include taxonomy, biology, physiology, behavior, disease, aging, growth, mortality, migration, recruitment, distribution, abundance, ecology, stock structure, bycatch or other collateral effects of fishing, conservation engineering, and catch estimation of fish species considered to be a component of the fishery resources.
Sources: Research Documentation: Exempted Fishing Permits, Temporary Possession Permits, Exempted Educational Activity Authorizations, and Letters of Acknowledgement. Updated 23 November 2010.

4.5 Framework provisions for deep-sea coral zones

These options would allow the measures adopted via this amendment to be changed using the framework adjustment process instead of a fishery management plan amendment.

This would not preclude the Council from determining, or NMFS from recommending, that an amendment is a more appropriate vehicle for consideration of the change. In some cases, an amendment might be more appropriate, particularly if the impacts of an action are likely to be substantial. Note that the decision about whether an environmental assessment vs. environmental impact statement is prepared is separate from the decision to pursue a framework or an amendment. Alternative 1/No Action, or one or more of the action Alternatives 2-4 could be selected.

4.5.1 Alternative 1/No Action: No additional frameworkable items

Under Alternative 1, there would be no change to framework adjustment provisions of the FMPs regarding deep-sea coral management measures.

4.5.2 Alternative 2: Add, revise, or remove coral zones via framework adjustment (preferred)

Alternative 2 would allow coral zones to be added, revised, or removed via framework adjustment.

4.5.3 Alternative 3: Change fishing restrictions in coral zones via framework adjustment (preferred)

Alternative 3 would allow the Council to change the types of fishing gears restricted within deep-sea coral zones via framework adjustment.

4.5.4 Alternative 4: Allow changes to fishery access or exploratory fishing programs via framework adjustment (preferred)

Alternative 4 would allow development of, or changes to, coral zone fishery access programs or exploratory fishing programs (e.g., permit and observer requirements, move-along provisions) via framework adjustment.

4.6 Dedicated habitat research areas

In June 2015, the Council took final action on Omnibus Essential Fish Habitat Amendment 2 (OHA2). The final rule was published on April 9, 2018. OHA2 includes various types of spatial management areas, specifically habitat management areas, spawning management areas, and dedicated habitat research areas (DHRAs). The latter are intended to focus the attention of the research community on particular habitat-related research topics, in locations that are well suited to addressing such questions.

OHA2 recommended two DHRAs. The Stellwagen DHRA is located within the Western Gulf of Maine Habitat Closure Area and closed to mobile bottom-tending gear, sink gillnet gear, and demersal longline gear on a year-round basis. The Georges Bank DHRA is located within the southern part of Closed Area I and would be closed to mobile bottom-tending gear on a year-round basis. These two DHRAs will be removed administratively if research activities are not planned or in progress three years following designation. A single DHRA is proposed in this amendment, without gear restrictions or a sunset provision.

The Council outlined a research agenda for DHRAs, which includes advancing the state of knowledge to support fishery management on the following topics:

Gear impacts

- How do different types of bottom-tending fishing gear affect the susceptibility and recovery of physical and biological characteristics of seabed habitat, and how do these impacts collectively influence key elements of habitat including spatial complexity, functional groups, community state, and recovery rates and dynamics?
- Are our estimates of gear contact with the bottom accurate?

Habitat Recovery

- What recovery models (e.g., successional vs. multiple-stable states) are operant in the region and how resilient are seafloor habitats to disturbance?
- Do "small" fishing-caused disturbances surrounded by unimpacted habitat recover more quickly and exhibit greater resilience in contrast to "large" fishing-caused disturbances embedded with small unimpacted patches? When a particular area is fished for the first time vs. subsequent efforts, are these impacts equal per unit effort? Or, is the first pass over an area much more detrimental? Conversely, is there a tipping point beyond which the habitat is no longer capable of recovering?

Natural Disturbance

- In the absence of fishing, what are the dynamics of natural disturbance (e.g., major storm events) on seafloor habitat (especially biological components) across five major grain size classes (mud, sand, coarse sand-granule, pebble-cobble, boulder) and across oceanographic regimes? In areas where natural disturbance is high, are signals of the impacts of fishing masked?

Productivity

- How does the productivity of managed species (and prey species) vary across habitat types nested within the range of oceanographic and regional settings? And how does this productivity change when habitats are impacted by fishing gear? Do durable mobile bottom tending gear closures increase fish production? Why are highly productive areas so productive?

In addition to the above questions associated with all DHRAs, the Habitat PDT identified a specific list of research needs related to deep-sea corals and sponges:

Location and Characterization of Deep-Sea Corals and Sponges

1. Gap analysis/data mining (to guide future sampling/surveys)
2. Predictive modeling
3. Field work
    a. Multibeam mapping
    b. Monitoring of water column properties
    c. Distribution and extent of coral habitats

4. Presence/absence, abundance, density, associated megafauna, habitat characterization

Continued efforts are needed to locate and characterize deep-sea corals and sponges. This work will require multibeam sonar mapping, especially in the Gulf of Maine, to better predict where corals communities could be located and the nature of seafloor substratum (based on backscatter and slope data). High resolution digital terrain models and associated oceanographic settings can be used to implement habitat suitability modelling and for planning field work to verify and refine model predictions. Such information can be used to refine spatial management alternatives (boundaries, gear restrictions, etc).

Biology, Biodiversity and Ecology of Deep-Sea Corals and Sponges

1. Species identification (based on morphology and genetics)
2. Connectivity
3. Biological information important for management
    a. Age
    b. Growth rates
    c. Reproduction
    d. Dispersal/Recruitment/Connectivity

Continued efforts are needed to assess the functional role of deep-sea corals and sponges as habitat for managed species (e.g., shelter, flow refuge, feeding habitat) and associated prey. Variation of functional role in both space and time should be linked to seasonal and diel variation in use across life history stages of managed species and their prey. Information on reproduction, dispersal, recruitment and connectivity is needed to improve predictions of recovery potential. Further, information on genetic connectivity is needed to assess management priorities in regard to the isolation of sub-populations of coral and sponge species.

Natural and Human Impacts on Deep-Sea Coral and Sponge Ecosystems

1. Understanding disturbance effects and recovery
2. Economic and social values associated with deep-sea corals
3. Resiliency of coral communities to various types of disturbance

Continued efforts are needed to assess variation in both natural and human-caused disturbances to deep-sea coral and sponge communities and associated patterns of recovery. Disturbances can range from local-scale predation events to shifts in temperature and pH due to variation in oceanographic regimes. The details of direct human-caused disturbances from different types of fishing gears are needed to refine management measures. Information on recovery dynamics based on variation in patch size of disturbance is needed to link effects from different gear types and natural background disturbances.

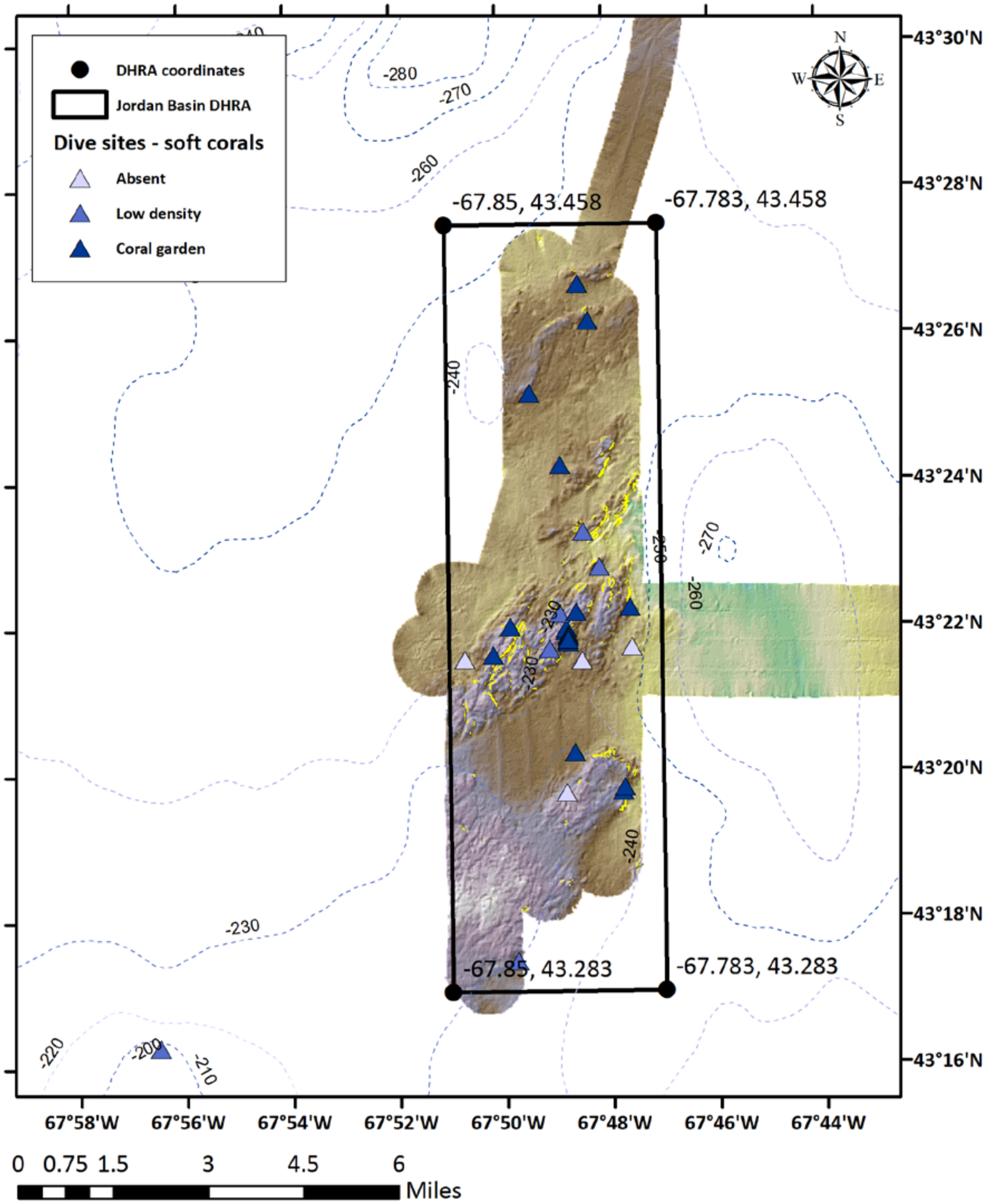
4.6.1 Alternative 1/No Action: No new DHRA designtions

Under No Action, there would be no new DHRAs designated by the Council in this amendment. Research related to the above objectives, specifically how different types of fishing affects coral habitats, and how coral habitats contribute to fish production, could of course continue within or outside of deep-sea coral protection zones.

4.6.2 Alternative 2: Jordan Basin DHRA (preferred)

Alternative 2 would designate a new DHRA in Jordan Basin, based on the Option 1 coral zone boundaries around 114 Fathom Bump (section 4.2.2.3.3). No new fishing restrictions would be imposed as part of the DHRA designation, and no sunset provision would apply to the designation. The purpose of the DHRA designation is to encourage further exploration of coral habitats at the site, and to encourage research on fishing gear impacts on these habitats.

Map 37 – Location and coordinates for Jordan Basin DHRA



Colored shading indicates depth, with shallow areas in white and deeper areas in aqua. Yellow shading shows areas where the slope exceeds 10 degrees. Contours are in meters.

5 Alternatives not developed in the environmental assessment

The following alternatives were considered by the Council but are not analyzed in this environmental assessment. In June 2015, the MAFMC approved coral management zones for their region through Amendment 16 to the Atlantic Mackerel/Squid/Butterfish FMP. The provisions of the amendment went into effect on January 13, 2017. Earlier versions of the NEFMC alternatives, developed prior to initiation of the MAFMC amendment, included areas with the MAFMC region. Following the 2013 memorandum of understanding between the Atlantic coast councils, the NEFMC coral zone alternatives were modified to remove areas south of the NEFMC/MAFMC boundary, including the Mey-Lindenkohl slope, Baltimore Canyon, Norfolk Canyon, Emery Canyon, Hudson Canyon, Toms Canyon, Lindenkohl Canyon, Wilmington Canyon, Accomac Canyon, and Washington Canyon.

A broad coral zone with a landward boundary based on the 200 m depth contour was considered by the Habitat Committee and rejected, due to concerns about potential fishery impacts of a zone extending into these relatively shallower depths on the outer continental shelf. Larger discrete coral zones in the Gulf of Maine were not recommended for further analysis at the April 6, 2012 Committee meeting because of concerns over impacts to existing or future fishing activity and, in the case of the Mt. Desert Rock area, overlaps with state-managed fisheries. These included:

- An expanded version of the Mt. Desert Rock zone that extended into similar depths and habitats, and also included some shallower areas within state waters
- Larger areas combining areas 1 and 2 and areas 3 and 4 in Western Jordan Basin, that would have encompassed a wider range of deeper and shallower habitat types

The PDT evaluated the following additional canyon and slope areas as possible discrete coral zones but did not recommend zones in these areas to the Habitat Committee based on limited evidence of coral habitats at the time, prior to availability of the habitat suitability model and the ACUMEN multibeam data. At the time, the Committee concurred with the PDT's assessment and did not ask for further analysis of these options at their February 23, 2012 meeting. Ultimately all of these areas were encompassed within either the MAFMC or NEFMC recommended broad zones, and some of the canyons were implemented as MAFMC discrete canyon zones.

- Slope near U.S. – Canadian border
- Slope between Veatch and Hydrographer Canyons
- Slope west of Alvin and Atlantis Canyons
- Slope area between Baltimore and Accomac canyons
- Canyons not recommended based on GIS analysis: Chebacco, Filebottom, Sharpshooter, Dogbody, Shallop, Nantucket, Atlantis, Block, McMaster, Ryan Canyon, Uchupi, and Spencer Canyons
- Canyons not recommended, did not incise shelf enough to conduct GIS analysis: Clipper, South Wilmington, North Heys, South Vries, Warr, Phoenix, and Leonard Canyons

6 Affected Environment

This section provides background information that informs analysis of impacts of the alternatives proposed in this amendment. Topics covered include:

- Physical setting, including geology and physical oceanography relevant to deep-sea coral and fishery distributions
- Background information on deep-sea corals, including species richness, geographic distribution, distribution of suitable habitats, associated species and ecological interactions, and vulnerability to impacts
- Essential fish habitat occurring within coral zones
- Managed resources, fisheries, and associated human communities
- Protected resources such as marine mammals, turtles, and any other Endangered Species Act-listed species occurring in or around coral zones

6.1 Physical setting

These two sections describe the oceanographic and geological features of the Gulf of Maine, continental slope, canyons, and seamounts.

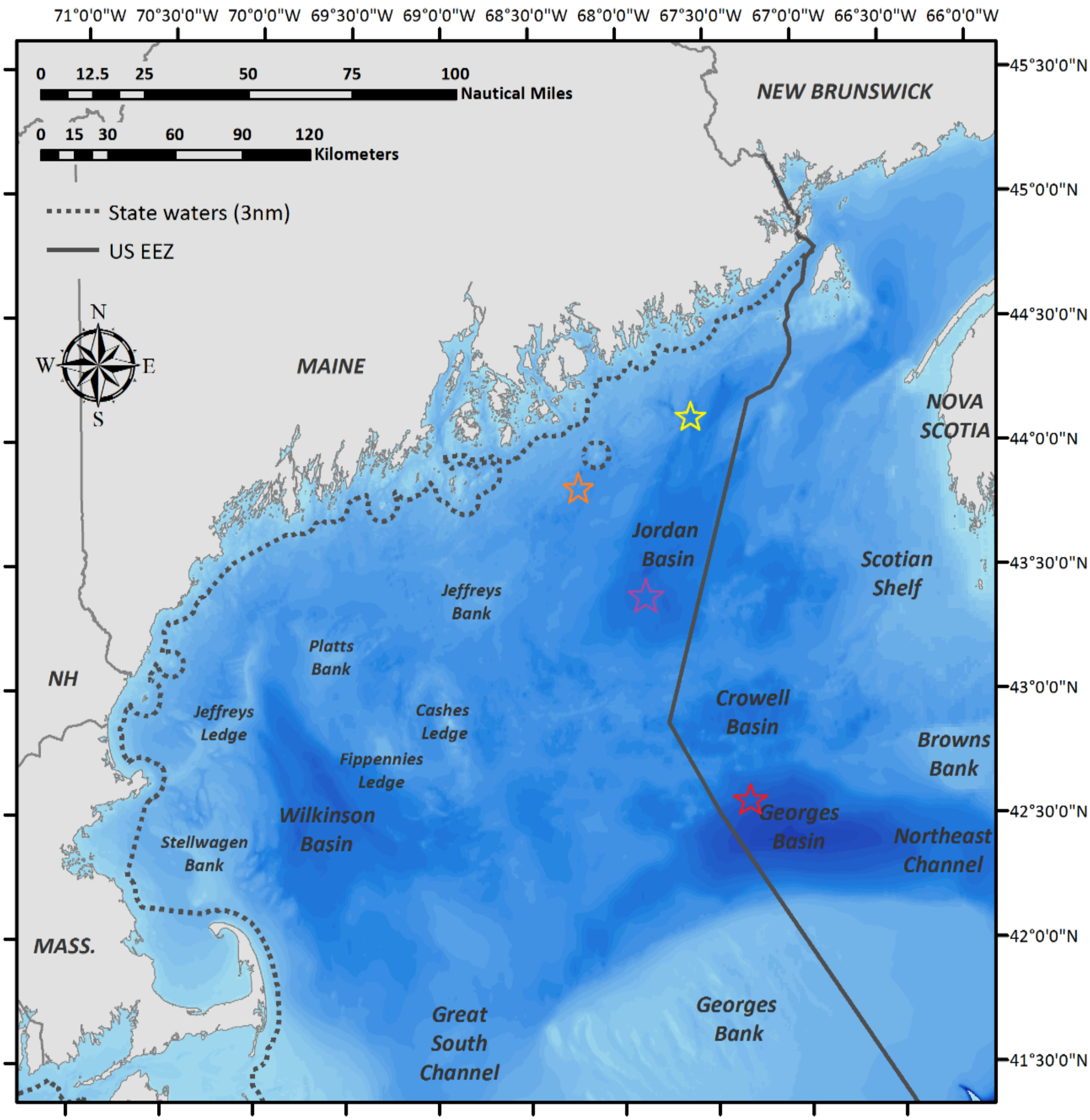
Gulf of Maine

The Gulf of Maine is an enclosed coastal sea, bounded on the east by Browns Bank, on the north by the Nova Scotian Shelf, on the west by the New England states, and on the south by Cape Cod and Georges Bank. The Gulf of Maine is glacially derived, and is characterized by a system of deep basins, moraines and rocky protrusions with limited access to the open ocean (Map 38). This geomorphology influences complex oceanographic processes that in turn produce a rich biological community.

The Gulf of Maine's geologic features, when coupled with vertical variations in water properties, result in a great diversity of habitat types. There are 21 distinct basins separated by ridges, banks, and swells. The three largest basins are Wilkinson, Georges, and Jordan. Corals are found in all three basins, although to date observations in Wilkinson Basin are limited to sea pens only. Depths in the basins exceed 250 m, with a maximum depth of over 350 m in Georges Basin which is just north of Georges Bank. The Northeast Channel between Georges Bank and Browns Bank leads into Georges Basin, and is one of the primary avenues for exchange of water between the Gulf of Maine and the North Atlantic Ocean.

In addition to the basins, other locations in the Gulf of Maine containing deep-sea coral habitats include rocky areas south of Mt. Desert Island and the Outer Schoodic Ridge, which runs southwest to northeast about 20 nm offshore the eastern Maine coast.

Map 38 – Major features of the Gulf of Maine.



Notes: Locations with coral management alternatives are indicated with stars (yellow – Outer Schoodic Ridge, orange – Mt. Desert Rock, purple – western Jordan Basin, red – Georges Basin). While most of Georges Basin lies in Canadian waters, Lindenkohl Knoll is west of the EEZ boundary.

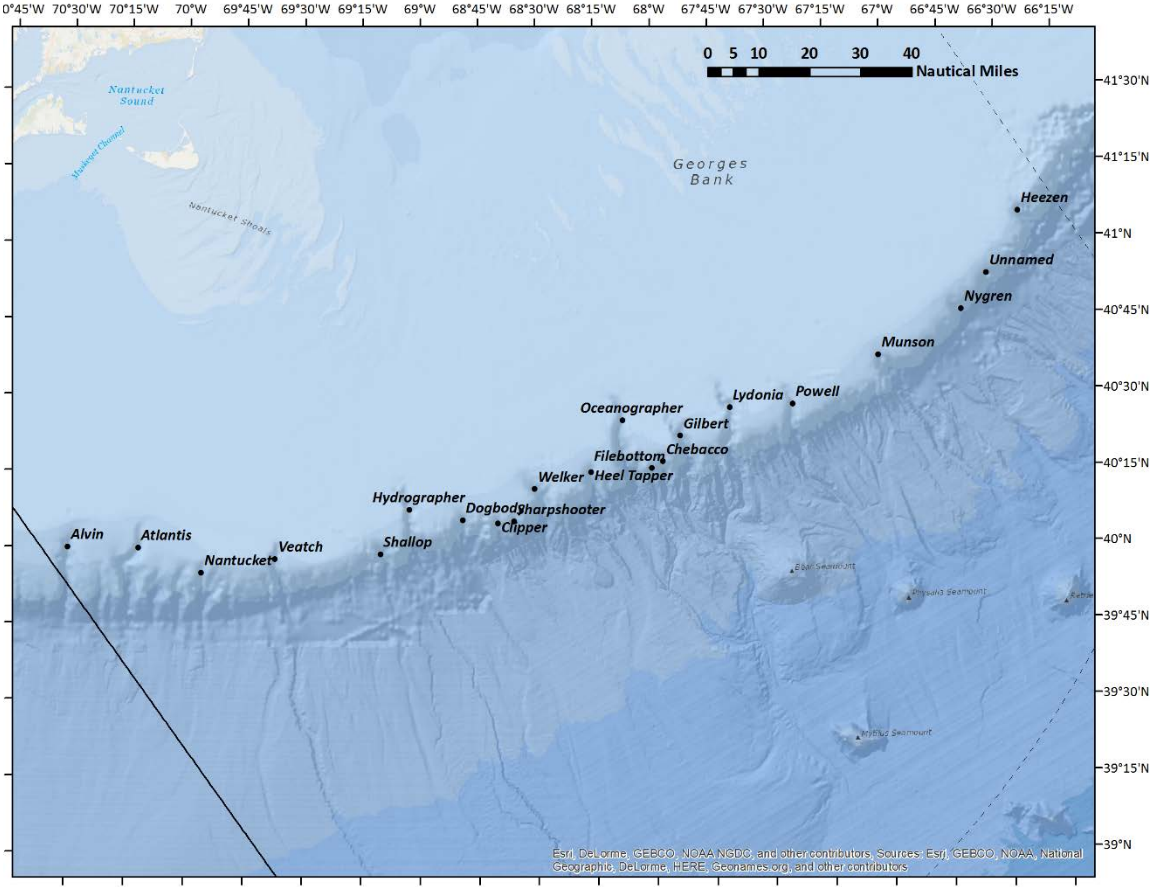
Continental slope, canyons, and seamounts

The continental slope extends from the continental shelf break, at depths between 60-200 m, eastward to a depth of 2,000 m. The width of the slope varies from 10-50 km, with an average gradient of 3-6°; however, local gradients can be nearly vertical. The base of the slope is defined by a marked decrease in seafloor gradient where the continental rise begins. The morphology of the present continental slope appears largely to be a result of sedimentary processes that occurred during the Pleistocene, including, 1) slope upbuilding and progradation by deltaic sedimentation principally during sea-level low stands; 2) canyon cutting by sediment mass movements during and following sea-level low stands; and 3) sediment slumping. This video includes a three-dimensional visualization of the shelf/slope region and shows some of the coral habitats found in the canyons and on the seamounts: http://www.whoi.edu/visualWHOI/deep-water-corals-in-the-northeast-canyons.

Sediments become progressively finer with increasing depth and distance from land, although in some areas submarine canyons channel coarser sediments onto the continental slope and rise. A “mud line” occurs on the slope at a depth of 250-300 m, below which fine silt and clay-size particles predominate. Localized coarse sediments and rock outcrops are found in and near canyon walls, and occasional boulders occur on the slope because of glacial rafting. Sand pockets may also be formed because of downslope movements. Gravity induced downslope movement is the dominant sedimentary process on the slope, and includes slumps, slides, debris flows, and turbidity currents, in order from thick cohesive movement to relatively nonviscous flow. Slumps may involve localized, short, down-slope movements by blocks of sediment. However, turbidity currents can transport sediments thousands of kilometers.

The slope is cut by at least 70 large canyons between Georges Bank and Cape Hatteras and numerous smaller canyons and gullies, many of which may feed into the larger canyon systems. Map 39 shows the canyons in the New England region. Submarine canyons are not spaced evenly along the slope but tend to decrease in areas of increasing slope gradient. Canyons form by erosion of the sediments and sedimentary rocks of the continental margin. They can be classed as high or low relief. Canyons with high relief that are deeply eroded into the continental margin may be U-shaped or V-shaped.

Map 39 – Canyons of the New England region. The unnamed canyon on this chart is now referred to as Kinlan Canyon.



Note: A discrete zone is not recommended in Shallop Canyon as there are no historical or recent observations of corals.

Erosion by glaciers produces U-shaped canyons. These include canyons in Canadian waters in the glacially-eroded Northeast Channel that separates Georges Bank and the Scotian Shelf, but these areas are not under consideration for management in this action. Erosion by rivers, mass wasting, and turbidity currents produces V-shaped canyons. These include the canyons on the southern margin of Georges Bank. These canyons did not experience direct glacial erosion because the glaciers terminated on the bank's northern margin. These V-shaped canyons contain the following sediment types:

- Gravel in canyons that was transported by floating ice
- Outcropping rocks exposed on canyon walls
- Rock rubble on canyon walls and floor from rock falls
- Stiff Pleistocene clay exposed on canyon walls; burrowed by crabs and fish to form "pueblo villages"; burrowed clay can collapse to form rubble on canyon walls and floors
- Veneer of modern sediment partly covering canyon walls
- Modern sediment covering canyon floors

- Modern sand transported onto the canyon floor from the shelf can be formed into bedforms by strong tidal currents in some canyons

Canyons shallowly eroded into the continental margin are produced by erosion/mass wasting events such as slumping or landslides. These types of shallow canyons are found on the shelf edge and upper slope of the southern margin of Georges Bank. Shallow canyons are less likely than deep canyons to have a well-defined canyon axis and floor, and because their walls are not steep, they are less likely than deep canyons to have outcropping rocks. They may contain the following sediment types:

- Gravel in canyons that was transported by floating ice
- Veneer of modern sediment covering canyon walls

Inter-canyon areas on the southern margin of Georges Bank are gently sloping seabed between canyons on the continental slope. They are characterized by both erosional (mass wasting) and depositional processes. Sediment types include:

- Gravel that was transported by floating ice
- Modern sediment

The continental shelf edge (shelf-slope break) represents a transition from a gently sloping shelf (1-2°) to a somewhat steeper continental slope (3-6°), and from coarser-grained shelf sediment to finer-grained upper slope sediment. Sediment types include:

- Modern sediment
- Gravel that was transported by floating ice
- Pebble gravel substrate in areas where sandy sediment has been eroded.

Canyons can alter the physical processes in the surrounding slope waters. Fluctuations in the velocities of the surface and internal tides can be large near the heads of the canyons, leading to enhanced mixing and sediment transport in the area. Shepard et al. (1979) concluded that the strong turbidity currents initiated in study canyons were responsible for enough sediment erosion and transport to maintain and modify those canyons. Since surface and internal tides are ubiquitous over the continental shelf and slope, it can be anticipated that these fluctuations are important for sedimentation processes in other canyons as well. In Lydonia Canyon, Butman et al. (1982) found that the dominant source of low frequency current variability was related to passage of warm core Gulf Stream rings rather than the atmospheric events that predominate on the shelf.

The water masses of the Atlantic continental slope and rise are essentially the same as those of the North American Basin. Worthington (1976) divided the water column of the slope into three vertical layers: deep-water (colder than 4°C), the thermocline (4 - 17°C), and surface water (warmer than 17°C). In the North American Basin, deep-water accounts for two-thirds of all the water, the thermocline for about one-quarter, and surface water the remainder. In the slope water north of Cape Hatteras, the only warm water occurs in the Gulf Stream and in seasonally influenced summer waters. The principal cold water mass in the region is the North Atlantic Deep Water. North Atlantic Deep Water is comprised of a mixture of five sources: Antarctic Bottom Water, Labrador Sea Water, Mediterranean Water, Denmark Strait Overflow Water, and Iceland-Scotland Overflow Water. The thermocline represents a straightforward water mass compared with either the deepwater or the surface water. Nearly 90% of all thermocline water comes from the water mass called the Western North Atlantic Water. This water mass is slightly less saline northeast of Cape Hatteras due to the influx of southward flowing Labrador Coastal Water. Seasonal variability in slope waters penetrates only the upper 200 m of the water column.

In the winter months, cold temperatures and storm activity create a well-mixed layer down to about 100-150 m, but summer warming creates a seasonal thermocline overlain by a surface layer of low density water. The seasonal thermocline, in combination with reduced storm activity in the summer, inhibits vertical mixing and reduces the upward transfer of nutrients into the photic zone.

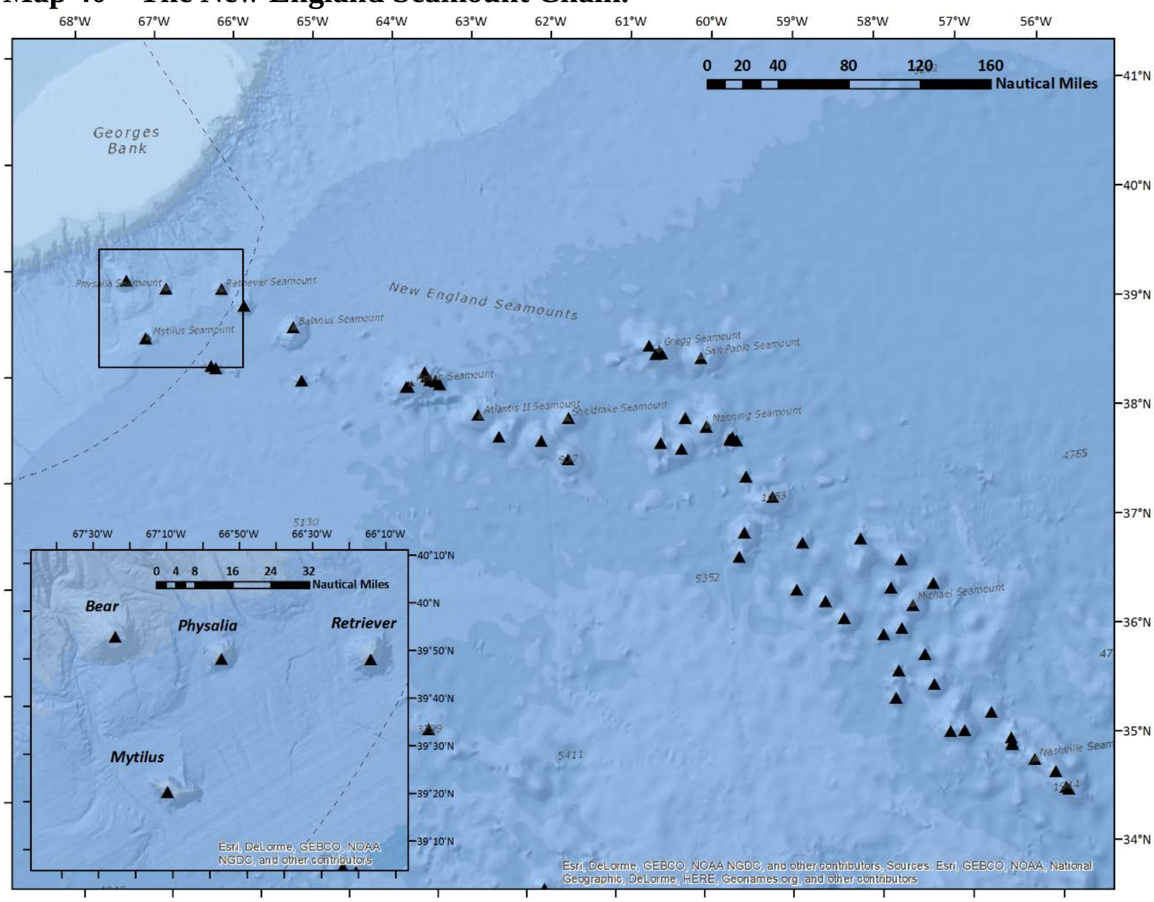
Two currents found on the slope, the Gulf Stream and Western Boundary Undercurrent, together represent one of the strongest low frequency horizontal flow systems in the world. Both currents have an important influence on slope waters. Warm and cold core rings that spin off the Gulf Stream are a persistent and ubiquitous feature of the northwest Atlantic Ocean. The Western Boundary Undercurrent flows to the southwest along the lower slope and continental rise in a stream about 50 km wide. The boundary current is associated with the spread of North Atlantic Deep Water, and it forms part of the generally westward flow found in slope water. North of Cape Hatteras, it crosses under the Gulf Stream in a manner not yet completely understood.

Shelf and slope waters of the northeast region are intermittently affected by the Gulf Stream. The Gulf Stream begins in the Gulf of Mexico and flows northeastward at an approximate rate of 1 m/s (2 knots), transporting warm waters north along the eastern coast of the United States, and then east towards the British Isles. Conditions and flow of the Gulf Stream are highly variable on time scales ranging from days to seasons. Intrusions from the Gulf Stream constitute the principal source of variability in slope waters off the northeastern shelf.

The location of the Gulf Stream’s shoreward, western boundary is variable because of meanders and eddies. Gulf Stream eddies are formed when extended meanders enclose a parcel of seawater and pinch off. These eddies can be cyclonic, meaning they rotate counterclockwise and have a cold core formed by enclosed slope water (cold core ring), or anticyclonic, meaning they rotate clockwise and have a warm core of Sargasso Sea water (warm core ring). The rings are shaped like a funnel, wider at the top and narrower at the bottom, and can have depths of over 2,000 m. They range in size from about 150 - 230 km in diameter. There are 35% more rings and meanders near Georges Bank than in the Mid-Atlantic region. A net transfer of water on and off the shelf may result from the interaction of rings and shelf waters. These warm or cold core rings maintain their identity for several months until they are reabsorbed by the Gulf Stream. The rings and the Gulf Stream itself have a great influence over oceanographic conditions all along the continental shelf.

Seamounts are topographic rises of the seabed that are typically conical in shape, with circular, elliptical, or elongate bases (Yesson et al. 2011). They vary in terms of elevation above the seafloor, with larger features have a relief of over 1,000 m above the adjacent seabed. Large seamounts are often volcanic in origin. Using a criterion of at least 1,000 m height above the seafloor, Yesson et al. (2011) identified over 33,000 seamounts globally based on an analysis of 30 arc-second bathymetry data. The New England seamount chain (Map 40) includes four seamounts within the U.S. EEZ, and additional seamounts further east. Yesson et al. classified seamounts with summits shallower than 1,500 meters as middle-depth seamounts, noting that these features can interact with zooplankton that migrate diurnally in the water column (the deep scattering layer). Bear Seamount falls into this category. Mytilus, Physalia, and Retriever Seamounts are classified as deep seamounts, as they are below the influence of the deep-scattering layer.

Map 40 – The New England Seamount Chain.



Notes: The four seamounts within the U.S. EEZ are shown in the inset. Seamount locations (triangles) are from a global seamount identification study (Yesson et al. 2011).

6.2 Coral species of the New England region

This section describes the data sources used to characterize the coral fauna of New England, lists coral types and known species found in the region, and summarizes the species richness in particular locations, based on sampling conducted to date.

6.2.1 Coral observations

Sources of information on coral species richness and distribution in New England include physical and visual samples, most recently (2012-2017) visual exploratory surveys conducted with remoted operated vehicles and towed camera systems. The primary sources of deep-sea coral records and observations in this region are discussed and referenced in NOAA's State of Deep-Sea Coral and Sponge Ecosystems Reports, (Packer et al. 2007 and Packer et al. 2017). These include geo-referenced presence records and non-geo-referenced presence records (i.e., "observations"). There is also a small amount of deep-sea coral density or abundance data.

The Northeast deep-sea coral database, which was used in habitat suitability modeling (section 6.3), is based largely on geo-referenced presence records from the late 1800s to the present. The database only shows presence data. Unlike NOAA's systematic trawl surveys, coral surveys have been largely exploratory and individually of limited spatial extent, focused primarily in areas where corals are expected to occur based on earlier data or modeling efforts. Also, some specimens in the historical database are not identified to the family, genus, or species level. Despite these caveats, the more recent records in this database, particularly those collected via submersible that document corals in situ, are very useful indicators of coral presence.

The database was updated between 2007 and 2013 by incorporating taxonomic changes and adding additional presence records gleaned from museum collection databases and other data mining activities. Museum records were obtained from the Smithsonian Institution's National Museum of Natural History collection, which includes records of coral taxa collected from various research surveys, 1873 through the present, and from other collections. Other records were added based on the NOAA-Ocean Explorer 2003 *Mountains in the Sea* expeditions to the New England Seamounts. Additional records of sea pens (especially *Pennatula aculeata*) collected between 1956 and 1984 were compiled from various sources (e.g., Langton et al. 1990). Records of new species of soft corals, mostly from Bear and Retriever seamounts, with some from the submarine canyons off New England, were obtained from recently published literature (Cairns et al. 2007, Thoma et al. 2009, Pante and Watling 2011, Watling et al. 2011). New records of antipatharians (black corals) were also obtained from recently published seamount literature (Thoma et al. 2009). The major coral datasets covered by this database are summarized in Table 10.

Recent survey work, which was used in the development of this amendment and will be added to the database in time, includes towed camera, remotely operated vehicle (ROV), and autonomous underwater vehicle (AUV) dives conducted from 2012 to 2017 (Table 11). These recent dives cover many additional areas and are a much more comprehensive inventory of coral habitats compared with the previous database. All of these survey technologies are capable of collecting visual samples, and many of the survey gears were able to collect physical specimens as well. Different survey gears have distinct capabilities and advantages (Kilgour et al 2014) and are used for various reasons in different settings. For example, AUVs have fewer support vessel needs than ROVs, may be easier to deploy and retrieve, and can be used to survey a larger area more quickly. While ROVs, towed camera sleds, and manned submersibles require additional vessel support and move more slowly than AUVs, they can be used to study areas at a very fine spatial scale and collect physical samples. With the exception of the 2012 cruise on Physalia Seamount, which used AUV technology, all of the recent cruises used either towed camera systems or ROVs. Because so much data are gathered during each dive, detailed analyses of many of these dives are still in progress, but high level classifications of geological and biological habitats are presently available to inform management decisions.

Table 10 – Data sources for the Northeast Region deep-sea coral database (includes records through 2007)

Dataset	Citation
Deichmann, 1936	Deichmann, Elisabeth, 1936, The Alcyonaria of the western part of the Atlantic Ocean: Memoirs of the Museum of Comparative Zoology at Harvard College, v. 53, 317 p.
Hecker et al., 1980, 1983	These reports were prepared for Minerals Management Service in the early 1980s. Several canyons and slope areas were surveyed via submersible and towed camera sled. Hecker, B., Blechschmidt, G., and Gibson, P. 1980. Epifaunal zonation and community structure in three mid- and north Atlantic canyons—final report for the canyon assessment study in the mid- and north Atlantic areas of the U.S. outer continental shelf: U.S. Department of the Interior, Bureau of Land Management Monograph, 139 p. Hecker, B., et al. 1983. Final Report – Canyon and Slope Processes Study. Prepared for U.S. Department of the Interior, Minerals Management Service. Contains three volumes: Vol. I, Executive Summary; Vol. II, Physical Processes; and Vol. III, Biological Processes.
NEFSC HUDMAP	Records from 2001, 2002, and 2004 video samples taken near the head of Hudson Canyon between 100-200 m depth. Corals sampled include the sea pen *Stylatula elegans* and the stony coral *Dasmosmilia lymani*.
NEFSC Sea Pens	Records of sea pens compiled from various sources, including submersible surveys, trawl surveys, and towed camera surveys. Data collected between 1956 and 1984.
NES CR Dives	These data summarize dives locations of samples collected during NOAA Ocean Explorer "Mountains in the Sea" cruises to the New England seamounts during 2003 and 2004.
Smithsonian National Museum of Natural History	Records off all coral types from various research vessel surveys conducted from 1873 through present. Surveys conducted in GOM as well as along shelf/slope break on Georges Bank and in Mid-Atlantic Bight.
Theroux and Wigley	Theroux, Roger B. and Wigley, Roland L., 1998, Quantitative composition and distribution of the macrobenthic invertebrate fauna of the continental shelf ecosystems of the northeastern United States. NOAA Technical Report NMFS 140: 240.
US Fish Commission	Records for *Dasmosmilia lymani* off NJ/VA; collected in the 1880s
VIMS for BLM/MMS	Mostly *Dasmosmilia lymani* records; fewer records of *Stylatula elegans*; records from mid-late 1970s; collected for Minerals Management Service by Virginia Institute of Marine Science

Dataset	Citation
Watling et al, 2003	Watling, L., Auster, P.J., Babb, I., Skinder, C., and Hecker, B., 2003, A geographic database of deepwater alcyonaceans of the northeastern U.S. continental shelf and slope: Groton, National Undersea Research Center, University of Connecticut, Version 1.0 CD-ROM.
Yale University Peabody Museum Collection	Yale University Peabody Museum Collection, Yale Invertebrate Zoology—Online Catalog: accessed July 2007. Current url is: http://collections.peabody.yale.edu/search/Search/Advanced?collection=Invertebrate%20Zoology

Table 11 – Recent deep-sea coral oriented cruises within the New England region (2012-2017)

Year	Cruise Dates	Cruise Number	Vessel	Gear	Tows (#)[a]	Locations
2012	5-6 Oct		*Scarlett Isabella*	REMUS 6000 AUV	2	Physalia Seamount
2012	7-17 Jul	HB1204	*Bigelow*	TowCam	11	Veatch Canyon (3), Gilbert Canyon (8)
2013	11-24 Jul	ISIS2_2013	*Connecticut*	ISIS2	40	Western Jordan Basin (18), Blue Hill Bay (3), Monhegan (5), Schoodic Ridges (9), Sommes Sound (4), test tow of tethering system
2013	9-23 Jun	HB1302	*Bigelow*	TowCam	16	Powell Canyon (6), Munson Canyon (7), minor Canyon between Powell and Munson (2), Munson-Powell intercanyon area (1)
2013	8-25 Jul	EX1304L1	*Okeanos*	D2	12	Alvin Canyon (2), Atlantis Canyon (2), Hydrographer Canyon (2), NE Seep2 (1), NE Seep3 (1), USGS Hazard 2 (1), USGS Hazard 4 (1), NE Seep (1), Veatch Seeps (1)
2013	31 Jul-16 Aug	EX1304L2	*Okeanos*	D2	14	Heezen Canyon (2), Lydonia Canyon (1), Lydonia-Powell intercanyon area (1), Mytilus Seamount (2), Nygren Canyon (2), Nygren-Heezen intercanyon (1), Oceanographer Canyon (2), Minor canyon next to Shallop Canyon (1), Welker Canyon (1), USGS Hazard 5 (1)
2014	23 Jul-6 Aug	K2_2014	*Connecticut*	Kraken2	21	Outer Schoodic Ridge (8), western and central Jordan Basin (11), Stellwagen Bank (1), Wilkinson Basin (1)
2014	18 Jun-1 Jul	HB1402	*Bigelow*	ROPOS	7	Nygren Canyon (2), Heezen Canyon (3), minor Canyon btw Nygren and Heezen (1), Jordan Basin (1)
2014	23 Sep-6 Oct	EX1404L3	*Okeanos*	D2	4	Nantucket Canyon (1), Physalia Seamount (1), Retriever Seamount (1), unnamed canyon east of Veatch (1)

Year	Cruise Dates	Cruise Number	Vessel	Gear	Tows (#)[a]	Locations
2015	1-10 Jul	ISIS2_2015	*Connecticut*	ISIS2	26	Outer Schoodic Ridge (4), Mount Desert Rock (4), Georges Basin and Lindenkohl Knoll (9), West Wilkinson Basin (5), Stellwagen Bank (1), Chandler Bay (3)
2015	27 Jul-7 Aug	HB1504	*Bigelow*	TowCam	23	Dogbody Canyon (3), Chebacco Canyon (5 – dives 4 and 5 repeated), Heel Tapper (3), Filebottom Canyon (4 – dive 8 repeated), Sharpshooter Canyon (2), Welker Canyon (4 – dive 15 repeated), Clipper Canyon (2)
2017	8 -22 Jun	HB1703	*Bigelow*	ROPOS	6	Minor canyon between Munson and Nygren (3), minor canyon between Nygren and Heezen (1), Western Jordan Basin (1), Southwest of Grand Manan Bank (1)

[a] Number of tows in New England locations only; some cruises included tows in the Mid-Atlantic region or in Canadian waters.

These recent surveys have greatly expanded our knowledge of coral species richness and distribution in New England. Dive locations were often selected by identifying topographic features of interest on maps generated from high-resolution multibeam or side-scan sonar data. To guide survey efforts and better understand the seafloor terrain in the canyons, the Atlantic Canyons Undersea Mapping Expeditions (ACUMEN) program was developed to generate integrated, coherent digital terrain model for the Atlantic shelf/slope region. Between February and August 2012, NOAA ships *Ferdinand R. Hassler* and *Okeanos Explorer* collected high-resolution bathymetry data that was quickly processed into mapping products. The data from this project are used throughout this amendment in mapping and analysis. Despite the relatively large number of cruises and dives conducted, many areas of the canyons, seamounts, and Gulf of Maine remain unexplored. Thus, survey results, combined with terrain data and suitability model outputs, are the best way to understand the likely distribution of corals in the region. Additional details of particular surveys listed in Table 11 are summarized below.

The 2012 ACUMEN field efforts finished with a July survey aboard the FSV *Henry B. Bigelow* (HB1204). The goals of the Bigelow mission were to survey and ground-truth known or suspected deep-sea coral habitats associated with the submarine canyons off the edge of the Northeastern U.S continental shelf/slope, and included (1) characterizing benthic habitats and identifying new areas where deep-sea corals and sponges were present; (2) initial ground-truthing of areas predicted to be coral "hotspots" based on data and outputs provided from the deep-sea coral habitat suitability model; (3) ground-truthing newly collected high resolution (25-50 m) continental slope bathymetric maps created from the multibeam data collected during the ACUMEN cruises; and, (4) ground-truthing historical deep-sea coral records. Using the Woods Hole Oceanographic Institution's (WHOI) towed camera system (TowCam), three main canyon areas were targeted, including Veatch and Gilbert Canyons off New England and the rim of an unnamed canyon northeast of Veatch. Gilbert Canyon in particular was identified as a deep-sea coral "hotspot" by the habitat suitability model; all three main canyon areas were either under-explored or unknown with regards to deep-sea coral and sponge occurrences. During the 2012 Bigelow mission, there were 18 TowCam tows and over 38,600 high resolution photos taken at 10 second intervals during the dives, along with concurrent sampling of environmental data (e.g., depth, temperature, salinity) to characterize benthic and deep-sea coral/sponge habitats. Each bottom image was visually screened for corals, sponges, and fish, and presence/absence information was logged for each image.

These initial survey efforts were an important precursor to the 2013-2015 NOAA Deep Sea Coral Research and Technology Program (DSCRTP) Northeast fieldwork initiative. The overall purpose of the initiative was to locate, survey, and characterize deep-sea coral and sponge communities in this region. The work was guided by the Northeast Fieldwork Planning Team and implemented by NOAA scientists in collaboration with other NOAA line offices, other government agencies (including the Canadian Department of Fisheries and Oceans), and researchers from academic institutions. The major objectives included:

- Assisting resource managers by characterizing the deep-sea coral and sponge ecosystems and determining the distribution, abundance, and diversity of deep-sea corals/sponges in select areas of the continental slope, including the submarine canyons, the seamounts within the EEZ, and select areas of the Gulf of Maine where major structure forming corals/sponges may or were known to exist. Establishing the spatial extent of corals/sponges in these areas, their scales of patchiness, and correlation with substrate features.
- Collecting specimens, where possible, for taxonomic analyses, age and growth studies, genetic analyses, and reproduction studies.
- Using the deep-sea coral/sponge survey and distribution data to refine the next iterations of the Northeast's deep-sea coral habitat suitability model; conversely, the model would assist in choosing survey sites and thus be continuously "field tested" and ground-truthed.
- Continuing collaborative work with other NOAA line offices (Oceanic and Atmospheric Research, Office of Exploration and Research; National Ocean Service, Office of Coast Survey) to obtain high resolution multibeam maps and data of the Northeast shelf, slope, and seamounts where corals/sponges are known to or may occur.
- Assisting the NEFSC groundfish and shellfish surveys and the Northeast Fisheries Observer Program in better identifying and quantifying their deep-sea coral and sponge bycatch.

By combining DSCRTP resources with other partners within and outside of NOAA, leveraging funding, and employing a wide range of research tools, the initiative advanced deep-sea coral science and management through three major fieldwork projects, which included:

1. Surveys and exploration of coral/sponge habitats in submarine canyons, slope areas, and seamounts off New England and the Mid-Atlantic.
2. Characterizations of seafloor communities in the U.S. and Canadian transboundary Gulf of Maine region and on the U.S. and Canadian continental margin.
3. Surveys of northern Gulf of Maine (U.S.) habitat areas for deep-sea corals and sponges.

Tow Cam surveys aboard the NOAA *FSV Henry B. Bigelow* occurred every summer from 2013-2015 off New England and the Mid-Atlantic, targeting areas in and around submarine canyons. Scientists collected still images from all major and some minor canyons not previously surveyed by the other recent expeditions. Cruise HB1302 (2013) covered Munson and Powell Canyons off New England. Cruise HB1404 surveyed mid-Atlantic areas only. During Cruise HB1504, seven New England minor canyons were surveyed.

Also during 2013, 31 ROV dives (494-3271 m) over two cruises were conducted from the NOAA Ship *Okeanos Explorer* (Cruise EX1304, Legs 1 and 2). A variety of broad-scale habitat features, including 11 canyons in the New England and Mid-Atlantic regions (Heezen, Nygren, Lydonia, Oceanographer, Welker, Hydrographer, Atlantis, Alvin, Block, two unnamed canyons), open areas on the continental slope and intercanyon areas, Mytilus Seamount, and three cold seeps (1053–1484 m) were surveyed. The ROV transects ranged from 300 to 2200 m in length. During September and October 2014, the NOAA *RV Okeanos Explorer* returned to the region and surveyed two seamounts off New England and several canyons off both New England and the Mid-Atlantic (Cruise EX1404, "Our Deepwater Backyard"). Sixteen *ROV Deep Discoverer* dives were conducted during EX1404, and high-resolution multibeam sonar data covering 36,200 km^2 of seafloor was collected. Full descriptions of the dives can be found at: http://oceanexplorer.noaa.gov/okeanos/explorations/ex1404/welcome.html. The areas surveyed off New England included Physalia and Retriever Seamounts (see seamount section below), Nantucket Canyon, and an un-named, minor canyon east of Veatch Canyon.

NOAA scientists collaborated with Canadian academic partners and Canada's Department of Fisheries and Oceans to characterize coral communities in the transboundary Gulf of Maine region and along the continental margin south of Georges Bank in 2014, and again in 2017. These international collaborations enabled the U.S. and Canadian science teams, each with limited resources, to establish a better understanding of shared waters in the Gulf of Maine and along the continental margin and slope. Using the Canadian *ROV ROPOS* aboard *FSV Henry B. Bigelow*, the project teams collected video, still images, and coral samples from Nygren and Heezen canyons and three minor canyons in U.S. waters; Corsair and Georges canyons and the Northeast Channel Coral Conservation Area in Canada; and both sides of the international boundary in Jordan Basin, Gulf of Maine.

The goals of 2013-15 Gulf of Maine exploratory surveys, undertaken in partnership with the Universities of Connecticut and Maine, included:

- Delineating the spatial extent of deep-sea coral habitats at depths about 200 m in and around the proposed management areas;
- Characterizing deep-sea coral community structure and composition, including the abundance, density, size and size classes of coral;
- Documenting fauna found near or associated with the coral and their habitats, especially federally managed species;
- Collecting specimens for taxonomy, reproductive analyses, aging/growth, and genetics;
- Documenting anthropogenic impacts to these habitats;
- Using the survey results to directly inform NEFMC coral management.

Previous deep-sea coral exploratory surveys and seafloor mapping in the Gulf of Maine guided the selection of survey sites in 2013. Initial deep-sea coral surveys using ROVs in 2002 and 2003 documented a limited number of locations in Western Jordan Basin and around Mount Desert Rock with dense coral garden communities at about 200 m (Auster 2005, Watling and Auster 2005). Deep-sea corals were found on rocks, boulders, ridges and walls extending above the surrounding fine-grained sediments. During a cruise aboard the NOAA Ship *Ronald H. Brown* during 2005, preliminary multibeam bottom sonar data was collected in Western Jordan Basin and revealed that hard bottom in the immediate area around one of the sites surveyed for corals in 2002-2003 (known as “114 Bump”) was more spatially extensive than indicated by existing bathymetry.

In 2013-2015, two different camera platforms on the *RV Connecticut* were used to assess the presence and composition of coral communities in the Gulf of Maine: the towed camera sled ISIS 2 (2013, 2015) and ROV Kraken 2 (2014); both systems had high-definition still and video cameras, and the ROV could collect specimens. For the 2013 survey, using a bathymetric map created from the 2005 multibeam bottom sonar data and a detailed bathymetric chart of the Jordan Basin-Mount Desert Rock-Schoodic Ridge regions (Fisheries and Oceans Canada LC 4011), areas of steep topographies in depth ranges where corals were expected to occur (about 200 m) were selected for exploration. Thirty-five ISIS 2 camera tows were conducted in four areas: Western Jordan Basin, near Mount Desert Rock, on Outer Schoodic Ridge, and off Monhegan Island.

High quality multibeam data were collected in the region after the initial 2013 survey. Maps of the two primary survey areas, Western Jordan Basin and Outer Schoodic Ridge, were produced during a collaborative effort with the Ecosystem Monitoring group of the NEFSC and NOAA's Office of Exploration and Research during the fall 2013 ecosystem monitoring cruise aboard the NOAA Ship *Okeanos Explorer*. A map of a Central Jordan Basin dive site, next to the U.S.-Canada boundary, was also produced during the June 2014 joint U.S.-Canadian deep-sea coral cruise on the *FSV Bigelow*. Selection of ROV dive locations in 2014 was based on topographic features shown in these detailed maps. Based on these data, 18 ROV dives in 2014 re-explored areas in Western Jordan Basin and Outer Schoodic Ridge, along with one dive in Central Jordan Basin near and north of the U.S./Canadian dive site.

For 2015, merged bathymetric data (combined regional hydrographic survey data and site specific multibeam coverages) for the larger Gulf of Maine region at a finer scale then available on bathymetric charts, along with resultant slope maps, facilitated exploration in areas beyond existing multibeam in Western Jordan Basin and Outer Schoodic Ridge regions. An area was also surveyed on the northern edge of Georges Bank, down into Georges Basin, where corals had been previously seen during a 1995 submersible survey of seafloor geology.

Detailed analyses of video and still images to determine coral and sponge distributions in relation to geology, associated species, and coral size structure are ongoing. The 2014 *ROV Kraken 2* dives in Outer Schoodic Ridge and western and central Jordan Basin collected specimens of coral and other invertebrates for studies on deep-sea coral reproduction, population genetics, aging and growth, and taxonomy.

During 2017, multibeam backscatter and bathymetry data were collected in Georges Basin (Lindenkohl Knoll) during a cruise on the NOAA Ship *Thomas Jefferson*. These data could inform future deep-sea coral management in Georges Basin. The *FSV Bigelow* also conducted mapping operations during 2017 near both Outer Schoodic Ridge and Mt. Desert Rock.

6.2.2 Species richness

Deep-sea corals in the northwest Atlantic are a diverse assortment of two Anthozoan subclasses. The subclass Hexacorallia (Zoantharia) includes the hard or stony corals (order Scleractinia) and the black corals (order Antipatharia), and the subclass Octocorallia (Alcyonaria or octocorals) includes the true soft corals and gorgonians (order Alcyonacea) as well as the sea pens (order Pennatulacea). Some taxonomists have assigned the gorgonians to a separate order, Gorgonacea, but they are often combined, and that convention is adopted in this document (Bayer 1981, Daly et al. 2007; McFadden et al 2010). “Octocoral” is an umbrella term for the true soft corals, gorgonians, and sea pens, but is avoided here because the soft corals and gorgonians are generally distinct from the sea pens in terms of their habitat affinities, morphology, and susceptibility to fishing gear impacts. Coral taxonomy is an active field of research, and continues to evolve as additional specimens are collected, and genetic analyses allow for discrimination between morphotypes.

The following four sections describe the species richness of corals in New England, grouped by taxonomic order. Some of these species are known to occur in the region only because of recent surveys. In the tables below, the genus and species names are listed in italics. The abbreviation ‘sp.’ indicates that the listed coral was only resolved to genus. “Spp.” indicates it may be one of several species. Names following the species and genus refer to the author(s) who described the species. When this name is in parentheses, the species name has been changed since it was originally described. A question mark preceding the genus or species name indicates that the identification at this taxonomic level is probable but not confirmed. Species that thus far have only been found or described from the Mid-Atlantic region are not included in these tables.

6.2.2.1 True soft corals and gorgonians (Order Alcyonacea)

Along with the sea pens, which belong to a different taxonomic order and are discussed separately below, true soft corals and gorgonians are members of the subclass Octocorallia. The octocorals have polyps that are are subdivided into eight mesenteries, or spaces, each of which gives rise to a tentacle (Watling et al. 2011). Combining true soft corals and gorgonians together, eleven families are represented in New England: Acanthogorgiidae, Alcyoniidae, Anthothelidae, Chrysogorgiidae, Clavulariidae, Corallidae, Isididae, Nephtheidae, Paragorgiidae, Plexauridae, and Primnoidae. All of the species in these families are colonial (Watling et al. 2011). Table 12 lists true soft corals and gorgonians found in the New England region, by family affiliation. A version of this table that shows species in both the New England and Mid-Atlantic regions is found in Packer et al. (2017).

These corals exhibit a variety of forms. True soft corals in the family Clavulariidae grow from ribbon-like stolons, while those in the families Alcyoniidae and Nephtheidae are fleshy and lack an axial skeleton. Many of their relatives are found in shallow reef environments. True soft corals in the families Anthothelidae, Corallidae, and Paragorgiidae have an axial skeleton composed of sclerites. Gorgonian corals in the families Acanthogorgiidae, and Plexauridae have a fan-like shape, with an organic central axis that has varying amounts of calcareous material, while those in the families Chrysogorgiidae, Isididae (bamboo corals), and Primnoidae are also fan-shaped, but have a solid axis comprised of large amounts of calcareous material.

Watling and Auster (2005) noted two distinct distributional patterns for alcyonaceans. Most are deepwater species that occur at depths > 500 m; these include corals in the genera *Acanthogorgia*, *Acanella*, *Anthomastus*, *Anthothela*, *Clavularia*, *Lepidisis*, *Radicipes*, and *Swiftia*. Others occur throughout upper continental slope and deep shelf waters, including *Paragorgia arborea*, *Primnoa resedaeformis*, and species in the genus *Paramuricea*.

Table 12 – True soft corals and gorgonians (Order Alcyonacea) of the New England region.

Family	***Species***	***References***
Acanthogorgiidae	*Acanthogorgia armata* Verrill, 1878	Hecker and Blechschmidt 1980; Hecker et al. 1980; Opresko 1980; Malahoff et al. 1982; Watling and Auster 2005; Watling et al. 2011; Auster et al. 2013, 2014; Quattrini et al. 2015
Alcyoniidae	*Alcyonium digitatum* Linné, 1758	Watling and Auster 2005, Watling et al. 2011
	Anthomastus agassizii Verrill, 1922	Hecker and Blechschmidt 1980; Hecker et al. 1980, 1983; Opresko 1980; Valentine et al. 1980; Maciolek et al. 1987a; Hecker 1990; Moore et al. 2003; Watling and Auster 2005; Watling et al. 2011

Family	***Species***	***References***
	Anthomastus grandiflorus Verrill, 1878	Hecker and Blechschmidt 1980; Hecker et al. 1980; Opresko 1980; Watling and Auster 2005, Watling et al. 2011
	Anthomastus (sp.?)	Quattrini et al. 2015
Anthothelidae	*Anthothela grandiflora* (Sars, 1856)	Hecker et al. 1980; Opresko 1980; Watling and Auster 2005
Chrysogorgiidae	*Chrysogorgia tricaulis* Pante and Watling, 2011	Thoma et al. 2009, Pante and Watling 2011
	Chrysogorgia agassizii (Verrill, 1883)	Hecker et al. 1983; Watling and Auster 2005; Watling et al. 2011
	Chrysogorgia sp.	Quattrini et al. 2015
	Metallogorgia melanotrichos (Wright and Studer, 1889)	Mosher and Watling 2009; Thoma et al. 2009; Watling et al. 2011; Quattrini et al. 2015
	Iridogorgia pourtalesii Verrill, 1883	Watling and Auster 2005
	Radicipes gracilis (Verrill, 1884)	Moore et al. 2004; Watling and Auster 2005; Thoma et al. 2009
Clavulariidae	Stoloniferan sp. 1 (yellow) [Family Clavulariidae?]	Quattrini et al. 2015
	Stoloniferan sp. 2 (white) [Family Clavulariidae?]	Quattrini et al. 2015
	Clavularia modesta (Verrill, 1874)	Watling and Auster 2005
	Clavularia rudis (Verrill, 1922)	Hecker and Blechschmidt 1980; Hecker et al. 1980; Opresko 1980; Watling and Auster 2005
Coralliidae	*Hemicorallium cf. bathyrubrum* (Simpson and Watling, 2011) (= *Corallium bathyrubrum* Simpson and Watling, 2011)	Quattrini et al. 2015
	?Hericorallium Gray 1867	Quattrini et al. 2015
Isididae	*Acanella arbuscula* (Johnson, 1862)	Hecker and Blechschmidt 1980; Hecker et al 1980; Opresko 1980; Maciolek et al. 1987a, b; Hecker 1990; Theroux and Wigley 1998; Watling and Auster 2005; Thoma et al 2009
	Keratoisis grayi Wright, 1869	Watling and Auster 2005; Bear Seamount: Moore et al. 2004; Deep Atlantic Stepping Stones Science Team/IFE/URI/NOAA
	Keratoisis sp. 1	Quattrini et al. 2015
	Keratoisis sp. 2	Quattrini et al. 2015
	Keratoisis sp. 3	Quattrini et al. 2015

Family	***Species***	***References***
	Keratoisis sp. 4	Quattrini et al. 2015
	Keratoisis sp. 5	Quattrini et al. 2015
	Keratoisis spp.	Quattrini et al. 2015
	Lepidisis caryophyllia Verrill, 1883	Moore et al. 2003; Watling and Auster 2005
	Lepidisis sp. 1	Quattrini et al. 2015
	Lepidisis sp. 2	Quattrini et al. 2015
	?Eknomisis Watling and France, 2011	Quattrini et al. 2015
	Keratoisidinae (unbranched)	Quattrini et al. 2015
	Isidella Gray 1857	Quattrini et al. 2015
	Jasonisis Alderslade and McFadden, 2012	Quattrini et al. 2015
	Isididae unknown 1	Quattrini et al. 2015
Nephtheidae	*Duva* [= *Capnella*] *florida* (Rathke, 1806)	Hecker and Blechschmidt 1980; Hecker et al. 1980; Opresko 1980; Maciolek et al. 1987a; Hecker 1990; Watling and Auster 2005; Watling et al. 2011
	Drifa glomerata Verrill, 1869 *(=Capnella glomerata (Verrill, 1869))*	Hecker et al. 1980; Opresko 1980; Watling and Auster 2005; Watling et al. 2011
	Gersemia fruticosa (Sars, 1860)	Hecker and Blechschmidt 1980; Opresko 1980; Watling and Auster 2005
	Gersemia rubriformis (Ehrenberg, 1934)	Watling and Auster 2005
	Nephtheidae Unidentified sp. 1	Quattrini et al. 2015
Paragorgiidae	*Paragorgia arborea* (Linné, 1758)	Wigley 1968; Hecker and Blechschmidt 1980; Hecker et al. 1980; Opresko 1980; Theroux and Grosslein 1987; Theroux and Wigley 1998; Moore et al. 2003; Watling and Auster 2005
	Paragorgia ?johnsoni Gray, 1862	Quattrini et al. 2015
	Paragorgia sp.	Quattrini et al. 2015
	Paragorgia/Sibogagorgia sp. 1	Quattrini et al. 2015
Plexauridae	*Paramuricea grandis* Verrill, 1883	Hecker and Blechschmidt 1980; Hecker et al. 1980, 1983; Opresko 1980; Valentine et al. 1980; Watling and Auster 2005; Thoma et al 2009
	Paramuricea placomus (Linné, 1758)	Watling and Auster 2005
	Paramuricea biscaya Grasshoff, 1977	Watling et al. 2011; Thoma 2013
	Paramuricea n. sp.	Watling and Auster 2005

Family	*Species*	*References*
	Paramuricea spp.	Quattrini et al. 2015
	Paramuricea/Placogorgia sp. 1	Quattrini et al. 2015
	Swiftia casta (Verrill, 1883)	Moore et al. 2003; Watling and Auster 2005
	Swiftia ?pallida Madsen, 1970	Quattrini et al. 2015
	Plexauridae Unidentified sp. 1	Quattrini et al. 2015
Primnoidae	*Primnoa resedaeformis* Gunnerus, 1763)	Hecker and Blechschmidt 1980; Hecker et al. 1980, 1983; Opresko 1980; Valentine et al. 1980; Theroux and Grosslein 1987; Theroux and Wigley 1998; Moore et al. 2003; Cairns and Bayer 2005; Watling and Auster 2005; Heikoop et al. 2002
	Thouarella grasshoffi Cairns, 2006	Watling and Auster 2005 = *Thouarella* n. sp.; Cairns 2006, 2007
	Narella laxa Deichmann, 1936	Watling and Auster 2005
	Parastenella atlantica Cairns, 2007	Cairns 2007, Watling et al. 2011
	Calyptrophora antilla Bayer, 2001	Cairns 2007, Watling et al. 2011
	Paranarella watlingi Cairns, 2007	Cairns 2007, Watling et al. 2011, Quattrini et al. 2015
	Convexella ?jungerseni (Madsen, 1944)	Quattrini et al. 2015
	Primnodidae Unidentified sp. 1	Quattrini et al. 2015

6.2.2.2 Sea pens (Order Pennatulacea)

Like the true soft corals and gorgonians, sea pens are also members of the subclass Octocorallia. Almost all sea pens are deepwater species. Generally, the sea pens are associated with soft sediments, and each colony is anchored to the seabed with a fleshy foot. In New England, the most widespread species occur on the continental shelf and include the common sea pen *Pennatula aculeata* (Family Pennatulidae) and the white sea pen *Stylatula elegans* (family Virgulariidae). *P. aculeata* is common in the Gulf of Maine (Langton et al. 1990), and there are numerous records of *Pennatula* sp. on the outer continental shelf as far south as the Carolinas (Theroux and Wigley 1998). *S. elegans* is abundant on the Mid-Atlantic coast outer shelf (Theroux and Wigley 1998). Seven additional families are represented in New England: Anthoptilidae, Funiculinidae, Halipteridae, Kophobelemnidae, Protoptilidae, Scleroptilidae, and Umbellulidae.

Table 13 lists the sea pens that have been documented in New England waters. Some of these identifications are at the genus or even family level only. A more detailed version of this table that applies to both the New England and Mid-Atlantic regions is provided in Packer et al. (2017). Older records of sea pens are drawn from Smithsonian Institution collections and the Wigley and Theroux benthic database (Packer et al. 2007). Nearly all materials from the former source were collected either by the U.S. Fish Commission

(1881-1887) or for the Bureau of Land Management (BLM) by the Virginia Institute of Marine Sciences (1975-1977) and Battelle (1983-1986). These latter collections heavily favor the continental slope fauna. The Wigley and Theroux collections (1955-1974) were made as part of a regional survey of all benthic species (Theroux and Wigley 1998), heavily favoring the continental shelf fauna.

Table 13 – Sea pens (Order Pennatulacea) of the New England region.

Family	Species	References
Anthoptilidae	*Anthoptilum grandiflorum*	US NMNH collection, OBIS; Hecker and Blechschmidt 1980; Opresko 1980, Quattrini et al. 2015
	Anthoptilum murrayi	US NMNH collection, OBIS
	Anthoptilum sp. 1	Quattrini et al. 2015
	Anthoptilum sp. 2	Quattrini et al. 2015
Funiculinidae	*Funinculina armata* Verrill, 1879	US NMNH collection
Halipteridae	*Halipteris (=Balticina) finmarchica* (Sars, 1851)	US NMNH collection as *Balticina*; Hecker and Blechschmidt 1980 and Opresko 1980 as *Balticina*; Quattrini et al. 2015
	?Halipteris Kölliker, 1880	Quattrini et al. 2015
Kophobelemnidae	*Kophobelemnon stelliferum*	US NMNH collection, OBIS; Hecker et al. 1980, 1983; Opresko 1980; Maciolek et al. 1987b
	Kophobelemnon scabrum	US NMNH collection
	Kophobelemnon tenue [may not be a valid species]	US NMNH collection
	Kophobelemnon sp. 1	Quattrini et al. 2015
	Kophobelemnon sp. 2	Quattrini et al. 2015
Pennatulidae	*Pennatula aculeata*	US NMNH collection, OBIS. Hecker et al. 1980, 1983; Hecker and Blechschmidt 1980; Opresko 1980; Moore et al. 2004
	Pennatula grandis	US NMNH collection, OBIS; Hecker et al. 1983
	Pennatula borealis	US NMNH collection, OBIS
	Pennatula sp.	Quattrini et al. 2015
Protoptilidae	*Distichoptilum gracile*	US NMNH collection, OBIS; Hecker et al 1980, 1983; Opresko 1980; Maciolek et al. 1987a; Hecker 1990; Quattrini et al. 2015
	Protoptilum carpenteri Kölliker, 1872 (=*Protoptilum aberrans* Kölliker 1880)	US NMNH collection
Scleroptilidae	*Scleroptilum grandiflorum* Kölliker, 1880 (= *Scleroptilum gracile* Verrill 1884)	US NMNH collection
Umbellulidae (= Ombellulidae)	*Umbellula guentheri* Kölliker, 1880	US NMNH collection
	Umbellula lindahli Kölliker, 1880	US NMNH collection, OBIS
Virgulariidae	*Stylatula elegans*	US NMNH collection, OBIS; Hecker et al. 1980, 1983; Opresko 1980; Pierdomenico et al. 2015

6.2.2.3 Hard (stony) corals (Order Scleractinia)

Hard or stony corals are in the subclass, Hexacorallia, and as their subclass name would suggest, the stony corals have a six-part division, rather than eight like the octocorals (Pechenik 2000). Stony corals (and hexacorallians generally) commonly exhibit solitary body forms, although many are colonial as well (Pechenik 2000). As their common name indicates, these species have substantial hard exoskeletons made from calcium carbonate (sclero is Greek for hard, Pechenik 2000). Some stony corals form reefs or mounds over time, as new colonies overgrow old ones (Pechenik 2000). These reef builders are referred to as the hermatypic corals (Pechenik 2000). Most of the stony corals in New England are non-reef building or ahermatypic (e.g., solitary stony corals such as *Desmophyllum dianthus*), although *Lophelia pertusa* and *Solenosmilia variabilis* are notable exceptions. *L. pertusa* was only recently found in New England waters, but is more commonly known from the Southeastern U.S and Canada, as well as the eastern North Atlantic and elsewhere in the world. Colonies of *L. pertusa* larger than any previously observed off New England were found in the minor canyon between Nygren and Heezen during the 2017 NOAA *FSV Bigelow* cruise. The carbonate skeletons of stony corals are sensitive to changes in ocean chemistry. Assessing the resilience of these species to more acid and warmer waters is an active field of research.

Table 14 lists stony corals found in the New England region. Families with representatives in New England include the Caryophillidae, Dendrophylliidae, Deltocyathidae, Flabellidae, Fungiacyathidae, and Rhizangiidae. A version of this table that applies to both the New England and Mid-Atlantic regions is provided in Packer et al. (2017).

Table 14 – Hard (stony) corals (Order Scleractinia) of the New England region

Family	***Species***	***References***
Caryophillidae	*Caryophyllia ambrosia ambrosia* Alcock, 1898	Cairns and Chapman 2001; Moore et al. 2003
	Dasmosmilia lymani (Pourtales, 1871)	Hecker 1980; Hecker et al. 1983; Maciolek et al. 1987a; Hecker 1990; Cairns and Chapman 2001
	Desmophyllum dianthus (Esper, 1794)	Hecker 1980; Hecker and Blechschmidt 1980; Hecker et al. 1980, 1983; Malahoff et al. 1982; Cairns and Chapman 2001; Moore et al. 2003; Quattrini et al. 2015
	Lophelia pertusa (L, 1758)	Hecker 1980; Hecker and Blechschmidt 1980; Hecker et al. 1980; Cairns and Chapman 2001; Moore et al. 2003; Quattrini et al. 2015
	Premocyathus cornuformis (Pourtalès, 1868)	NMNH 2015
	Solenosmilia variabilis Duncan, 1873	Hecker 1980; Hecker et al. 1983; Cairns and Chapman 2001; Moore et al. 2004; Quattrini et al. 2015

Family	*Species*	*References*
	Vaughanella margaritata (Jourdan, 1895)	Cairns and Chapman 2001; Moore et al. 2003
Deltocyathidae	*Deltocyathus italicus* (Michelotti, 1838)	Cairns and Chapman 2001
Dendrophylliidae	*Enallopsammia profunda* (Pourtales, 1867)	Cairns and Chapman 2001
	Enallopsammia rostrata (Pourtales, 1878)	Cairns and Chapman 2001; Moore et al. 2004
Flabellidae	*Flabellum alabastrum* Moseley, 1873	Hecker 1980; Hecker and Blechschmidt 1980; Hecker et al. 1980, 1983; Maciolek et al. 1987a; Cairns and Chapman 2001; Moore et al. 2003, 2004
	Flabellum angulare Moseley, 1876	Hecker 1980; Hecker and Blechschmidt 1980; Hecker et al. 1980, 1983; Cairns and Chapman 2001; Moore et al. 2003
	Flabellum macandrewi Gray, 1849	Hecker 1980; Hecker and Blechschmidt 1980; Hecker et al. 1980, 1983; Cairns and Chapman 2001; Moore et al. 2003
	Javania cailleti (Duch. and Mich., 1864)	Hecker 1980; Hecker et al. 1983; Cairns and Chapman 2001; Quattrini et al. 2015
Fungiacyathidae	*Fungiacyathus fragilis* Sars, 1872	Cairns and Chapman 2001
Rhizangiidae	*Astrangia poculata* (Ellis and Solander, 1786)	Theroux and Wigley 1998; Cairns and Chapman 2001

6.2.2.4 Black corals (Order Antipatharia)

Like the stony corals, black corals are also members of the subclass Hexacorallia. The black corals, however, are almost all deepwater species, occurring well below 50 m, often with increasing abundance with depth, perhaps to avoid competition with other coral types (Wagner et al. 2012). Black corals are very slow growing and long lived, and while they do not form reefs (ahermatypic), over time some can form dense aggregations or beds, and are therefore important habitat engineers for other invertebrate taxa (Wagner et al. 2012). In other parts of the world, black corals are culturally important, and may be harvested for medicinal purposes, or for making decorative objects such as jewelry (Wagner et al. 2012).

All black corals are colonial, but they have a wide array of body forms, from long, whip shapes to branching structures that may be bushy, feathery, fan like, or shaped like a bottle brush (Wagner et al. 2012). The majority of black corals attach to hard substrates by means of a basal plate, but a small number of species are adapted to anchor in soft sediments (Wagner et al. 2012). They are referred to as black corals because their underlying skeleton is brown to black, although this skeleton is covered by a layer of soft tissue, to which the polyps are attached (Wagner et al. 2012). The outer soft tissues come in a rainbow of colors.

Many of the black coral species occurring in New England, including all of the records in the canyons, are known from recent exploratory surveys conducted since 2013. Prior to these recent explorations, black corals were thought to occur only on the seamounts, but now they are known to be more widespread. Most are members of the family Schizopathidae, identified to the genus level only. A single Leiopathid species is known from Bear Seamount. This lack of taxonomic specificity is not surprising, as black corals are one of the less well studied coral types, and reference specimens are often lacking (Wagner et al. 2012). A version of this table that applies to both the New England and Mid-Atlantic regions is provided in Packer et al. (2017).

Table 15 – Black corals (Order Antipatharia) of the New England region.

Family	Species	References
Leiopathidae	*Leiopathes sp.*	Brugler 2005, Smithsonian Institution
Schizopathidae	*Bathypathes* sp.	Thoma et al. 2009
	Bathypathes sp. 1	Quattrini et al. 2015
	Bathypathes sp. 2	Quattrini et al. 2015
	Parantipathes sp.	Thoma et al. 2009
	Parantipathes sp. 1	Quattrini et al. 2015
	Parantipathes sp. 2 (branched)	Quattrini et al. 2015
	Telopathes magna MacIssac and Best, 2013	Quattrini et al. 2015
	Stauropathes sp. 1	Quattrini et al. 2015
	Unidentified *Schizopathidae* sp. 1	Quattrini et al. 2015

6.2.3 Geographic distribution

The following three sections describe the geographic distribution of corals in New England.

6.2.3.1 Canyons and slope

Deep-sea corals are generally more densely distributed and diverse in the canyons than on the adjacent slope because exposed hard substrates are more common in these settings. The larger canyons especially have hard substrates along most of their axes and walls. Some coral species are generally found only in the canyons, while others that frequently occur on soft substrates, such as *Acanella arbuscula*, are found both in canyons and on the slope.

Recent surveys provide a wealth of new information on the distribution of corals in the canyons. While analyses are ongoing, the results of the 2013 *Okeanos Explorer* survey EX1304 have been published (Quattrini et al. 2015). At least 58 taxa of deep-sea corals were noted, and at least 24 of these had not been documented in this region previously. Broad-scale habitat features and high habitat heterogeneity within features influenced coral assemblages. Quattrini et al. (2015) found no significant differences between deep-sea coral assemblages in continental shelf-breaching canyons vs. canyons confined to the continental slope but did find lower diversity and different faunal assemblages at cold seeps and soft-bottom open slope sites. The canyons often had large patches of deep-sea coral habitat, which also included bivalves, anemones, and sponges. Stony (e.g., *Desmophyllum*, *Solenosmilia*, *Lophelia*) and soft corals were abundant on canyon walls and under and around overhangs. While coral communities were generally uncommon on the open slope and in soft sediments, sea pens and other octocorals occur in these habitat types. Corals and sponges were observed on boulders and rocky outcrops in some open slope and intercanyon areas. At Veatch seeps and on the canyon wall adjacent to the seep community in Nygren Canyon, soft corals and stony cup corals (*Desmophyllum*) were found attached to carbonate substrates.

Quattrini et al. (2015) found that depth was a significant factor influencing the coral assemblages. Although species richness did not change significantly with depth over the range explored by the surveys (494-3,271 m), species composition changed at approximately 1,600-1,700 m. Species composition in the canyons and other areas with hard substrates was significantly dissimilar across this depth boundary. Stony corals and the soft corals *Anthothela* spp., *Keratoisis* sp. 1, and *Paragorgia arborea* occurred at depths < 1,700 m, whereas chrysogorgiids and sea pens were more common at depths >1,700 m. Overall, depth, habitat, salinity and dissolved oxygen explained 71% of the total variation observed in coral assemblage structure (Quattrini et al. 2015). Coral types observed in individual canyons are described below.

There are 11 Northeast database records that fall within **Alvin Canyon**, including observations of stony corals, sea pens, and soft corals. The two shallowest observations are a stony cup coral *Dasmosmilia lymani* and the soft coral *Duva florida*. Both were older records from 1883 such that the exact location of these records is somewhat uncertain. There were two 2013 dives in the Alvin Canyon area at depths ranging from 846 to 927 m (Cruise EX1304L1, dives 9 and 10)[2]. Both the east and west walls were surveyed. The dives traversed a range of soft sediment and rock wall/overhang habitats, and corals were observed during both dives, especially in rocky areas.

There are two Northeast database observations that fall within **Atlantis Canyon**, one stony coral and one sea pen. There were two 2013 dives in Atlantis Canyon (Cruise EX1304L1, dives 7 and 8), at depths ranging from 885 to 1,794 m. Both the east and west walls were surveyed. Corals were observed during both dives. Dive 7 found colonial and solitary stony corals, soft corals, and black corals. A diversity of stony, soft, and black corals, as well as sea pens, were found on Dive 8.

There are seven Northeast database coral observations within **Nantucket Canyon**, including observations of stony corals. During 2014, Cruise EX1404L3 Dive 13 visited the southwestern canyon wall (1,600-1,900 m). Corals observed on a debris field at 1,875 m include the soft corals *Acanthogorgia* and *Anthomastus* and small *Distichoptilum* sea pens. The sea pen *Umbellula* was seen at 1,870 m. At 1,861 m, tall whip-like sea pens had large *Asteronyx* brittle stars clinging to them. At the base of the wall (~1,825 m)

[2] Do not have detailed logs for these dives.

Paramuricea sea fans (with associated *Ophiocreas* brittlestars) were noted. On the wall face were the soft corals *Anthomastus* and *Paramuricea* and the black coral *Bathypathes*. Overall, the wall was sparsely colonized. Other corals observed include bamboo corals (soft corals) *Keratoisis* (1,783 m) *Lepidisis, Acanella,* and *Isidella*; the soft corals *Anthomastus* and *Clavularia* stoloniferous (creeping) coral; *Parantipathes* black coral; and stony cup corals. *Paramuricea* sea fans and *Pennatula* sea pens were observed atop the outcrop. *Chrysogorgia* soft coral colonies appeared at 1,750 m, some with a shrimp associate. *Eknomisis* bamboo coral were seen, as well as different morphs of hexactinellid or glass sponges.

While there are no Northeast database observations of coral presence in **Veatch Canyon**, there have been five recent dives, including three TowCam dives in 2012 (HB1204). During Dive 8, only stony and soft corals were observed, and in a smaller percentage of the collected images compared with the other two dives. Dives 7 and 9, which were in deeper parts of the canyon, had larger percentages of images with corals, and stony corals, soft corals, black corals and sea pens were observed. Overall, between 570-750 m, the canyon has mostly sedimented habitats, with some mud-draped chalky rocks. Between 1,050-1,250 m there are hard-bottom walls dominated by sparsely distributed soft coral *Acanthogorgia* and stony corals *Solenosmilia* and *Desmophyllum*. Between 1,290-1,424 m, the seafloor is dominated by chalky rock bottom intermingled with flat, fully sedimented areas. On the hard substrate (rocks and walls) there is a diverse coral fauna, including the soft corals *Parmuricea*, *Anthomastus*, *Paragorgia*, *Swiftia*, *Clavularia*, *Acanthagorgia,* and bamboo corals; the stony coral *Desmophyllum*; and the black coral *Parantipathes*. On soft sediments at this deeper depth range, cerianthid anemones and the soft coral *Anthomastus* were noted. Overall, black coral abundance increased with depth, and none were observed between 569-751 m. Sea pen occurrence was low throughout.

Cruise EX1404 (2014) explored a small mid-canyon cliff and the main canyon walls in an unnamed, narrow **minor canyon east of Veatch Canyon** (“Okeanos Canyon”). Large boulders at the base of the cliff had a high density of corals, including the soft corals *Anthomastus*, *Paramuricea*, and *Swiftia*, and stony cup corals. Stony cup corals and *Solenosmilla*, black corals (?*Bathypathes*), bamboo coral (*Keratoisis*), and sponges were seen on the wall. Ascending the wall to about 1,395 m, there were many patches of cup corals (*Desmophyllum*) and *Solenosmilia*, the black coral *Parantipathes*, and the soft corals *Clavularia* and *Acanthogorgia*. At 1,385 m, *Keratoisis* bamboo coral and *Paragorgia* ?*johnsoni* were observed. Other corals included the sea pens ?*Distichoptilum* and the black corals *Bathypathes* and *Telopathes*.

There are two Northeast database observations of coral presence within **Hydrographer Canyon**, both soft corals. There have been two recent dives in Hydrographer Canyon (Cruise EX1304L1, dives 5 and 6), where both the east and west walls of the canyon were surveyed. Dive 5 (1,299-1,418 m) found multiple species of stony, soft, and black corals, including some smaller colonies noted as new recruits. Dive 6 (610-907 m) found soft and stony corals, including *Lophelia pertusa*.

Dogbody Canyon has eight Northeast database observations of soft corals. In 2015 (cruise HB1504), tow 1 (558-675 m) found sponges, but corals were uncommon. Tow 2 (894-1,014 m) found abundant and diverse stony (*Desmophyllum*), soft (*Thouarella*, *Paramuricea*, *Acanthogorgia*, *Swiftia*) and black (*Telopathes*?) corals. During tow 3 (1,461-1,620 m), corals were rare with low diversity, and only soft (*Paramuricea*, *Radicipes*?) corals were observed.

Clipper Canyon had one Northeast database observation of soft coral presence. In 2015 (cruise HB1504), sightings of corals were sparse, with soft corals seen during both tow 19 (495-571 m, *Paragorgia*) and tow 20 (1,216-1,455 m, *Paramuricea*).

During cruise HB1504 (2015), tows 16 and 17 were conducted in **Sharpshooter Canyon**, in two of the larger contiguous areas of high slope. No corals were noted during the shallow tow 16 (800-901 m); but the deeper tow, 17 (1,144-1,168 m), found stony corals (*Solenosmilia*) and soft corals (*Paramuricea*).

Welker Canyon had no Northeast database records. On dive 14 of Cruise EX1304L2 (1,377-1,445 m), a high diversity of corals was observed, including at least 17 species in all four major groupings. Three tows during cruise HB1504 (2015) surveyed the walls of the canyon. Tow 13 (559-778 m) found stony corals (*Solenosmilia, Desmophyllum*) and soft corals (*Acanthogorgia, Paragorgia*); tow 14 (851-1,156 m) found stony corals (*Solenosmilia*), soft corals (*Paramuricea, Thouarella*), and black corals (*Telopathes, Bathypathes*?); and tow 15 (1,480-1,650 m) found soft corals (*Paramuricea, Anthomastus*) and black corals (*Parantipathes, Bathypathes*?).

There are no Northeast database observations of coral presence in **Heel Tapper Canyon**. However, there have been recent camera tows during 2015 (Cruise HB1504). Soft corals (*Thourella*, *Paramuricea*, and *Acanella*) were observed at 666-1,444 m depth.

There are a relatively large number of Northeast database observations (150+) within **Oceanographer Canyon**, including observations of soft corals and stony corals, making it one of the best studied locations prior to the recent exploratory surveys. Some additional areas to the west of the canyon have Northeast database observations as well. In addition, there were two recent dives (EX1304L2) on both the eastern and western walls. Dive 3 (983-1,239 m) and Dive 13 (1,102-1,248 m) both encountered diverse habitat types and at least 16 species of stony, soft, and black corals. The colonial stony coral *Lophelia* was observed during Dive 3.

Filebottom Canyon had one Northeast database record of soft coral. There were four tows during HB1504. Tow 7 (664-887 m) and Tow 8 (1,029-1,077 m) recorded stony corals (*Solenosmilia, Desmophyllum*) and soft corals (*Paramuricea, Primnoa*?).

Chebacco Canyon had no Northeast database coral records. During cruise HB1504, there were two tows on the east wall. Tow 4 (801-875 m) found stony corals (*Solenosmilia, Desmophyllum*) and tow 5 (1,133-1,356 m) found soft corals (*Paramuricea, Swiftia, Acanthogorgia, Clavularia,* bamboo), stony corals (*Solenosmilia*), and black corals (*Parantipathes*?). Tow 6 (1,909-2,061 m), the deepest in the series, found soft corals (*Paramuricea*).

Gilbert Canyon is a hotspot of coral abundance and diversity. The tows during cruise HB1204 covered various locations throughout the canyon. All of the tows found soft corals, with the percentage of images with soft corals ranging from 2% to 54%. Black corals, stony corals, and sea pens were also found. Two of the eight tows revealed high coral abundance and diversity. These tows were on the western wall between 1,370-1,679 m and in the canyon head between 640-820 m. The western canyon slopes had the greatest abundance and diversity of corals, with the hard bottom hosting solitary stony corals and a few colonial stony corals (*Solenosmilia*). Soft coral diversity (*Paramuricea*, *Acanella*, *Paragorgia*) was high in this canyon due to the diversity of habitats. Sea pen abundance was also high in the canyon. Soft corals in the head of the canyon (640-820 m) were highly abundant but dominated by a single type of coral (likely *Acanella*). Black corals (including *Parantipathes*) were also noted.

There are 105 Northeast database observations of coral presence in **Lydonia Canyon**, including soft corals, sea pens, and stony corals. Similar to Oceanographer, Lydonia was one of the best studied locations prior to the recent surveys. There was one recent ROV dive (EX1304L2, dive 12, 1,135-1,239 m). At least 15 species from all four coral groups were observed.

There were six tows in **Powell Canyon** during cruise HB1302. Tows 7 (753-1,306 m) and 8 (905-1,340 m) had high abundances and diversities of corals. Tow 9 (1,302-1,630 m) had abundant corals, often with areas of high localized abundances, with some areas having widely dispersed corals or none at all. The remaining three deeper tows (1,292-2,053 m) had low abundances as well as low diversities of corals. Examples of species observed included the stony corals *Solenosmilia* and *Desmophyllum*; the soft corals *Paramuricea, Acanthogorgia, Anthomastus, Paragorgia, Primnoa, Radicipes, Thourella, Swiftia*, *Acanella, Chrysogorgia*, and bamboo corals; the black corals *Parantipathes, Bathypathes*, and ?*Telepathes*; and sea pens. In addition to these efforts within Powell Canyon, one tow surveyed a relatively shallow inter-canyon area (482-508 m) between Munson and Powell. In this intercanyon area, corals were rare, with low diversity, and only the soft coral *Acanthogorgia* was noted. Two tows surveyed a minor canyon between Munson and Powell (927-1,273 m). On these tows, corals were common, diverse, and widely distributed, with some areas of high localized abundance or no corals at all. Stony corals found included *Solenosmilia* and *Desmophyllum*; soft corals included *Paramuricea, Anthomastus, Swiftia*, and bamboo corals; black corals included *Parantipathes*.

In **Munson Canyon**, seven TowCam tows were completed during cruise HB1302. Corals were abundant in images from tows 14 (535-1,040 m), 16 (983-1,346 m), 17 (935-1,455 m), 18 (1,330-1,941 m) and 24 (1,084-1,472 m), often with areas of high localized abundance. Other areas had widely dispersed corals or none at all. Tow 19 (1,283-1,855 m) had fewer corals overall, while Tow15 (550-1,089 m) had a low abundance and diversity of corals present. Examples of species observed included the stony corals

Solenosmilia and *Desmophyllum*; the soft corals *Paramuricea, Acanthogorgia, Anthothela, Anthomastus, Paragorgia, Primnoa, Radicipes,* and bamboo corals; the black coral *Parantipathes,* and sea pens.

There were three dives in an **unnamed minor canyon between Munson and Nygren** during 2017 (HB1703), covering depths between 785-1,016 m. Corals were common, diverse, and locally abundant. Examples of species observed included the stony corals *Lophelia, Solenosmilia* and *Desmophyllum*; the soft corals *Paramuricea*, *Acanthogorgia, Anthomastus, Clavularia, Paragorgia, Primnoa,* and bamboo corals; and the black corals *Parantipathes* and *Telepathes*.

Relative to Munson Canyon, coral diversity in **Nygren Canyon** was higher, based on observations during HB1402, with few species occurring at locally high abundance. One notable exception was a vertical wall covered with colonies of the stony coral *Solenosmilia variabilis*. Bamboo corals, *Paramuricea* sp. and the stony coral *Desmophyllum dianthus* were numerically dominant species. Sponges were diverse and abundant in Nygren Canyon. These observations were consistent with dives conducted during EX1304L2. Dive 6 (1,310-1,590 m) traversed a diverse range of habitats, including soft sediments, a cold seep, and exposed rock faces. Corals found included soft corals (at least 17 species), black corals (three species), stony corals (three to four species), and sea pens (three species). Dive 8 (678-914 m) traversed a shallower area of the canyon, with sediments ranging from soft sediment with large boulders to rugged steep terrain with sediment-draped rock. A diverse coral assemblage was observed during this dive.

There are no Northeast database observations of coral presence in the **Kinlan Canyon**, previously referred to as an unnamed minor canyon between Nygren and Heezen. There was a 2013 ROV dive in the canyon (*Okeanos Explorer* Cruise EX1304 leg 2, dive 10, 497-824 m). The dive track transited diverse habitat types and geological features, including soft sediments over rocky ledges, sediment with coral rubble, and a steeply sloping wall. The wall ledges harbored various coral types, including stony corals (solitary cup corals and colonial species) and soft corals. At the top of the slope the dive concluded on a sediment field with scattered rocks, colonized by attached organisms including soft corals (*Acanthogorgia*).

A **second unnamed minor canyon between Nygren and Heezen** was visited later, during HB1703. The dive was relatively shallow, 632-870 m, and corals were abundant and diverse. Stony corals included massive colonies of *Lophelia* as well as the cup coral *Desmophyllum*. Soft corals included *Anthothela*, *Paragorgia*, *Clavularia*, *Primnoa*, and *Paramuricea*.

There are 67 Northeast database records within **Heezen Canyon**, including observations of stony corals, soft corals, and sea pens. Two dives were completed in the area during cruise EX1304L2. Dive 7 (1,615-1,723 m), traversed varied habitat types along the southwestern flank of the canyon. Various coral taxa were found, including soft corals (*Paramuricea*, *Acanella*, *Clavularia*, and *Radicipes*), stony corals (the colonial

Solenosmilia), black corals (*Stichopathes*), and sea pens (*Umbellela*). Dive 9 (703-926 m), was in a shallower portion of the canyon along the southwestern wall. Vertical rock faces traversed during the dive were inhabited by enormous soft coral (*Paragorgia*, *Primnoa*, and *Paramuricea*) colonies. Other coral taxa were also observed during the dive. In contrast to Nygren Canyon, Heezen Canyon had lower diversity of corals, but several species were locally abundant based on observations made during HB1402. For example, vertical canyon walls were populated with numerous, large colonies of the *Paragorgia* interspersed with *Primnoa* and *Paramuricea*. at depths of 569-668 m (Dive 1). In addition, true soft corals (Neptheidae) were commonly observed on the wall of Heezen Canyon. At deeper depths (1,046-1,133 m), the soft coral *Anthomastus* was more abundant, often found co-occurring with the hard corals *Desmophyllum* and *Solenosmilia* and the soft coral *Anthothela*.

6.2.3.2 Seamounts

The summit of **Bear Seamount** is approximately 1,100 m below sea level, and base at over 3,000 m depth. Bear was not visited during recent cruises, but soft, stony, sea pens, and black corals had been previously documented in the area (see references in Packer et al. 2007).

Mytilus has the deepest summit depth of the four seamounts (~2,400 m) with the base at over 4,000 m. It was surveyed during EX1304L2, dives 4 and 5 (Quattrini et al. 2015). Dive 4 documented a diversity of soft corals as well as two species of black coral. Sea pens, soft corals, and black corals were noted during Dive 5. The seamount harbors a diverse assemblage of taxa, including soft and black corals. The corals observed (below 2,600 m) were significantly different from those at other sites. Differences in species composition between Mytilus Seamount and other sites were primarily due to the presence/absence of numerous species. *Chrysogorgia*, *Convexella*, *Corallium*, *Paranarella*, and *Paragorgia*/*Sibogagorgia* were observed on Mytilus Seamount, while *Acanthogorgia*, *Anthothela*, *Clavularia*, *Paragorgia*, and *Paramuricea* were not seen on Mytilus Seamount, but occurred at other sites. No stony corals were observed here; Quattrini et al. (2015) suggest that the deeper depths (2,600 to 3,200 m) are beyond the stony corals' bathymetric limits.

In October 2012, AUVs were used to investigate deep-sea coral presence distribution on **Physalia Seamount** (summit depth approximately 1,880 m), a previously unexplored member of the New England Seamount chain (Kilgour et al. 2014). The AUVs collected 2,956 color seafloor images as well as 120 kHz (low-frequency) and 420 kHz (high-frequency) sidescan sonar. Vehicle altitude of 8-10 m was necessary to maintain speeds of 3-4 kts and maximize area of coverage to locate coral aggregations. The presence of octocorals were confirmed from the images; sea pens were found in flat, soft sediments, but most other octocorals were found at either the interface of soft sediment and hard bottom, or on hard bottom features such as walls, ledges, and gravel/bedrock pavement (Kilgour et al. 2014). Cruise EX1404 (2014) Physalia seamount. The ROV dive took place on the upper flanks and ascended a steep slope on the southern side of the seamount (maximum depth 2,589 m). Corals were observed in low abundance and diversity, with the soft coral *Chrysogorgia* and sea pen *Anthoptilum* being seen most commonly; the latter were seen in typical sea pen habitats embedded in soft sediments but also on hard substrates. The occasional bamboo coral *Lepidisis* sp. was seen. Other corals include black corals *Telopathes* and *Bathypathes*, the soft coral *Anthomastus*, and stony cup coral.

Retriever Seamount, the furthest offshore within the EEZ, has three distinct peaks, reaching approximately 2,000 m above the seafloor. Retriever was surveyed in 2004 with the Hercules ROV (Mountains in the Sea cruise). Corals observed included soft corals *Paramuricea*, *Acanella*, and *Metallogorgia* and the black corals *Bathypathes* and *Parantipathes.* Cruise EX1404 surveyed Retriever Seamount. The ROV was deployed to a depth of 2,142 m and settled on a fairly monotonous sandy slope. Many sea pens colonies were seen in sedimented areas, with *Anthoptilum*. more common than *Pennatula*, as well as stony cup corals *Caryophyllia*. Soft coral *Metallogorgia* colonies were very abundant on a rock outcrop, and several “sub-adult” colonies were observed, suggesting different bouts of recruitment to the area. The orientation of many of the coral colonies clearly pointed to a downslope current. Other corals observed included the soft corals *Corallium*, *Paramuricea*, *Iridogorgia*, *Candidella,* and an unidentified Primnoidae, bamboo corals *Lepidisis* and *Acanella*, and the black corals *Parantipathes*, *Stauropathes*, and *Bathypathes*.

6.2.3.3 Gulf of Maine

Deep-sea corals in the Gulf of Maine have been reported since the 19th century, both as fisheries bycatch and from naturalist surveys. Corals may once have been considered common on hard bottoms in the region, but their current distribution appears to be more restricted. Presently, substantial concentrations of deep-sea corals are now confined to small areas where the bottom topography makes them mostly inaccessible to fishing gear (Auster 2005; Watling and Auster 2005; Cogswell et al. 2009; Auster et al. 2013).

Similar to the canyons and seamounts, recent survey work has added substantially to our knowledge of coral diversity and distribution in the Gulf of Maine. These surveys revealed extensive coral at about 200-250 m depth in western and central Jordan Basin, Mount Desert Rock, Outer Schoodic Ridge, and Lindenkohl Knoll in Georges Basin (Auster et al. 2013, 2014; Packer et al. 2017; Packer et al., unpublished data). At all sites, structure-forming corals on hard substrate were predominantly gorgonian soft corals, in particular *Primnoa resedaeformis* and *Paragorgia arborea*, although scarce numbers of tiny, stony cup corals were seen on some dives, and sea pens were also observed. The sea pen *Pennatula aculeata*, which is common in the Gulf of Maine, was found in dense patches in the mud and gravel/mud habitats adjacent to hard-bottom habitats. The highest densities of sea pens were observed in the Mount Desert Rock region.

During these surveys, coral occurrences were classified as either coral present (sparse to medium density) or coral garden (high density patches). Coral gardens are areas where soft corals are among the dominant fauna and occur at densities higher than surrounding patches (Bullimore et al. 2013). Here, we adopt the threshold of 0.1 colonies/m^2 used by ICES (2007) to define coral garden habitat. Dense and extensive coral gardens were seen in Jordan Basin, at the Outer Schoodic Ridge site, and near Mount Desert Rock, especially in areas of high vertical relief.

Both low density coral habitats and coral garden habitats have been observed within the proposed **Mt. Desert Rock** coral zone, with the coral garden sites aligning with high slope areas. Six dives with corals and one nearby dive without corals have been conducted in the proposed zone since 2002, specifically dive 224 (2002), dive 235 (2003), tows 24 and 32 (2013), and tows 10 and 11 (2015). The 2013 and 2015 tows were all completed with the ISIS 2 towed camera system. The 2015 tows exhibited dense soft coral communities. Fine-grained sediment areas encountered during tow 11 exhibited very high densities of sea pens.

Structure forming corals within the **Outer Schoodic Ridge** zone are mostly soft corals, although some smaller stony corals are also present. Outer Schoodic Ridge has topography reminiscent of narrow slot canyons on land (e.g., western U.S., in southern Utah). Based on the 2013 images (Auster et al. 2013), these steep areas had some of the highest coral densities found in the Gulf of Maine, with about 16-39 colonies/m^2, well above the threshold of 0.1 colonies/m^2. In some locations, *Primnoa* colonies were so densely packed it was impossible to identify and count individual colonies. Some colonies may have been as large as one meter in size. All but one of the Outer Schoodic Ridge dives within the proposed coral zone found corals at coral garden densities, with sea pens and sponges found at the remaining dive site in the coral zone. Nearby dives outside the zone did not have coral. Common species at the Outer Schoodic Ridge dive sites include *Primnoa*, along with *Paramuricea placomus* and *Acanthogorgia* cf. *armata.* Areas outside these very steep rock faces with scattered gravels and smaller rock outcrops support lower densities of corals, primarily *Paramuricea*, co-occurring with other structure-forming species such as burrowing cerianthid anemones, sponges, and sea pens (*Pennatula*).

Generally, the dense corals on the steep vertical walls and cliffs of Outer Schoodic Ridge and Mount Desert Rock were primarily *Primnoa*, with lower abundances of *Paramuricea*, which exhibits two color morphs in this region, yellow and purple. The proximity of extremely high densities of large *Primnoa* and *Paramuricea* so close to shore and their association with economically important species increases the potential role of these habitats to function as EFH (Auster 2005). Of note during the recent Gulf of Maine cruises were the first observations of the white coral *Anthothela* (*?grandiflora*) in relatively shallow waters. Two colonies were seen at Outer Schoodic Ridge around 200 m. This species has been observed off the Northeast Channel along the continental margin at depths below 1,400 m (Cogswell et al. 2009).

Unlike the more inshore sites, where *Primnoa* dominates, the major coral species found in the offshore basins was *Paramuricea,* with lower abundances of *Primnoa* and *Acanthogorgia*. Similar to Outer Schoodic Ridge, coral garden habitats on 114 Fathom Bump in **Jordan Basin** exhibited the highest soft coral densities on steep rock walls. Both pink and white forms of *Paragorgia* were noted at 114 Bump during a 2003 survey, but they are the same species. Lower density coral habitats were observed at the nearby

96 Bump and 118 Bump sites, which have been surveyed with only a single dive each. Two dives have been completed in the central portion of Jordan Basin, and both have documented coral presence. Lower density coral habitats were found at the northern dive site (K2_2014), and higher density coral habitats at the southern site (HB1402). The southern site would be classified as a coral garden. In areas of high abundance in central Jordan Basin, corals were often a mix of the soft corals *Paramuricea*, *Primnoa* and *Acanthogorgia*. High abundances of sea pens were also observed. Based on multivariate analyses of eight 2013 transects in Jordan Basin with coral garden habitat (Martins 2015), temperature, depth, sediment type, rock outcrop, and topographic rise were primary factors that correlated with coral distributions. In 2017, additional coral garden habitat was discovered in the western part of the 114 Bump coral management zone (HB1703).

Georges Basin also contains coral communities, found at **Lindenkohl Knoll.** Corals at Lindenkohl Knoll were generally patchier, less dense, and occurred in lower relief environments than in other Gulf of Maine sites. Specifically, the 2015 camera tows found corals at coral garden densities (> 0.1 colony per m^2, one tow) and lower densities (three tows). The soft coral *Paramuricea* was the most commonly occurring species. One dive located just east of the proposed coral zones did not document any corals.

Noteworthy are the results of recent genetic analyses of *Primnoa* samples collected during the 2014 Gulf of Maine cruise suggesting Western Jordan Basin and Outer Schoodic Ridge sites exhibit a degree of genetic separation from eastern Gulf and continental margin sites (Coykendall et al. 2016).

6.3 Deep-sea coral habitat suitability model

Habitat suitability modeling examines the associations between the presence and/or absence of organisms and their relevant environmental or habitat variables. Because of the prohibitive costs and logistical difficulties of surveying the deep-sea, geo-referenced deep-sea coral location data are often limited, patchy, and mostly presence-only. As noted in the previous section, coral data in the New England region, in particular those data collected prior to 2012-2015 fieldwork, are no exception to these general rules. Predictive habitat modeling for deep-sea corals has therefore become a cost-effective tool to identify potential locations of corals and other benthic species, and aid managers in determining management zones (Leverette and Metaxes 2005; Bryan and Metaxas 2007; Davies et al. 2008; Tittensor et al. 2009; Davies and Guinotte, 2011; Guinotte and Davies 2012; Yesson et al. 2012; Vierod et al. 2013).

NOAA’s National Ocean Service (NOS) National Centers for Coastal Ocean Science (NCCOS), in partnership with the Northeast Fisheries Science Center (NEFSC), developed a deep-sea coral predictive habitat model for the Northeast region (Kinlan et al. 2013; Kinlan et al., in review). The spatial domain of the model is based on the footprint of the coastal relief digital elevation model, and thus includes the continental shelf and canyons in New England and the Mid-Atlantic, but not the seamounts. Results are reported on a 370 m grid, which was selected based on the resolution of the underlying bathymetry data and is appropriate given that older coral presence records have some positional uncertainty.

A machine-learning technique called Maximum Entropy modeling (MaxEnt), was used to predict suitability of unexplored habitats based on locations and environmental characteristics of known deep-sea coral presence (Guinotte et al. 2016). This method was selected because it has performed well in previous deep-sea coral predictive habitat modeling studies using presence-only data, and outperformed other types of habitat suitability models, such as environmental niche factor analysis, in cross-validation studies (Tittensor et al. 2009, Davies and Guinotte 2011, Guinotte and Davies 2012, Yesson et al. 2012).

The model was run with selected predictor (environmental) variables and presence data for three groups of deep-sea corals in the Northeast database (true soft corals and Gorgonians, stony corals, and sea pens; Table 16). Black coral data were insufficient to include in the model. Data included were: 1) coral presence records, 2) NOAA Coastal Relief Model bathymetry (NOAA 2011), and 3) environmental predictors (seafloor terrain statistics; physical, chemical, and biological oceanographic data, and sediment/substrate information). Only one coral record per taxonomic group was used per grid cell, and older records were dropped when there were multiple records in a grid.

In areas of the region with fewer coral records, model outputs should still be predictive assuming that the ecological setting is similar to the areas where there are more coral records. However, the Gulf of Maine high suitability areas do not align well with the distribution of coral habitats determined from remotely operated vehicle and towed camera data. The discrepancy in the Gulf of Maine could be the result of lower resolution terrain data, so the steep slopes where structuring-forming coral species tend to occur are not adequately resolved. Therefore, the PDT determined that the suitability model results are not a useful metric in the Gulf of Maine.

Table 16 – Coral taxonomy used in the habitat suitability model

Group	Description	Code name
1	**Order Alcyonacea**	**ALCY**
1a	Gorgonian Alcyonacea (Suborders Calcaxonia, Holaxonia, Scleraxonia)	ALCY-GORG
1b	Non-Gorgonian Alcyonacea (Suborders Alcyoniina, Stolonifera)	ALCY-NONGORG
2	**Order Scleractinia**	**SCLER**
2a	Family Caryophylliidae	SCLER-CARYO
2b	Family Flabellidae	SCLER-FLAB
3	**Order Pennatulacea**	**PENN**
3a	Suborder Sessiliflorae	PENN-SESS
3b	Suborder Subsessiliflorae	PENN-SUBSESS

Maps and model evaluation methods predicted suitable habitat in the vicinity of known deep-sea coral presence locations, as well as in some areas without recorded presences. Some of these model outputs are better predictors of coral presence than others, due to different sample sizes of coral records of each type in the Northeast database. The combined output for the three Alcyonacean models (all Alcyonaceans, Gorgonians only, and true soft corals only) is the model with the best predictive ability for structure-forming deep-sea corals, as it is based on a sizeable number of data points from known structure-forming species. The model for Scleractinians, on the other hand, is based on a smaller number of records of mostly solitary, soft-sediment dwelling cup corals (e.g., *Dasmosmilia* and *Desmophyllum*), and is likely to under-predict the likelihood of suitable habitat for this coral type. The sea pens are more widespread in their distribution and the contributions of the two common species, including *Pennatula* as structure forming habitat for other species remains poorly understood. Thus, the results of the sea pen model were not used to formulate management advice. Future incorporation of recent data for structure-forming scleractinians and black corals in the Northeast region will improve this model's predictive ability for these coral groups.

A large number of predictor variables were considered. These included variables describing seafloor terrain, including depth, slope, curvature (slope of slope), and rugosity (a measure of surface area to total area). These topographic variables were analyzed at multiple spatial scales to highlight large scale and finer features. Climatologic variables including bottom dissolved oxygen, temperature, and chlorophyll were also used. Bottom dissolved oxygen was taken from the World Ocean Database (https://www.nodc.noaa.gov/OC5/WOD/pr_wod.html) and NEFSC data. For some climatologic variables, seasonal data were used, while annual averages were used for others. In general, the maximum and minimum values are most predictive. Highly correlated predictor variables were removed to arrive at a set of 64 predictors. The final model uses 22 predictor variables, out of a total of 64 variables (Table 17). For each predictor variable, response curves were generated to help users understand how that variable relates to coral distributions.

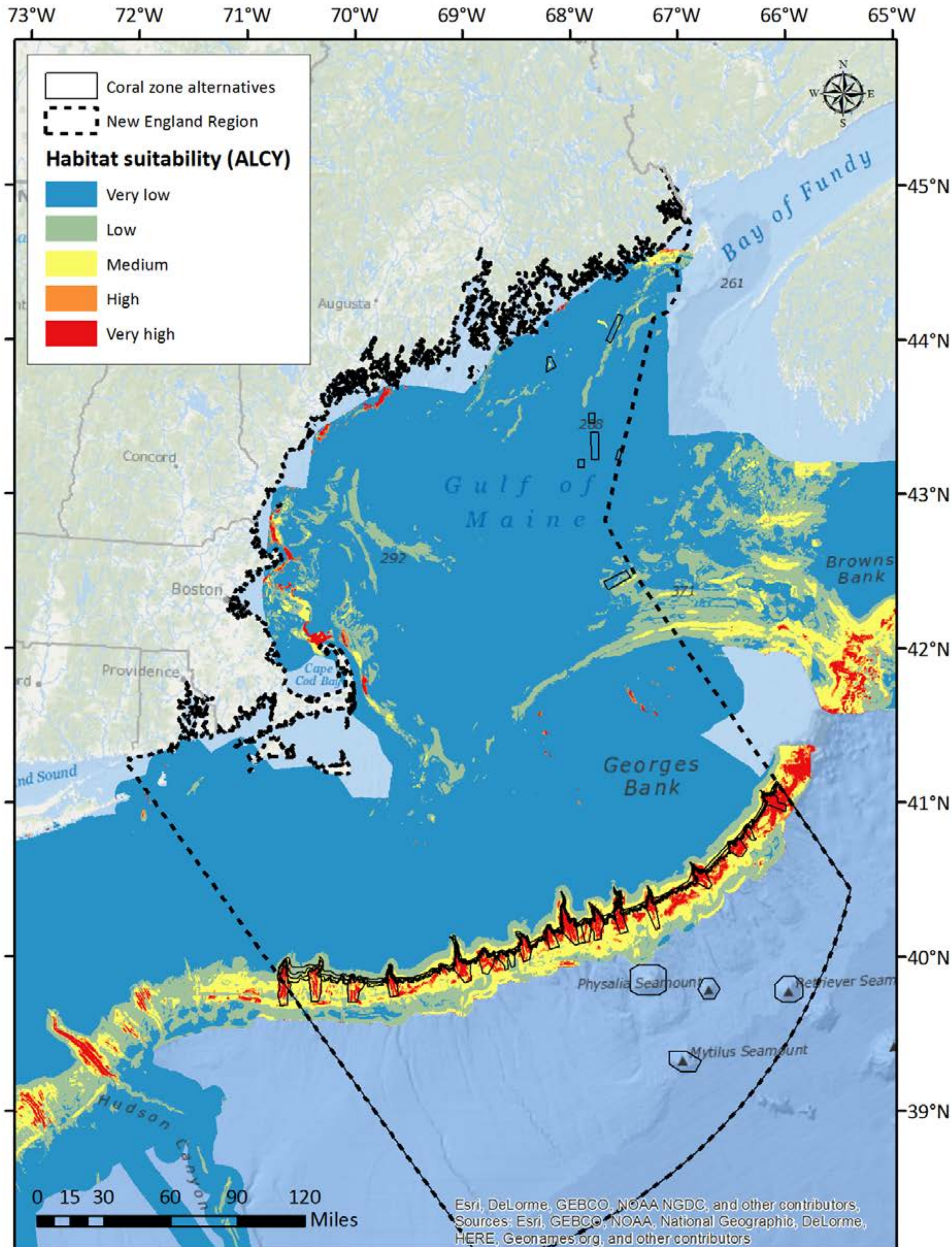
The model selection process relied on more formal selection criteria (area under the receiver operating characteristic curve, or AUC, and Akaike's Information Criteria, or AIC) combined with informed judgement of the analysts to identify a parsimonious suite of predictor variables. The model was fit to 70 percent of the coral data points for each taxa and validated with the remaining 30 percent of the dataset. For single variable response curves, peak suitability for each predictor variable is the highest point on the response curve. Multivariate response curves were also generated that indicate response to one varying predictor while others are held at their mean values.

When using the results, it is important to consider the underlying data quality and resolution. As noted above, the model grid resolution was selected to accommodate the positional uncertainty associated with the underlying coral data, but the canyon areas in particular have complex terrain at this spatial scale, such that the model outputs should be considered a somewhat coarse predictor of suitable habitat. In addition, the taxonomic resolution is also fairly coarse, to the order or sub-order level, and there is considerable diversity of coral species within each of these groupings. The model does not predict abundance, density, or diversity, rather, it is indicating the likelihood of finding corals of a particular type in a particular area. The basic suitability outputs are generated on 0 to 1 scale, but they are not probabilities and cannot be compared across taxonomic groupings. Thresholded outputs were developed to allow comparisons between taxonomic groupings. The following likelihood categories were used: very low, low, medium, high, and very high. High and very high likelihood categories were combined to support impacts analysis.

Table 17 – Predictor variables retained in coral habitat suitability model.

Predictor Variable	Code	Category
Aspect (derived at 1500 m scale)	asp1500m	Geomorphology
Aspect (derived at 5 km scale)	asp5km	Geomorphology
Depth	bathy	Geomorphology
Bathymetric Position Index (BPI) / Slope Index (derived at 20 km scale)	bpislp20km	Geomorphology
Predicted Mean Annual Bottom Salinity	bsalann	Oceanography
Predicted Mean Annual Bottom Temperature	btempann	Oceanography
Mean Annual Surface Chlorophyll-a	chlann	Oceanography
Predicted Mean Annual Bottom Dissolved Oxygen	doann	Oceanography
Predicted Surficial Sediment Percent Gravel	gravel	Substrate
Predicted Surficial Sediment Mean Grain Size	meanphi	Substrate
Plan Curvature / Slope Index (derived at 1500 m scale)	plcurslp1500m	Geomorphology
Plan Curvature / Slope Index (derived at 5 km scale)	plcurslp5km	Geomorphology
Profile Curvature / Slope Index (derived at 1500 m scale)	prcurslp1500m	Geomorphology
Profile Curvature / Slope Index (derived at 5 km scale)	prcurslp5km	Geomorphology
Rugosity (derived at 370 m scale)	rug370m	Geomorphology
Rugosity (derived at 1500 m scale)	rug1500m	Geomorphology
Predicted Surficial Sediment Percent Sand	sand	Geomorphology
Slope (derived at 370 m scale)	slp370m	Geomorphology
Slope (derived at 5 km scale)	slp5km	Geomorphology
Slope of Slope (derived at 1500 m scale)	slpslp1500m	Geomorphology
Slope of Slope (derived at 5 km scale)	slpslp5km	Geomorphology
Mean Annual Turbidity	turann	Oceanography
Source: Table 2 in Kinlan, B.P., M. Poti, A.F. Drohan, D.B. Packer, D.S. Dorfman, and M.S. Nizinski (in review). Predictive Modeling of Suitable Habitat for Deep-Sea Corals Offshore of the Northeast United States.		

Map 41 – Habitat suitability model outputs for Alcyonacean corals.



Data from Kinlan et al. 2013.

The deep-sea coral habitat suitability model was qualitatively validated during later visual surveys. All sites observed to be hotspots of coral abundance and diversity (e.g., Gilbert Canyon) were predicted hotspots based on the model. Each validation attempt indicated that the model performs well in predicting areas of likely coral habitat, as well as predicting areas where corals are unlikely to occur. However, the exact location of deep-sea coral hotspots often depends on fine-scale seabed features (e.g., ridges or ledges of exposed hard substrate) that are smoothed over in this regional-scale model. In addition, model predictions are of the likelihood of coral presence, and high likelihood of presence will not necessarily correlate with high abundance. There are plans to improve the model by increasing resolution to 25 m^2 and incorporating more recent coral observations.

6.4 Deep-sea coral associates and ecological interactions

Deep-sea coral habitats have been noted to have higher associated concentrations of fish than surrounding areas and are believed to serve as nursery grounds and provide habitat for many species of fish and invertebrates at various life stages, including commercially important fish species (Costello et al. 2005; Auster 2007; Foley et al. 2010). There is recent evidence that deep-sea corals play an important role in the early life history of some fish and shark species, providing nursery grounds and habitat for protection, reproduction, and feeding (Costello et al. 2005; Armstrong et al. 2014). Numerous types of fish have been noted to co-occur with deep-sea coral habitat, including redfish (*Sebastes sp.*), rabbit fish (*Chimaera monstrosa*), cusk (*Brosme brosme*), cod (*Gadhus morhua*), morid cods (*Laemonema sp.*), slimeheads (e.g., *Hoplostethus sp.*), American anglerfish (*Lophius americanus*), cusk eels (e.g., *Benthocometes robustus*), cutthroat eels (e.g., *Dysommina rugosa*), and deep water sharks (see Costello et al. 2005; Auster 2007; Henry et al. 2013; Ross et al. 2015). Fish associating with corals and other three-dimension habitat types may be seeking cover from predators, and/or sites for enhanced capture of prey (Costello et al. 2005; Auster 2007).

Many invertebrate species are directly associated with deep-sea corals. Brittle stars, sea stars, and feathery crinoids live directly on coral colonies, and smaller animals burrow into coral skeletons (Foley et al. 2010). Recent studies in the Northeast U.S. highlight relationships of symbionts and their octocoral hosts at deep-sea coral habitats on the seamounts (Watling et al. 2011). In an extreme case of host fidelity, Mosher and Watling (2009) showed that the ophiuroid *Ophiocreas oedipus* was found only on the gorgonian *Metallogorgia melanotrichos*. *Ophiocreas* is an obligate associate of *Metallogorgia*, with young brittle stars settling on young corals and the two species then remain together for life. The brittle star may receive some refuge and feeding benefits from the coral, but the coral's relationship to the brittle star appears to be neutral. Within the EEZ, these two species were collected from Bear Seamount at 1,491 and 1,559 m. Another ophiuroid, *Asteroschema clavigera*, has a close relationship with *Paramurecia* and *Paragorgia* on both the seamounts and continental slope (Cho and Shank 2010; this was also noted in images from HB1204). The shrimp *Bathypalaemonella serratipalma* as well as the egg cases of an unknown octopus were found on *Chrysogorgia tricaulis* on the seamounts (Pante and Watling 2011). Additionally, older colonies of *Acanella arbuscula* collected from the seamounts were host to a scale worm (Watling et al. 2011). See Watling et al.

(2011) for reviews and lists of known invertebrate symbionts and their octocoral hosts worldwide.

Quattrini et al. (2015) noted that the presence of certain deep-sea coral species may influence crustacean assemblage patterns. For example, the squat lobster *Uroptychus* sp. was only observed on the black coral *Parantipathes* sp. In contrast, the squat lobster *Munidopsis* spp. utilized a variety of different coral species as habitat, particularly those with structurally complex morphologies. Other observations suggesting associations between deep-sea corals and invertebrates are documented in the dive logs from recent surveys.

A cause and effect relationship between coral presence and fish populations is hard to determine, and our understanding of relationships between deep-sea corals and fishes is situational and inferential (e.g., Baker et al. 2012), particularly in seamount habitats (Auster 2007). However, specific associations have been documented, for example false boarfish (*Neocyttus helgae*) occurrence in horizontal and vertical basalt habitats with gorgonian corals and sponges on Bear and other seamounts (Moore et al. 2008). Dead coral on seamounts could also be habitat for juveniles of deep-sea fish, but observations have been limited (Moore and Auster 2009).

There is new information from recent surveys regarding the functional role deep-sea corals play in fish life history and ecology. Quattrini et al. (2015) found that deep-sea coral species richness was an important variable in explaining demersal fish assemblage structure. They speculated that the corals may increase fish diversity because the fish use the corals as habitat, among other reasons. Baltimore and Norfolk canyons were surveyed by BOEM (Southern Mid-Atlantic Canyon Surveys 2012-2013) to determine demersal fish distributions and habitat associations, including the influence of deep-sea corals and sponges (Ross et al. 2015). Although it was determined that deep-sea coral and sponge presence did not statistically influence fish assemblages in the two canyons, deep-sea coral and sponges did increase habitat complexity, which is an important factor governing the distribution of deep-sea fishes (Ross et al. 2015), and some of the fishes were closely associated with the corals.

In all areas surveyed in the Gulf of Maine, sponges (e.g., *Polymastia*, *Iophon, Phakellia/Axinella*) and anemones (e.g., *Urticina*) often occurred in high density patches amongst the more extensive corals on walls and on steep features without corals. Crustaceans such as shrimp, amphipods, krill (*Meganyctiphanes norvegica*), and king crab (*Lithodes maja*) were commonly associated with coral communities along steep walls, and were seen foraging amongst structure-forming organisms, including corals, on the seafloor. In mud and gravel-mud habitats adjacent to hard-bottom habitats, other structure forming and non-structure forming attached and mobile invertebrates were found including brachiopods, attached anemones, the large burrowing anemone (*Cerianthus borealis*), sponges, sea stars, and the ubiquitous and abundant brittle stars.

At the Gulf of Maine sites, economically important species were observed in coral habitats, including Acadian redfish (juveniles, adults, and pregnant females), haddock, pollock, cusk, monkfish, cod, silver hake, Atlantic herring, spiny dogfish, squid, and lobster. The fish were observed searching for and catching prey that were also found among the coral, including shrimp, amphipods, krill, and other small fish. The corals seemed to provide refuge from the strong, tidally generated bottom currents.

Baillon et al. (2012) collected sea pens as trawl bycatch during routine multispecies research surveys and found convincing evidence that several species of sea pens, including *Pennatula aculeata*, *Anthoptilum grandiflorum*, *Pennatula grandis*, and *Halipteris finmarchica*, are being directly utilized as shelter by fish larvae, mainly by those of redfish (*Sebastes* spp.). *Anthoptilum grandiflorum* appeared to be of particular importance to redfish larvae in that study.

Although Baillon et al. collected sea pens from the Laurentian Channel and southern Grand Banks, because the same species of redfish and sea pens co-occur in the Gulf of Maine, researchers hypothesized that similar associations could be occurring in New England. To test this hypothesis, speciments of the sea pen *Pennatula* were collected via ROV from different sites during the 2014 Gulf of Maine coral cruise; the specimens were examined for fish larvae, and none were found. *P. aculeata* were then collected as bycatch from the 2015 NEFSC Gulf of Maine northern shrimp survey aboard the *RV Gloria Michelle*. Eight stations on the shrimp survey generated sea pen bycatch and 186 individual *P. aculeata* were subsequently examined in the laboratory. Redfish larvae were found on *Pennatula* at four stations, either adhering to the exterior of the colony, or entrapped within the arms or polyps (Dean et al. 2016).

Because both these sea pens and those collected by Baillon et al. were trawl survey bycatch, this introduces the possibility that fish larvae were extruded by ripe and running redfish during capture, and then the larvae then subsequently adhered to the sea pens. Baillon et al. (2012) reported the presence of adult redfish in all but one of their hauls; however, they found no correlation between the number of adult redfish and yield of fish larvae per sea pen colony. For this Gulf of Maine study, it was observed that there were instances of redfish extruding larvae in the checker on deck, but at other times adult redfish were noted in the catch but were not spawning. Thus, while these results confirm some general co-occurrence and possible association between these two species in the Gulf of Maine, the strength of the relationship cannot be determined without taking the state of the co-occurring redfish in the trawls into account.

In June 2016, a two-day cruise aboard the *RV Gloria Michelle* resampled some of the previous stations where a positive association had been found between redfish larvae and *Pennatula* only this time a small beam trawl was used as the sampling gear, with the hope that it would only capture sea pens without adult redfish, thus eliminating the potential cross contamination described above. Over 1,400 sea pens were collected over two days of beam trawling at depths around 150-180 m over soft bottoms. No larval redfish were found associated with the sea pens, but that may be because ~80 to 85% of the sea pens collected were quite small, < 25-50 mm total length (adults are upwards of 200-250 mm), suggesting a recent recruitment event. These younger, smaller sea pens are probably too small to be used as nursery habitat. Very few of the larger sea pens were captured, and those that were caught were generally tangled in the chain rather than caught in the net, suggesting that the beam trawl may not have dug deep enough into the sediment to dislodge the animals. Thus, the role of *Pennatula* as possible nursery habitat for larval redfish in the Gulf of Maine remains uncertain. Collection of sea pens will continue to future examine this possible relationship.

Despite inconclusive results in the northwest Atlantic, deep-sea corals appear to be an important component of redfish habitat in other locations. In Norway, Foley et al. (2010) applied a production function approach to estimate the link between deep-sea corals and redfish (*Sebastes* spp.). Both the carrying capacity and growth rate of the redfish were found to be functions of deep-sea coral habitat and thus they concluded that deep-sea corals can be considered as essential fish habitat; they also estimate a facultative relationship between deep-sea coral and *Sebastes* stocks.

In addition to these direct interactions with other organisms, deep-sea corals support ecosystem processes. Given the contribution of anthropogenic carbon dioxide (CO_2) to global climate change, the deep-sea may provide ecosystem services in the form of CO_2 sequestration, thus removing CO_2 from the atmosphere (Foley et al. 2010), though this idea has become more controversial recently (Armstrong et al. 2014). Deep-sea corals have also been shown to have high microbial diversity, even among different colonies of the same species separated over a short distance (Gray et al. 2011). Microorganisms associated with corals may provide other ecosystem functions in addition to cycling carbon, such as fixing nitrogen, chelating iron, producing protective antibiotics, and other beneficial activities (Gray et al. 2011). Deep-sea corals have also offered opportunities for pharmaceutical and engineering research. Some species have been used in clinical trials for cancer research or bone grafting (Foley et al. 2010).

6.5 Coral vulnerability to fishing impacts

The biological characteristics of deep-sea corals influence their vulnerability to physical disturbance. Fishing with bottom-tending gears, particularly bottom trawls, has impacted deep-sea coral habitats worldwide. The studies and reviews summarized below have assessed the impacts of commercial fishing on deep-sea corals, addressing a range of gear types as well as study locations. While other activities such as mining or energy exploration can threaten deep-sea corals, fishing restrictions are within the purview of the Council and are the subject of this action. This section concludes with a summary of the data on recent interactions between corals and fishing gears in New England.

6.5.1 Coral vulnerability and recovery potential

Deep-sea corals are sensitive to physical disturbance given that they are sessile, fragile, and extend above the seafloor in a manner that makes interactions with fishing gear more likely. The ability of deep-sea corals to recover from injury, their rates of growth, and their ability to reproduce and colonize new sites is directly related to the spatial distribution and intensity of impacts, their ability to recover from fishing or other mechanical disturbance, as well as their resilience to longer-term environmental change, specifically warming and increasingly acidic waters.

When fishing gear interacts physically with corals, mechanical impacts can include removal of entire colonies, branches, or polyps, fracture, abrasion, crushing, or burial. Severe mechanical impacts could cause immediate mortality. Sub-lethal effects might result from wounds in the tissue and possible microbial infection (Fosså et al. 2002), or from increased predation (Malecha and Stone 2009). Bottom trawling can also suspend sediments, which can impact coral feeding and may suppress growth and recovery of colonies. Because black coral polyps do not retract, these species are particularly sensitive to physical abrasion from sediments (Wagner et al. 2012). Alternatively, some types of Scleractinian corals are able to shed sediment and may be able to cope with sediment suspension (Fosså et al. 2002; Clark et al. 2015). Disturbance can also alter the physical or chemical composition of sediments, particularly in the more stable settings (Clark et al. 2015), potentially impacting suitable habitat for corals.

The effects of mechanical disturbance and trauma to the shallow-water soft coral *Gersemia rubiformis* were examined in a laboratory by rolling over and crushing the colonies every two weeks (Henry et al. 2003). While adult *Gersemia* repaired and healed between 18 and 21 days, such physical disturbance could have negative long-term effects on the fitness of impacted corals. There was evidence in the study that the corals were unable to produce surviving offspring during this period of tissue repair. There have not been analogous laboratory studies of deeper-water species.

The approximate growth rates of different deep-sea corals have been calculated in several studies, and they are extremely slow. Off Atlantic Canada, Risk et al. (2002) examined the growth rates for *Primnoa resedaeformis*. The corals were found at 200-600 m and were dated to 2,600-2,920y ± 50-60y using ^{14}C dating techniques. Using the dated age and size of the colony (~0.5-0.75 m tall) the average radial growth at the base of the coral was found to be 0.44 mm/y and tip extension growth rates were around 1.5-2.5 mm per year. Another study of *Primnoa* and *Paragorgia arborea* (Mortensen and Buhl-Mortensen 2005) found that the height of colonies ranged from 5-180cm for *Paragorgia* (averaging 57cm) and 5-80cm for *Primnoa* (averaging 29.5 cm). The maximum age of samples collected was 61y (found by counting annual growth rings under a dissecting microscope and x-ray examination). It estimated that the rate of growth for the first 30 years was around 1.8-2.2 cm/yr. After the coral began to age (>30 years), growth slowed to 0.3-0.7 cm/yr. Additional growth rate studies include Sherwood and Edinger 2009 (*Acanella*, *Keratoisis*, *Primnoa*, *Paramuricea*).

Deep-sea coral reproduction is a subject that has not been the topic of research until recently. While the physiology of reproduction has been studied, little is known about the timing involved and the survival of resulting offspring. Studies have shown that many of the deep-sea corals have separate sexes (Brooke and Stone 2007; Roberts et al. 2006; Waller et al. 2002; Waller et al. 2005). Brooke and Stone (2007) collected samples of corals (*Stylaster, Errinopora, Distichopora, Cyclohelia, and Crypthelia*) around the Aleutian Islands and discovered that the collection held a mix of females containing mature eggs, developing embryos, and planulae, males producing spermatozoa, and organisms with no reproductive material. The gametes within the collection were not synchronized, which indicates that reproduction is either continuous, or prolonged during a certain season of the year (Brooke and Stone 2007).

Waller et al. (2002) found *Fungiacyathus marenzelleri* collected from the Northeast Atlantic at 2,200 m to be gonochoric, with an approximately 1:1 sex ratio. The mean diameter of oocytes did not vary significantly from month to month and all levels of sperm development were noted in the collection. The coral was thus considered a quasi-continuous reproducer. While *Fungiacyathus* has separate sexes, it can also undergo asexual reproduction, and budding was present during the study. However, this was limited to no more than one bud found on any individual and no more than two individuals were found to bud at the same time (Waller et al. 2002).

Fecundity and reproductive traits for three other corals collected in the Northeast Atlantic were also determined in a study by Waller et al. (2005). *Caryophyllia ambrosia* (collected from 1,100-1,300 m), *C. cornuformis* (from 435-2,000 m), and *C. seguenzae* (from 960-1,900 m) were all found to be cyclical hermaphrodites, but only one sex was dominant at a time. Corals transitioning between sexes were seen in the study and labeled as “intermediates”. There was no significant difference in the average number of oocytes per month and continuous reproduction is assumed for both *C. ambrosia* and *C. cornuformis* (Waller et al. 2005).

More research is needed to determine the ability of corals to recolonize disturbed areas. Brooke and Stone (2007) concluded that a lightly impacted area would be able to recover via colony growth alone. However, heavily impacted areas, where the seafloor has been scoured and stripped of cover, would require coral larvae to be dispersed via currents and settle the area again, which could be a slow, time-intensive process.

6.5.2 Gear interaction studies

Research on gear impacts to deep-sea corals specifically within the New England Council region is extremely limited; thus, studies reviewed here include a range of different study locations worldwide. While the characteristics of the study sites vary, the impacts of commercial fishing on the local corals and the seafloor are virtually identical throughout the literature. The conclusions drawn by these studies are that commercial fishing gear can damage or destroy deep-sea corals and associated fauna. Trawling, specifically, is very detrimental to coral. Several studies have concluded that deep-sea corals are especially fragile, and the greatest disturbance and destruction occurs at depths targeted by commercial fishing (Heifetz et al. 2009; Hall-Spencer et al. 2002). The substrates of areas heavily fished with bottom-tending gear have been stripped to bare rock or reduced to coral rubble and sand, whereas unfished and lightly fished areas typically do not see such degradation (Grehan et al. 2005).

Most of the relevant research has involved studies using some form of imaging transects. Several studies mapped the area using sidescan or multibeam sonar in conjunction with deep camera systems (Wheeler et al. 2005, Fosså et al. 2002, Althaus et al. 2009, Grehan et al. 2005). This approach can directly identify and visually survey damage caused by dragging gear over the seafloor. In other cases, the magnitude of fishing effort was assessed indirectly using various methods and data sources, including logbooks, reports from fishermen, and related literature on fishing activities (Althaus et al. 2009, Koslow et al. 2001, Heifetz et al. 2009, Fosså et al. 2002, Cryer et al. 2002).

Potential gear impacts to corals depend on many factors, such as the configuration and weight of the gear, towing speed, sediment type, the strength of tides and currents, and the frequency of disturbance (Jones 1992; Clark et al. 2015). It should be noted that in many studies the gear descriptions were frequently inadequate, so generalizations should be made with caution. A few studies provide detailed gear descriptions, but the dimensions of gear size can vary, and a universal description and size should not be assumed for all fishing effort with each gear type. Nevertheless, general conclusions were similar among various studies using different configurations of gear.

Passive or static gear types, such as pots, traps, or longlines, impact localized areas of corals, though their impacts are not as widespread as bottom trawls and dredges. Several studies have described passive gear interactions with benthic habitat, commonly in the form of observed entanglements of coral with fishing gear (Fosså et al. 2002, Ross et al. 2015). Even though these gears contact a much smaller area of the seafloor than towed gear, in certain conditions they may drag across the seafloor, potentially entangling corals or stirring up sediments (Clark et al. 2015). Longline impacts on corals and sponges have been observed where corals have been broken by longline weights or by the mainline cutting through them during fishing or hauling. A Canadian report (DFO 2010) concluded that traps can crush and entangle sponges and corals and cited a number of factors that can affect their habitat impacts, including the type of bottom, their weight, size, and construction material, the type of rope (floatline or sinkline), retrieval methods and weather conditions, soak time, the number of traps on a string, and the use of anchors.

Some studies have compared fixed versus mobile gear impacts. In Alaska, Heifetz et al. (2009) and Stone (2006) conducted studies in commercially fished areas in the Aleutian Islands using a ROV and a research submersible, and Krieger (2001) made direct observations inside and outside the paths of two research trawl paths in the Gulf of Alaska from a submersible. Stone found that disturbance attributable to longline gear was observed on 76% of transects, but was very localized, occurring on only 5% of the observed seafloor. Damage attributed to trawling, on the other hand, was observed in 28% of transects, but affected about 33% of the observed seafloor, indicating a relatively greater impact of trawls. Overall, 22 of the 25 transects showed disturbance to the seafloor and about 39% of the total observed area showed signs of disturbance.

The Heifetz et al. study (2009) was conducted over a broader area and greater depth range and provided additional evidence of trawling impacts, as indicated by uniform parallel striations in the seafloor, seen on several dives. The proportion of damaged corals was significantly lower in areas with little or no bottom trawl fishing than in areas with medium and high intensity bottom trawling activity. There was also a general tendency for coral damage to be greater in areas fished with crab pots, fish pots, and longlines, but due to high variability, there were no statistically significant differences in the proportion of damaged corals between the fished and unfished areas. Both studies observed that the most damage done to corals occurred at depths where commercial fishing intensity was the highest (100-200 m), with higher population densities occurring at 200-300 m. All damage deeper than 700 m was attributed to longlines and pots, since those were the only two gear types used at those depths.

Observations made by Krieger (2001) in the Gulf of Alaska revealed severe impacts to *Primnoa* spp. along two paths of a research trawl. At one site in an un-fished area, a 30-minute trawl tow over a distance of 2.72 km had removed a metric ton of coral colonies seven years before the in-situ observations were made. The path of the net was identified by displaced boulders, broken corals, and pieces of net twine. Thirty-one coral colonies were observed over a distance of 0.68 km. Almost all of the branches were removed from 5 of 13 large colonies and 80% of the polyps were missing from two smaller colonies. Damage was attributed primarily to corals that were attached to boulders that had become entangled in the net, causing the boulders to tip or be moved. Large patches of bare rock on boulders showed where the trawl had removed entire colonies. No damage was observed outside the trawl path, including areas within 10 m of the net path that had been swept by the net bridles. No young colonies were seen in the trawl path, indicating that corals had not recolonized the bottom during the seven-year time period.

In a more recent study in the eastern Gulf of Alaska, Stone et al. (2014) attributed most of the damage to red tree corals (*Primnoa pacifica*) to fishing gear rather than predation. Study sites were located in an area that was closed to trawling in 1998 where large catches of red tree corals have been observed as bycatch in groundfish surveys. The area was virtually untrawled for ten years prior to the closure. Small longline fisheries still occur in or near the study sites. At one site, 90.7% of the observed damage was attributed to fishing gear. A total of 24 derelict longlines were seen at the two study sites on 13 of 19 transects. Damaged corals and sponges were observed in the immediate vicinity of all derelict longlines and anchor drag furrows were seen in soft sediment areas. Larger colonies were much more susceptible to damage at both sites.

Studies conducted in the Northeast Atlantic Ocean have reached similar conclusions to those from the Aleutian Islands. Fosså et al. (2002) found that damage to *Lophelia pertusa* reefs off Norway was most severe at shallower depths where commercial fishing primarily took place. The various study sites presented a range of disturbance due to fishing. While the deeper water corals were intact and living at one site, almost all corals were crushed or dead at another. A third site demonstrated multiple stages of coral degradation, from living to dead and crushed, as well as the base aggregate the reefs often form and grow on being crushed and spread out. The percent of damage to the area was correlated with the number of reports by the fishermen of fishing activity, bycatch, and corals in the area; ranging from 5-52% damaged. The continental shelf, at approximately 200-400 m (below the highest levels of fishing), had the highest abundance of corals. These corals were intact and developed, whereas the shallower sites contained crushed coral and coral rubble, where damages were estimated at 30-50%.

Hall-Spencer et al. (2002), in a study focused on the West Ireland continental shelf break, found scars from trawl doors (indicated by parallel marks or furrows on the sea floor) that were up to 4km long, as well as coral rubble on trawled areas. Locations lacking observable trawl scars contain living, unbroken, *L. pertusa*. Similar findings were observed at a site off the northern coast of Ireland (Wheeler et al. 2005). Trawl marks were located on side scan sonar records, and video showed parallel marks left by trawl doors, as well as the net and ground line gear, on the seafloor. The amount of dead coral and coral rubble increased at sites that were obviously trawled.

A study at the Corner Rise Seamounts in the North Atlantic showed extreme negative impacts of trawling on corals. ROV observations showed that sustained deep-sea fishing on the summits had denuded the areas of large attached fauna, such that they no longer support habitat-forming corals in any significant numbers, unlike other nearby peaks and seamounts (Waller et al. 2007).

Althaus et al. (2009) and Koslow et al. (2001) conducted studies on seamounts in Tasmania. Areas that had never been trawled, or were lightly fished (determined via logbooks), were dominated by the stony coral *Solenosmilia variabilis*, making up 89-99% of coral cover in never trawled areas (Althaus et al. 2009) as well as seamount peaks below 1,400 m (Koslow et al. 2001). These studies demonstrated that active trawling at sites removed most, or all, of the coral and associated substrate, leaving bare rock in heavily trawled areas, and coral rubble and sand at the lower limits of fishing activity (Koslow et al. 2001). This was supported by photographic transects by Althaus et al. (2009) showing coral in less than 2% of trawled areas. Areas, where trawling had effectively stopped five to ten years earlier showed coral in approximately 21% of transects. This study also found a higher abundance of fast-growing hydroids colonizing cleared areas.

While several studies reported that much of the coral on fishing grounds was damaged or destroyed, some research showed areas of higher three-dimensional complexity were relatively untouched. For example, the effect of seafloor topography on fishing and the resulting impact on corals was observed in a study site west of Ireland (Grehan et al. 2005). While evidence of active trawling was seen, indicated by trawl scars in mud and non-coral habitat, there was no fishing-related damage to corals on mounds having slopes greater than 20^{o}. Here, these areas were avoided by the fishermen for fear of damage and loss of their gear. Hall-Spencer et al. (2002) also noted that fishermen avoided uneven ground due to the loss of time and money from resulting gear upkeep of tangled and damaged gear. Areas of large coral bycatch were avoided in the future, as known trouble areas for the fishermen. Because of this, only five of the 229 trawls in the study contained large amounts of coral bycatch. Thus, the areas where corals were present and undamaged tended to have a higher topographic complexity of the seafloor.

6.5.3 Fishing gear interactions with corals in the New England region

Overall, the fishery independent trawl surveys are not particularly useful in terms of characterizing the distribution of corals in the region. Several years ago, the NEFSC's fishery independent survey and Northeast Fishery Observer Program (NEFOP) databases were searched for coral bycatch records (Packer at al. 2007). Historically, observers aboard NEFSC research vessels and commercial fishing vessels loosely described and quantified any substrate (rock, shell, etc.) or non-coded invertebrate species that were retained in the gear and were not trained to recognize corals. Although this bycatch information could possibly be useful as presence/absence data, since deep-sea corals are not the focus of the bottom trawl surveys, these data should be used with caution (John Galbraith, NOAA Fisheries Service, NEFSC, Woods Hole Laboratory, Woods Hole, MA, pers. comm.).

Outside of the Gulf of Maine, the general lack of deep-sea coral in both the NEFSC spring/fall groundfish trawl and scallop dredge surveys may be a function of the surveys fishing in waters shallower than where the larger deep-sea coral species are likely to occur (e.g., nearly all the scallop surveys fish < 100 m and all are < 140 m). Alternatively, these larger corals (e.g., *Paragorgia*, *Primnoa*) may have already been "fished out" in the survey areas during the 19th and 20th centuries (Packer et al. 2007). Anecdotal accounts from the period before the groundfish survey began (1950's or early 60's) reference an area on Georges Bank called "The Trees" where large corals existed in shallower water before being eventually cleared out, supposedly by foreign trawling vessels. In Canadian waters near the Northeast Channel, but within the survey region, there is a deep-sea coral protection area that is closed to fishing. John Galbraith (NEFSC, pers. comm.) stated that this was the only area he could remember where any amount of coral was encountered during the survey.

The fishery dependent deep-sea coral bycatch data collected by observers aboard commercial fishing vessels used to suffer many of the same problems (i.e., coral catches were poorly characterized). A small NEFOP database of coral bycatch collected form 1994-2009 was examined and showed to only include 39 confirmed coral entries (Packer et al. 2007). Two of these entries were labeled *Astrangia* (a genus of stony coral) and 10 additional entries were labeled as "stony corals." Basic information about the haul (gear type, year, month, depth, and geographic coordinates) was included. Gear used included otter trawls, scallop dredges, and gill nets, at depths from 5.5-253 m (depths were taken at the beginning of a trawl). Estimated or actual weights for the coral in a given haul ranged from 0.05-22.7 kg. No specimens or photographs were included.

In 2013, the NEFOP training curriculum and associated sampling protocols were significantly upgraded to improve deep-sea coral bycatch identification, retention, enumeration, and documentation (Lewandowski et al. 2016). This included the development of a Northeast deep-sea coral identification guide for the onboard observers, and standardized recording, sampling, and preservation procedures. Since the new protocols were implemented, although deep-sea coral bycatch is still low, the number of recorded and verified samples has increased, and photographic records and samples are being stored using the NEFOP Species Verification Program (Lewandowski et al. 2016). Specimens collected at sea were recently examined and classified by Northeast deep-sea coral experts, and several species of structure-forming soft corals and sea pens were identified. Improved NEFOP fishery dependent deep-sea coral bycatch data will lead to a better understanding of fisheries and deep-sea coral interactions and impacts, and guide conservation efforts of deep-sea corals habitats in the Northeast.

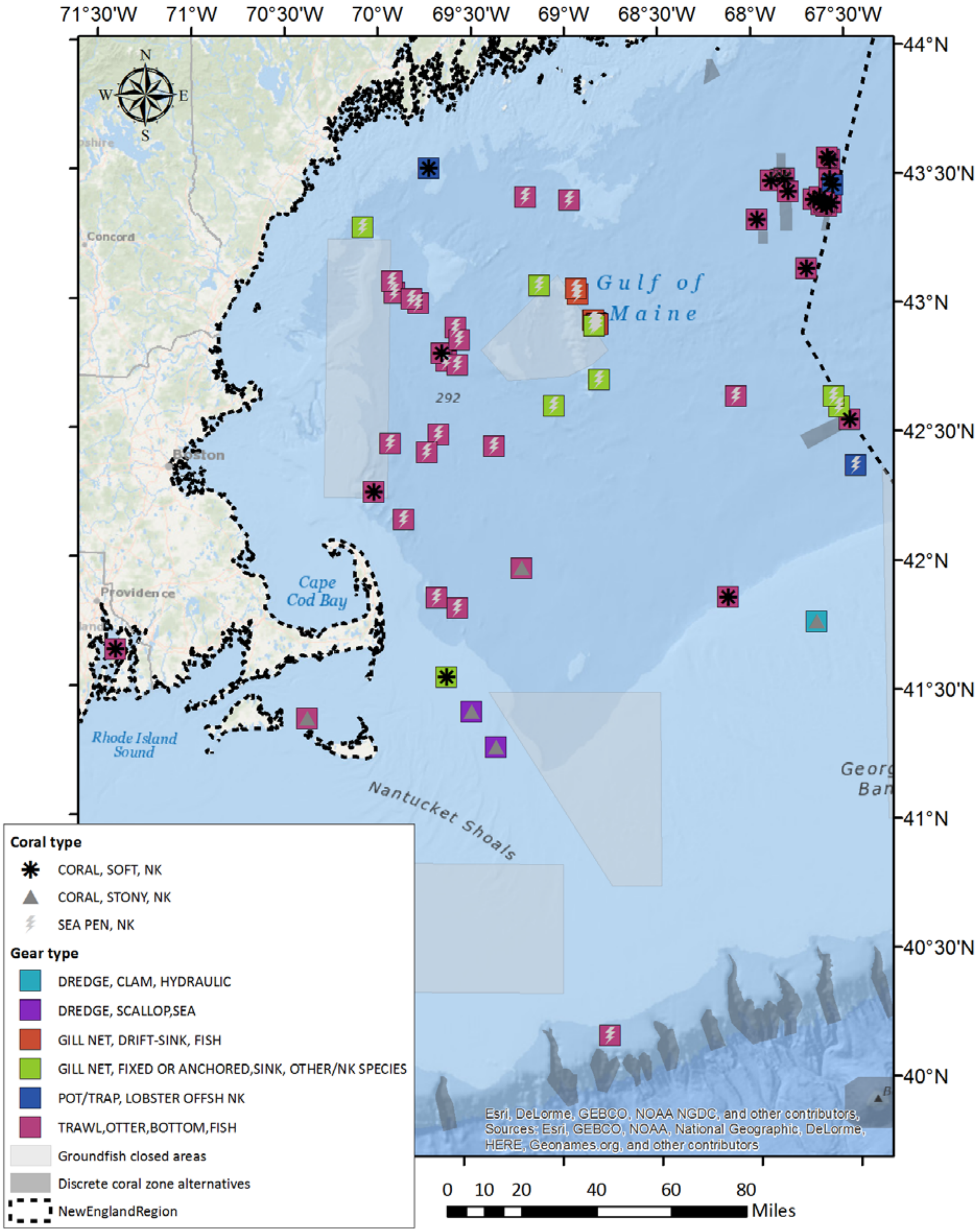
Since 2013, the NEFOP program has documented coral catches during 63 hauls occurring within the New England Fishery Management Council region (Map 42). Just over half (N=36) were identified as sea pens, 22 were identified as soft corals, and five were identified as stony corals. Just under half of the 63 records (N=28) have been identified to species. Documented taxa include the sea pens *Pennatula aculeata* and *Halipteris finmarchica*, the soft corals *Paramuricea placomus* and *Primnoa resedaeformis*, and one record of the stony coral *Astrangia poculata*. With a small number of exceptions, these catch records are concentrated in the Gulf of Maine. Catches occur in a variety of gears, mainly bottom trawl (N=40), and gillnet (N=17), but also pot/trap, sea scallop dredge, and clam dredge. The three dredge records were in shallow waters on Georges Bank and in the Great South Channel and captured stony corals.

The spatial patterns of coral bycatch by species are consistent with known distributions of corals in the Gulf of Maine. There are relatively large number of observed catches of sea pens in Wilkson Basin and surrounding Cashes Ledge. The catches in Wilkinson Basin (N=15) were taken with bottom trawls targeting plaice, pollock, and other unspecified groundfish. The catches around Cashes (N=13) were taken with gillnets, targeting pollock and other unspecified groundfish.

A relatively large number of the catch records (N=15) occur in Jordan Basin, and all of these records are of soft corals, including *P. placomus* and *P. resedaeformis*, which are the most common soft coral taxa in the Gulf of Maine. With the exception of a single lobster trap record, the Jordan Basin catches occurred in bottom trawls targeting species such as white hake, plaice, and other unspecified groundfish. Assuming straight line tow paths between haul start and end positions, it is possible that a few of these catches occurred within proposed coral management zones, but most appear to be outside them as the tow paths do not intersect the proposed management areas. Four of the observed catches (three sea pen, one soft coral) occurred in Georges Basin, but outside the Lindenkohl Knoll zone. The remaining 16 records were scattered throughout the region, roughly half in the Gulf of Maine and half outside it.

It is impossible to extrapolate from these data to estimate the annual number of interactions between fishing gear and deep-sea corals. The percentage of fishing effort that is observed ranges from around 10-40%, depending on the fishery, and a grand average may be somewhere around 10%. Observer coverage rates by gear type and fishery are designed to estimate bycatch of specific managed resources and are not intended to accurately assess bycatch rates of corals. However, given the large number of observed fishing events, and the low number of documented interactions, it is probably fair to say that a relatively small number of trips interact with deep-sea corals.

Map 42 – Observed fishery interactions with deep-sea corals in the New England region, 2013-present.



Source: **Northeast Fishery Observer Program.**

In addition to these observed catches, evidence of fishing gear damage has been noted in recent camera surveys. Areas exhibiting direct impacts from fishing activities were observed at sites in the Gulf of Maine in Western and Central Jordan Basin, Outer Schoodic Ridge, and Georges Basin. In steep areas, paths or tracks, consistent with the setting or recovery of trap gear, were denuded of corals and associated fauna. The peaks of some ridges and nearly horizontal sections of wider rock outcrops were also denuded. Tracks observed here were consistent with impacts from mobile fishing gear. Some coral patches exhibited damage in the form of live colonies with disjunct size class structure, suggesting past impacts. In areas such as Georges Basin, colonies of *Paramuricea placomus* and associated species were often small and virtually all occurred in physical refuges such as cracks and crevices of outcrops and along the sediment-rock interface of large cobbles and boulders. Of note is that the sea star *Hippasteria phrygiana* was observed eating or preying on *P. resedaeformis* colonies at the Outer Schoodic Ridge site. These were seen on living coral colonies that had been detached from rock walls and were laying on the seafloor, possibly due to fishing activity, as one was seen next to an abandoned fishing net. Opportunistic predation by *H. phrygiana* has also been noted in Alaska on *Primnoa pacifica* that had been injured or detached by fishing gear (Stone et al. 2015). This may indicate that coral damaged by fishing gear interactions are at an increased risk of predation by sea stars, thus further reducing the chances that a coral colony will recover from gear-related injuries and impacts.

In 2011, NMFS granted the Maine Department of Marine Resources an exempted fishing permit for redfish to conduct a baseline catch and bycatch evaluation in and around Wilkinson Basin in the central Gulf of Maine. Redfish are currently harvested in this area, but many smaller individuals escape from the 6.5 in mesh nets currently in use. The experimental fishing used nets with smaller, 4.5 in mesh liners in the cod end and targeted schools of redfish that congregate on "bumps" or pinnacles that occur in the normally deep, muddy areas in the central Gulf of Maine. Since redfish seek shelter near structure-forming organisms such as deep-sea corals and sponges, as well as boulder reefs (Packer et al. 2007), concerns were raised by NMFS that the smaller mesh nets would increase the probability of increased bycatch of deep-sea corals. NMFS determined that the project could have an adverse effect on EFH, particularly on any deep-sea corals found there. Therefore, they requested that deep-sea coral bycatch be carefully monitored to enhance the understanding of deep-sea coral distribution in the Gulf of Maine and the potential effects of an expanded redfish fishery on deep-sea corals. However, by the end of the project the only coral bycatch was that of a single specimen of the common sea pen, *Pennatula aculeata,* which is ubiquitous in muddy areas of the Gulf of Maine.

6.6 Essential Fish Habitat

Essential fish habitat (EFH) is defined as the waters and substrate necessary for spawning, breeding, feeding, and growth to maturity. Councils are required by the Magnuson Stevens Act to identify EFH for all managed species. EFH designations include both a map representation (spatial coverage) and text description of preferred habitat attributes. This section summarizes the degree of spatial overlap between designated EFH and coral zone alternatives. This information is used to indicate which coral zones may provide conservation benefits for particular managed species in the impacts analysis section of this document. NEFMC text and map designations were recently updated via OHA2 (NEFMC 2016); MAFMC designations have been implemented periodically through various individual FMP actions. This overlap analysis uses the same approach as the one completed for OHA2 (see Volume 4, section 3 of the OHA2 FEIS for more detailed methods).

The focus here is on species and lifestages that are benthic versus pelagic (upper vs. lower sections of Table 18). The coral zone management measures focus on bottom-tending gear restrictions, and benthic lifestages that are in close association with the seabed and are most likely to benefit from measures that protect seabed habitats. For species where more than one lifestage is combined into a single designation (e.g., Atlantic halibut), if any of the lifestages are benthic, the designation was included in the spatial overlap analysis.

Table 18 – NEFMC and MAFMC-managed benthic vs. pelagic habitat use by species and lifestage.

	Egg and larvae	Juveniles and adults
Benthic	NEFMC species: Atlantic salmon, Atlantic wolffish, sea scallop (larvae are benthic after settlement). Ocean pout, red crab (attached to adults), winter flounder, and Atlantic herring have benthic eggs only. EFH is not designated for skate eggs, but skate egg cases are benthic. Deep-sea red crab eggs are benthic because they are attached to adult female crabs. MAFMC species: None.	NEFMC species: Acadian redfish, American plaice, Atlantic cod, Atlantic halibut, Atlantic salmon, Atlantic wolffish, barndoor skate, clearnose skate, monkfish, haddock, little skate, ocean pout, offshore hake, pollock, red crab, red hake, rosette skate, sea scallop, silver hake, smooth skate, thorny skate, white hake (juveniles after settlement), windowpane flounder, winter flounder, winter skate, witch flounder, yellowtail flounder, deep-sea red crab. Spawning Atlantic herring and Atlantic salmon also use benthic habitats. MAFMC species: Black sea bass, golden tilefish, ocean quahog, surfclam, scup, spiny dogfish (pelagic and epibenthic), summer flounder.
Pelagic	NEFMC species: Acadian redfish (larvae), American plaice, Atlantic cod, Atlantic halibut, Atlantic herring (larvae), Atlantic wolffish (larvae), monkfish, haddock, offshore hake, pollock, red hake, silver hake, white hake, windowpane flounder, witch flounder, yellowtail flounder, larval sea scallops prior to settlement, deep-sea red crab (larvae). MAFMC species: Atlantic mackerel, black sea bass, bluefish, butterfish, golden tilefish, shortfin and longfin squid eggs, scup, summer flounder	NEFMC species: Atlantic herring, Atlantic salmon adults, white hake juveniles prior to settlement, offshore hake MAFMC species: Atlantic mackerel, bluefish, butterfish, shortfin and longfin squid (pre-recruits and recruits)

The various EFH maps were developed using a range of methods and have variable underlying data support. For the NEFMC desginations, most of the juvenile and adult

EFH map representations were developed by conditioning relative abundance survey data binned into ten-minute squares of latitude and longitude by preferred depth and temperature ranges. Although two different catch rate thresholds (75% and 90%) were used to make the maps, and survey catchability varies by species, it is reasonable to compare the degree of overlap across species and lifestages when assessing the benefits of different areas and alternatives. Most MAFMC designations also rely on trawl survey relative abundance data. Certain species managed by the Councils occur in deeper waters of the continental slope (400 m plus). Because the continental slope is not generally sampled in the trawl survey, the portions of the EFH designation maps that overlap the slope are generally based on depth ranges from the literature, rather than relative abundance data. These depth ranges are summarized in Table 19.

Table 19 – Species with deep-water distribution

Species	Depth (m)	Location	References	Max. depth determined by NEFMC Habitat PDT
Atlantic halibut (*Hippoglossus hippoglossus*) juveniles/adults	a) 37-550 b) 200-750 c) 100-700, max 720-900	a) Virginia to Greenland b) Iceland Slope c) Virginia to Labrador	a) Moore et al. 2003 b) Haedrich and Merrett 1998 c) Cargnelli et al. 1999	700 (juvs/adults)
Barndoor skate (*Dipturus laevis*) juveniles/adults	0-750	Cape Hatteras to Grand Banks	Moore et al. 2003	750 (juvs/adults)
Monkfish (*Lophius americanus*) juveniles/adults	a) 0-948 b) max 744-839 c) very few >823	a) FL- Gulf of St. Lawrence b) SNE Slope c) GB/SNE Slope	a) Moore et al. 2003 b) Kvilhaug and Smolowitz 1996 c) Balcom 1997	1000 (juvs/adults)
Offshore hake (*Merluccius albidus*) juveniles/adults	a) 80-1170 (mostly 160-640) b) 200-750	a) Northern Brazil to Le Have Bank b) SNE Slope	a) Moore et al. 2003 b) Haedrich and Merrett 1988	750 (juvs/adults)
Deep-sea red crab (*Chaceon quinquedens*) juveniles/adults	a) 200-599 b) 360-540; max 915-932 c) 274-1463 (juvs mostly d) 503-1280, adults mostly 320-914	a) Continental Slope MAB thru GOM b) Continental Slope-Sable Island to Corsair Canyon c) SNE Slope d) Continental Slope (38° - 41°30' N)	a) Wahle 2005 b) Stone and Bailey 1980 c) Kvilhaug and Smolowitz 1996 d) Wigley et al. 1975	1,300 on slope (juvs) 900 on slope (adults) 2,000 on seamounts (juvs/adults)
Acadian redfish (*Sebastes* sp.) juveniles/adults	a) 200-592 b) 200-750 c) max 768-786 (mostly 490-616)	a) VA - Labrador/ Greenland Slope b) Newfoundland; Iceland Slope c) GB/SNE Slope	a) Moore et al. 2003 b) Haedrich and Merrett 1988 c) Balcom 1997	600 (juvs/adults)

Species	Depth (m)	Location	References	Max. depth determined by NEFMC Habitat PDT
Red hake (*Urophycis chuss*) juvniles/adults	a) 37-792 b) 200-750	a) NC - Southern Newfoundland b) SNE Slope	a) Moore et al. 2003 b) Haedrich and Merrett 1988	750 (adults)
Smooth skate (*Malacoraja senta*) juveniles/adults	46-956	North Carolina to southern Grand Banks	Moore et al. 2003	900 (juvs/adults)
Thorny skate (*Amblyraja radiata*) juveniles/adults	18-996	South Carolina to Greenland	Moore et al. 2003	900 (juvs/adults)
White hake (*Urophycis tenuis*) juveniles/adults	0-1,000	North Carolina to Labrador	Moore et al, 2003	900 (adults)
Witch flounder (*Glyptocephalus cynoglossus*) juveniles/adults	a) 18-1,570 (mostly 45-366) b) max 635	a) North Carolina to Greenland b) GB/SNE Slope	a) Moore et al. 2003 b) Balcom 1997	1,500 (juvs/adults)
Shortfin squid (*Illex illecebrosus*) recruits	Generally, 41-400 but have been caught as deep as 2500 m	GOM, GB to South Carolina	Hendrickson and Holmes 2004 (EFH Source Doc)	n/a
Golden tilefish (*Lopholatilus chamaeleonticeps*) juveniles and adults	To 300 m	US/CAN Exclusive Economic Zone international boundary to VA/NC interstate boundary	Steimle et al 1999 (EFH Source Doc)	n/a

Table 20 and Table 21 identify the spatial overlap between the EFH for each species (and lifestage) and the coral zone boundaries under consideration. Overlaps were assessed visually and are coded as follows:

Overlap	Score	Definition
None	0	No spatial overlap
Slight	1	Overlap of less than 25% of the coral zone(s)
Moderate	2	Overlap of greater than 25% but less than 75% of the coral zone(s)
High	3	Overlap of greater than 75% of the coral zone(s)

At the bottom of each table, some summary statistics are provided. First, the numeric scores were added across all designations listed in the table to represent the number of designations evaluated and the degree of overlap for those designations. This “total score” metric ranges from 2 to 74, out of a possible score of 183 (equivalent to a score of 3 for all 61 benthic lifestages). The “species count” metric indicates the number of species that have at least one benthic lifestage designated in a coral zone or group of zones. These benthic species include 26 managed by NEFMC (clearnose skate and Atlantic salmon excluded) and 7 managed by MAFMC, for a total of 33. The "designation count" metric is the number of individual benthic designations overlapping an area. Spiny dogfish adults have four separate, sex-specific designations for adults vs. sub-adults, but all four EFH maps were pooled for this evaluation. If the lifestage is denoted as "all" (wolffish, halibut, scallops) that indicates that there is a single map designation, which only counts once towards the denominator in the number of designations ratio.

Table 20 – Degree of overlap between designated EFH and coral zones, Gulf of Maine. The scores for the Mt. Desert Rock Option 2 zone boundaries, if different, are shown in parentheses. Where multiple benthic designations were evaluated but all overlaps were scored as zero, there is only one row in the table, with the number of designations evaluated in parentheses.

Species and life stage	Outer Schoodic Ridge	Mt. Desert Rock	Jordan Basin	Lindenkohl Knoll
Acadian redfish juvenile	3	3	1	2
Acadian redfish adult	2	1 (0)	3	3
American plaice juvenile	1	2	0	0
American plaice adult	3	3	3	0
Atlantic cod juvenile	0	1	1	0
Atlantic cod adult	1	1 (2)	0	0
Atlantic halibut - all stages	1	1	0	0
Atlantic wolffish - all stages	3	3	3	3
Haddock juvenile	1	1	0	0
Haddock adult	2	2	0	0
Ocean pout egg	0	0	0	0
Ocean pout juvenile	0	0	0	0
Ocean pout adult	1	0	0	0
Pollock juvenile	3	3 (2)	0	1 (0)
Pollock adult	2	1 (0)	3	3
White hake juvenile	3	3	3	3
White hake adult	3	3	3	3
Windowpane flounder juvenile	1	0	0	0
Windowpane flounder adult	1	0	0	0
Winter flounder egg	1	0	0	0
Winter flounder larvae and adult	1	0	0	0
Winter flounder juvenile	1	0	0	0
Witch flounder juvenile	3	3	3	3 (2)
Witch flounder adult	3	3	3	3
Yellowtail flounder juvenile	0	3	0	0
Yellowtail flounder adult	1	3	0	0
Red hake egg, larvae, and juvenile	1	0	0	0
Red hake adult	3	3	3	3
Silver hake juvenile	3	3	3	3
Silver hake adult	3	3	3	3
Offshore hake juvenile and adult	0	0	0	0
Monkfish juvenile	2	3	2	3
Monkfish adult	2	3	3	3

Species and life stage	Outer Schoodic Ridge	Mt. Desert Rock	Jordan Basin	Lindenkohl Knoll
Smooth skate juvenile	3	3	3	3
Smooth skate adult	0	3	2	2
Thorny skate juvenile	3	3	3	1
Thorny skate adult	3	3	3	3
Barndoor skate – juv/adu	0	0	0	0
Little skate juvenile	1	0	0	0
Little skate adult	0	0	0	0
Winter skate juvenile	1	0	0	0
Winter skate adult	1	0	0	0
Rosette skate juvenile and adult	0	0	0	0
Atlantic sea scallop - all	1	0	0	0
Atlantic herring egg	0	0	0	0
Deep-sea red crab (2)	0	0	0	0
Golden tilefish (2)	0	0	0	0
Summer flounder (2)	0	0	0	0
Spiny dogfish – juvenile	3	3	3	3
Spiny dogfish- adults (pooled)	3	3	3	3
Black seabass (2)	0	0	0	0
Ocean quahog (2)	0	0	0	0
Atlantic surfclam (2)	0	0	0	0
Scup (2)	0	0	0	0
Total score (out of 183)	**74**	**73**	**71**	**57**
Count of species (out of 33)	**22**	**17**	**17**	**13**
Count of designations (out of 61)	**37**	**29**	**29**	**21**

Table 21 – Degree of overlap between designated EFH and the No Action and discrete coral zones overlapping the canyons, continental slope, and seamounts. Where multiple benthic desginations were evaluated but all overlaps were scored as zero, there is only one row in the table, with the number of designations evaluated in parentheses.

Species and life stage	Slope depth range, m	Tilefish GRAs (No action)	Monkfish and squid closure (No action)	Canyon setion of MNM	Seamount section of MNM	Discrete canyon within MNM	Discrete canyons outside MNM	Discrete sea-mount zones
Acadian redfish juv	400-600	1	1	1	0	1	1	0
Acadian redfish adult	400-600	1	1	1	0	1	1	0
American plaice (2)	None	0	0	0	0	0	0	0
Atlantic cod juvenile	None	0	0	1	0	0	0	0
Atlantic cod adult	None	0	0	1	0	0	0	0
Atlantic halibut - all	400-700	1	1	2	0	1	1	0
Atlantic wolffish - all	None	0	0	0	0	0	0	0
Haddock juvenile	None	0	0	2	0	0	0	0
Haddock adult	None	0	0	0	0	0	0	0

Ocean pout egg	None	0	0	1	0	0	0	0
Ocean pout juvenile	None	0	0	1	0	0	0	0
Ocean pout adult	None	0	0	1	0	0	0	0
Pollock juvenile	None	0	0	0	0	0	0	0
Pollock adult	None	1	0	1	0	0	0	0
White hake juvenile	None	1	1	2	0	1	1	0
White hake adult	400-900	1	1	1	0	2	2	0
Windowpane (2)	None	0	0	0	0	0	0	0
Winter flounder (3)	None	0	0	0	0	0	0	0
Witch fl juvenile	400-1500	3	3	3	0	3	3	0
Witch flounder adult	400-1500	3	3	2	0	3	3	0
Yellowtail fl (2)	None	0	0	0	0	0	0	0
Red hake e/l/j	None	0	0	0	0	0	0	0
Red hake adult	400-750	2	1	2	0	1	1	0
Silver hake juvenile	None	0	0	1	0	0	0	0
Silver hake adult	None	2	1	2	0	1	1	0
Offshore hake juvenile and adult	400-750	3	2	2	0	2	2	0
Monkfish juvenile	400-1000	2	2	1	0	2	2	0
Monkfish adult	400-1000	3	2	3	0	2	2	0
Smooth skate juv	400-900	2	2	1	0	2	2	0
Smooth skate adult	400-900	2	2	1	0	2	2	0
Thorny skate juvenile	400-900	2	2	1	0	2	2	0
Thorny skate adult	400-900	2	2	1	0	2	2	0
Barndoor skate j/a	400-750	3	2	2	0	2	2	0
Little skate juvenile	None	0	0	0	0	0	0	0
Little skate adult	None	0	0	1	0	0	0	0
Winter skate (2)	None	0	0	0	0	0	0	0
Rosette skate j/a	None	0	0	0	0	0	1	0
Sea scallop all	None	0	0	1	0	0	0	0
Atlantic herring egg	None	0	0	0	0	0	0	0
Red crab lar/juv	400-1300	3	3	2	1	3	3	1
Red crab adult	400-900	3	2	1	1	2	2	1[a]
Golden tilefish juv	To 300	1	1	2	0	1	1	0
Golden tilefish adult	To 300	1	1	2	0	1	1	0
Summer flounder juv	None	0	0	0	0	0	0	0
Summer flounder a	None	1	0	1	0	1	1	0
Spiny dogfish juv	None	3	3	3	0	2	2	0
Spiny dogfish adults (pooled)	None	3	3	3	0	3	2	0
Black seabass (2)	None	0	0	0	0	0	0	0
Ocean quahog (2)	None	0	0	0	0	0	0	0
Atlantic surfclam (2)	None	0	0	0	0	0	0	0
Scup (2)	None	0	0	0	0	0	0	0
Total score (out of 183)		**50**	**42**	**53**	**2**	**43**	**43**	**2**

Count of species (out of 33)	**16**	**14**	**21**	**1**	**15**	**16**	**1**
Count of designations (out of 61)	**25**	**23**	**34**	**2**	**24**	**25**	**2**

Table 22 – Degree of overlap between designated EFH and the broad coral zones overlapping the canyons, continental slope, and seamounts. Option 6 is the preferred alternative. Where multiple benthic desginations were evaluated but all overlaps were scored as zero, there is only one row in the table, with the number of designations evaluated in parentheses.

Species and life stage	Slope depth range, m	300 m (Option 1)	400 m (Option 2)	500 m (Option 3)	600 m (Option 4)	900 m (Option 5)	600 m min (Option 6)	Option 7
Acadian redfish juv	400-600	1	1	1	0	0	0	1
Acadian redfish adult	400-600	1	1	1	0	0	0	1
American plaice (2)	None	0	0	0	0	0	0	0
Atlantic cod (2)	None	0	0	0	0	0	0	0
Atlantic halibut - all	400-700	1	1	1	1	0	1	1
Atlantic wolffish - all	None	0	0	0	0	0	0	0
Haddock (2)	None	0	0	0	0	0	0	0
Ocean pout (3)	None	0	0	0	0	0	0	0
Pollock (2)	None	0	0	0	0	0	0	0
White hake juvenile	None	0	0	0	0	0	0	0
White hake adult	400-900	1	1	1	1	0	1	1
Windowpane (2)	None	0	0	0	0	0	0	0
Winter flounder (3)	None	0	0	0	0	0	0	0
Witch fl juvenile	400-1500	1	1	1	1	1	1	1
Witch flounder adult	400-1500	1	1	1	1	1	1	1
Yellowtail fl (2)	None	0	0	0	0	0	0	0
Red hake e/l/j	None	0	0	0	0	0	0	0
Red hake adult	400-750	1	1	1	1	0	1	1
Silver hake juvenile	None	0	0	0	0	0	0	0
Silver hake adult	None	1	0	0	0	0	0	0
Offshore hake juvenile and adult	400-750	1	1	1	1	0	1	1
Monkfish juvenile	400-1000	1	1	1	1	1	1	1
Monkfish adult	400-1000	1	1	1	1	1	1	1
Smooth skate juv	400-900	1	1	1	1	0	1	1
Smooth skate adult	400-900	1	1	1	1	0	1	1
Thorny skate juvenile	400-900	1	1	1	1	0	1	1
Thorny skate adult	400-900	1	1	1	1	0	1	1
Barndoor skate j/a	400-750	1	1	1	1	0	1	1
Little skate (2)	None	0	0	0	0	0	0	0
Winter skate (2)	None	0	0	0	0	0	0	0
Rosette skate j/a	None	1	0	0	0	0	0	0

Sea scallop all	None	0	0	0	0	0	0	0
Atlantic herring egg	None	0	0	0	0	0	0	0
Red crab lar/juv	400-1300	1	1	1	1	1	1	1
Red crab adult	400-900	1	1	1	1	1	1	1
Golden tilefish – juv	To 300	1	0	0	0	0	0	0
Golden tilefish – adu	To 300	1	0	0	0	0	0	0
Summer flounder j	None	0	0	0	0	0	0	0
Summer flounder a	None	1	1	1	1	1	1	1
Spiny dogfish juv	None	1	1	1	1	1	1	1
Spiny dogfish adults (pooled)	None	1	1	1	1	1	1	1
Black seabass (2)	None	0	0	0	0	0	0	0
Ocean quahog (2)	None	0	0	0	0	0	0	0
Atlantic surfclam (2)	None	0	0	0	0	0	0	0
Scup (2)	None	0	0	0	0	0	0	0
Total score (out of 183)		**24**	**20**	**20**	**18**	**9**	**18**	**20**
Count of species (out of 33)		**16**	**13**	**13**	**12**	**5**	**12**	**13**
Count of designations (out of 61)		**24**	**20**	**20**	**18**	**9**	**18**	**20**

Overall, EFH for the largest number of species overlaps the inshore Gulf of Maine zones, with moderate numbers of EFH designations overlapping the offshore Gulf of Maine zones, and lower numbers of species with EFH in the canyon and especially the seamount zones. This is consistent with the findings of Omnibus Habitat Amendment 2, where inshore habitat management areas tended to have more EFH designations. Generally, the species associated with the coral zones are those that occur in deeper water. These include pollock, white hake, witch flounder, monkfish, and some skates within the Gulf of Maine zones. The species overlapping the canyon, seamount, and broad zones are those that occupy continental slope depth ranges, namely Atlantic halibut, barndoor skate, monkfish, offshore hake, deep-sea red crab, Acadian redfish, red hake, smooth skate, thorny skate, white hake, and witch flounder.

Of the canyon/slope/seamount management areas, the canyon section of the Monument overlaps the distribution and EFH for the broadest range of species because it encompasses the largest range of depths. The No Action tilefish and monkfish/squid areas as well as the discrete canyon zones encompass habitats for a slightly narrower range of species, i.e. those with continental slope distributions listed above. The seamount discrete zones and seamount section of the Monument have very little overlap with managed resources or their EFH, only deep-sea red crab and possibly shortfin squid (which are not considered benthic and are therefore not scored in the tables).

Only small fractions of each the broad zones are designated as EFH because these broad zones include extensive deepwater areas outside the distribution of managed species. This is evidenced by the overlap scores of zero or at most one for all broad zones. However, as the broad zones extend all the way from Alvin Canyon to the EEZ boundary, they do provide widespread protection from fishery impacts within the depths to which they are designated. Progressively deeper broad zones ecompass EFH for fewer species. The 900 m zone in particular is distinct from the other broad zones in that a number of species do not range into waters that deep (i.e. halibut, white hake, red hake, offshore hake, barndoor skate, smooth skate, thorny skate). Acadian redfish are unlikely to occur in the deepest three broad zones (Options 5, 6, or 9) as they are only distributed to around 600 m. While some of the Mid-Atlantic species' designations overlap the deeper broad zones, this is because the desginations are spatially coarse, i.e. mapped by ten-minute square, and since most species do not range into these deeper waters, actual overlap between the various MAFMC species and the broad zones are relatively unlikely.

6.7 Managed resources and fisheries

The managed resources described here are those that may be impacted by the coral zone alternatives under consideration, whose fisheries use bottom-tending gear in areas overlapping the alternatives. These resources were identified through the VTR analysis (section 7.1.3.1). Some of these resources, and their fisheries, occur exclusively in areas overlapping the deep-sea coral zones off the southern flank of Georges Bank, in just the Gulf of Maine, or in both (Table 23).

Each fishery is managed with a unique set of measures that constrain catch and effort, including seasonal and year-round closures. Closures specifically designed to protect deep-sea corals are described within the No Action alternative (section 4.1). Should additional closures be implemented through this action, they would be additive to both the No Action alternative and other existing closures, further constraining where and when fishing may occur. The closures most relevant to this action, other than No Action, are described in this section.

Table 23 – Distribution of managed resources and their fisheries relative to the alternatives under consideration

Species/Fishery	Managed by	Canyon, slope and seamount zones south of Georges Bank	Gulf of Maine zones
Northeast multispecies, large mesh	NEFMC	GB haddock, white hake	GOM cod, GOM haddock, American plaice, witch flounder, white hake, GOM winter flounder, pollock, Acadian redfish
Northeast multispecies, small mesh	NEFMC	Silver and offshore hake along shelf break, particularly in eastern canyons	Silver and red hake occur in these areas, but the fishery is precluded.
Longfin squid, butterfish	MAFMC	Longfin squid and butterfish along shelf break	No overlap noted
Monkfish	NEFMC, MAFMC	Along the shelf break in western canyons	Offshore zones (Jordan Basin, Lindenkohl)
Golden tilefish	MAFMC	Along shelf break in western canyons	No overlap noted
Deep-sea red crab	NEFMC	Along shelf break in all canyons	No overlap noted
Lobster	ASMFC	Along shelf break in all canyons	Fishery overlaps all zones; distinct fisheries inshore vs. offshore

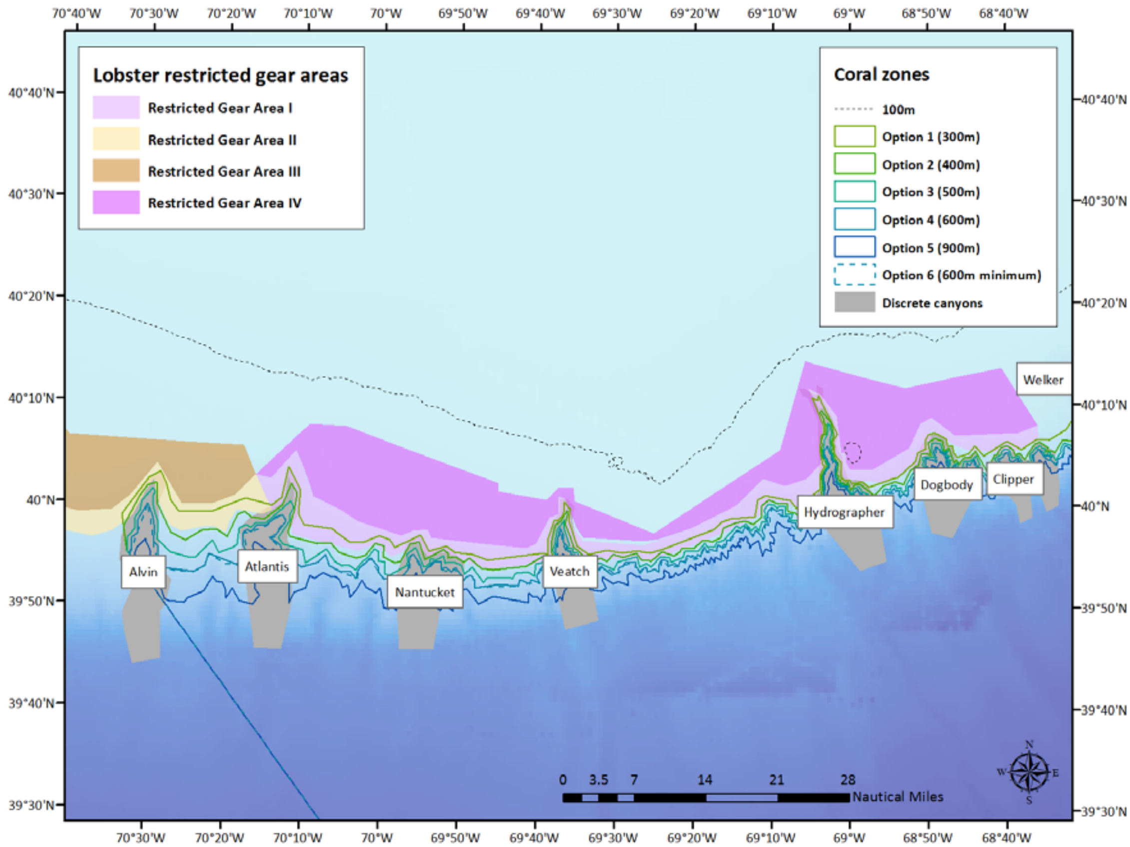
Species/Fishery	Managed by	Canyon, slope and seamount zones south of Georges Bank	Gulf of Maine zones
Jonah crab	ASMFC	Along shelf break particularly in western New England canyons	No overlap noted

Restricted Gear Areas I-IV

One series of closures relevant to several fisheries are the Restricted Gear Areas I-IV on the southwestern flank of Georges Bank (Map 43). These areas were established with input from both mobile and fixed gear fishermen and are intended to reduce gear conflicts as lobster vessels move their traps to follow the seasonal migration of lobsters (deeper waters in winter, shallower in summer). The seaward areas prohibit trawl gear in winter and trap gear in summer, and the landward areas the reverse, prohibiting trawl gear in summer and trap gear in winter.

The shallower Restricted Gear Areas (III and IV) have very little spatial overlap with coral zones, except for Area IV at the head of Hydrographer Canyon (Map 43). The deeper Restricted Gear Areas I and II overlap the 300 m broad zone and the heads of the canyon zones. Specifically, Area II overlaps the head of Alvin Canyon, and Area I overlaps the head of Atlantis, Nantucket, Veatch, and Hydrographer Canyons, as well as small portions of Dogbody and Clipper Canyons (Welker Canyon is just east of the RGA). The 400 m broad coral zone is generally outside the restricted gear areas, and the 500-900 m zones are almost entirely outside the boundaries of the restricted gear areas.

Map 43 – Lobster restricted gear areas and deep-sea coral zones



6.7.1 Large mesh multispecies (groundfish)

There are 13 species managed under the Northeast Multispecies Fishery Management Plan (FMP) as large mesh (groundfish) species, based on fish size and type of gear used to harvest the fish: American plaice, Atlantic cod, Atlantic halibut, Atlantic wolffish, haddock, pollock, redfish, ocean pout, yellowtail flounder, white hake, windowpane flounder, winter flounder, and witch flounder. Several large mesh species are managed as two or more stocks based on geographic region.

Population status

Of the nine stocks with fisheries that potentially overlap the alternatives under consideration, two are currently considered overfished and overfishing is occurring (Table 24; NEFMC 2016).

Management

Groundfish has been managed under the Magnuson-Stevens Act (MSA) beginning with the adoption of a groundfish plan for cod, haddock, and yellowtail flounder in 1977. This plan first relied on hard quotas, but the quota system ended in 1982 with the adoption of the Interim Groundfish Plan, which controlled fishing mortality with minimum fish sizes and codend mesh regulations. The Northeast Multispecies FMP replaced this plan in 1986, initially continuing to control fishing mortality with gear restrictions and minimum mesh size, and used biological targets based on a percentage of maximum spawning potential. The FMP has had many revisions in subsequent years. Since 2010, the vast majority of the fishery has been managed with a catch share program, in which self-selected groups of commercial fishermen (i.e., sectors) are allocated a portion of the available catch.

Table 24 – Status of selected Northeast groundfish stocks for FY2015.

Stock	2015 Assessments[a]		Fishery overlap with coral zone[b]	
	Overfishing?	Overfished?	GB/canyon?	Gulf of Maine?
Gulf of Maine cod	Yes	Yes	No	Yes
Georges Bank haddock	No	No	Yes	No
Gulf of Maine haddock	No	No	No	Yes
American plaice	No	No	No	Yes
Witch flounder	Yes	Yes	No	Yes
Gulf of Maine winter flounder	No	Unknown	No	Yes
Acadian redfish	No	No	No	Yes
White hake	No	No	Yes	Yes
Pollock	No	No	No	Yes

[a] *Source:* Groundfish Framework 55 (NEFMC 2016).
[b] *Source:* VTR analysis.

Fishery

Since the start of sector management through 2013, there has been a decline in groundfish landings (42.3M lbs in FY2013), revenue ($58.7M in FY2013), the number of vessels with a limited access groundfish permit (1,119 in FY2013), and the number of vessels with revenue from at least one groundfish trip (316 in FY2013). The groundfish fishery has had a diverse fleet of vessels sizes and gear types. Over the years, as vessels entered and exited the fishery, the typical characteristics defining the fleet changed as well. The decline in active vessels has occurred across all vessel size categories. Since FY2009, the 30’ to < 50’ vessel size category, which has the largest number of active groundfish vessels, experienced a 38% decline (305 - 159 active vessels). The <30’ vessel size category, containing the least number of active groundfish vessels, experienced the largest (50%) reduction since FY2009 (34 - 17 vessels). The vessels in the largest (≥75’) vessel size category experienced the least reduction (30%) since FY2009 (Murphy et al 2013).

6.7.2 Small mesh multispecies (whiting)

The silver, red, and offshore hake trawl fishery, commonly referred to as the “whiting” fishery, and is managed by the NEFMC under the Small Mesh Multispecies FMP. Silver hake is the primary target species. There is little to no separation of silver and offshore species in the market, and both are generally sold under the name "whiting."

Population status

Silver hake *(Merluccius bilinearis*) occur throughout the Gulf of Maine and in moderate to deeper depths on Georges Bank and in the Mid-Atlantic Bight. In the NEFSC trawl survey, larger and older fish are found further north and in deeper waters, and smaller younger fish are found in relatively shallow waters. Depth appears to be a more important determinant of silver hake distribution than temperature (NEFSC 2006). The 2013 assessment update concluded that both the northern and southern stocks were found to be not overfished and overfishing was not occurring (NEFMC 2013).

Red hake *(Urophycis chuss*) occur throughout the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic Bight. They occur at a wide range of depths throughout the year, the juveniles in particular making seasonal migrations to follow preferred temperature ranges. I the Mid-Atlantic Bight, the juveniles move into deeper waters in the fall, while on Georges Bank, they are found in shallower waters in fall and nearly absent in the spring, when they occur mostly on the northern edge. Overall, juveniles have a shallower distribution in the NEFSC trawl surveys, 0-30 m in spring and 40-80 m in fall, while adults occur between 60-300 m in spring, and 50-160 m in the fall. The 2015 assessment update concluded that both northern and southern stocks of red hake were not overfished and overfishing was not occurring. Northern red hake had previously experienced overfishing (NEFMC 2015).

Offshore hake (*Merluccius albidus*) occur along the shelf/slope break. Their distribution in the Northeast U.S. extends from the southeastern flank of Georges Bank to Cape Hatteras. At night, juveniles and adults occur in the water column. During the day, both occur in mud, mud/sand, and sand habitats. As their common name implies, offshore hake have the deepest distribution of any of the hake species managed by NEFMC. There is little information available on the reproductive biology of offshore hake. Spawning appears to occur over a protracted period or even continually throughout the year from the Scotian Shelf through the Mid-Atlantic Bight. Offshore hake feed on pelagic invertebrates (e.g., euphausiids and other shrimps) and fish, including conspecifics. There is no accepted assessment of offshore hake.

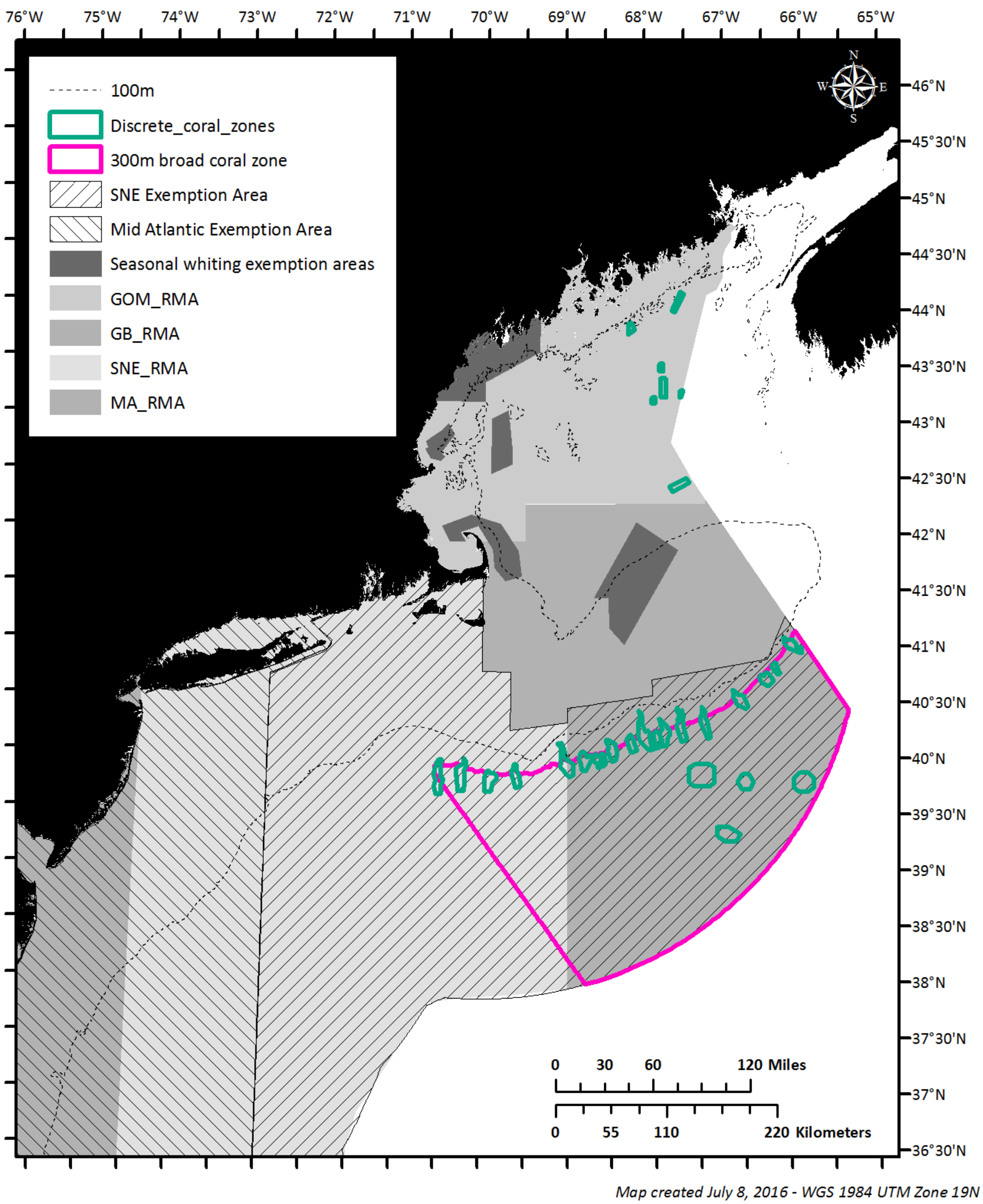
Management

The whiting fishery is managed under the Northeast Multispecies FMP via a series of exemptions to the regulations for large mesh stocks, including a 6.5 in. codend mesh size requirement that limits catch of undersized groundfish. This exemption requires that a fishery should routinely catch under 5% of regulated multispecies (i.e., large mesh species and ocean pout). The whiting fishery also has possession limits and area restrictions on small-mesh use. Seasonally, the whiting fishery can operate within spatially-discrete exemption areas within the Gulf of Maine and Georges Bank regulated mesh areas (RMAs). Year-round, the fishery can also operate throughout the southern portion of the Georges Bank RMA, as well as throughout the Southern New England and Mid-Atlantic RMAs. The deep-sea canyons and slope are part of the Southern New England/Southern GB exemption area. The Gulf of Maine coral zones are outside the discrete exemption areas and therefore are not accessible to the whiting fishery (Map 44).

Fishery

Landings and revenues of silver hake in the northern and southern area have been increasing since 2006. Landings of northern silver hake have been over 1,000 mt per year ($1.2 – 2.3M annual revenue). Landings of southern silver hake have been higher, between 2,600 mt to 13,000 mt per year ($7.6 – 15.5M annual revenue). Most of the high landings trips targeting whiting are made by vessels fishing along the Mid-Atlantic continental shelf edge and along the southern edge and eastern portion of Georges Bank. Almost all trips landing over 12.7 mt and targeting whiting occurred in the Southern New England Exemption Area. Other trips targeting whiting are more broadly distributed along the Southern New England shelf edge and within statistical area 537. There is an increasing trend of trips targeting whiting in the southern stock area and landing closer to 13.6 mt per trip.

Map 44 – Deep-sea coral zones and whiting exemption areas



6.7.3 Longfin inshore squid and butterfish

Population status

Longfin inshore squid *(Doryteuthis (Amerigo) pealeii*) is distributed primarily in continental shelf waters located between Newfoundland and the Gulf of Venezuela (Cohen 1976; Roper et al. 1984). In the northwest Atlantic Ocean, longfin squid are most abundant in the waters between Georges Bank and Cape Hatteras, where the species is commercially exploited. The stock area extends from the Gulf of Maine to Cape Hatteras. Distribution varies seasonally. North of Cape Hatteras, squid migrate offshore during late autumn to overwinter in warmer waters along the shelf edge and slope, and then return inshore during the spring where they remain until late autumn (Jacobson 2005). The species lives for about nine months, grows rapidly, and spawns year-round with peaks during late spring and autumn. Individuals hatched in summer grow more rapidly than those hatched in winter and males grow faster and attain larger sizes than females (Brodziak and Macy III 1996). At the latest assessment in 2011, overfishing was not occurring, and the overfished status could not be determined, as there is no biomass reference point (NEFSC 2011a).

Butterfish *(Peprilus tricanthus)* is a semi-pelagic/semi-demersal schooling fish, primarily distributed between Nova Scotia and Florida, but are most abundant between the Gulf of Maine and Cape Hatteras. Butterfish are fast-growing, short-lived, pelagic fishes that form loose schools, often near the surface. They winter near the edge of the continental shelf in the Middle Atlantic Bight and migrate inshore in the spring into southern New England and Gulf of Maine waters. During the summer, butterfish occur over the entire mid-Atlantic shelf from sheltered bays and estuaries out to about 200 m. In late fall, butterfish move southward and offshore in response to falling water temperatures (Cross et al. 1999, and references therein). At the latest assessment in 2014, butterfish was not overfished and overfishing was not occurring (NEFSC 2014). Butterfish are also managed as a single stock. The most recent assessment in 2010 questioned the 2004 reference points, and while it was agreed that overfishing was unlikely to be occurring, the overfished status of butterfish was classified as unknown. A benchmark assessment of the stock is ongoing.

Management

Longfin squid and butterfish have been managed by the MAFMC under the Atlantic Mackerel, Squid, and Butterfish FMP since 1983. Management measures for the *D. pealeii* stock include annual TACs, which have been partitioned into seasonal quotas since 2000 (trimesters in 2000 and quarterly thereafter), a moratorium on fishery permits, and a minimum codend mesh size of 1 7/8 inches. The directed longfin squid fishery is managed via trimester quota allocations. The directed longfin squid fishery closes when the Regional Administrator projects that 90 percent of the longfin squid quota is harvested before April 15 of Trimester I and/or August 15 of Trimester II, and when 95 percent of the longfin squid DAH has been harvested in Trimester III. On or after April 15 of Trimester I and/or August 15 of Trimester II, NMFS closes the directed fishery for longfin squid when the Regional Administrator projects that 95 percent of the longfin squid quota is harvested.

There is also a cap on butterfish discards in the longfin squid fishery that is allocated by trimester and closes the longfin squid fishery to directed harvest once it has been exceeded. Butterfish is managed using a phased system. The system triggers butterfish possession limit reductions at different points to ensure quota is available for directed harvest throughout the fishing year. During closures of the directed longfin squid or butterfish fisheries, incidental catch fisheries for these species are permitted.

Fishery

The domestic longfin fishery occurs primarily in Southern New England and Mid-Atlantic waters, but some fishing also occurs along the edge of Georges Bank. Fishing effort reflects seasonal longfin distribution, and effort is generally directed offshore during October through April and inshore during May through September. The fishery is dominated by small-mesh otter trawlers, but near-shore pound net and fish trap fisheries occur during spring and summer. Since 1984, annual offshore landings have generally been three-fold greater than inshore landings.

Although 1.5% of butterfish landed from 2007-2011 were reported as caught with gillnets, and trace amounts were reported as caught with a variety of fishing gears, more than 98% of reported landings of all four species during this period were caught with otter trawls (midwater and bottom). Management measures implemented under the FMP restrict only the commercial fishing sectors, although there is a recreational fishery for Atlantic mackerel. Fishing for Atlantic mackerel occurs year-round, although most fishing activity occurs from January through April. Butterfish are landed year-round, with no apparent seasonality.

Butterfish had been landed domestically since the late 1800s, and in the 1960s and 1970s there was a substantial increase in catch, mostly by foreign vessels. After extended jurisdiction was implemented, domestic landings expanded but then declined in the 1990s due to lower abundance and market conditions. As of January 2013, a limited domestic fishery has been reestablished, although landings have been low so far. In general discards represent a substantial fraction of the catch.

6.7.4 Monkfish

Population status

Juvenile and adult monkfish (*Lophius americanus*, i.e., “goosefish”) are common in mud habitats and occur in U.S. waters from the EEZ boundary with Canada to Cape Hatteras, North Carolina, in depths up to 900 m. Monkfish have seasonal onshore-offshore migrations, which may relate to spawning or possibly to food availability. Female monkfish begin to mature at age four with 50% of females maturing by age five (17 in, 43 cm). Males generally mature at slightly younger ages and smaller sizes (50% maturity at age 4.2 (14 in, 36 cm). Spawning takes place from spring through early autumn. It progresses from south to north, with most spawning occurring during the spring and early summer. Females lay a buoyant egg raft or veil that can be up to 39 ft (12 m) long and 5 ft (1.5 m) wide, and only a few mm thick. The larvae hatch after 1 - 3 weeks, depending on water temperature. The larvae and juveniles spend several months in a pelagic phase before settling to a benthic existence at a size of 3 in (8 cm; NEFSC 2011).

The Monkfish FMP defines two management areas for monkfish (northern and southern), divided roughly by an east-west line bisecting Georges Bank. As of 2013 data, monkfish in both management areas are not overfished and overfishing is not occurring, although the 2013 stock assessment emphasized a high degree of uncertainty: “due to cumulative effects of under-reported landings, unknown discards during the 1980s, uncertainty in survey indices, and incomplete understanding of key biological parameters such as age and growth, longevity, natural mortality and stock structure contributing to retrospective patterns primarily in the northern management area” (NEFSC 2013c).

Management

Since 1999, monkfish has been jointly managed by the NEFMC and MAFMC in two management units, a Northern Management Area in the Gulf of Maine, the Great South Channel, and most of Georges Bank, and a Southern Management Area covering the southwest part of Georges Bank, Southern New England, and Mid-Atlantic waters. Monkfish have a large, bony head and are harvested for their livers and the tender meat in their tails. During the early 1990s, fishermen and dealers in the monkfish fishery approached both Councils with concerns about the increasing amount of small fish being landed, the increasing frequency of gear conflicts between monkfish vessels and those in other fisheries, and the expanding directed trawl fishery. Since the implementation of the FMP, vessels are more commonly landing large, whole monkfish for export to Asian markets. The Northern Management Area monkfish fishery is closely integrated with the northeast multispecies fishery, and is primarily a trawl fishery, while the Southern Management Area fishery is primarily a gillnet fishery targeting monkfish almost exclusively. These differences have resulted in some differences in management measures, such as trip limits and DAS allocations, between the two areas.

The fishery is primarily managed through the issuance of limited access permits, as well as days-at-sea (DAS) allocations, landing limits, and gear restrictions that differ in each fishery management area. Limited access monkfish vessels having a limited access groundfish permit are also required to comply with applicable Multispecies DAS and sector provisions or common pool regulations, depending on the vessel’s enrollment for a given fishing year. Mesh size regulations for trawls and gillnets are set to prevent the fishery from targeting small monkfish and catching groundfish when not on a Multispecies DAS. As a measure to reduce habitat impacts requires trawl vessels in the SFMA to use nets with roller gear with a diameter no larger than 6 in (Monkfish Amendment 2, section 4.1.8.1). Vessels in the western Gulf of Maine may not use roller gear with a diameter larger than 12 in.

The canyon and slope coral zones overlap the Offshore Fishery Program Area, which was established by Amendment 2 (2005). The offshore program allows vessels to declare into the area for the year, in which case NMFS issues them a Category F permit. Although this permit includes a lower number of days at sea, and limits vessels to fishing in the Offshore Fishery Program Area only, the advantage of Category F is that it has a higher possession limit. Other vessels can fish in the Offshore Fishery Program Area, and other monkfish management areas, but they are constrained to lower possession limits. The number of vessels in the Category F program has generally been small (e.g., 6 permits issued during FY2012).

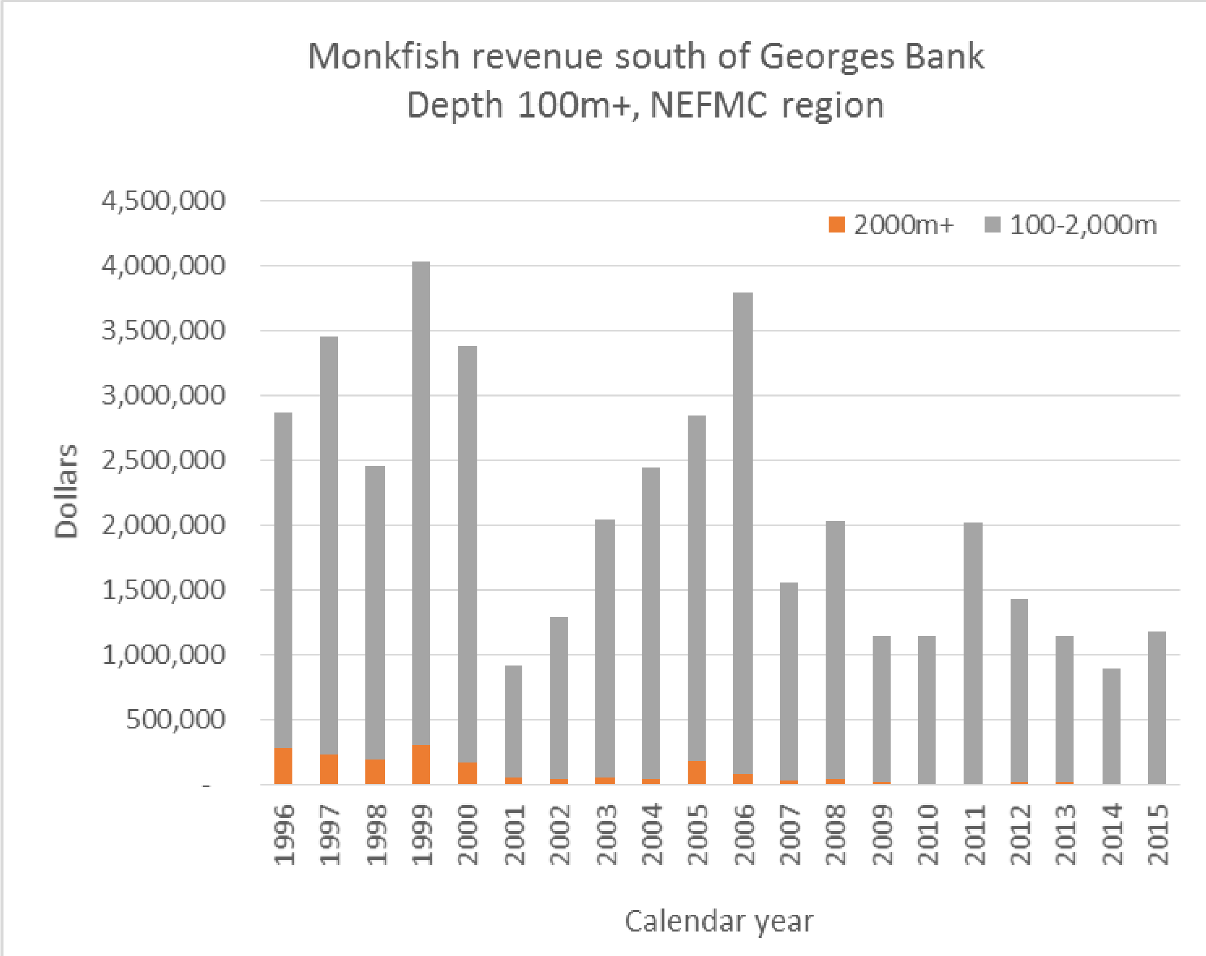
Fishery

Monkfish are harvested primarily with bottom trawls and gillnets. Scallop dredges catch a small amount of monkfish. No other gear types account for more than trace landings of monkfish, and there is no recreational fishery. Revenues have generally increased since the mid-1980s, peaking in 1999 and 2000, before declining through 2010. Vessels using trawls typically target monkfish along the continental shelf edge, next to canyons and in deeper water than vessels fishing with gillnets.

Landings for both areas combined have generally decreased since 1999, with a peak in 2003 (26,353 mt), and have been under 10,000 mt since 2009. Revenue was just under $20M in 2014. In 2014, there were 637 monkfish limited access permits, of which 282 were Category C permits holding limited access permits in either the multispecies (52%) or scallop (59%) fisheries, and 264 were Category D permits, primarily (98%) holding limited access multispecies permits (NEFMC 2016a).

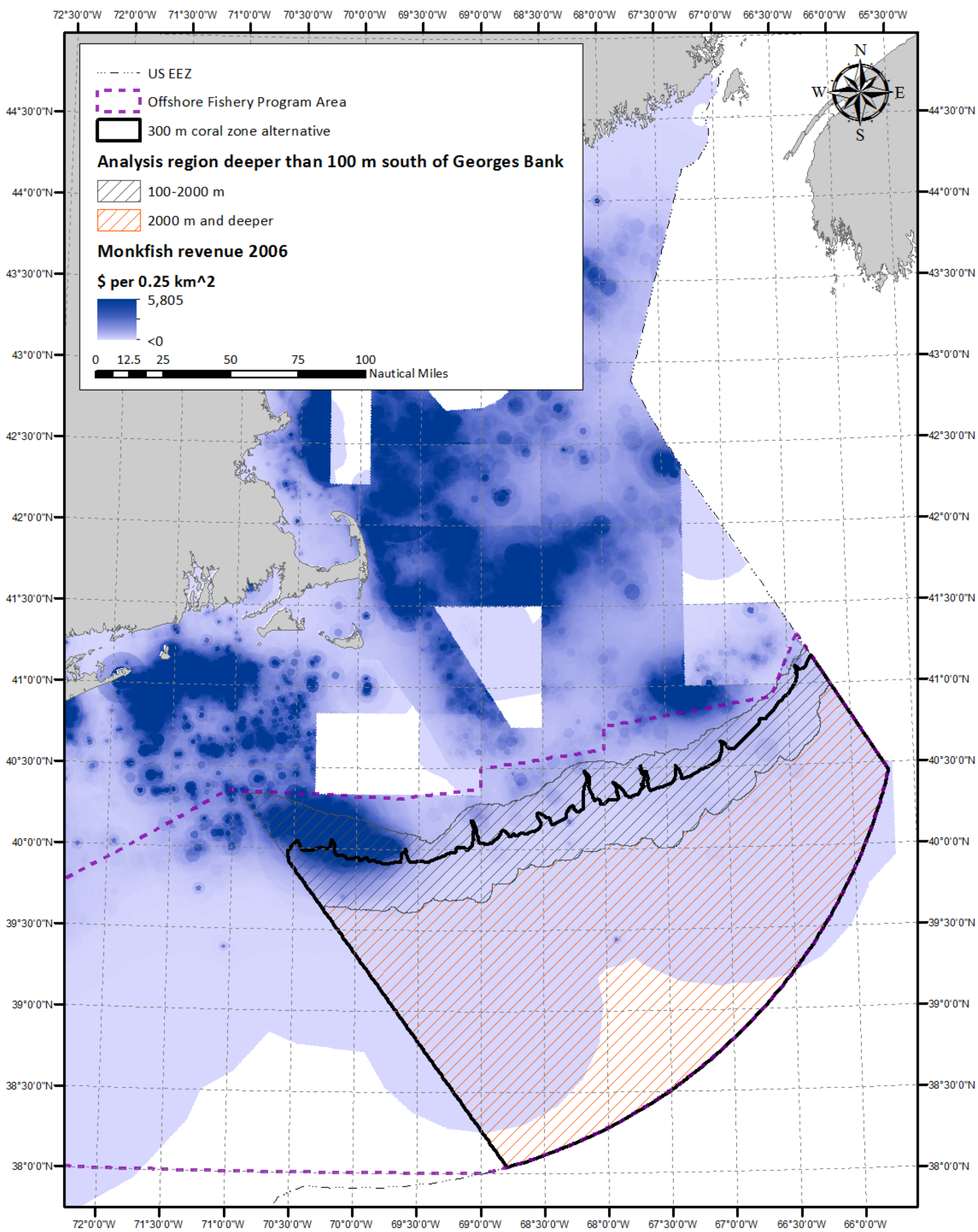
Considering just the area deeper than 100 m south of Georges Bank and within the NEFMC management region (essentially the New England part of the Offshore Fishery Program Area), recent monkfish revenues are lower than they have been historically. Since calendar year 2007, revenues for this location have ranged from $1-2M, which contrasts with higher revenues in this location during the late 1990s and mid-2000s. Peaks approaching $4M occurred in 1999 and 2006. The reasons for this decrease are likely related to both management and stock abundance. For fishing year 2006-2007, days at sea were reduced from prior levels, which may explain the decline between CY2006 and CY2007. However, recently monkfish days at sea have increased, and landings remain low relative to historic values. Industry observations suggest that fewer monkfish, or lower catch rates of monkfish, are contributing to catches that are below annual allocations (F. Hogan, personal communication).

Figure 3 – Monkfish revenue in and around the coral zones south of Georges Bank (within hatched areas of map on following page). All gear types, by calendar year.



Source: **VTR data.**

Map 45 – Distribution of monkfish revenues in the New England region, all gear types, calendar year 2006.



Offshore Fishery Program Area, 300 m broad zone alternative, and hatched analysis region shown for reference. Source: VTR data.

6.7.5 Golden tilefish

Population status

The golden tilefish (*Lopholatilus chamaeleonticeps*) is the largest and longest lived of all the tilefish species, and in U.S. waters ranges from Georges Bank to Key West, Florida, and throughout the Gulf of Mexico. In the SNE/MA area, golden tilefish generally occur at depths of 76-366 m along the outer continental shelf and are most abundant in depths of 100-240 m. Temperature may also constrain their range, as they are most abundant near the 15° C isotherm. Although golden tilefish occupies a variety of habitats, it is somewhat unique in that it creates and modifies existing vertical burrows in the sediment as its dominant habitat in U.S. waters. The most recent stock assessment (SAW 58) determined that tilefish is not overfished and overfishing is not occurring (NEFSC 2014).

Management

The MAFMC has managed golden tilefish fishery within the Tilefish FMP since 2001 for the fishery that occurs north of the Virginia/North Carolina border. An original intent was to address the overfished status of the species (the stock was considered rebuilt in 2014). Amendment 1 to the Tilefish FMP, implemented in 2009, adopted an IFQ program, initially with 13 quota holders, based primarily on historical participation in the fishery. Since then, the IFQ fishery has been allocated 95% of the annual quota. The open access incidental fishery, under a 500 lb. trip limit, is allocated the remainder (MAFMC 2016).

Fishery

During 2001-2015, golden tilefish landings have averaged 1.9 million pounds, ranging from 1.3 (2015) to 2.5 (2004) million pounds. Based on dealer data from 2011 through 2015, the bulk of the golden tilefish landings are taken by longline gear (98%) followed by bottom trawl gear (~1%). No other gear had any substantial commercial landings. Minimal catches were also recorded for hand line and gillnets. There is a minimal recreational fishery for this species, with less than 8,300 lb. landed annually for the last 30 years. In 2015, just 4% of landings were from Statistical Area 526 and 525 on Georges Bank, with all other landings from areas to the west and south (MAFMC 2016).

6.7.6 Deep-sea red crab

Population status

Deep-sea red crab is a data poor stock. Red crab inhabit deep water, are rarely caught in the trawl survey, and there is little information about their life history. In U.S. waters, deep-sea red crab (*Chaceon quinquidens*) occurs in the Gulf of Maine, along the continental slope from Georges Bank to the Gulf of Mexico, and on the seamounts. Red crabs are managed as a single stock, and red crabs in the Gulf of Maine are not included in reference point, biomass, or management calculations. Additional details are provided in the 2008 Data Poor Stocks Working Group Report (NEFSC 2009), which found that as of 2008, the stock status was unknown.

There is limited information about red crab spawning locations and times. Erdman et al. (1991) suggest that the egg brooding period may be about nine months, at least for the Gulf of Mexico population, and larvae are hatched in the early spring there. There is no evidence of any restricted seasonality in spawning activity in any geographic region of the population, although a mid-winter peak is suggested as larval releases are reported to extend from January to June (Wigley et al. 1975; Haefner 1977; Lux et al. 1982; Erdman et al. 1991; Biesiot and Perry 1995).

Based on laboratory observations, larvae probably consume zooplankton. Juveniles and adults are opportunistic feeders. Post-larval, benthic red crabs eat a wide variety of infaunal and epifaunal benthic invertebrates (e.g., bivalves) that they find in the silty sediment or pick off the seabed surface. Smaller red crabs eat sponges, hydroids, mollusks (gastropods and scaphopods), small polychaetes and crustaceans, and possibly tunicates. Larger crabs eat similar small benthic fauna and larger prey, such as demersal and mid-water fish (*Nezumia* and myctophids), squid, and the relatively large, epibenthic, quill worm (*Hyalinoecia artifex*). They can also scavenge deadfalls (e.g., trawl discards) of fish and squid, as they are readily caught in traps with these as bait and eat them when held in aquaria.

Management

The NEFMC has managed the deep-sea red crab fishery under a FMP since 2002. In 1999, members of the red crab fishing industry requested that the Council development a FMP to prevent overfishing of the red crab resource and address a threat of overcapitalization of the red crab fishery. The FMP established a limited access permit program for qualifying vessels with documented history in the fishery, days-at-sea limits, trip limits, gear restrictions, and at-sea processing limits. The directed, limited access red crab fishery is a male-only fishery. In 2011, Amendment 3 implemented Annual Catch Limits and accountability measures and eliminated DAS and the vessel trip limit.

Fishery

There has been a small, directed fishery off the coast of New England and in the Mid-Atlantic since the early 1970s. Though the size and intensity of this fishery has fluctuated, it has remained small relative to more prominent fisheries (e.g., groundfish, sea scallops, and lobster). Although there is an open access permit category, and 1,295 such permits were issued in 2016 (NMFS, 2016), the small possession limit (500 pounds per trip) has kept this fishery component very small. The directed fishery is limited to using parlor-less crab pots, and is considered to have little, if any, incidental catch of other species. There is no known recreational fishery for deep-sea red crab.

The catch limit has been stable since 2002 at 1,775 mt and landings have fluctuated between about 1,000-1,700 during this time. The red crab fishery is a small, market-driven fishery, and landings are very closely tied to market demand. When landings are low, it is often because the demand for red crabs has decreased and the fleet has targeted other more profitable species. Catch is attributed to three regions: Georges Bank/Southern New England, New Jersey, and Delmarva. The GB/SNE area encompasses the area the canyon and/or seamount deep-sea coral zone areas considered in this action. Through 2007, the largest proportion of landings was attributed to the GB/SNE area. Since 2013, had the largest proportion has been attributed to New Jersey (NEMFC 2016b). Since at least 2014, limited access red crab permits have been issued to six vessels. Fishery revenue since 2002 has averaged $3.0M per year (NEFMC 2016b). The fishery occurs out of New Bedford, MA, where a red crab processing plant has been in operations since 2009 (NEFMC 2011; www.atlanticredcrab.com).

6.7.7 American lobster

Population status

American lobsters (*Homarus americanus*) are benthic crustaceans found in U.S. waters from Maine to New Jersey inshore and Maine to North Carolina offshore. Lobsters tend to be solitary, territorial, and exhibit a relatively small home range of 5-10 km^2, although large mature lobsters living in offshore areas may migrate inshore seasonally to reproduce, and southern inshore lobsters may move to deeper areas to seek cooler temperatures on a seasonal or permanent basis.

The 2009 lobster stock assessment assumed three distinct stocks: Gulf of Maine, Georges Bank, and Southern New England. However, the 2015 stock assessment combined the Gulf of Maine and Georges Bank stocks to more effectively model recruitment size compositions and seasonal variations in the location of large females. The 2015 assessment concluded that the SNE stock is depleted (record low levels), while the GOM/GB stock not overfished (record abundance). However, overfishing is not occurring for either stock. However, the overfishing determination for SNE may be misleading and unreliable because the methods used to estimate fishing mortality are not designed for such low biomass situations (ASMFC 2015).

Management

Lobster is managed by the Atlantic States Marine Fisheries Commission in state waters (0-3 nm from shore) and by NMFS in federal waters (3-200 mi from shore). The fishery occurs within the three stock units: Gulf of Maine, Georges Bank, and Southern New England, each with an inshore and offshore component. The management areas most relevant to this action are Area 1 (inshore Gulf of Maine) and Area 3 (offshore Gulf of Maine, Georges Bank, and Mid-Atlantic Bight to the EEZ).

Map 46 shows the overlap between the lobster management areas and coral zones. The fishery is managed using minimum and maximum lobster sizes; limits on the number and configuration of traps; possession prohibitions on egg-bearing females and v-notched lobsters, lobster meat, or lobster parts; prohibitions on spearing lobsters; and limits on non-trap landings. Between 1981 and 2013, 96% of all lobster was harvested using traps (ASMFC 2015).

Each fishery is managed with a unique set of measures that constrain catch and effort, including seasonal and year-round closures. Closures specifically designed to protect deep-sea corals are described within the No Action alternative (section 4.1). Should additional closures be implemented through this action, they would be additive to both the No Action alternative and other existing closures, further constraining where and when fishing may occur. The closures most relevant to this action, other than No Action, are described in this section.

One series of closures relevant to several fisheries are the Restricted Gear Areas I-IV on the southwestern flank of Georges Bank (Map 43). These areas were established with input from both mobile and fixed gear fishermen and are intended to reduce gear conflicts during certain times of year. These areas restrict access seasonally. The seaward areas prohibit trawl gear in winter and trap gear in summer, and the landward areas the reverse, prohibiting trawl gear in summer and trap gear in winter.

Fishery

The lobster fishery is one of the top fisheries on the U.S. Atlantic coast (>$461M total revenue in 2013). An average of 11,396 vessels were issued commercial lobster permits each year between 2009 and 2013, including permits issued by each state (n=7) from Maine to New Jersey for fishing in their respective state waters (73%) and by NMFS (27%) for the federal fishery (Table 25). The State of Maine is the jurisdiction that has issued the largest number of permits (45%). Vessels with Federal lobster permits in 2013 had homeports in 15 states, 48% from Maine and 28% from Massachusetts (NMFS 2016).

Table 25 – Commercial lobster licenses issued by jurisdiction, 2009-2013

Year	ME	NH	MA	RI	CT	NY	NJ	NMFS	Total
2009	5,376	365	1,314	979	220	375	109	3,176	11,914
2010	5,226	347	1,278	948	206	360	109	3,141	11,615
2011	5,155	333	1,245	922	180	344	109	3,119	11,407
2012	5,079	334	1,214	905	161	334	109	3,003	11,139
2013	4,979	322	1,188	874	142	326	109	2,963	10,903
Average	**5,163**	**340**	**1,248**	**926**	**182**	**348**	**109**	**3,080**	**11,396**
Source: ASMFC (2015a).									

The Gulf of Maine stock supports the largest portion of the fishery (average of 79% of the U.S. landings between 1981 and 2013; over 90% since 2009; 95% in 2013). The fishery is prosecuted mainly with small, 22-42’ vessels that conduct day trips within about 12 miles of shore. Some larger vessels fish offshore in the Gulf of Maine. Maine vessels account for most of the fishing effort, and the number of traps fished increased substantially between 1993 and 2002 and has remained at over 3.5 million since then. Trap effort in New Hampshire and Massachusetts is much smaller than in Maine. Since 1989, effort in New Hampshire has increased and Gulf of Maine effort in Massachusetts has declined.

For Georges Bank, the offshore fishery dominates, however, inshore Georges Bank catch from statistical area 521 has increased in recent years. On Georges Bank, most of the effort is on multi-day trips using larger (55-75’) vessels. There is day trip fishery in the Outer Cape Cod area. According to the 2009 stock assessment, the number of traps fishing on Georges Bank is “not well characterized, due to a lack of mandatory reporting, and/or a lack of appropriate resolution in the reporting system” (ASMFC 2009, p 42). Data from Massachusetts, which constitutes a large fraction of the Georges Bank fishery, indicate that the number of traps remained relatively stable between 1994 and 2007.

In Southern New England, the offshore fishery has dominated total catch since the late 1990s, due to dramatic declines in the catch from inshore SNE (attributed to waters increasingly exceeding the lobster thermal stress threshold of 20° C). Southern New

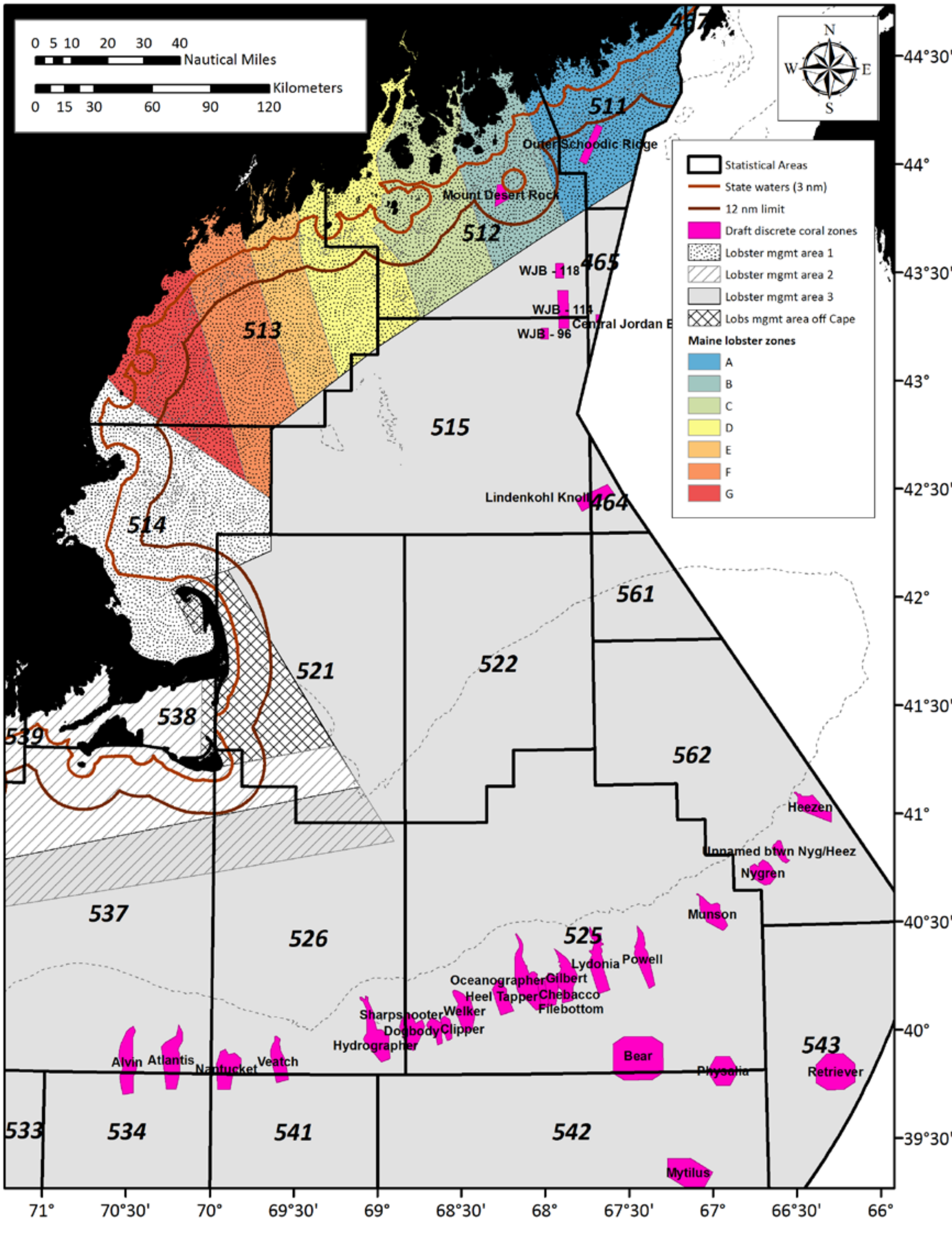
England has been the second largest fishery (average of 22% of the U.S. landings between 1981 and 2001), but recent declines in SNE landings (≤9% since 2002) make this component more on par with the Georges Bank fishery (5% from 1981 to 2013). In Southern New England, there is a nearshore, small vessel day boat fleet as well as an offshore fleet that takes multi-day trips to the canyons along the edge of the continental shelf.

Lobster landings have generally increased over time, from about 5,000 mt in the 1920s to an average of about 59,000 mt between 2009 and 2013 (Table 26). Given that the Gulf of Maine supports the largest portion of the fishery, and Maine is the state with the most permitted vessels, it follows that Maine has the largest portion of landings, about 83% between 2009 and 2013 (ASMFC 2015a). In 2015, the Maine lobster fishery revenue was in excess of $500M for state-only and federally permitted vessels (ASMFC 2017).

Table 26 – Total lobster landings (mt) by state, 2009-2013.

	ME	NH	MA	RI	CT	NY	NJ + south	Total
2009	36,828	1,354	5,929	1,289	187	331	388	**46,306**
2010	43,654	1,654	6,094	1,328	201	369	366	**53,666**
2011	47,590	1,777	6,333	1,249	90	156	341	**57,536**
2012	57,446	1,905	6,753	1,219	110	125	450	**68,008**
2013	57,797	1,729	6,894	978	58	112	359	**67,927**
Average	**48,663**	**1,684**	**6,401**	**1,213**	**129**	**219**	**381**	**58,689**
Source: ASMFC (2015a).								

Map 46 – Overlap between coral management zones and lobster management areas. The broad zones (not shown) are within management Area 3.



6.7.8 Jonah crab

Population status

Jonah crab (*Cancer borealis*) are distributed in the waters of the Northwest Atlantic Ocean primarily from Newfoundland, Canada to Florida. The Jonah crab life cycle is poorly understood; what is known is largely compiled from a patchwork of studies that have both targeted and incidentally documented the species. Female crabs (and likely some males) move inshore during the late spring and summer. Motivations for this migration are unknown, but could be due to maturation, spawning, and molting. It is also widely accepted that migrating crab move back offshore in the fall and winter. Due to the lack of a widespread and well-developed aging method for crustaceans, the age, growth, and maturity of Jonah crab is poorly described. The status of the Jonah crab resource is unknown, as no range-wide stock assessment has been conducted (ASMFC 2015b).

Management

The ASMFC instituted a Jonah crab FMP in 2015, prompted by the American Lobster Board's concern for potential impacts to the status of the Jonah crab resource given the recent and rapid increase in landings. Jonah crab has long been lobster fishery bycatch, but in recent years, there has been increasing targeted fishing pressure and growing market demand for crab. Over time, a mixed crustacean fishery has emerged that can target both lobster or crab or both at different times of year. The goal of the Commission's plan is "to promote conservation, reduce the possibility of recruitment failure, and allow the full utilization of the resource by the industry" and cap effort at 2015 levels. Addendum 1 to the FMP (2016) established a bycatch limit of 1,000 crabs per trip for non-trap gears. Addendum II (2017) allows for claw only harvest with certain restrictions. Addendum III (2018) increased monitoring requirements in the fishery. The Commission formally recommended that the Secretary of Commerce implement measures to complement the Jonah Crab Plan and its addenda in Federal waters. NMFS published a proposed rule in the Federal Register on March 22, 2019 (84 FR 10756), proposing measures that mirror Commission recommendations. A final rule is anticipated later in 2019. See http://www.asmfc.org/species/jonah-crab for more information.

Fishery

Commercial Jonah crab landings were 2-3M lbs. throughout the 1990s, but steadily rose to over 17M lbs. in 2014. A similar increase occurred in the value of fishery, as ex-vessel values grew from about $1.5M in the 1990s to about $12.7M in 2013. Landings in 2014 predominately came from Massachusetts (70%), followed by Rhode Island (24%). The practice of declawing the Jonah crab while fishing lobster traps and pots occurs in the mid-Atlantic and constitutes less than 1% of the total Jonah crab fishery. The magnitude of recreational landings is unknown but is likely minimal (ASMFC 2015b).

6.7.9 Other species and fisheries

The VTR analysis (section 7.1.3.1) indicates that other species and their associated fisheries overlap, or at least appear to overlap, with the deep-sea coral zones (Table 27).

In some cases (sea scallop and summer flounder), this apparent overlap may be the result of spatially imprecise vessel trip report data.

Table 27 – Other species and fisheries that may overlap deep-sea coral zones

Species	FMP	Gear
Atlantic sea scallop	Atlantic sea scallop (NEFMC)	Dredge, some bottom trawl
Atlantic mackerel	Mackerel/squid/butterfish (MAFMC)	Midwater trawl, some bottom trawl
Summer flounder (fluke)	Summer flounder/scup/black seabass (MAFMC)	Bottom trawls, some handlines and gillnets
Hagfish (slime eel)	No federal FMP	Pots

Scallops are not generally known to occur at commercial abundance in waters below 110 m. Thus, it is unlikely that there is truly a substantial degree of overlap between the scallop fishery and deep-sea coral zones. Mackerel catch was under 1,000 mt between 2012 and 2014 for the statistical areas overlapping the coral zones (MAFMC 2016). Summer flounder catches are concentrated in southern New England and the Mid-Atlantic (see Appendix F). The only statistical area overlapping the coral zones with summer flounder catch is Area 537, which accounted for 24% of summer flounder catch reported in VTRs during 2014 (MAFMC 2016). Essential fish habitat for adult summer flounder is designated to 500 feet (150 m), generally shallower than the coral zones.

Hagfish are harvested almost exclusively in specialized pots for export to Asia. From 1993-2015, the value of hagfish landings was $0.2-1.8M annually, though there were no landings in five of these years (Table 28). They are used for both leather and food. There is no federal FMP, so reporting via VTRs is not required unless the vessel carries other federal permits, so data are likely incomplete. The NEFMC considered initiating a hagfish FMP in the early 2000s, and a detailed report was prepared by staff characterizing the fishery and what was known about the species' biology. No plan was developed. At that time, the New England hagfish fishery, which began in the inshore Gulf of Maine in the early 1990s, appeared to be shifting offshore. Jordan Basin was noted as a fishing ground.

Table 28 – Recent landings in the New England hagfish fishery

Year	Hagfish landings				$ VTR data, New England region only
	States	Metric Tons	Pounds	Revenue	
1993	ME, MA	477.1	1,051,896	$316,769	*Not calculated*
1994	ME, MA	1,105.2	2,436,574	$691,449	*Not calculated*
1995	MA	1,421.4	3,133,716	$865,459	*Not calculated*
1996	ME, MA	1,959.2	4,319,182	$1,209,541	*Not calculated*
1997	ME, NH	422.1	930,455	$235,866	*Not calculated*
1998	ME, MA	1,447.6	3,191,277	$909,262	*Not calculated*
1999	ME, MA	2,382.1	5,251,648	$1,423,799	*Not calculated*
2000	ME, MA	3,085.2	6,801,556	$1,886,160	*Not calculated*
2001	CT	0.0	70	$10	*Not calculated*

Year	Hagfish landings				$ VTR data, New England region only
	States	Metric Tons	Pounds	Revenue	
2002	MA	1,360.8	2,999,949	$1,059,066	*Not calculated*
2003	-	0.0	0	$0	*Not calculated*
2004	-	0.0	0	$0	*Not calculated*
2005	-	0.0	0	$0	*Not calculated*
2006	MA	383.4	845,138	$359,664	*Not calculated*
2008	ME, MA	1,058.1	2,332,676	$1,312,253	*Not calculated*
2009	-	0.0	0	$0	*Not calculated*
2010	ME	299.0	659,097	$469,089	738,380
2011	-	0	0	$0	578,512
2012	ME	629.0	1,386,656	$1,282,294	641,594
2013	MA	596.4	1,314,897	$1,426,918	1,644,365
2014	-	0.0	0	$0	1,883,553
2015	MA	571.6	1,260,167	$1,286,518	1,747,895

Data are almost certainly incomplete given the lack of mandatory reporting or perhaps due to confidentiality requirements.
Source: NMFS Annual Commercial Landings Statistics.

6.8 Human Communities

This section describes the human communities that could be affected by the alternatives under consideration in this amendment.

6.8.1 Fishing communities

This amendment considers and evaluates the impact management alternatives may have on people’s economy, way of life, traditions, and community. These social and economic impacts may come from changes in fishery flexibility, opportunity, stability, certainty, safety, and/or other factors. While individuals alone could experience these impacts, it is likely that community impacts would also occur.

The alternatives under consideration could affect fishing communities throughout the Northeast. Consideration of the social impacts on these communities from proposed fishery regulations is required as part of the National Environmental Policy Act (NEPA) of 1969 and the Magnuson Stevens Fishery Conservation and Management Act (Magnuson Stevens Act) of 1976. A “fishing community” is defined in the Magnuson-Stevens Act, as amended in 1996, as “a community which is substantially dependent on or substantially engaged in the harvesting or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community” (16 U.S.C. section 1802(17)). For detailed descriptions of the affected human communities and fisheries affected by the Omnibus Amendment refer to the respective FMPs available from the New England and Mid-Atlantic Fishery Management Councils and the Atlantic States Marine Fisheries Commission.

Given the geographic scope of this action, and the fact that it will influence fishing with various gear types, these alternatives will impact numerous fishing communities.

Identifying specific communities that will be impacted is can be difficult and uncertain. In part, this reflects challenges with the confidential nature of the information used to narrow the focus to individual communities in the analysis of fishing dependence. Data must be presented so that proprietary information such as landings or revenue cannot be attributed to an individual vessel or a small group of vessels. This is particularly difficult when presenting information on small ports and communities that may only have a small number of vessels, such that information can easily be attributed to a particular vessel or individual.

The communities that are likely to experience substantial impacts from the alternatives under consideration include those that support fishing that would be prohibited by this action (e.g., excluded from certain coral zones). The specific communities of interest were identified through the economic analysis of recent vessel trips that overlap the deep-sea coral zones under consideration. It is important to note that this is not an exhaustive list of communities that could be impacted. It is necessary to consider the impacts of the proposed alternatives across all communities, particularly those identified as communities of interest in their respective FMPs.

Community characteristics are described in other publications. Brief snapshots of the Human Communities and Fisheries of the Northeast with the most recent data available for key indicators for Northeastern fishing communities related to dependence on fisheries and other economic and demographic characteristics can be found at http://www.nefsc.noaa.gov/read/socialsci/communitySnapshots.php. More detailed profiles providing in-depth information regarding the historic, demographic, cultural, and economic context for understanding a community's involvement in fishing can be found at http://www.nefsc.noaa.gov/read/socialsci/communityProfiles.html.

Identifying the key communities potentially impacted

The communities likely to be most impacted by the alternatives under consideration are identified below using two approaches:

1. ***VTR analysis.*** Communities were identified using the VTR analysis of recent (2010-2015) trips that overlap the deep-sea coral zones under consideration (section 7.1.3). The analysis uses fishing trips reported through VTRs that used bottom-tending fishing gear. However, there are known uncertainties with this analysis (e.g., only a portion of the lobster fishery operates with a federal VTR requirement). The impacts analysis (section 7.1) contains tables identifying landings revenue from fishing with federal permits using bottom-tending fishing gear within the specific areas under consideration during 2010-2015 – as estimated by the VTR analysis. Landings are reported by states and the top ten ports, as constrained by data confidentiality requirements.
2. ***MLA.*** The Maine Lobstermen's Association (MLA), via MEDMR, provided input on the communities potentially impacted by the Mt. Desert Rock and Outer Schoodic Ridge alternatives.

Based on the VTR analysis, between 2010 and 2015, there were at least 90 communities that landed species with bottom-tending fishing gear from the areas under consideration in this action. These communities occur between Maine and North Carolina. Of those communities, 20 are identified as being within the top 10 landing ports for a given alternative (and meeting the data confidentiality requirement; Table 29). In addition, the MLA identified 26 ports that are likely important to lobstermen fishing in the vicinity of the Mt. Desert Rock and Outer Schoodic Ridge zones, eight of which were also identified through the VTR analysis.

Engagement in and reliance on fisheries

Using the NMFS Community Vulnerability Indicators provides a broader view of the degree of involvement of communities in fisheries than simply using pounds or revenue of landed fish. The indicators portray the importance or level of dependence of commercial or recreational fishing to coastal communities. The degree of engagement in or reliance on commercial fishing is reported here (Table 30) for the key communities identified in this action, based on multiple sources of information, averaged over five years, 2010-2014.

- *The engagement index* incorporates the pounds and value of landed fish, the number of commercial fishing permits with that community as the permit holder’s home, and the number of dealers buying fish in that community.
- *The reliance index* is a per capita measure using similar data to the engagement index but divided by total population in the community.

Using a principal component and single solution factor analysis, each community receives a factor score. A score of 1.0 or more places the community at 1 standard deviation above the mean (or average) and is considered highly engaged or reliant. Communities with scores of 0.0-0.49 have low engagement (Jepson and Colburn 2013; Jacob et al. 2012).

In general, the fishing communities with low populations, primarily in eastern Maine have a medium to low engagement index, but a medium-high to high reliance index (Table 30). The communities from Portland south have much higher populations and score high on the engagement index, but low on the reliance index. Communities that score high on both engagement and reliance indices are Jonesport, Stonington, the Port Clyde area in Maine, and Montauk, New York.

Table 29 – Key fishing communities identified through the VTR analysis and by the MLA

State	Port		Identified by	
			VTR analysis[a]	MLA[b]
ME	Eastern	Jonesport	√	√
		Beals Island	√	√
		Addison	√	√
		Harrington		√
		Milbridge		√
		Dyers Bay		√
		Stueben	√	√
		Corea		√
		Prospect Harbor		√
		Birch Harbor		√
		Bunkers Harbor		√
		Winter Harbor	√	√
		Sorrento		√
		Bar Harbor		√
		Cranberry Islands		√
		Bass Harbor		√
		Isleford		√
		Northeast Harbor		√
		Southwest Harbor	√	√
		Frenchboro		√
		Swans Island		√
		Northwest Harbor		√
		Oceanville		√
		Stonington	√	√
	Mid-Coast	Vinalhaven	√	√
		Owls Head		√
		Port Clyde	√	
	Southern	Portland	√	
NH	Portsmouth		√	
MA	Gloucester, New Bedford, Sandwich, Boston		√	
RI	Newport, Pt. Judith, Tiverton		√	
NY	Montauk		√	
VA	Newport News		√	

[a] Includes non-confidential ports within the top 10 landing ports for a given alternative.
[b] Port identified by the Maine Lobstermen's Association as important to lobstermen fishing in the vicinity of the Mt. Desert Rock and Outer Schoodic Ridge zones.

Table 30 – Fishing community engagement and reliance indicators for the key communities

State	Community (& ports within community)	2014 Population	Community Index	
			Engagement	Reliance
ME	Jonesport (West Jonesport)	1,239	High	High
	Beals (Beals Island)	485	Med-High	High
	Addison (Eastern Harbor, South Addison)	1,170	Medium	Med-High
	Harrington	985	Low	Medium
	Milbridge	1,409	Medium	High
	Steuben (Dyer Bay, Pigeon Hill, Pigeon Hill Bay)	1,017	Medium	Med-High
	Gouldsboro/Corea/Prospect Harbor (Bar Island, Birch Harbor, Bunkers Harbor, Wonsqueak, Wonsqueak Harbor)	1,675	Medium	High
	Winter Harbor	475	Medium	High
	Sorrento	285	Low	Med-High
	Bar Harbor (Hulls Cove, Salisbury Cove, Sailsbury Cove, Salsbury Cove, Salsbury)	5,269	Low	Low
	Cranberry Isles (Islesford)	123	Low	High
	Tremont (Bass Harbor, Bernard, Goose Cove, Seal Cove, West Tremont)	1,764	Medium	Medium
	Mount Desert (Northeast Harbor, Otter Creek, Seal Harbor, Somesville)	2,174	Low	Low
	Southwest Harbor (Manset)	1,976	Medium	Medium
	Frenchboro (Lunt Harbor)	79	Low	High
	Swans Island (Minturn, Minturnnkport)	302	Medium	High
	Stonington (Oceanville)	1,312	High	High
	Vinalhaven (Carvers Harbor, Greens Island)	1,327	Med-High	High
	Owls Head (Owls Head Harbor)	1,669	Medium	Medium
	Port Clyde/Tenants Harbor/Saint George/Spruce Head (Allen Island, Watts Cove, Great Pond Island, Spruce Head Island, Wheelers Bay, Mosquito Harbor, Martinsville)	2,586	High	High
	Portland (Cliff Island, Great Diamond Island, Great Diamond Island Landing, Peaks Island)	66,317	High	Low
NH	Portsmouth (Portsmouth Harbor)	21,366	Medium	Low
MA	Gloucester (Annisquam, Lanes Cove, Magnolia)	29,237	High	Medium
	Boston (Allston, Brighton, Charlestown, Dorchester, Dorchester Bay, E. Boston, Roslindale, Roxbury, S. Boston)	639,594	High	Low
	Sandwich (Sandwich Basin)	20,605	Medium	Low
	New Bedford	94,873	High	Medium

State	Community (& ports within community)	2014 Population	Community Index	
			Engagement	Reliance
RI	Newport	24,599	Med-High	Low
RI	Narragansett (Galilee, Jerusalem, Pt. Judith, Salt Pond)	15,786	High	Med-High
RI	Tiverton	15,805	Low	Low
NY	Montauk (Montauk Harbor, Montauk Point)	3,471	High	High
VA	Newport News	181,362	High	Low
Source: http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/index				

6.8.2 Port descriptions (selected)

The following port descriptions are for a representative subset of the key fishing communities potentially impacted by this action.

6.8.2.1 Maine ports

Steuben, Maine

Steuben is a fishing community in Washington County, Maine, with a population of 1,131, as of 2010 (U.S. Census 2017b). In 2011-2015, about 21% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing and hunting in Steuben; the poverty rate was about 25%; and the population was 91% white, non-Hispanic (U.S. Census 2017a). Steuben has a medium fishing engagement index and a medium-high fishing reliance index (Jepson and Colburn 2013).

In 2015, Steuben was the homeport and primary landing port identified for 26 federal fishing permits (GARFO 2017). Total landings in Steuben were valued at $9.9M, 2% of the state-wide total ($591M). American lobster accounted for $9.4M (94%) of the 2015 landings in Steuben, landed by 66 vessels and sold to 11 dealers. All other species landed are confidential (Table 31; ACCSP, 2017).

Table 31 – Top five species landed by value in Steuben ME, 2015

Species	Nominal revenue ($)	Vessels	Dealers
American lobster	$9.4M	66	11
Note: Data for four of the five top species landed are confidential. *Source:* ACCSP, as of March 2017.			

Stonington, Maine

Stonington is a fishing community in Hancock County, Maine, with a population of 1,043, as of 2010 (U.S. Census 2017b). In 2011-2015, about 33% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing and hunting in Stonington; the poverty rate was about 15%; and the population was 97% white, non-Hispanic (U.S. Census 2017a). Stonington has a high fishing engagement index and a high fishing reliance index (Jepson and Colburn 2013).

In 2015, Stonington was the homeport and primary landing port identified for 89 and 90 federal fishing permits, respectively (GARFO 2017). Total landings in Stonington were valued at $64M, 11% of the state-wide total ($591M). American lobster accounted for $62M (97%) of the 2015 landings in Stonington, landed by 372 vessels and sold to 10 dealers (Table 32; ACCSP, 2017).

Table 32 – Top five species landed by value in Stonington ME, 2015

Species	Nominal revenue ($)	Vessels	Dealers
American lobster	$62M	372	10
Sea scallop	$0.44M	35	9
Atlantic halibut	$0.23M	39	5
Atlantic rock crab	$0.034M	33	5

Note: Data for one of the five top species landed are confidential.
Source: ACCSP, as of March 2017.

Portland, Maine

Portland is a fishing community in Cumberland County, Maine, with a population of 66,194, as of 2010 (U.S. Census 2017b). In 2011-2015, about 0.5% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing and hunting in Portland; the poverty rate was about 20%; and the population was 83% white, non-Hispanic (U.S. Census 2017a). Portland has a high fishing engagement index and a low fishing reliance index (Jepson and Colburn 2013).

In 2015, Portland was the homeport and primary landing port identified for 69 and 95 federal fishing permits, respectively (GARFO 2017). Total landings in Portland were valued at $35M, 6% of the state-wide total ($591M). American lobster accounted for $17M (49%) of the 2015 landings in Portland, landed by 218 vessels and sold to 21 dealers (Table 33; ACCSP, 2017).

Table 33 – Top five species landed by value in Portland ME, 2015

Species	Nominal revenue ($)	Vessels	Dealers
American lobster	$62M	372	10
Atlantic herring	$8.1M	8	50
Pollock	$1.9M	32	5
White hake	$0.89M	27	3
Goosefish (monkfish)	$0.58M	27	4

Source: ACCSP, as of March 2017.

6.8.2.2 New Hampshire ports

The principal ports of New Hampshire include Newington, Portsmouth, Rye, Hampton, and Seabrook, in Rockingham County. These towns, collectively, have a population of 50,953, as of 2010 (U.S. Census 2017b). In 2011-2015, about 0.8% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing and hunting in these towns; the poverty rate was about 4-12%; and the population was 92% white, non-Hispanic (U.S. Census 2017a). Portsmouth has a medium fishing engagement index and a low fishing reliance index (Jepson and Colburn 2013).

In 2015, ports in New Hampshire were the homeport and primary landing port identified for 160 and 162 federal fishing permits, respectively (GARFO 2017). The value of commercial fishery landings in New Hampshire was $28M in 2015 (ACCSP, 2017).

6.8.2.3 Massachusetts ports

Gloucester, Massachusetts

Gloucester is a fishing community in Essex County, Massachusetts, with a population of 28,789, as of 2010 (U.S. Census 2017b). In 2011-2015, about 1% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing and hunting in Gloucester; the poverty rate was about 9%; and the population was 94% white, non-Hispanic (U.S. Census 2017a). Gloucester has a high fishing engagement index and a medium fishing reliance index (Jepson and Colburn 2013).

In 2015, Gloucester was the homeport and primary landing port identified for 214 and 232 federal fishing permits, respectively (GARFO 2017). Total landings in Gloucester were valued at $44M, 8% of the state-wide total ($524M). American lobster accounted for $16M (36%) of the 2015 landings in Gloucester, landed by 199 vessels and sold to 24 dealers (Table 34; ACCSP, 2017).

Table 34 – Top five species landed by value in Gloucester MA, 2015

Species	Nominal revenue ($)	Vessels	Dealers
American lobster	$16M	199	24
Atlantic herring	$5.3M	9	25
Haddock	$3.8M	70	13
Goosefish (monkfish)	$2.5M	70	9
Acadian redfish	$2.5M	55	12
Source: ACCSP, as of March 2017.			

New Bedford, MA

New Bedford is a fishing community in Bristol County, Massachusetts, with a population of 95,072, as of 2010 (U.S. Census 2017b). In 2011-2015, about 2% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing and hunting in New Bedford; the poverty rate was about 23%; and the population was 66% white, non-Hispanic (U.S. Census 2017a). New Bedford has a high fishing engagement index and a medium fishing reliance index (Jepson and Colburn 2013).

In 2015, New Bedford was the homeport and primary landing port identified for 220 and 242 federal fishing permits, respectively (GARFO 2017). Total landings in New Bedford were valued at $322M, 62% of the state-wide total ($524M). Sea scallops accounted for $245M (76%) of the 2015 landings in New Bedford, landed by 275 vessels and sold to 28 dealers (Table 35; ACCSP, 2017).

Table 35 – Top five species landed by value in New Bedford MA, 2015

Species	Nominal revenue ($)	Vessels	Dealers
Sea scallop	$245M	275	28
Atlantic surfclam	$12M	18	11
American lobster	$8.3M	103	22
Haddock	$6.4M	50	9
Winter flounder	$5.7M	57	8
Source: ACCSP, as of March 2017.			

Newport, RI

Newport is a fishing community in Newport County, Rhode Island, with a population of 24,672, as of 2010 (U.S. Census 2017b). In 2011-2015, about 0.2% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing and hunting in Newport; the poverty rate was about 10%; and the population was 86% white, non-Hispanic (U.S. Census 2017a). Newport has a medium-high fishing engagement index and a low fishing reliance index (Jepson and Colburn 2013).

In 2015, Newport was the homeport and primary landing port identified for 30 and 33 federal fishing permits, respectively (GARFO 2017). Total landings in Newport were valued at $7.5M, 9% of the state-wide total ($82M). American lobster accounted for $4.6M (61%) of the 2015 landings in Newport, landed by 29 vessels and sold to 10 dealers (Table 36; ACCSP, 2017).

Table 36 – Top five species landed by value in Newport, RI 2015

Species	Nominal revenue ($)	Vessels	Dealers
American lobster	$4.6M	29	10
Jonah crab	$1.5M	19	10
Goosefish (monkfish)	$0.27M	10	6
Summer flounder	$0.21M	32	9
Winter skate	$0.16M	8	4
Source: ACCSP, as of March 2017.			

Point Judith, RI

Point Judith is a fishing community within the town of Narragansett in Washington County, Rhode Island. Narragansett has a population of 15,868, as of 2010 (U.S. Census 2017b). In 2011-2015, about 2% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing and hunting in Narragansett; the poverty rate was about 16%; and the population was 95% white, non-Hispanic (U.S. Census 2017a). Point Judith has a high fishing engagement index and a medium-high fishing reliance index (Jepson and Colburn 2013).

In 2015, Point Judith was the homeport and primary landing port identified for 112 and 138 federal fishing permits, respectively (GARFO 2017). Total landings in Point Judith were valued at $46M, 56% of the state-wide total ($82M). Inshore longfin squid accounted for $13M (29%) of the 2015 landings in Point Judith, landed by 98 vessels and sold to 17 dealers (Table 37; ACCSP, 2017).

Table 37 – Top five species landed by value in Point Judith, RI 2015

Species	Nominal revenue ($)	Vessels	Dealers
Inshore longfin squid	$13M	98	17
American lobster	$7.0M	109	14
Sea scallop	$5.5M	36	14
Summer flounder	$5.3M	326	20
Scup	$3.6M	254	21
Source: ACCSP, as of March 2017.			

Montauk, NY

Montauk is a fishing community within the town of East Hampton in Suffolk County, New York. As of 2010, Montauk had a population of 3,326 (U.S. Census 2017b). In 2011-2015, about 3% of the civilian employed population aged 16 years and over worked in agriculture, forestry, fishing and hunting in Montauk; the poverty rate was about 13%; and the population was 83% white, non-Hispanic (U.S. Census 2017a). Montauk has a high fishing engagement index and a high fishing reliance index (Jepson and Colburn 2013).

In 2015, Montauk was the homeport and primary landing port identified for 128 and 144 federal fishing permits, respectively (GARFO 2017). Total landings in Montauk were valued at $16M, 31% of the state-wide total ($51M). Inshore longfin squid accounted for $3.5M (22%) of the 2015 landings in Montauk, landed by 50 vessels and sold to 21 dealers (Table 37; ACCSP, 2017).

Table 38 – Top five species landed by value in Montauk, NY 2015

Species	Nominal revenue ($)	Vessels	Dealers
Inshore longfin squid	$3.5M	50	21
Tilefish	$3.2M	7	10
Scup	$2.6M	117	18
Summer flounder	$1.7M	98	23
Silver hake	$1.3M	37	15
Source: ACCSP, as of March 2017.			

6.8.3 Other affected communities

In addition to participants in potentially affected fisheries, there are other human communities that have an interest in the alternatives under consideration. During amendment development, the Council has received a number of public comments from a diverse array of interested parties. There is a strong interest in the conservation goals of this amendment from stakeholders beyond those in the fishing communities described in the sections above. Specifically, the conservation community (e.g., environmental NGOs, agencies, or individuals focused on marine conservation) are expected to experience indirect positive impacts from the protection of deep-sea corals. These stakeholders are interested in preserving the integrity of marine ecosystems and the ecosystem services they provide, as well as the non-use or existence value of deep-sea corals. Additional indirect benefits to human communities interested in deep-sea corals may include increased public and conservation interest, academic interest, and funding for monitoring and research on these ecosystems. The general public has had increasing opportunities in recent years to view and appreciate deep-sea communities by engaging virtually in deep-sea exploration streamed via the internet.

6.9 Protected resources

Numerous protected species inhabit the New England Fishery Management Council region. These species are under NMFS jurisdiction and are afforded protection under the Endangered Species Act of 1973 (ESA), the Marine Mammal Protection Act of 1972 (MMPA), or both, in the case of ESA-listed mammals. **Error! Reference source not found.** lists protected resources present in the affected environment of the deep-sea coral amendment. This table summarizes their status and the species potential to be affected by the action and identifies marine mammal species considered to be MMPA Strategic Stocks (see Hayes et al. 2018). A strategic stock is defined under the MMPA as a marine mammal stock for which: (1) the level of direct human-caused mortality exceeds the potential biological removal level; (2) based on the best available scientific information, is declining and is likely to be listed as a threatened species under the ESA within the foreseeable future; and/or (3) is listed as a threatened or endangered species under the ESA, or is designated as depleted under the MMPA (§3 of the MMPA of 1972).

Note that cusk, alewife, and blueback herring are NMFS "candidate species" under the ESA. Candidate species are those petitioned species for which NMFS has determined that listing may be warranted under the ESA and those species for which NMFS has initiated an ESA status review through an announcement in the Federal Register. If a species is proposed for listing the conference provisions under Section 7 of the ESA apply (see 50 CFR 402.10); however, candidate species receive no substantive or procedural protection under the ESA. As a result, these species will not be discussed further in this and the following sections; however, NMFS recommends that project proponents consider implementing conservation actions to limit the potential for adverse effects on candidate species from any proposed action. Additional information on cusk, alewife, and blueback herring can be found at: http://www.nmfs.noaa.gov/pr/species/esa/candidate.htm.

Table 39 – Species and/or critical habitat protected under the ESA and/or MMPA that occur in the affected environment of the Deep-Sea Coral Amendment.

Group	Species (DPS = Distinct Population Segment)	Status[c]	MMPA strategic stock?	Potentially affected by action?
Large whales	N. Atlantic right whale (*Eubalaena glacialis*)	E, P	Yes	Yes
	Humpback whale, West Indies DPS (*Megaptera novaeangliae*)	P	Yes	Yes
	Fin whale (*Balaenoptera physalus*)	E, P	Yes	Yes
	Minke whale (*B. acutorostrata*)	P	No	Yes
	Sei whale (*B. borealis*)	E, P	Yes	Yes
	Blue whale (*B. musculus*)	E, P	Yes	No

Group	Species (DPS = Distinct Population Segment)	Status[c]	MMPA strategic stock?	Potentially affected by action?
	Sperm whale (*Physeter macrocephalus*	E, P	Yes	Yes
Small cetaceans	Risso's dolphin (*Grampus griseus*)	P	No	Yes
	Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	P	No	Yes
	Short beaked common dolphin (*Delphinus delphis*)	P	No	Yes
	Bottlenose dolphin, Western North Atlantic Offshore Stock (*Tursiops truncatus*)	P	Yes	Yes
	Harbor porpoise (*Phocoena phocoena*)	P	No	Yes
	Striped dolphin (*S. coeruleoalba*)	P	No	No
	Pilot whale (*Globicephala spp.*)[a]	P	Yes	Yes
	Dwarf sperm whale (*K. sima*)	P	No	No
	Beaked whales (*Ziphius and Mesoplodon spp*)[b]	P	No	No
	Pygmy sperm whale (*Kogia breviceps*)	P	No	No
	Atlantic spotted dolphin (*S. frontalis*)	P	No	No
Pinnipeds	Harbor seal (*Phoca vitulina*)	P	No	Yes
	Gray seal (*Halichoerus grypus*)	P	No	Yes
	Harp seal (*P. groenlandicus*)	P	No	Yes
	Hooded seal (*Cystophora cristata*)	P	No	Yes
Sea turtles	Leatherback sea turtle (*Dermochelys coriacea*)	E	n/a	Yes
	Loggerhead sea turtle (*Caretta caretta*), Northwest Atlantic DPS	T	n/a	Yes
	Kemp's ridley sea turtle (*Lepidochelys kempii*)	E	n/a	Yes
	Green sea turtle (*Chelonia mydas*), North Atlantic DPS	T	n/a	Yes
	Hawksbill sea turtle (*Eretmochelys imbricate*)	E	n/a	No
Fishes	Atlantic sturgeon (*A. oxyrinchus*), Gulf of Maine DPS	T	n/a	Yes
	Atlantic sturgeon (*A. oxyrinchus*), New York Bight DPS, Chesapeake Bay DPS, Carolina DPS & South Atlantic DPS	E	n/a	Yes
	Atlantic salmon, Gulf of Maine DPS (*Salmo salar*)	E	n/a	Yes
	Cusk (*Brosme brosme)*	Candidate (ESA)	n/a	Yes
	Alewife *(Alosa pseudoharengus)*	Candidate (ESA)	n/a	Yes
	Blueback herring *(Alosa aestivalis)*	Candidate (ESA)	n/a	Yes
	Shortnose sturgeon (*Acipenser brevirostrum*)	E	n/a	No
Critical habitat	North Atlantic Right Whale Critical Habitat	Protected (ESA)	n/a	No

Group	Species (DPS = Distinct Population Segment)	Status[c]	MMPA strategic stock?	Potentially affected by action?
[a] The two species of pilot whales are difficult to identify at sea, so short finned (*G. melas melas*) and long finned (*G. macrorhynchus*) are often referred to as *Globicephala* spp. [b] Multiple species include Cuvier's (*Ziphius cavirostris*), Blainville's (*Mesoplodon densirostris*), Gervais' (*M. europaeus*), Sowerbys' (*M. bidens*), and Trues' (*M. mirus*) beaked whales. Species of *Mesoplodon* are difficult to identify at sea, so much of the available characterization is to the genus level only. [c] ESA status: E = endangered, T = threatened. P = MMPA protected.				

Protected resources are at risk of interacting with fishing gears, and changes to spatial management via designation of deep-sea coral zones may influence expected interaction rates. Fishing gears that could be regulated via this amendment include bottom-tending gears of various types, specifically bottom trawls, dredges (scallop and surfclam/ocean quahog), traps, sink gillnets, and demersal longlines, as described in section 6.7. The determination as to whether a species or critical habitat designation may potentially be affected this action is based on the species distribution and whether there have been confirmed interactions with gear types that may be regulated by this amendment, as well as whether the action has the potential to adversely destroy or modify the essential features of designated critical habitat. Distribution data were obtained from the following sources. Note that while the gear restrictions in this amendment would be implemented on a year-round basis, many protected resources have seasonally varying distributions in New England waters.

- OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations) online database: seamap.env.duke.edu/
- Northeast Ocean Data Portal: www.northeastoceandata.org
- NOAA Greater Atlantic Regional Fisheries Office ESA-listed species maps: www.greateratlantic.fisheries.noaa.gov/protected/section7/listing/index.html
- NOAA Fisheries Northeast Fisheries Science Center protected species surveys: www.nefsc.noaa.gov/psb/surveys/
- NOAA Fisheries Marine Mammal Stock Assessment Reports: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region
- BOEM and NOAA data portal: marinecadastre.gov/
- Information on candidate species: https://www.fisheries.noaa.gov/endangered-species-conservation/candidate-species-under-endangered-species-act

The remainder of this section summarizes the best available information on protected species occurrence and distribution in the areas utilized by Council fisheries, as well as gear interaction risks.

6.9.1 Species and Critical Habitat not likely to be affected

This section lists protected resources (species and critical habitats) unlikely to be affected by the measures proposed in the coral amendment, providing a brief rationale for each. These species and critical habitats are not discussed further in the impact analysis (section 7). Direct effects refer to interaction with gear, and indirect effects refer to prey removal and habitat modification.

6.9.1.1 Large whales

Blue whales are unlikely to be affected by the amendment, for reasons outlined below. North Atlantic Right Whale Critical Habitat is also unlikely to be affected, as the essential physical and biological habitat features of this habitat will not be destroyed or adversely modified by the management actions in the amendment.

Blue whales do not regularly occur in waters of the U.S. EEZ (Waring et al. 2010; Lesage et al. 2018; http://seamap.env.duke.edu/). For the purposes of this action, we are considering the U.S. waters within the Greater Atlantic region; this region ranges from Maine to Key West, Florida. Over last 48 years, there have only been 42 sightings of blue whales in waters of the EEZ from Maine to Key West, Florida (http://seamap.env.duke.edu/); this equates to less than one blue whale sighting per year within the Greater Atlantic region. Given that there is limited co-occurrence between blue whales and Greater Atlantic Region fisheries that operate in these waters, effects to blue whales from the operation of any of these fisheries are not expected.[3] This conclusion is further supported by the fact that there have been no observed or documented U.S. Atlantic fishery-related mortalities or serious injuries to blue whales to date (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region; Henry et al. 2016; Henry et al. 2017; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html). Based on this information, effects of the fisheries on blue whales is extremely unlikely and therefore are discountable.

On January 27, 2016 (81 FR 4837) critical habitat for North Atlantic right whales was expanded to encompass approximately 29,763 nm^2 of marine habitat in the Gulf of Maine and Georges Bank region (Unit 1: foraging habitat) and off the Southeast U.S. coast (Unit 2: calving habitat). In the final rule to expand North Atlantic right whale critical habitat (81 FR 4837), as well as in the ESA §4(b)(2) report issued by NMFS in December 2015 (NMFS 2015b), it was determined that the continued operation of any Greater Atlantic Region fishery will not affect the physical or biological features that are essential to the conservation of North Atlantic right whales. In Unit 1, the essential biological and physical features include physical oceanographic conditions and structures of the Gulf of Maine and Georges Bank regions (e.g., currents, circulation patterns, bathymetric features, and temperature), low flow velocities in Jordan, Wilkinson, and Georges Basins, and dense aggregations of *Calanus finmarchicus* (i.e., late stage in Gulf of Maine and Georges Bank region; diapause phase in Jordan, Wilkinson, and Georges Basins) (NMFS 2015c). In Unit 2, the essential biological and physical features include calm sea surface conditions, sea surface temperatures between 7°C to 17°C, and depths between 6 to 28 m

[3] Greater Atlantic Region (i.e., Maine to Key West Florida) fisheries include: Northeast multispecies, monkfish, spiny dogfish, Atlantic bluefish, northeast skate complex, mackerel/squid/butterfish, summer flounder/scup/black sea bass, American lobster, Atlantic herring, Atlantic sea scallop, Atlantic deep-sea red crab, surfclam/ocean quahog, tilefish (blue and golden), and Jonah crab.

(NMFS 2015c). As Greater Atlantic Region fisheries will not destroy or affect the availability of copepods and will not modify or destroy any physical features identified as essential in Unit 1 or 2 (e.g., temperature, depth, physical oceanographic conditions, currents), the continued operation of any of the Greater Atlantic Region fisheries will not destroy or adversely modify North Atlantic right whale critical habitat (NMFS 2015b; NMFS 2015c; 81 FR 4837 (January 27, 2016)).

6.9.1.2 Small cetaceans

Pygmy and dwarf sperm whales occur primarily in oceanic waters (≥1,000 meters), with some incursions in continental shelf waters (Mullin and Fulling 2003; Waring *et al*. 2014a; Hayes et al. 2017). Striped dolphins are distributed along the continental shelf edge from Cape Hatteras to the southern margin of Georges Bank, and also occur offshore over the continental slope and rise in the mid-Atlantic region (CETAP 1982; Mullin and Fulling 2003; Waring *et al*. 2014a). Striped dolphins were observed during the CeTAP surveys along the 1,000 m depth contour in all seasons (CETAP 1982). Atlantic spotted dolphins regularly occur in continental shelf waters south of Cape Hatteras; however, in waters north of Cape Hatteras, this species of dolphin occurs in continental shelf edge and continental slope waters (≥ 1,000 meters; Payne *et al.* 1984; Mullin and Fulling 2003; Waring *et al*. 2014a). Beaked whale sightings in the Greater Atlantic Region have occurred principally along the continental shelf edge and deeper oceanic waters (CETAP 1982; Waring *et al.* 2014a; Waring *et al*. 2015; Hamazaki 2002; Palka 2006).

Taking into consideration the above information, it is evident that these dolphin and whale species are primarily deep water (≥ 1,000 meters), continental shelf edge, and/or slope inhabitants. Although some Greater Atlantic Region stocks occur below 1,000 m (e.g., red crab), fishing operations occur in waters 800 m and shallower, and therefore, outside of the preferred depths for these cetaceans. Interactions with these cetacean species have only been observed in fisheries prosecuted by pelagic longline and/or pelagic drift gillnet; these are not managed by the Greater Atlantic Region Fisheries Office and would not be affected by the measures proposed in this amendment. Given the low likelihood of overlap between fishing activity affected by this amendment and these cetaceans, and lack of observed or documented fishery interactions associated with Greater Atlantic Fisheries (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region; Henry et al. 2017; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries), this action is unlikely to result in direct or indirect effects on striped dolphins or Atlantic spotted dolphins.

6.9.1.3 Turtles

Hawksbill sea turtles are widely distributed throughout the Caribbean Sea, off the coasts of Florida and Texas, in the Greater and Lesser Antilles, and along the mainland of Central America south to Brazil (Lund 1985; Plotkin and Amos 1988; Amos 1989; Groombridge and Luxmoore 1989; Plotkin and Amos 1990; NMFS and USFWS 2013; Meylan and Donnelly 1999). They are uncommon in the northern waters of the continental United States, preferring tropical coral reefs, such as those found in the Caribbean and Central America. The Culebra Archipelago of Puerto Rico contains especially important foraging habitat for hawksbills, and nesting areas in the western North Atlantic include Puerto Rico and the Virgin Islands. Although individuals have been sighted along the East Coast as far north as Massachusetts, sightings north of Florida are rare, and strandings in New England were observed only after hurricanes or offshore storms. Due to a lack of spatial overlap between their distribution and that of fisheries potentially affected by this amendment, this action is not expected to cause adverse effects to hawksbill sea turtles.

6.9.1.4 Fishes

Shortnose sturgeon are benthic fish that mainly occupy the deep channel sections of large rivers. They occupy rivers along the western Atlantic coast from St. Johns River in Florida to the Saint John River in New Brunswick, Canada. The species is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while some northern populations are amphidromous (NMFS 2010a). Given the range of the species (remaining mostly in the river systems, with some coastal migrations between rivers), and that the fisheries in the Greater Atlantic Region do not operate in or near the rivers where concentrations of shortnose sturgeon are most likely found, direct (e.g., interaction with gear) and indirect (e.g., prey removal, habitat modification) impacts to shortnose sturgeon are not expected to result from any of the management measures in this amendment.

6.9.2 Species and Critical Habitat potentially affected

Error! Reference source not found. lists protected species of sea turtle, marine mammal, and fish species present in the affected environment of the action. Some are identified as having the potential to become entangled or bycaught in the fishing gear used to prosecute the fisheries affected by this action. Pertinent information to support assessment of impacts of the measures proposed in this action to each category of protected resources is provided in the sections that follow.

To aid in the identification of MMPA protected species potentially affected by the action, the MMPA List of Fisheries and marine mammal stock assessment reports for the Atlantic Region were referenced (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region ; https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries).

To help identify ESA listed species potentially affected by the action, ESA section 7 consultations (informal or formal (Biological Opinion)) on FMPs considered in this action were reviewed. The Batched Fisheries Biological Opinion (December 16, 2013)[4], Red Crab Opinion (February 6, 2002), and Lobster Opinion (July 13, 2014) issued by NMFS on the operation of these fisheries, and its impact on ESA listed species was

[4] FMPs covered under the Batched Fisheries Opinion: Northeast multispecies, monkfish, spiny dogfish, Northeast skate complex, Atlantic mackerel/squid/butterfish, Atlantic bluefish, and summer flounder/scup/black sea bass.

referenced. The Opinions, which considered the best available information on ESA listed species and observed or documented ESA listed species interactions with gear types used to prosecute the 7 FMPs (e.g., gillnet, bottom trawl, and pot/trap), concluded that the fisheries may adversely affect, but was not likely to jeopardize the continued existence of any ESA listed species. The Opinion included an incidental take statement (ITS) authorizing the take of specific numbers of ESA listed species of sea turtles, Atlantic salmon, and/or Atlantic sturgeon.[5] Reasonable and prudent measures and terms and conditions were also issued with the ITS to minimize impacts of any incidental take.

Up until recently, the Opinions noted above remained in effect; however, new information on North Atlantic right whales has been made available that may reveal effects of the fisheries analyzed in the Opinions that may not have been previously considered. As a result, per an October 17, 2017, ESA 7(a)(2)/7(d) memo issued by NMFS, the Batched Fisheries, Red Crab, and Lobster Opinions have been reinitiated. However, the October 17, 2017, memo concludes that allowing these fisheries to continue during the reinitiation period will not increase the likelihood of interactions with ESA listed species above the amount that would otherwise occur if consultation had not been reinitiated, and therefore, the continuation of these fisheries during the reinitiation period would not be likely to jeopardize the continued existence of any ESA listed species. Until replaced, these fisheries are currently covered by the incidental take statement authorized in Opinions. Other fisheries (i.e., Atlantic herring, tilefish, Atlantic sea scallop) not covered under the above noted Biological Opinions but are still covered by their own ESA section 7 informal or formal consultation were also reviewed to obtain information on fishery impacts to listed species.

As the primary concern for both MMPA protected and ESA listed species is the potential for the fishery to interact (e.g., bycatch, entanglement) with these species it is necessary to consider (1) species occurrence in the affected environment of the fishery and how the fishery will overlap in time and space with this occurrence; and (2) data and observed records of protected species interaction with particular fishing gear types, to understand the potential risk of an interaction. Information on species occurrence in the affected environment for this amendment is provided below, while information on protected species interactions with specific fishery gear is in Section 6.9.3.

6.9.2.1 Large whales

Baleen whales, such as North Atlantic right, humpback, fin, sei, and minke whales, occur in the affected environment of the proposed action and as provided in Table 39, have the potential to be affected by the action. Baleen whales follow an annual pattern of migration between low latitude (south of 35° N) wintering/calving grounds and high

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[5] The Opinions did not authorize take of ESA listed species of whales because (1) an incidental take statement cannot be lawfully issued under the ESA for a marine mammal unless incidental take authorization exists for that marine mammal under the MMPA (see 16 U.S.C. § 1536(b)(4)(C)), and (2) the incidental take of ESA- listed marine mammals (e.g., whales) by commerical fisheries has not been authorized under MMPA Section 101(a)(5)(E).

latitude spring/summer foraging grounds (primarily north of 41°N; Hayes *et al.* 2017; Hayes et al. 2018; NMFS 1991, 2005, 2010, 2011, 2012). This, however, is a simplification of whale movements, particularly as it relates to winter movements. It remains unknown if all individuals of a population migrate to low latitudes in the winter, although, increasing evidence suggests that for some species (e.g., right and humpback whales), some portion of the population remains in higher latitudes throughout the winter (Hayes et al. 2017; Hayes et al. 2018; ;Khan et al. 2009, 2010, 2011, 2012; Brown et al. 2002; NOAA 2008; Cole et al. 2013; Clapham et al. 1993; Swingle et al. 1993; Vu et al. 2012).Although further research is needed to provide a clearer understanding of large whale movements and distribution in the winter, the distribution and movements of large whales to foraging grounds in the spring/summer is well understood. Movements of whales into higher latitudes coincide with peak productivity in these waters. As a result, the distribution of large whales in higher latitudes is strongly governed by prey availability and distribution, with large numbers of whales coinciding with dense patches of preferred forage (Mayo and Marx 1990; Kenney et al. 1986, 1995; Baumgartner et al. 2003; Baumgartner and Mate 2003; Payne et al.1986, 1990; Brown et al. 2002; Kenney and Hartley 2001; Schilling et al. 1992). For additional information on the biology, status, and range wide distribution of each whale species refer to: Hayes *et al.* 2017; Hayes et al. 2018; NMFS 1991, 2005, 2010, 2011, 2012.

Sperm whales, which are considered toothed whales, also occur in the affected environment and may be affected by the proposed action as well. The geographic distribution of sperm whales may be linked to their social structure/social units (i.e., nursery schools, harem or mixed schools, juvenile or immature schools, bachelor schools, bull schools or pairs, and solitary bulls) (Whitehead et al. 1991; Christal et al. 1998; Waring et al. 2010). Females and juveniles generally occur in tropical and subtropical waters, while males are more wide-ranging and occur in higher latitudes. (Waring et al. 2010). Off the northeast United States, CETAP and NMFS/NEFSC sperm whale sightings occur primarily in shelf-edge and off-shelf waters (CETAP 1982; Waring et al. 2010; http://seamap.env.duke.edu/).

To further assist in understanding how fisheries may overlaps in time and space with the occurrence of large whales, a general overview of species occurrence and distribution in the area of operation for the 13 Greater Atlantic Region fisheries is in **Error! Reference source not found.**.

Table 40 – Large whale occurrence in the Greater Atlantic Region

Species	Prevalence and Month of Occurrence

North Atlantic Right Whale	• Distributed throughout all continental shelf waters of the Mid-Atlantic (SNE included), GOM, and GB throughout the year; however, passive acoustic studies demonstrate year-round presence in the GOM and waters off New Jersey and Virginia.
	• New England waters (GOM and GB regions) = **Foraging Grounds (~January - October)**. Seasonally important foraging grounds include, but not limited to:
	  • Massachusetts and Cape Cod Bays;
	  • Great South Channel;
	  • Basins/banks within the GOM (e.g., Jordan and Wilkinson Basins); and,
	  • Northern edge of GB/Georges Basin.

Species	Prevalence and Month of Occurrence

	• Mid-Atlantic waters: Migratory corridor to/from northern (high latitude) foraging and southern calving grounds.
	• Location of much of the population unknown in winter; however, increasing evidence of wintering areas (~November – January) in:
	    • Cape Cod Bay;
	    • Jeffreys and Cashes Ledges;
	    • Jordan Basin; and
	    • Massachusetts Bay (e.g., Stellwagen Bank).

Humpback Whale	• Distributed throughout all continental shelf waters of the Mid-Atlantic (SNE included), GOM, and GB throughout the year. • New England waters (GOM and GB regions) = **Foraging Grounds** (~March-November). • Mid-Atlantic waters: Migratory pathway to/from northern (high latitude) foraging and southern (West Indies) calving grounds. • Increasing evidence of whales remaining in mid- and high-latitudes throughout the winter. (e.g., Mid-Atlantic: waters near Chesapeake and Delaware Bays, peak presence about January through March; Massachusetts Bay: peak presence about March-May and September-December).

Fin Whale	• Distributed throughout all continental shelf waters of the Mid-Atlantic (SNE included), GOM, and GB throughout the year.
	• Mid-Atlantic waters:
	    • Migratory pathway to/from northern (high latitude) foraging and southern (low latitude) calving grounds; and
	    • Possible offshore calving area (October-January).
	• New England (GOM and GB)/SNE waters = **Foraging Grounds** (greatest densities March-August; lower densities September-November). Important foraging grounds include, but are not limited to:
	    • Massachusetts Bay (esp. Stellwagen Bank);
	    • Great South Channel;
	    • Waters off Cape Cod (~40-50 meter contour);
	    • GOM;
	    • Perimeter (primarily eastern) of GB; and
	    • Mid-shelf area off the east end of Long Island.
	• Evidence of wintering areas in mid-shelf areas east of New Jersey (NJ), Stellwagen Bank; and eastern perimeter of GB.

Sei Whale	• Uncommon in shallow, inshore waters of the Mid-Atlantic (SNE included), GB, and GOM; however, occasional incursions during peak prey availability and abundance. • Primarily found in deep waters along the shelf edge, shelf break, and ocean basins between banks. • Spring through summer, found in greatest densities in offshore waters of the GOM and GB; sightings concentrated along the northern, eastern (into Northeast Channel) and southwestern (in the area of Hydrographer Canyon) edge of GB.
Minke Whale	• Widely distributed within the U.S. EEZ. • Spring to Fall: widespread (acoustic) occurrence on the continental shelf; however, most abundant in New England waters during this period of time. • September to April: high (acoustic) occurrence in deep-ocean waters.
Sperm Whale	• Distribution in the EEZ occurs on the continental shelf, continental shelf edge, over the continental slope, and into the mid-ocean regions. • Winter: concentrated east and northeast of Cape Hatteras, North Carolina

Species	Prevalence and Month of Occurrence
	• Spring: Distributed east of Delaware and Virginia and is widespread throughout the central portion of the Mid-Atlantic bight and the southern portion of Georges Bank. • Summer: Similar distribution to spring, but also includes area east and noth of Georges Bank, Northeast Channel, as well as the continental shelf (inshore of the 100m isobaths) south of New England. • Fall: Occurrence south of New England on the continental shelf is at its highest level. There also remains a continental shelf edge occurrence in the Mid-Atlantic bight.

***Sources*:** NMFS 1991, 2005, 2010, 2011, 2012; Hain et al. 1992; Payne et al. 1984; Good 2008; Pace and Merrick 2008; McLellan et al. 2004; Hamilton and Mayo 1990; Schevill et al. 1986; Watkins and Schevill 1982; Payne et al.1990; Winn et al. 1986; Kenney et al. 1986, 1995; Khan et al. 2009, 2010, 2011, 2012; Brown et al. 2002; NOAA 2008; 50 CFR 224.105; CETAP 1982; Clapham et al. 1993; Swingle et al. 1993; Vu et al. 2012; Baumgartner et al. 2011; Cole et al. 2013; Risch et al. 2013; Waring et al. 2010; Hayes et al. 2017; Hayes et al. 2018; 81 FR 4837 (January 27, 2016); NMFS 2015b; Bort et al. 2015.

6.9.2.2 Small cetaceans

Atlantic white sided dolphins, short and long finned pilot whales, Risso's dolphins, short beaked common dolphins, harbor porpoise, and bottlenose dolphins (western North Atlantic offshore stock) are found throughout the year in the Northwest Atlantic Ocean (**Error! Reference source not found.**); these species will occur in the affected environment of the action. Within this range, however, there are seasonal shifts in species distribution and abundance. To further assist in understanding how fisheries may overlap in time and space with the occurrence of small cetaceans, a general overview of species occurrence and distribution in the area of operation for the 13 Greater Atlantic Region fisheries is in Table 45. For additional information on the biology, status, and range-wide distribution of each species please refer to the Marine Mammal Stock Assessment Reports provided at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region.

Table 41 – Small cetacean occurrence in the Greater Atlantic Region

Species	Prevalence and approximate months of occurrence
Risso's dolphin	Spring through fall: distributed along the continental shelf edge from Cape Hatteras, NC, to Georges Bank. Winter: distributed in the Mid-Atlantic Bight, extending into oceanic waters. Rarely seen in the Gulf of Maine; primarily a Mid-Atlantic continental shelf edge species (can be found year-round).

Species	Prevalence and approximate months of occurrence
Atlantic white-sided dolphin	Distributed throughout the continental shelf waters (primarily to 100 m isobath) of the Mid-Atlantic (north of 35ºN), Southern New England, Georges Bank, and Gulf of Maine; however, most common in continental shelf waters from Hudson Canyon (~ 39° N) to Georges Bank, and into the Gulf of Maine. • January-May: low densities found from Georges Bank to Jeffreys Ledge. • June-September: high densities found from Georges Bank through the Gulf of Maine. • October-December: intermediate densities found from southern Georges Bank to southern Gulf of Maine. South of Georges Bank (Southern New England and Mid- Atlantic), particularly around Hudson Canyon, low densities found year-round; waters off Virginia and NC representing southern extent of species range during winter months.
Short-beaked common dolphin	Regularly found throughout the continental shelf-edge- slope waters (primarily between the 100-2,000 m isobaths) of the Mid-Atlantic, Southern New England, and Georges Bank (esp. in Oceanographer, Hydrographer, Block, and Hudson Canyons). Less common south of Cape Hatteras, NC, although schools have been reported as far south as the Georgia/South Carolina border. January-May: occur from waters off Cape Hatteras, NC, to Georges Bank (35° to 42° N). Mid-summer-fall: occur in the Gulf of Maine and on Georges Bank; Peak abundance found on Georges Bank in the autumn.
Harbor porpoise	Distributed throughout the continental shelf waters of the Mid-Atlantic (north of 35°N), Southern New England, Georges Bank, and Gulf of Maine. • July-September: concentrated in the northern Gulf of Maine (waters < 150 m); low numbers can be found on Georges Bank. • October-December: widely dispersed in waters from NJ to Maine; seen from the coastline to deep waters (>1,800 m). • January-March: intermediate densities in waters off NJ to NC; low densities found in waters off NY to Gulf of Maine. • April-June: widely dispersed from NJ to ME; seen from the coastline to deep waters (>1,800 m).

Species	Prevalence and approximate months of occurrence
Pilot Whales: *Short- and Long-Finned*	**<u>Short- Finned Pilot Whales</u>** • Except for area of overlap (see below), primarily occur south of 40° N (Mid- Atlantic and SNE waters); although low numbers have been found along the southern flank of GB, but no further than 41° N. • May through December (about): distributed primarily near the continental shelf break of the Mid-Atlantic and SNE; individuals begin shifting to southern waters (i.e., 35° N and south) beginning in the fall. **<u>Long-Finned Pilot Whales</u>** • Except for area of overlap (see below), primarily occur north of 42° N • Winter to early spring (November-April): primarily distributed along the continental shelf edge-slope of the Mid-Atlantic, SNE, and GB. • Late spring through fall (May-October): movements and distribution shift onto/within GB, the Great South Channel, and the GOM. **<u>Area of Species Overlap:</u>** between about 38° N and 41° N.
Bottlenose dolphin, Western North Atlantic Offshore Stock	Distributed primarily along the outer continental shelf and continental slope in the Northwest Atlantic from Georges Bank to FL. Depths of occurrence: ≥40 m.
Sources: Hayes *et al.* 2017; Hayes et al. 2018; Payne and Heinemann 1993; Payne *et al.* 1984; Jefferson *et al*. 2009.	

6.9.2.3 Pinnipeds

Pinnipeds are found in the nearshore, coastal waters of the Northwest Atlantic Oceam from New Jersey to Maine. Harbor and grey seals occur in the Greater Atlantic Region throughout the year, while harp and hooded seals are present seasonally. Some species (e.g., harbor seals) may be extending their range seasonally into waters as far south as Cape Hatteras, North Carolina (35° N; Waring et al. 2007, 2014a, 2015, 2016). To further assist in understanding how fisheries may overlap in time and space with the occurrence of pinnipeds, a general overview of species occurrence and distribution in the Greater Atlantic Region is in **Error! Reference source not found.**. For additional information on the biology, status, and range-wide distribution of each species of pinniped refer to Waring et al. (2007) and Hayes et al. 2018.

Table 42 – Pinniped occurrence in the Greater Atlantic Region

Species	Prevalence and approximate months of occurrence
Harbor seal	Primarily distributed in waters from NJ to ME; however, increasing evidence indicates that their range is extending into waters as far south as Cape Hatteras, NC (35° N). Year-round: waters of ME; September-May: waters from southern New England to NJ
Grey seal	Primarily distributed in waters from New Jersey to Maine; however, increasing evidence indicates that their range is extending into waters as far south as Cape Hatteras, NC (35° N). Year Round: Waters from Maine to Massachusetts. September-May: Waters off SNE states (Connecticut, Rhode Island, portions of Southern Massachusetts, Long Island, and New Jersey)

Species	Prevalence and approximate months of occurrence
Harp seal	Winter-Spring (approximately January-May): waters from ME to NJ.
Hooded seal	Winter-Spring (approximately January-May): waters of New England.
Sources: Waring et al. 2007 (for hooded seals); Hayes et al. 2018.	

6.9.2.4 Turtles

Kemp's ridley, leatherback, the North Atlantic DPS of green, and the Northwest Atlantic DPS of loggerhead sea turtle are the four ESA-listed species of sea turtles that occur in the Greater Atlantic Region that could be affected by this amendment. Green, loggerhead, and Kemp's ridley are hard-shelled turtles. Background information on the range-wide status, descriptions, and life histories of these four species can be found in a number of published documents, including sea turtle status reviews, biological reports, and recovery plans (Conant et al. 2009; Hirth 1997; NMFS et al. 2011; NMFS and USFWS 1991, 1992, 1995, 1998a, 1998b, 2007a, 2007b, 2008, 2013, 2015; Seminoff et al. 2015; TEWG 1998, 2000, 2007, 2009).

In U.S. Northwest Atlantic waters, hard-shelled turtles commonly occur throughout the continental shelf from Florida to Cape Cod, Massachusetts, although their presence varies with the seasons due to changes in water temperature (Shoop and Kenney 1992; Epperly et al. 1995a, 1995b; Braun and Epperly 1996; Mitchell et al. 2003; Braun-McNeill et al. 2008; TEWG 2009). While hard-shelled turtles are most common south of Cape Cod, MA, they are known to occur in the Gulf of Maine. Loggerheads, the most common hard-shelled sea turtle in the Greater Atlantic Region, feed as far north as southern Canada. Loggerheads have been observed in waters with surface temperatures of 7 °C to 30 °C, but water temperatures ≥11 °C are most favorable (Shoop and Kenney 1992; Epperly et al. 1995b). Sea turtle presence in U.S. Atlantic waters is also influenced by water depth. While hard-shelled turtles occur in waters from the beach to beyond the continental shelf, they are most commonly found in neritic waters of the inner continental shelf (Mitchell et al. 2003; Braun-McNeill and Epperly 2002; Morreale and Standora 2005; Blumenthal et al. 2006; Hawkes et al. 2006; McClellan and Read 2007; Mansfield et al. 2009; Hawkes et al. 2011; Griffin et al. 2013).

Hard-shelled sea turtles occur year-round in waters off Cape Hatteras, North Carolina and south. As coastal water temperatures warm in the spring, loggerheads begin to migrate to inshore waters of the southeast United States and also move up the Atlantic Coast (Epperly et al. 1995a, 1995b, 1995c; Braun-McNeill and Epperly 2002; Morreale and Standora 2005; Griffin et al. 2013), occurring in Virginia foraging areas as early as late April and on the most northern foraging grounds in the Gulf of Maine in June (Shoop and Kenney 1992). The trend is reversed in the fall as water temperatures cool. The large majority leave the Gulf of Maine by September, but some remain in Mid-Atlantic and Northeast areas until late fall. By December, sea turtles have migrated south to waters offshore of NC, particularly south of Cape Hatteras, and further south (Shoop and Kenney 1992; Epperly et al. 1995b; Hawkes et al. 2011; Griffin et al. 2013).

Leatherback sea turtles also engage in routine migrations between northern temperate and tropical waters (NMFS and USFWS 1992; James et al. 2005; James et al. 2006; Dodge et al. 2014). Leatherbacks, a pelagic species, are known to use coastal waters of the U.S. continental shelf (James et al. 2005; Eckert et al. 2006; Murphy et al. 2006; Dodge et al. 2014). They have a greater tolerance for colder water than hard-shelled sea turtles (NMFS and USFWS 2013). They are also found in more northern waters later in the year, with most leaving the Northwest Atlantic shelves by mid-November (James et al. 2005; James et al. 2006; Dodge et al. 2014).

6.9.2.5 Atlantic sturgeon

The marine range of U.S. Atlantic sturgeon extends from Labrador, Canada, to Cape Canaveral, FL. Fishery-independent survey data indicate a coastwide distribution of Atlantic sturgeon during the spring and fall; a southerly (e.g., NC, VA) distribution during the winter; and a centrally located (e.g., Long Island to DE) distribution during the summer. Atlantic sturgeon from all five DPSs have the potential to be located anywhere in this marine range (ASSRT 2007; Dovel and Berggren 1983; Dadswell et al. 1984; Kynard et al. 2000; Stein et al. 2004a; Dadswell 2006; Laney et al. 2007; Dunton et al. 2010; Dunton et al. 2012; Dunton et al. 2015; Erickson et al. 2011; Wirgin et al. 2012; O'Leary et al. 2014; Waldman et al. 2013; Wirgin et al. 2015a,b; ASMFC 2017).

Based on fishery-independent and dependent data, as well as data collected from tracking and tagging studies, Atlantic sturgeon appear to primarily occur inshore of the 50 m depth contour (Stein et al. 2004 a,b; Erickson et al. 2011; Dunton et al. 2010); however, Atlantic sturgeon are not restricted to these depths, as excursions into deeper continental shelf waters have been documented (Timoshkin 1968; Collins and Smith 1997; Stein et al. 2004a,b; Dunton et al. 2010; Erickson et al. 2011). Within the marine range of Atlantic sturgeon, several marine aggregation areas have been identified adjacent to estuaries and/or coastal features formed by bay mouths and inlets along the U.S. eastern seaboard (i.e., waters off North Carolina, Chesapeake Bay, and; Delaware Bay; New York Bight; Massachusetts Bay; Long Island Sound; and Connecticut and Kennebec River Estuaries); depths in these areas are generally no greater than 25 meters (Bain et al. 2000; Savoy and Pacileo 2003; Stein et al. 2004a; Laney et al. 2007; Dunton et al. 2010; Erickson et al. 2011; Oliver et al. 2013; Waldman et al. 2013; O'Leary et al. 2014; Wipplehauser 2012; Whipplehauser and Squiers 2015). Although additional studies are still needed to clarify why these sites are chosen by Atlantic sturgeon, there is some indication that they may serve as thermal refuge, wintering sites, or marine foraging areas (Stein et al. 2004a; Dunton et al. 2010; Erickson et al. 2011).

Data from fishery-independent surveys and tagging and tracking studies indicate that Atlantic sturgeon undertake seasonal movements along the coast. For instance, adult sturgeon from the Hudson River were found concentrated in the southern part of the Mid-Atlantic Bight below 20 m during winter and spring, shifting to the northern portion of the Mid-Atlantic Bight at depths less than 20 m during summer and fall (Erickson et al. 2011). A similar seasonal trend was found by Dunton et al. 2010. Although studies such as Erickson et al. (2011) and Dunton et al. (2010) provide some indication that Atlantic sturgeon are undertaking seasonal movements horizontally and vertically along the U.S. eastern coastline, there is no evidence to date that all Atlantic sturgeon make these seasonal movements. For instance, during inshore surveys conducted by the Northeast

Fisheries Science Center in the Gulf of Maine, Atlantic sturgeon have been caught in the fall, winter, and spring between the Saco and Kennebec Rivers Dunton et al. 2010; Wipplehauser 2012).

6.9.2.6 Atlantic salmon (Gulf of Maine DPS)

The wild populations of Atlantic salmon are listed as endangered under the ESA. Their freshwater range occurs in the watersheds from the Androscoggin River northward along the Maine coast to the Dennys River, while the marine range of the Gulf of Maine DPS extends from the Gulf of Maine (primarily northern portion of the Gulf of Maine) to the coast of Greenland (NMFS and USFWS 2005, 2016; Fay et al. 2006). In general, smolts, post-smolts, and adult Atlantic salmon may be present in the Gulf of Maine and coastal waters of Maine in the spring (beginning in April), and adults may be present throughout the summer and fall months (Baum 1997; Fay et al. 2006; USASAC 2004; Hyvarinen et al. 2006; Lacroix and McCurdy 1996; Lacroix et al. 2004, 2005; Reddin 1985; Reddin and Short 1991; Reddin and Friedland 1993, Sheehan et al. 2012; NMFS and USFWS 2005, 2016; Fay et al. 2006). For additional information on the on the biology, status, and range-wide distribution of the Gulf of Maine DPS of Atlantic salmon refer to NMFS and USFWS 2005, 2016; Fay et al. 2006.

6.9.3 Interactions between gear and protected species

Protected species are vulnerable to interactions with various types of fishing gear, with interaction risks associated with gear type, quantity, and soak or tow time. Available information on gear interactions with a given species (or species group) is provided in the sections below. These sections are not a comprehensive review of all fishing gear types known to interact with a given species; emphasis is only being placed on fishing gears that could be regulated via this amendment (i.e., bottom trawls, dredges (scallop and surfclam/ocean quahog), traps, sink gillnets, and demersal longlines).

6.9.3.1 Marine mammals

In terms of the potential for interactions with marine mammals (ESA listed or not), NMFS, pursuant to the MMPA, publishes an annual list of fisheries defined by gear type and region (Table 43). Each fishery is assigned (1) a category which reflects the expected rate of annual mortality or serious injury of marine mammals and (2) a list of marine mammals potentially affected. The 2019 List of Fisheries is available at 84 FR 22051. Fishery classifications include:

- Category I: Annual mortality and serious injury of a stock in a given fishery is greater than or equal to 50 percent of the PBR level (i.e., frequent incidental mortality and serious injury of marine mammals).
- Category II: Annual mortality and serious injury of a stock in a given fishery is greater than 1 percent and less than 50 percent of the PBR level (i.e., occasional incidental mortality and serious injury of marine mammals).
- Category III: Annual mortality and serious injury of a stock in a given fishery is less than or equal to 1 percent of the PBR level (i.e., a remote likelihood of or no known incidental mortality an injury of marine mammals).

Additional details on marine mammal interactions with fishing gear are provided in the US Atlantic and Gulf of Mexico marine mammal stock assessment reports (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region), Northeast Fisheries Observer Program incidental take reports (http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html), and Northeast Fisheries Science Center publications (https://www.nefsc.noaa.gov/publications/crd/).

Table 43 – Marine mammal stocks incidentally killed or seriously injured, by fishery. Categories are explained in the text.

	Fishery, including location and target species	Marine mammal species potentially affected (WNA = Western North Atlantic)
Category I	*Northeast sink gillnet* – operates in GOM, GB, SNE, south to the VA/NC border, excluding areas classified as Category II and III. Target species include cod, haddock, pollock, yellowtail flounder, winter flounder, witch flounder, American plaice, windowpane flounder, spiny dogfish, monkfish, silver hake, red hake, white hake, ocean pout, skate spp, mackerel, redfish, and shad.	Bottlenose dolphin, WNA offshore; Common dolphin, WNA; Fin whale, WNA; Gray seal, WNA; Harbor porpoise, Gulf of Maine/Bay of Fundy; Harbor seal, WNA; Harp seal, WNA; Hooded seal, WNA; Humpback whale, Gulf of Maine; Long-finned pilot whale, WNA; Minke whale, Canadian east coast; North Atlantic right whale, WNA; Risso's dolphin, WNA; White-sided dolphin, WNA
	Northeast/Mid-Atlantic Lobster trap/pot – inshore and offshore waters from Maine to New Jersey, as far south as NC. Target species is American lobster.	Humpback whale, Gulf of Maine; Minke Whale, Canadian east coast; North Atlantic right whale, WNA
Category II	Mid-Atlantic bottom trawl – U.S. waters from NC to Cape Cod and west of 70° W. Deeper water target species include bluefish, Atlantic mackerel, longfin squid, black sea bass, and scup.	Bottlenose dolphin, WNA offshore; Common dolphin, WNA; Gray seal, WNA; Harbor seal, WNA; Risso's dolphin, WNA; white sided dolphins, WNA
	Northeast bottom trawl – all U.S. waters south of Cape Cod, MA and east of 70° W, plus all waters north of Cape Cod to the Maine-Canada border. Target species include Atlantic cod, haddock, pollock, yellowtail flounder, winter flounder, witch flounder, American plaice, Atlantic halibut, redfish, windowpane flounder, summer flounder, spiny dogfish, monkfish, silver hake, red hake, white hake, ocean pout, and skate species.	Bottlenose dolphin, WNA offshore; Common dolphin, WNA; Gray seal, WNA; Harbor porpoise, GME/BF; Harbor seal, WNA; Harp seal, WNA; Long-finned pilot whale, WNA; Risso's dolphin, WNA; White-sided dolphin, WNA
	Atlantic mixed species trap/pot – hagfish, shrimp, conch/whelk, red crab, Jonah crab, rock crab, black sea bass, scup, tautog, cod, haddock, Pollock, redfish (ocean perch) white hake, spot, skate, catfish, stone crab, and cunner	Fin whale, WNA; Humpback whale, Gulf of Maine
Category III	*Northeast/Mid-Atlantic bottom longline/hook-and-line*	None documented
	Gulf of Maine, U.S. Mid-Atlantic sea scallop dredge – GOM, GB, Mid-Atlantic Bight. Target species is the Atlantic sea scallop.	None documented

	New England and Mid-Atlantic offshore surfclam/quahog dredge – Georges Bank, Southern New England, Mid-Atlantic Bight. Target species are Atlantic surfclams and ocean quahogs.	None documented

6.9.3.1.1 Large whales

Sink gillnet and trap/pot: The greatest entanglement risk to large whales is posed by pot/trap and gillnet gear, which are comprised of line (vertical or ground) that rise into the water column (Johnson et al. 2005; NMFS 2014; Kenney and Hartley 2001; Hartley et al. 2003; Whittingham et al. 2005a,b; Knowlton et al. 2012; Hayes et al. 2017; Henry et al. 2017; Hayes et al. 2018). Any line can become entangled in the mouth (baleen), flippers, and/or tail of the whale when the animal is transiting or foraging through the water column (Johnson et al. 2005; NMFS 2014; Kenney and Hartley 2001; Hartley et al. 2003; Whittingham et al. 2005a,b; Henry et al. 2017; Hayes et al. 2018). Effects of entanglement to large whales can range from no injury to death (Johnson et al. 2005; Angliss and Demaster 1998; Moore and van der Hoop 2012; NMFS 2014; van der Hoop et al. 2016; van der Hoop et al. 2017a,b; Pettis et al.2017; Henry et al. 2017; Hayes et al. 2017; Hayes et al. 2018).

Table 44 has confirmed human-caused injury and mortality to humpback, fin, sei, minke, and North Atlantic right whales along the Gulf of Mexico Coast, U.S. East Coast, and Atlantic Canadian Provinces from 2011 to 2015 (Henry et al. 2017). The data are specific to confirmed injury or mortality to whales from entanglement in fishing gear. As many entanglement events go unobserved, and because the gear type, fishery, and/or country of origin for reported entanglement events are often not traceable, it is important to recognize that the information likely underestimates the rate of large whale serious injury and mortality due to entanglement. Further studies looking at scar rates for right whales and humpbacks suggest that entanglements may be occurring more frequently than the observed incidences indicate (NMFS 2014; Robbins 2009; Knowlton et al. 2012).

Table 44 – Summary of confirmed human-caused injury or mortality to fin, minke, humpback, sei, and North Atlantic right whales from 2011-2015 due to entanglement in fishing gear.

Species	Total Confirmed Entanglement: Serious Injury	Total Confirmed Entanglement: Non-Serious Injury	Total Confirmed Entanglement: Mortality	Entanglement Events: Total Average Annual Injury and Mortality Rate (US waters/Canadian waters/unassigned waters)
North Atlantic Right Whale	19	35	5	4.55 (0.4/0/4.15
Humpback Whale	32	61	5	6.45 (1.5/0.3/4.65)

Fin Whale	6	2	4	1.85 (0.2/0.8/0.85)
Sei Whale	0	0	0	0
Minke Whale	20	12	22	7.75 (1.9/3.25/2.6)

Notes:
Information is based on confirmed human-caused injury and mortality events along the Gulf of Mexico Coast, US East Coast, and Atlantic Canadian Provinces; it is not specific to US waters only. NMFS defines serious injury as an injury that is more likely than not to result in mortality (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-policies-guidance-and-regulations#distinguishing-serious-from-non-serious-injury-of-marine-mammalsf).
Source: Henry *et al.* 2017

In response to its obligations under the MMPA, in 1996, NMFS established the Atlantic Large Whale Take Reduction Team (ALWTRT) to develop a plan (Atlantic Large Whale Take Reduction Plan (ALWTRP) to reduce serious injury to, or mortality of large whales, specifically, humpback, fin, and North Atlantic right whales, due to incidental entanglement in U.S. commercial fishing gear.[6] In 1997, the ALWTRP was implemented; however, since 1997, the Plan has been modified; recent adjustments include the Sinking Groundline Rule and Vertical Line Rules (72 FR 57104, October 5, 2007; 79 FR 36586, June 27, 2014; 79 FR 73848, December 12, 2014; 80 FR 14345, March 19, 2015; 80 FR 30367, May 28, 2015).

The ALWTRP identifies gear modification requirements and restrictions for MMPA List of Fisheries Category I and II gillnet and trap/pot fisheries in the Northeast, Mid-Atlantic, and Southeast regions of the U.S. (designated management areas); these fisheries must comply with all regulations of the ALWTRP. For further details on the gear modification requirements, restrictions, and management areas under the ALWTRP see: http://www.greateratlantic.fisheries.noaa.gov/Protected/whaletrp/.

Bottom trawl: Except for minke whales, there have been no observed interactions with large whales and bottom trawl gear. In bottom trawl gear, to date, interactions have only been observed in the northeast bottom trawl fisheries. From the period of 2008-2012, the estimated annual mortality attributed to this fishery was 7.8 minke whales for 2008, and zero minke whales from 2009-2012; no serious injuries were reported during this time (Waring et al. 2015). Based on this information, from 2008-2012, the estimated annual average minke whale mortality and serious injury attributed to the northeast bottom trawl fishery was 1.6 (CV=0.69) whales (Waring et al. 2015). Lyssikatos (2015) estimated that from 2008-2013, mean annual serious injuries and mortalities from the northeast bottom trawl fishery were 1.40 (CV=0.58) minke whales. Serious injury and mortality records

[6] The fisheries currently regulated under the ALWTRP include: Northeast/Mid-Atlantic American lobster trap/pot; Atlantic blue crab trap/pot; Atlantic mixed species trap/pot; Northeast sink gillnet; Northeast anchored float gillnet; Northeast drift gillnet; Mid-Atlantic gillnet; Southeastern U.S. Atlantic shark gillnet; and Southeast Atlantic gillnet (NMFS 2014).

for minke whales in U.S. waters from 2010-2015 showed zero interactions with bottom trawl (northeast or Mid-Atlantic) gear (Henry et al. 2016; Henry et al. 2017; Hayes et al. 2017; Hayes et al. 2018). Based on this information, bottom trawl gear is likely to pose a low interaction risk to any large whale species. Should an interaction occur, serious injury or mortality to any large whale is possible; however, trawl gear represents a low source serious injury or mortality to any large whale (Henry et al. 2016; Henry et al. 2017; Hayes et al. 2017; Hayes et al. 2018).

Bottom longline, surfclam/ocean quahog dredge, and scallop dredge: Based on information provided by the Northeast Fisheries Observer Program (https://www.nefsc.noaa.gov/fsb/take_reports/nefop.html), as well as information provided in Henry et al. (2017), marine mammal stock assessment reports and the MMPA List of Fisheries (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region; https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries), there has been no confirmed serious injury or mortality, or documented interactions, in general, with bottom longline, surfclam/ocean quahog dredge, or scallop dredge gears and large whales. Based on this information, these gears are not expected to pose an interaction risk to large whale and therefore, are not expected to be source of serious injury or mortality to these species.

6.9.3.1.2 Small cetaceans and pinnipeds

Bottom trawl and sink gillnet: Small cetaceans and pinnipeds are at risk of interacting with sink gillnet and bottom trawl gear (Read et al. 2006; Lyssikatos 2015; Chavez-Rosales et al. 2017; Hayes et al. 2017; Hayes et al. 2018; 84 FR 22051 (May 16, 2019)). Table 43 provides a list of species incidentally killed or seriously injured, by fishery (Hayes et al. 2018; 84 FR 22051 (May 16, 2019)). Of the species listed in the table, gray seals, followed by harbor seals, harbor porpoises, short beaked common dolphins, and harps seals are the most frequently bycaught small cetacean and pinnipeds in sink gillnet gear in the Greater Atlantic Region (Hatch and Orphanides 2014, 2015, 2016, 2017, 2019). In terms of bottom trawl gear, short-beaked common dolphins and Atlantic white-sided dolphins are the most frequently observed bycaught marine mammal species in the Greater Atlantic Region, followed by gray seals, long-finned pilot whales Risso's dolphins, bottlenose dolphin (offshore), harbor porpoise, harbor seal, and harp seals (Lyssikatos 2015; Chavez-Rosales et al. 2017).

While numerous species of small cetaceans and pinnipeds interact with Category I and II fisheries in the Greater Atlantic Region, several species have experienced such great losses to their populations due to interactions with Category I and/or II fisheries that they are now considered strategic stocks under the MMPA. These include several stocks of bottlenose dolphins, pilot whales, and until recently, the harbor porpoise.[7] MMPA

[7] In the most recent U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessment (Hayes et al. 2018); harbor porpoise is no longer designated as a strategic stock.

Section 118(f)(1) requires the preparation and implementation of a take reduction plan (TRP) for any strategic marine mammal stock that interacts with Category I or II fisheries. Thus, the Harbor Porpoise TRP (HPTRP) and the Bottlenose Dolphin TRP (BDTRP) were developed and implemented for these species.[8] Also, due to the incidental mortality and serious injury of small cetaceans, incidental to bottom and midwater trawl fisheries operating in both the Northeast and Mid- Atlantic regions, the Atlantic Trawl Gear Take Reduction Strategy (ATGTRS) was implemented. Additional information on each TRP or Strategy is at: https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-take-reduction-plans-and-teams.

Trap/pot: Over the past several years, observer coverage has been limited for trap/pot fisheries. In the absence of extensive observer data for these fisheries, stranding data provides the next best source of information on species interactions with trap/pot gear. Stranding data underestimates the extent of human-related mortality and serious injury because not all of the marine mammals that die or are seriously injured in human interactions are discovered, reported, or show signs of entanglement. Additionally, if gear is present, it is often difficult to definitively attribute the animal's death or serious injury to the gear interaction, or to a specific fishery. Therefore, the conclusions below should be taken with these considerations in mind.

Table 39 provides the list of small cetacean and pinniped species that may occur in the affected environment of and be affected by this action. Of these species, only several bottlenose dolphin stocks have been identified as species at risk of becoming seriously injured or killed by trap/pot gear. Stranding data provides the best source of information on species interaction history with these gear types. Based on stranding data from 2007-2013, estimated mean annual mortality for each stock was less than one animal (Waring et al. 2014; Waring et al. 2016). Interactions with trap/pot gear, resulting in the serious injury or mortality to small cetaceans or pinnipeds are believed to be infrequent (for bottlenose dolphin stocks) to non-existent (for all other small cetacean and pinniped species).

Scallop dredge, surfclam/ocean quahog dredge, and bottom longline: Based on information provided by the Northeast Fisheries Observer Program (https://www.nefsc.noaa.gov/fsb/take_reports/nefop.html, as well as information provided in marine mammal stock assessment reports and the MMPA List of Fisheries (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region; https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-protection-act-list-fisheries), there have been no confirmed serious injury or mortality, or documented interactions, in general, with scallop dredge, surfclam/ocean quahog dredge, or bottom longline gears and small cetaceans or pinnipeds. Based on this information, these gears are not expected to pose an

[8] Although the most recent U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessment (Hayes et al. 2018) no longer designates harbor porpoise as a strategic stock, HPTRP regulations are still in place per the mandates provided in Section 118(f)(1).

interaction risk to any of these species and therefore, are not expected to be source of serious injury or mortality to these species.

6.9.3.2 Turtles

Bottom trawl: Sea turtle interactions with trawl gear have been observed in the Gulf of Maine, Georges Bank, and the Mid-Atlantic; however, most of the observed interactions have occurred in the Mid-Atlantic (see Warden 2011a,b; Murray 2015a). As few sea turtle interactions have been observed in the Gulf of Maine and Georges Bank regions of the Northwest Atlantic, there is insufficient data available to conduct a robust model-based analysis on sea turtle interactions with trawl gear in these regions or produce a bycatch estimate for these regions. As a result, the bycatch estimates and discussion below are for trawl gear in the Mid-Atlantic.

Green, Kemp's ridley, leatherback, loggerhead, and unidentified sea turtles have been documented interacting with bottom trawl gear. However, estimates are available only for loggerhead sea turtles. Warden (2011a,b) estimated that from 2005-2008, the average annual loggerhead interactions in bottom trawl gear in the Mid-Atlantic was 292 (CV=0.13, 95% CI=221-369), with 61 more loggerheads (CV=0.17, 95% CI=41-83) interacting with trawls, but released through a Turtle Excluder Device (TED). The 292 average annual observable loggerhead interactions equates to about 44 adult equivalents (Warden 2011a,b). Most recently, Murray (2015a) estimated that from 2009-2013, the total average annual loggerhead interactions in bottom trawl gear in the Mid-Atlantic was 231 (CV=0.13, 95% CI=182-298); this equates to about 33 adult equivalents (Murray 2015). Bycatch estimates by Warden (2011a) and Murray (2015a) are a decrease from the average annual loggerhead bycatch in bottom otter trawls during 1996-2004, which Murray (2008) estimated at 616 sea turtles (CV=0.23, 95% CI over the nine-year period: 367-890). This decrease is likely due to decreased fishing effort in high-interaction areas (Warden 2011a, b).

Pot/trap: Leatherback, loggerhead, green and Kemp's ridley sea turtles are known to interact with trap/pot gear. Interactions are primarily associated with entanglement in vertical lines, although sea turtles can also become entangled in groundline or surface systems. Records of stranded or entangled sea turtles indicate that fishing gear can wrap around the neck, flipper, or body of the sea turtle and severely restrict swimming or feeding (Balazs 1985; Sea Turtle Disentanglement Network (STDN) and Sea Turtle Stranding and Salvage Network (STSSN) unpublished data). As a result, sea turtles can incur serious injuries, and in some cases, mortality immediately or at a later time.

NMFS Northeast Region Sea Turtle Disentanglement Network's (STDN) database, a component of the Sea Turtle Stranding and Salvage Network, provides the most complete dataset of sea entanglements. Based on information provided in this database, a total of 333 sea turtle entanglements in vertical line gear were reported to the STDN and NMFS GARFO between 2002 and 2016 (STDN 2016). Of the 333 reports, 316 were classified as probable or confirmed vertical line gear entanglement. Out of the 316 confirmed and probable entanglement events, there were 147 cases in which the gear type associated with the entanglement could be assigned to a specific fishery. The majority of interactions involved leatherback sea turtles (130) followed by loggerhead (16), and green (1) sea turtles. Of the 130 leatherbacks, 68.5 % of the vertical line interactions involved gear associated with the lobster fishery (vertical line), 17.7 % the whelk fishery, 7.7% the sea bass fishery, 2.3 % the crab fishery, 1.5 % the conch fishery, 1.5% research, and 0.77 % whelk and lobster fishery (both trap/pots present). Of the 16 loggerheads, 56.3% involved interactions with vertical line associated with the whelk fishery and 43.8% the crab fishery. The one green sea turtle case involved an interaction with vertical line associated with the whelk fishery.

Gillnet: Sea turtle interactions with gillnet gear have been observed in the Gulf of Maine, Georges Bank, and the Mid-Atlantic; however, most of the observed interactions have occurred in the Mid-Atlantic and Georges Bank (Murray 2018; NMFS NEFSC FSB 2018). As few sea turtle interactions have been observed in the Gulf of Maine, there is insufficient data available to conduct a robust model-based analysis on sea turtle interactions with gillnet gear in this region or produce a bycatch estimate for this region. As a result, the bycatch estimates and discussion below are for gillnet gear in the Mid-Atlantic and Georges Bank regions.

Murray (2018) conducted an assessment of loggerhead, Kemp's ridley, leatherback, and unidentified hard-shell sea turtle interactions in Mid-Atlantic and Georges Bank gillnet gear during 2012-2016. Based on Northeast Fisheries Observer Program, At-Sea Monitoring Program, and Vessel Trip Report data from 2012-2016, total estimated bycatch of sea turtles in commercial sink gillnet gear in the Mid-Atlantic and Georges Bank regions was 705 loggerheads (equivalent to 19 adults), 145 Kemp's ridleys, 27 leatherbacks, and 112 unidentified hard-shelled sea turtles (Murray 2018). Depending on species, sea turtles were observed captured in nets with mesh sizes ranging from 3.25 inches to 12 inches.

Bottom longline: Sea turtles are at risk of interacting with bottom longline gear; however, the risk is tied to where the gear is placed relative to where and when sea turtles are present. As sea turtles are commonly found in neritic waters of the inner continental shelf (Braun-McNeill and Epperly 2002; Morreale and Standora 2005; Blumenthal et al. 2006; Hawkes et al. 2006; McClellan and Read 2007; Mansfield et al. 2009; Hawkes et al. 2011; Griffin et al. 2013; James et al. 2005; Eckert et al. 2006; Murphy et al. 2006; Dodge et al. 2014) , bottom longline gear placed in continental shelf waters (<200 meters) poses a greater risk of an interaction than bottom longline gear placed in deep waters greater than 200 meters. This is evidenced by the large number of sea turtle interactions observed in the South Atlantic and Gulf of Mexico (under NMFS SERO jurisdiction; NMFS 2006; NMFS 2011; NMFS 2012), where numerous fisheries prosecuted by bottom longline gear (e.g., HMS fishery-Atlantic shark bottom longline component; Gulf of Mexico reef fishery) operate in nearshore southern continental shelf waters (<200 meters) where sea turtles are commonly present year-round. Under such conditions, the co-occurrence of gear and sea turtles is high, thereby causing increased interaction risks. In contrast, in the Greater Atlantic Region, no sea turtles have been observed in bottom longline gear from 1989-2017 (NMFS NEFSC 2018). This may in part be due to the fact that fisheries (e.g., tilefish spp.) prosecuted by bottom longline gear in the GAR primarily operate in deep continental shelf edge/slope waters (>200 meters). In deeper waters, sea turtle (primarily loggerhead and leatherback) behaviors are primarily directed at migratory movements. As a result, sea turtles are more likely to be present in the water column than near the deep benthos where bottom longline is present, thereby reducing the co-occurrence of bottom longline gear and sea turtles and thus, the potential for an interaction (Braun-McNeill and Epperly 2002; McClellan and Read 2007; Mansfield et al. 2009; Hawkes et al. 2011; Griffin et al. 2013; http://seamap.env.duke.edu/). Based on this, although sea turtle interactions with bottom longline gear are possible, due to the fishing behavior of Greater Atlantic Region fisheries prosecuted by bottom longline gear, the risk of an interaction is likely low.

Scallop dredge: Sea turtle interactions with scallop dredge gear have been observed in the Gulf of Maine, Georges Bank, and the Mid-Atlantic, however most of the observed interactions have occurred in the Mid-Atlantic. There is insufficient data available to conduct a robust model-based analysis to estimate sea turtle interactions with scallop trawl or dredge gear outside the Mid-Atlantic. As a result, the bycatch estimates and most of the discussion below are based on observed sea turtle interactions in scallop dredge gear in the Mid-Atlantic.

Kemp's ridley, green, loggerhead, and unknown sea turtle species have been documented interacting with sea scallop dredge gear; loggerhead sea turtles are the most commonly taken species (Murray 2015b, FSB 2016, 2017, 2018). Two regulations have been implemented to reduce serious injury and mortalities to sea turtles resulting from interactions with sea scallop dredges, chain mat modified dredges, and turtle deflector dredges. As of May 2015, both gear modifications are now required in waters west of 71°W from May 1 through November 30 each year (76 FR 22119, April 21, 2015). It should be noted, although the chain mat and TDD modifications are designed to reduce the serious injury and mortality to sea turtles interacting with dredge gear, it does not eliminate the take of sea turtles. NMFS continues to monitor the sea scallop fishery and its effects on sea turtles; however, to date, available data does indicate that since implementation of these regulations, sea turtle interactions with sea scallop dredge gear have decreased.

Using Northeast Fisheries Observer Program data, Murray (2011) assessed loggerhead and hard-shell turtle interactions in the Mid-Atlantic sea scallop fishery from 2001-2008. After the implementation of the chain-mat requirements, the average annual observable interactions of hard-shelled sea turtles and scallop dredge gear dropped to 20 turtles (95% CI=3-42; 3 adult equivalents; Table 28). Further, as stated by Murray (2011), "if the rate of observable interactions from dredges without chain mats had been applied to trips with chain mats, the estimated number of observable and inferred interactions of hard-shelled species after chain mats were implemented would have been 125 turtles per year (95% CI: 88–163; 22 adult equivalents ; Table 28)." Most recently, Murray (2015b) estimated loggerhead interactions in the Mid-Atlantic scallop dredge fishery from 2009-2014. The average annual estimate of observable turtle interactions in scallop dredge gear was 11 loggerhead sea turtles per year (95% CI: 3-22; Murray 2015b). When the observable interaction rate from dredges without chain mats, was applied to trips that used chain mats and TDDs, the estimated number of loggerhead interactions (observable and unobservable but quantifiable) was 22 loggerheads per year (95% CI: 4-67; Murray 2015b). These 22 loggerheads equate to 2 adult equivalents per year, and 1-2 adult equivalent mortalities (Murray 2015b).

Surfclam/ocean quahog dredge
To date, there have been no observed or documented surfclam/ocean quahog dredge gear interactions with any sea turtle species (NMFS NEFSC FSB 2018). Based on this information, this gear type is not expected to pose an interaction risk to sea turtle species and therefore, are not expected to be source of injury or mortality to these species.

6.9.3.3 Atlantic sturgeon

Based on available data, gillnet gear interactions are of greatest concern for this species. The potential for bottom trawl, scallop dredge, pot/trap, and longline interactions are also discussed.

Sink gillnet and bottom trawl: Atlantic sturgeon interactions (i.e., bycatch) with sink gillnet and bottom trawl gear have been observed since 1989; these interactions have the potential to result in the injury or mortality of Atlantic sturgeon (NMFS NEFSC FSB 2018). Three documents, covering three time periods, that use data collected by NEFOP to describe bycatch of Atlantic sturgeon in gillnet and bottom trawl gear: Stein et al. (2004b) for 1989-2000; ASMFC (2007) for 2001-2006; and Miller and Shepard (2011) for 2006-2010; none of these documents provide estimates of Atlantic sturgeon bycatch by Distinct Population Segment. Miller and Shepard (2011), the most of the three documents, analyzed fishery observer data and VTR data to estimate the average annual number of Atlantic sturgeon interactions in gillnet and otter trawl in the Northeast Atlantic that occurred from 2006 to 2010. This timeframe included the most recent, complete data and as a result, Miller and Shepard (2011) is considered to represent the most accurate predictor of annual Atlantic sturgeon interactions in the Northeast gillnet and bottom trawl fisheries (NMFS 2013).

Based on the findings of Miller and Shepard (2011), NMFS (2013) estimated that the annual bycatch of Atlantic sturgeon is 1,239 and 1,342 sturgeon in gillnet and bottom otter trawl gear, respectively. Miller and Shepard (2011) observed Atlantic sturgeon interactions in trawl gear with small (< 5.5 inches) and large (≥ 5.5 inches) mesh sizes, as well as gillnet gear with small (< 5.5 inches), large (5.5 to 8 inches), and extra-large mesh (>8 inches) sizes. Although Atlantic sturgeon were observed to interact with trawl and gillnet gear with various mesh sizes, Miller and Shepard (2011) concluded that, based on NEFOP observed sturgeon mortalities, gillnet gear, in general, posed a greater risk of mortality to Atlantic sturgeon than did trawl gear. Estimated mortality rates in gillnet gear were 20.0%, while those in otter trawl gear were 5.0% (Miller and Shepard 2011; NMFS 2013). Similar conclusions were reached in Stein et al. (2004b) and ASMFC (2007) reports; after review of observer data from 1989-2000 and 2001-2006, both studies concluded that observed mortality is much higher in gillnet gear than in trawl gear. However, an important consideration to these findings is that observed mortality is considered a minimum of what occurs and therefore, the conclusions reached by Stein et al. (2004b), ASMFC (2007), and Miller and Shepard (2011) are not reflective of the total mortality associated with either gear type. To date, total Atlantic sturgeon mortality associated with gillnet or trawl gear remains uncertain.

Scallop dredge: According to the NMFS Opinion on the sea scallop fishery issued on July 12, 2012, it was determined that some small level of bycatch may occur in the scallop fishery; however, the incidence rate is likely to be very low. Review of available observer data from 1989-2014 confirms this determination. NEFOP and ASM observer data have recorded one (1) Atlantic sturgeon interaction with scallop dredge gear targeting Atlantic sea scallops; this sturgeon was released alive (FSB 2015, 2016, 2017, 2018).

Pot/trap, surfclam/ocean quahog dredge, and bottom longline: To date, there have been no observed or documented pot/trap, surfclam/ocean quahog dredge, or bottom longline gear interactions with Atlantic sturgeon (NMFS NEFSC FSB 2018). Based on this information, these gears are not expected to pose an interaction risk to these species and therefore, are not expected to be source of injury or mortality to these species.

6.9.3.4 Atlantic salmon (Gulf of Maine DPS)

Atlantic salmon bycatch has occurred in sink gillnet and bottom trawl gear but is a rare event. Interactions with bottom longline, scallop dredge, and trap/pot have not been observed.

Sink gillnet and bottom trawl: Atlantic salmon interactions (i.e., bycatch) with gillnet and bottom trawl have been observed since 1989; in many instances, these interactions have resulted in the injury and mortality of Atlantic salmon (NMFS NEFSC FSB 2018). According to the Biological Opinion issued by NMFS Greater Atlantic Regional Fisheries Office (GARFO) on December 16, 2013 and Northeast Fisheries Science Center's (NEFSC) Northeast Fisheries Observer and At-Sea Monitoring Programs documented a total of 15 individual salmon incidentally caught on more than 60,000 observed commercial fishing trips from 1989 through August 2013 (NMFS 2013; Kocik et al. 2014). Atlantic salmon were observed caught in gillnet (n=11) and bottom otter trawl gear (n=4), with 10 of the incidentally caught salmon listed as "discarded" and five reported as mortalities (Kocik (NEFSC), pers. comm (February 11, 2013) in NMFS 2013). The genetic identity of these captured salmon is unknown; however, the NMFS 2013 Biological Opinion considers all 15 fish to be part of the Gulf of Maine Distinct Population Segment, although some may have originated from the Connecticut River restocking program (i.e., those caught south of Cape Cod, Massachusetts).

Since 2013, no additional Atlantic salmon have been observed in gillnet or bottom trawl gear (NMFS NEFSC FSB 2015, 2016, 2017, 2018). Based on the above information, specifically the very low number of observed Atlantic salmon interactions in gillnet and trawl gear reported in the Northeast Fisheries Observer Program's database (which includes At-Sea Monitoring data), interactions with Atlantic salmon are likely rare events (Kocik et al. 2014; NMFS NEFSC FSB 2015, 2016, 2017, 2018).

Bottom longline, surfclam/ocean quahog dredge, scallop dredge, and trap/pot: To date, there have been no observed or documented interactions with Atlantic salmon from the following fishing gear types: bottom longline, surfclam/ocean quahog dredge, scallop dredge, or trap/pot gears (NMFS NEFSC FSB 2018). Based on this information, these gear types are not expected to pose an interaction risk to this species and therefore, is not expected to be source of injury or mortality to Atlantic salmon.

7 Environmental Impacts of the Alternatives

This section describes the potential positive and negative impacts associated with the management alternatives considered in this amendment. The analyses for the spatial management alternatives and associated fishing restrictions are organized by alternative and then by valued ecosystem component (VEC) to facilitate a comprehensive understanding of the costs and benefits of any particular coral zone or set of zones.

Similar coral zone alternatives are grouped together for analysis when this grouping is consistent with how decisions might be made about the zones. Specifically, five sets of areas that are grouped for analysis are the No Action areas, canyon coral zones, seamount coral zones, Jordan Basin coral zones, and Lindenkohl Knoll coral zones. In some cases, data are presented at the individual zone level, for example depth statistics or number of coral records in Alvin vs. Atlantis Canyons. Other data, for example revenues by species or gear, are pooled within each of the five groupings. Because five of the 20 canyons analyzed fall entirely within the Northeast Canyons and Seamounts Marine National Monument, the canyon revenue data are divided into two sub-groups to more clearly discriminate between locations that would be newly managed via the coral amendment, vs. locations that are currently managed as part of the monument.

While the alternatives sections of this document describe coral zones and measures for coral zones in separate sections, the impacts analyses link these two decisions and their associated potential impacts. Potential impacts of designating coral zones independent of applying fishing restrictions in those zones are described under the deep-sea coral VEC. For example, even in the absence of fishing restrictions, coral zones might have indirect conservation benefits as they would educate the public about the existence of corals in a particular location.

Impacts are summarized across alternatives and VECs within the Executive summary, in Table 2.

7.1 Impacts analysis methods by VEC

The following sections summarize the methods used in the impact analyses. For a given VEC, these methods are generally similar across the various groupings of alternatives.

7.1.1 Deep-sea coral approach to analysis and summary of data by alternative

This portion of the analysis evaluates the potential impacts that a particular zone or group of zones might have on deep-sea corals. Various metrics are used to assess the potential impacts of each alternative on deep-sea corals. These include information about coral presence, species richness, and relative abundance, area of high/very high coral habitat suitability, seafloor terrain data including depth and occurrence of steep slopes, and likelihood of gear interactions based on the usage of a particular type of fishing gear in the zone(s).

Because only a small area of each zone has been directly observed, general habitat characteristics of each zone are summarized. These include water depth, area of modeled high and very high coral habitat suitability, and area of high slope calculated from a digital elevation model (canyon and broad zones only). The habitat suitability and slope data are provided as total values, and also as percentages of the zone area. The coral data are described in detail in section 6.2, and the habitat suitability model is described in section 6.3.

Coral presence

All zones under consideration in this amendment have corals documented during recent (since 2012) camera surveys, and some of the zones have pre-2012 records of coral presence as well. Additional background on the historical and recent data is in section 6.2, respectively. Detailed coral information by zone is summarized in section 6.2.3.

Overlaps between each coral zone and pre-2012 coral presence data are summarized in Table 45. These data should be viewed as indicators of both coral presence and survey effort. The occurrence of corals in some areas of New England was well documented prior to recent survey efforts, for example within Lydonia, Oceanographer, and Heezen Canyons, in the Bear and Retriever Seamount zones, and at the largest zone in Jordan Basin, 114 fathom bump, as well as at Mt. Desert Rock. Many of the zones under consideration in this amendment do not have pre-2012 records, and recent exploratory surveys represent the first time they were surveyed for corals. In some of these areas, corals were thought likely to occur before coral habitats were confirmed with ROV or camera surveys, on the basis of steep terrain, and later, the habitat suitability model.

Between 2012 and 2015, exploratory surveys using remotely operated vehicles, autonomous underwater vehicles, and towed camera systems were deployed throughout the region to collect data on coral distribution and species richness. Coral observations during these dives are described very briefly in Table 46. Site selection during these surveys was frequently guided by high resolution bathymetric data and the coral habitat suitability model. Additional recent dives not described here overlap with the broad zones but are outside the discrete zones.

Table 45 – Number of historical (pre-2012) records of coral presence in each zone

No Action (Tilefish, Monkfish-MSB, Monument)						
Area name	***None***	***Soft corals***	***Sea pens***	***Hard corals***	***Black corals***	***Total***
Tilefish closures		159	3	16	0	178
Monkfish-MSB		249	2	26	0	277
Monument		307	7	31	7	352
Broad zones						
Zone name	***None***	***Soft corals***	***Sea pens***	***Hard corals***	***Black corals***	***Total***
300 m (Option 1)		452	85	82	8	627
400 m (Option 2)		445	81	81	8	615
500 m (Option 3)		434	77	73	8	592
600 m (Option 4)		410	73	62	8	553
900 m (Option 5)		290	72	52	8	422
600 m minimum (Opt. 6)		386	73	58	8	525
Empirical zone (Opt. 7)		445	77	71	8	601
Canyons						
Zone name	***None***	***Soft corals***	***Sea pens***	***Hard corals***	***Black corals***	***Total***

Alvin		2	5	4		11
Atlantis			1	1		2
Nantucket				7		7
Veatch	X					0
Hydrographer		2				2
Dogbody		8				8
Clipper		1				1
Sharpshooter	X					0
Welker	X					0
Heel Tapper	X					0
Oceanographer		149		18		167
Filebottom		1				1
Chebacco	X					0
Gilbert	X					0
Lydonia		92	4	7		103
Powell	X					0
Munson		1				1
Nygren	X					0
Kinlan (prev. unnamed)	X					0
Heezen		42	12	13		67
Seamounts						
Zone name	***None***	***Soft corals***	***Sea pens***	***Hard corals***	***Black corals***	***Total***
Bear		32	1	5	6	44
Mytilus	X					1
Physalia	X					0
Retriever		12			1	13
Gulf of Maine						
Zone name	***None***	***Soft corals***	***Sea pens***	***Hard corals***	***Black corals***	***Total***
Mount Desert Rock (Options 1 and 2)		2				2
Outer Schoodic Ridge	X					0
Western Jordan Basin - 114 Fathom Bump (Options 1 and 2)		11				11
Western Jordan Basin - 96 Fathom Bump (Options 1 and 2)		1				1
Western Jordan Basin - 118 Fathom Bump (Options 1 and 2)		2				2
Central Jordan Basin (Options 1 and 2)	X					0
Lindenkohl Knoll (Options 1 and 2)	X					0

Table 46 – Recent exploratory survey dives in discrete deep-sea coral zones.

Canyons	
Zone name	***Dive notes***
Alvin Canyon	*Okeanos Explorer* 2013, Cruise EX1304L1, dives 9 and 10, depths ranging from 846 to 927 m depth. East and west walls; dives traversed a range of soft sediment and rock wall/overhang habitats. Corals observed on both dives, especially in rocky areas.
Atlantis Canyon	*Okeanos Explorer* 2013, Cruise EX1304L1, dives 7 and 8, depths ranging from 885 to 1,794 m depth. East and west walls. Corals were observed during both dives. Dive 7: colonial stony corals, soft corals, and black corals, plus cup corals, which are a solitary type of stony coral. Dive 8: stony, soft, and black corals; sea pens.
Nantucket Canyon	*Okeanos Explorer* 2014, Cruise EX1404. Southwestern canyon wall at the mouth (1600-1900 m). Stony, soft, and black corals; sea pens.
Veatch Canyon	Three *TowCam* dives from the *S/V Bigelow* during cruise HB1204 (2012). Dive 8: stony and soft corals. Deeper dives 7 and 9: stony, soft, and black corals; sea pens.
Hydrographer Canyon	*Okeanos Explorer* 2013, Cruise EX1304L1, dives 5 and 6. Dive 5 (east wall, 1299-1418 m): stony, soft, and black corals. Dive 6 (west wall, 610-907 m): soft and stony corals.
Dogbody Canyon	Three *TowCam* dives from the *S/V Bigelow* during Cruise HB1504 (2015). Tow 1 (558-675 m) found sponges, but corals were uncommon. Tow 2 (894-1014 m) found abundant and diverse stony, soft, and black corals. Tow 3 (1461-1620 m), soft corals only.
Clipper Canyon	Two *TowCam* dives from the *S/V Bigelow* during Cruise HB1504 (2015). Soft corals on both dives.
Sharpshooter Canyon	Two *TowCam* dives during Cruise HB1504 (2015). Tows 16 and 17 in two of the larger contiguous areas of high slope. No corals were noted during the shallow tow 16 (800-901 m); tow 17 (1144-1168 m) found stony and soft corals.
Welker Canyon	*Okeanos Explorer* 2013, Cruise EX1304L2 (dive 14, 1,377-1,445 m). Diversity of stony, soft, and black corals; sea pens. Three tows during cruise HB1504 (2015) surveyed the walls of the canyon. Tow 13 (559-778 m) found stony and soft corals; tow 14 (851-1156 m) found stony, soft, and black corals; tow 15 (1480-1650 m) found soft and black corals.
Heel Tapper Canyon	Three *TowCam* dives from the *S/V Bigelow* during Cruise HB1504 (2015). Depths of 666 to 1,444 m, soft corals observed.
Oceanographer Canyon	*Okeanos Explorer* Cruise EX1304L2, dives 3 and 13. Eastern and western walls were surveyed. Dive 3 (983-1,239 m) and Dive 13 (1,102-1,248 m) encountered at least 16 species of stony, soft, and black corals.
Filebottom Canyon	Three *TowCam* dives during Cruise HB1504 (2015). Tow 7 (664-887 m) and Tow 8 (1029-1077 m) recorded stony and soft corals. Tow 9 also found corals.
Chebacco Canyon	Two tows during cruise HB1504 (2015), on the east wall. Tow 4 (801-875 m) found stony corals and Tow 5 (1133-1356 m) found soft, stony, and black corals.
Gilbert Canyon	Seven tows during cruise HB1204 (2012) covered various locations throughout the canyon including an area near the head and on multiple walls and tributaries. All tows found soft corals, with the percentage of images with soft corals ranging from 2% to 54%. Other coral types were found in the canyon as well, including black corals, stony corals, and sea pens. Two tows had very high coral abundance and diversity (western wall between 1370-1679 m and in the canyon head between 640-820 m).

Lydonia Canyon	One recent ROV dive within the proposed zone, onboard the *RV Okeanos Explorer*, cruise EX1304L2, dive 12; 1,135-1,239 m. A large number of species (at least 15) from all four coral groups were observed.
Powell Canyon	Six tows during cruise HB1302 (2013). Tows 7 (753-1306 m) and 8 (905-1340 m) had high abundances and diversities of corals, while tow 9 (1302-1630 m) had abundant corals, and often with areas of high localized abundances, with some areas having widely dispersed corals or none at all. The remaining three deeper tows (1292-2053 m) have low abundances/low diversities of corals. Stony, soft, and black corals, as well as sea pens.
Munson Canyon	Seven *TowCam* tows during cruise HB1302 (2013). In tows 14 (535-1040 m), 16 (983-1346 m), 17 (935-1455 m), 18 (1330-1941 m) and 24 (1084-1472 m), corals were locally abundant, with some areas having widely dispersed corals or none at all. Tow 19 (1283-1855 m) had fewer corals overall, while Tow15 (550-1089 m) had a low abundance and diversity of corals present. Stony, soft, and black corals, as well as sea pens.
Nygren Canyon	Two tows during Cruise EX1304L2 (2013) and two during HB1402 (2014). Stony, soft, and black corals, and sea pens. Higher species richness than Munson Canyon.
Unnamed canyon between Nygren and Heezen	One ROV dive during *Okeanos Explorer* Cruise EX1304 leg 2, dive 10, 497-824 m. Stony and soft corals.
Heezen Canyon	Two dives during the 2013 *Okeanos Explorer* Cruise EX1304L2. Dive 7 (1615-1723 m): stony, soft, and black corals, as well as sea pens. Dive 9 (703-926 m): very large soft coral colonies, plus other coral types.
Seamounts	
Zone name	***Dive notes***
Bear Seamount	Not visited during recent (2012-2015) cruises.
Mytilus Seamount	Two dives during the 2013 *Okeanos Explorer* cruise EX1304L2. Dive 4: soft and black corals. Sea pens, soft corals, and black corals were noted during Dive 5.
Physalia Seamount	2012 AUV dives (Kilgour et al. 2014) collected 2956 color seafloor images. Soft corals and sea pens. Single dive during *Okeanos Explore* Cruise EX1404 (2014). Corals observed in low abundance and diversity, including soft, stony, and black corals, as well as sea pens.
Retriever Seamount	Single dive during *Okeanos Explorer* Cruise EX1404 (2014). Sea pens, soft corals, black corals.
Gulf of Maine	
Zone name	***Dive notes***
Mount Desert Rock (Options 1 and 2)	Ten dives during 2002, 2003, 2013 and 2015 (one without corals). Soft corals, primarily gorgonians, sometimes at very high densities; sea pens locally abundant in soft sediments. Two additional dives outside the zone did not have corals.
Outer Schoodic Ridge	Ten dives during 2013, 2014, and 2015. Soft corals, primarily Gorgonians, sometimes at very high densities, and sea pens. Twelve additional dives outside the site but in eastern Maine did not find corals.
Western and central Jordan Basin (Options 1 and 2)	37 dives during 2002, 2003, 2013, 2014, and 2017 five without corals. Soft corals, primarily gorgonians, sometimes at high densities; sea pens sparse to medium density. One dive without corals was excluded from the Option 2 zones at 114 Fathom Bump, otherwise the portfolio of dives is the same for both options.
Lindenkohl Knoll (Options 1 and 2)	Four dives during 2015. Soft corals, primarily Gorgonians; sea pens. Generally low to medium density except for one site with high density soft corals.

Habitat suitability for deep-sea corals

Many locations are likely to have habitat types suitable for colonization by deep-sea corals but have not yet been sampled due to the time and cost associated with conducting deep-sea research with remotely operated vehicles, towed camera systems, or other sampling gears. Instead of relying on sampled locations only to determine the species distribution, habitat suitability models can be used to predict a species occurrence. Habitat suitability models use a combination of environmental conditions to identify locations that are more likely to support a species than other locations. As described in section 6.3, NOAA developed a habitat suitability model for deep-sea corals by relating deep-sea coral presence locations (through 2012) and environmental and geological predictor variables (such as slope, depth, depth change, rugosity, salinity, oxygen, substrate, temperature, turbidity, and others). The spatial resolution of the model is somewhat coarse and is best applied to analyses at broader scales (hundreds of meters to a few kilometers).

The habitat suitability of several different taxonomic groups of deep-sea corals were modeled, including soft corals (Alcyonaceans), stony corals (Scleractinians), and sea pens (Pennatulacea). Data did not exist to model black corals (Antipatharia). The model outputs for soft corals are based on a sizeable number of data points from known structure-forming species, so confidence in the model is high. In contrast, the outputs for stony corals are based on many fewer records and model confidence is low. Sea pens are not the direct conservation focus of the amendment. Therefore, the soft coral modeling is the focus here. Three separate soft coral model runs (Alcyonacean, Gorgonian Alcyonacean, and Non-Gorgonian Alcyonacean) were combined to represent the broadest spatial extent of area suitable for soft corals. Although they do have different distributions by depth and sediment type, soft corals, sea pens, stony corals, and black corals are known to co-exist, giving us some confidence that management measures that align well with the soft coral model provide protection for other taxonomic groups.

The model outputs indicate the likelihood that a particular location is suitable habitat for a particular coral group. High and very high likelihoods for the three soft coral groupings are the focus on this analysis. These high and very high likelihood areas are concentrated along the edge of the continental shelf south of Georges Bank, and to a lesser extent in coastal areas of the Gulf of Maine. The ROV and towed camera data generally validate the model outputs in the canyons and on the slope. Given the resolution of the terrain data used in the model, the PDT determined that the suitability model results are not a useful metric in the Gulf of Maine (section 6.3). Therefore, this analysis focuses on the continental margin only (Map 47, grey shaded area). The total area of habitat suitable for deep-sea corals along the continental margin deeper than 100 m is 4,793 km^2 (Map 47, red shaded areas). In terms of evaluating the management alternatives, the question is to what extent the management alternatives proposed in this amendment overlap with areas predicted to be suitable for corals.

The alternatives vary in size, and in the amount of suitable habitat along the continental margin they encompass (Table 47). Both data points are accounted for to determine the percentage of suitable habitat covered by an alternative, and to calculate how efficiently the areas in the alternative overlap with suitable habitats. These results are explored further in the impacts analysis for each alternative (Sections 7.2.1.1, 7.2.2.1, etc.).

Map 47 – High suitability habitat for deep-sea corals (red), canyon zones (blue), and broad zones (black outline).

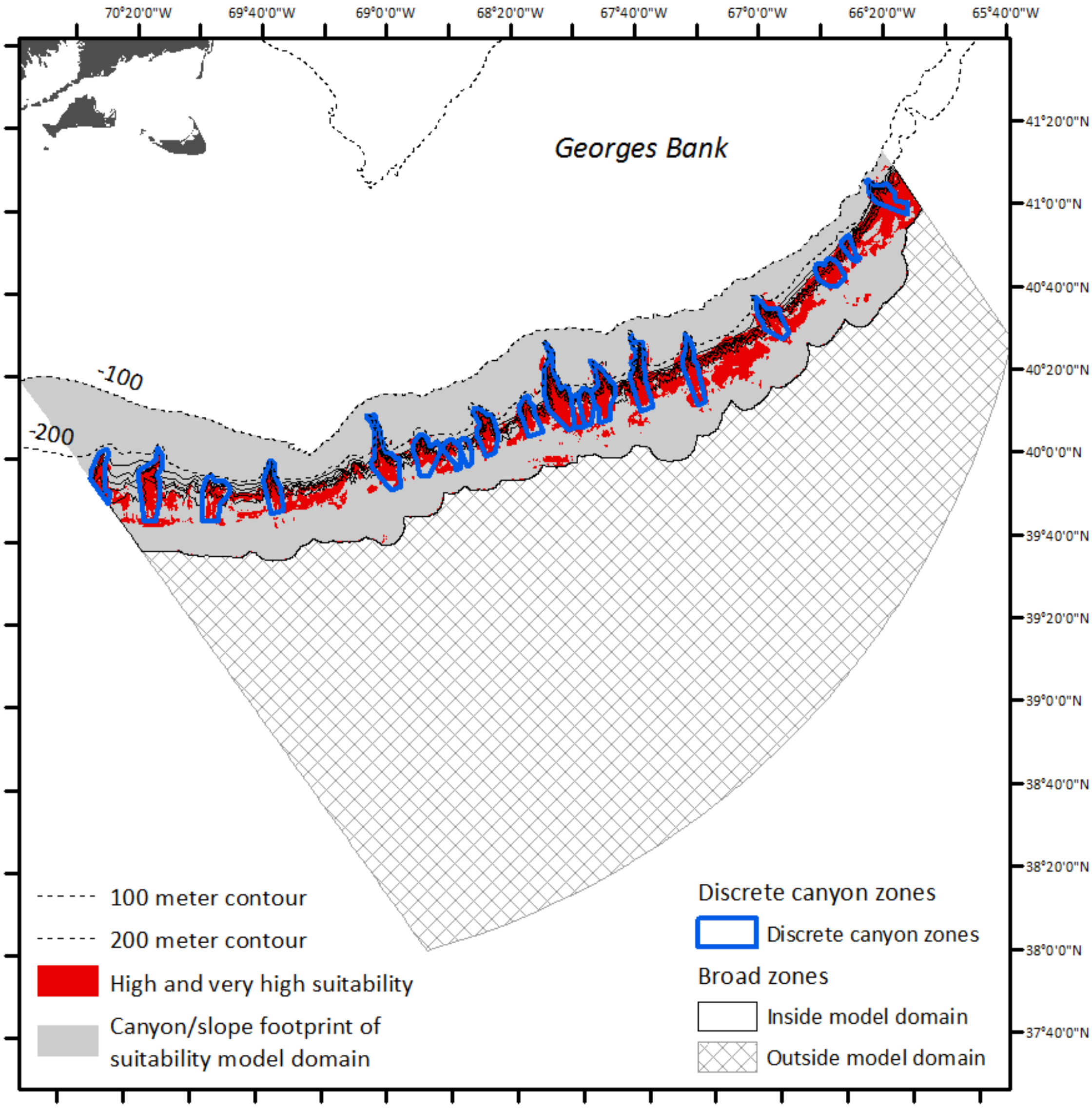


Table 47 – Suitable habitat for deep-sea corals by management area. Analysis considers portions of management areas within the suitability model domain only.

Management Area	Total size of coral zone (km^2)[1]	Area of suitable habitat covered by coral zone (km^2)	Proportion of suitable habitat covered by coral zone (%)[2]	Efficiency index[3]
Tilefish GRAs (No Action)	371	241	5%	65%
Monkfish-Mackerel/Squid/Butterfish Closures (No Action)	426	396	8%	93%
Northeast Canyons and Seamounts Marine National Monument (No Action)	2,354	886	18%	38%
Canyons (all 20 combined)	2,651	2,050	43%	77%
300 m (Option 1)	13,097	4,582	96%	35%
400 m (Option 2)	12,366	4,354	91%	35%
500 m (Option 3)	11,794	4,042	84%	34%
600 m (Option 4)	11,320	3,700	77%	33%
900 m (Option 5)	10,148	2,821	59%	28%
600 m minimum (Option 6)	11,186	3,587	75%	32%
Empirically-derived zone (Option 7)	12,081	4,320	90%	36%

[1] Considering just the area within the suitability model domain.
[2] This is calculated by dividing the area of suitable habitat covered by the management area by the total amount of suitable habitat modeled, which is 4,793 km^2. This only considers the portion of the model domain beyond 100 m south of Georges Bank.
[3] This index represents how efficiently the coral zone covers highly suitable habitat. It is the area of suitable habitat covered by the coral zone over the total size of the coral zone, again just considering the portion of the zones within the suitability model domain.

Bathymetry and slope

Table 48 provides descriptive statistics for the water depth within various coral zones. The data source for these calculations is a global, digital elevation model, the General Bathymetric Chart of the Oceans (GEBCO). This elevation model was used because it fully overlaps all of the coral zones, whereas some higher resolution data sources only partially overlap the areas. The grid resolution of these data is 30 arc seconds, and thus the cell size of the GEBCO digital elevation model varies by latitude. At 40° N, this translates to a distance of just under a kilometer (approximately 925 m). This resolution is somewhat coarse relative to the dimensions of various coral zones considered in this amendment, so the results in the table should be considered as rough approximations of true depth. The landward boundaries of the broad zones and canyon zones in particular were developed using a higher resolution dataset, ACUMEN, which covers just the slope region (see Map 48).

Values shown in the table include minimum depth, maximum depth, and depth range, as well as median, mean, and standard deviation. The results of this analysis are self-explanatory. The broad zones include the deepest depths as they encompass large areas of the continental rise and abyssal plain but have fairly shallow minimum depths. The same depth is reported as the minimum for both the 300 and 400 m zones owing to the coarse resolution of the depth model relative to the close spacing of the depth contours at the shelf break. The depth range for the seamounts indicates their height above the seabed, about 2 km. The canyon zones have minimum depths between roughly 150-400 m. Again, the minimum depths shown here should be viewed cautiously, given the steepness of the shelf break and the resolution of these depth data, but the slope-confined, smaller canyons such as Clipper, Sharpshooter, Filebottom, and Chebacco, have deeper minimum depths. On average, depth in the canyons is about 1 km, which suggests that they are deep habitats despite having their heads in shallower water where they cross the shelf break. The Gulf of Maine zones are the shallowest and have the narrowest depth range. The four Jordan Basin zones are generally deeper and have smaller depth ranges than the inshore and Lindenkohl zones.

Steeply sloped areas of the seafloor tend to contain deep-sea corals. Slope is a significant predictor variable in the habitat suitability model. In addition, locations with high slope (greater than 30°, and especially slopes over 36°) almost always contain corals when observed with remotely operated vehicles or towed cameras. These high-slope habitats tend to contain outcropping rocks, which provide attachment sites for various species of soft, stony, and black corals.

The best slope data available for the continental slope and canyons was compiled during a series of 2012 cruises, the Atlantic Canyons Undersea Mapping Expeditions (ACUMEN). The compiled data are referred to as ACUMEN, and are 25 m spatial resolution, which is a substantial improvement over the previously available digital elevation model. The footprint of the ACUMEN data in New England (Map 48) roughly approximates the slope and canyons between 300-2,000 m and covers a total area of approximately 12,811 km^2. Considering the intersection between the New England region and the area covered by the ACUMEN data, 164 km^2 has a slope greater than 30º. The 20 discrete canyon zones cover 3,029 km^2, just 24% of the ACUMEN footprint, but contain 108 km^2 (66%) of the high slope area. This means that the canyons identified as discrete zones have steeper terrain than the ACUMEN region overall, which is not surprising. A smaller area of the ACUMEN domain, 45 km^2, is very high slope (greater than 36°). Most of this area, 29 km^2 or 64%, overlaps the discrete canyon zones.

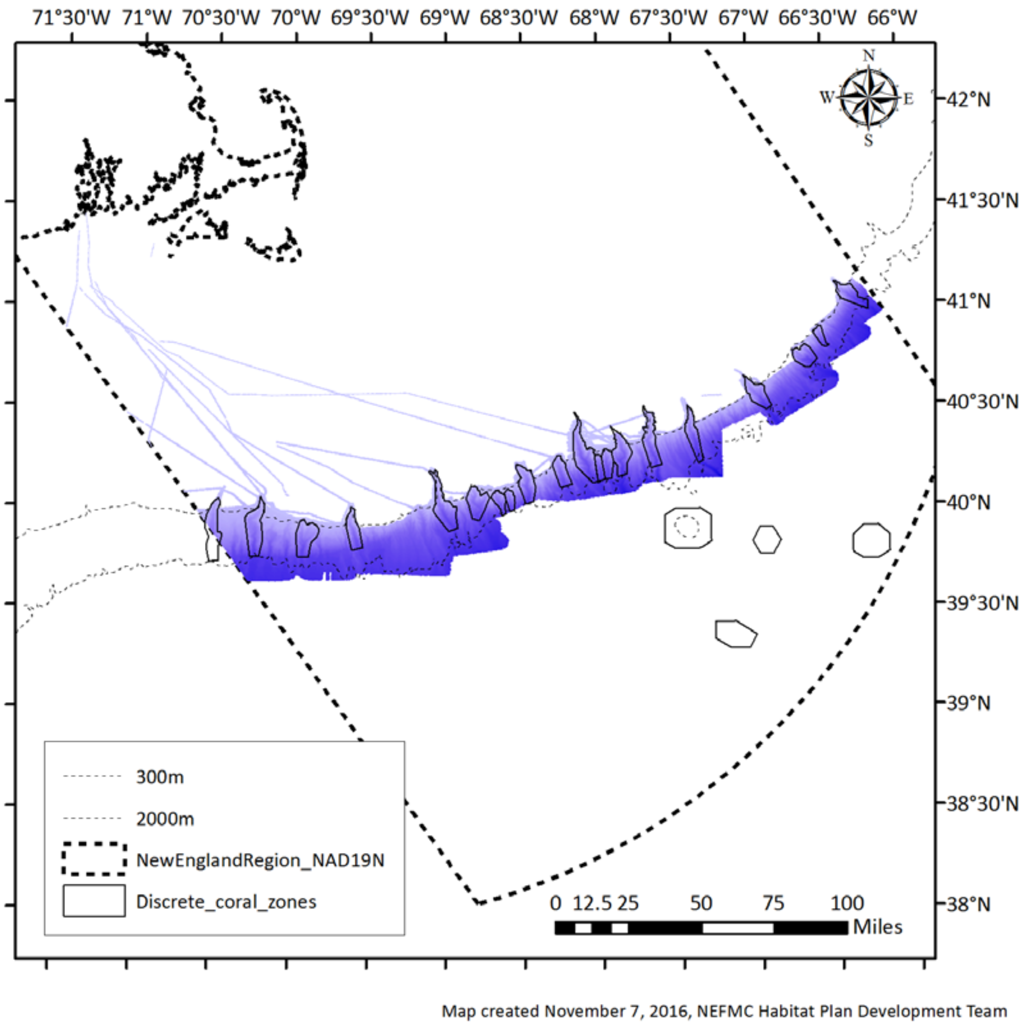
The high slope areas are difficult to visualize on a regional map, so Map 49 shows where high slope areas occur within Oceanographer Canyon. The ACUMEN bathymetry and slope datasets are not without artifacts, and in locations where datasets from individual cruises were stitched together, false areas of high slope can be seen. However, the majority of the areas mapped as high and very high slope are expected to represent truly steep areas of the seafloor. The overlap between high slope and management area is summarized in Table 49.

Table 48 – Depth statistics for deep-sea coral zones. Data source: General Bathymetric Chart of the Oceans (GEBCO) 30 arc second digital elevation model.

No Action management areas						
Zone name	***Shallow/ min***	***Deep/ max***	***Range***	***Median***	***Mean***	***Standard deviation***
Tilefish GRA - Veatch	-143	-878	735	-364	-393.6	168.6
Tilefish GRA – Oceanographer	-131	-1,262	1,131	-368	-453.7	271.8
Tilefish GRA – Lydonia	-145	-860	715	-332	-359.5	150.8
Monkfish-MSB – Oceanographer	-197	-1,906	1,709	-962	-979.5	464.0
Monkfish-MSB – Lydonia	-166	-1,672	1,506	-637	-721.9	372.9
Monument – Canyon section	-88	-2,094	2,006	-214	-534.3	537.1
Monument – Seamount section	-1,088	-4,434	3,346	-3832	-3,705.2	601.1
Broad zones						
Zone name	***Shallow/ min***	***Deep/ max***	***Range***	***Median***	***Mean***	***Standard deviation***
300 m (Option 1)	-191	-4,434	4,243	-3,131	-2,997.5	954.6
400 m (Option 2)	-191	-4,434	4,243	-3,140	-3,022.7	921.0
500 m (Option 3)	-248	-4,434	4,186	-3,151	-3,045.6	892.9
600 m (Option 4)	-390	-4,434	4,044	-3,162	-3,068.1	867.8
900 m (Option 5)	-556	-4,434	3,878	-3,180	-3,108.4	818.1
600 m minimum (Option 6)	-389	-4,434	4,045	-3,161	-3069.4	861.8
Empirically-derived (Option 7)	-214	-4434	4,220	-3,146	-3,035	906.5
Canyons						
Zone name	***Shallow/ min***	***Deep/ max***	***Range***	***Median***	***Mean***	***Standard deviation***
Alvin	-307	-1,955	1,648	-936	-1,022.8	472.7
Atlantis	-315	-1,998	1,683	-914	-968.8	426.4
Nantucket	-330	-1,935	1,605	-945	-999.9	422.4
Veatch	-230	-1,792	1,562	-844	-913.9	439.0
Hydrographer	-141	-1,949	1,808	-1,001	-991.8	521.0
Dogbody	-322	-1,835	1,513	-1,043	-1,059.9	415.1
Clipper	-440	-1,801	1,361	-979	-1,038.2	386.9
Sharpshooter	-441	-1,884	1,443	-1,082	-1,092.7	413.9
Welker	-290	-2,083	1,793	-881	-966.7	475.2
Heel Tapper	-321	-1,765	1,444	-1,009	-1,003.5	409.9
Oceanographer	-280	-2,026	1,746	-904	-999.7	498.6
Filebottom	-413	-1,965	1,552	-1,407	-1,340.1	442.8
Chebacco	-403	-1,925	1,522	-1,192	-1,182.4	436.7
Gilbert	-199	-2,094	1,895	-969	-1,035.8	480.9
Lydonia	-156	-1,960	1,804	-761	-859.0	492.7
Powell	-271	-2,146	1,875	-1203	-1,177.5	544.9
Munson	-202	-2,000	1798	-998	-1,006.1	445.9
Nygren	-344	-1,774	1430	-1108	-1,105.7	447.1

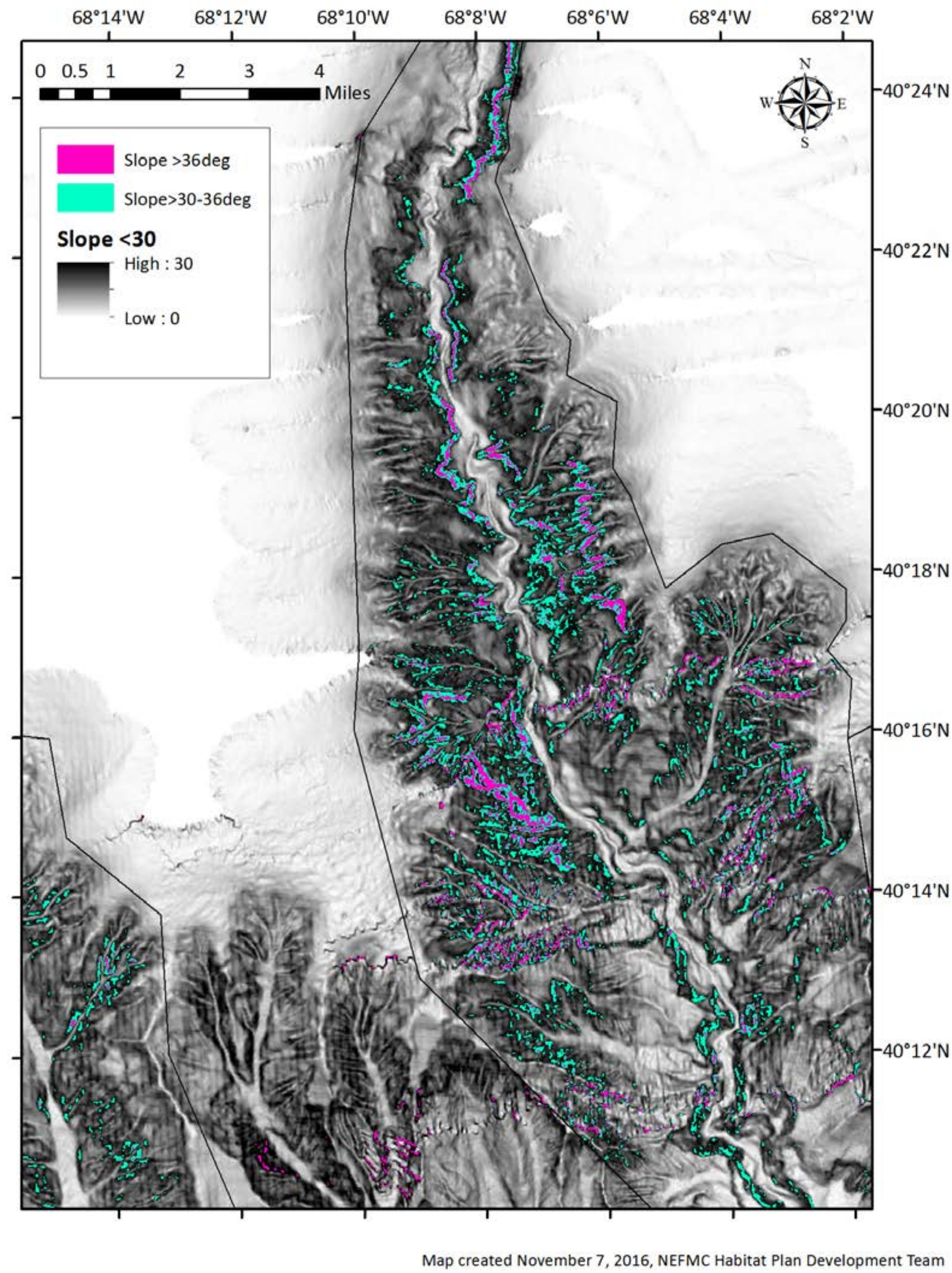
Kinlan (prev. unnamed)	-392	-1,573	1,181	-940	-932.3	348.8
Heezen	-151	-2,084	1,933	-909	-1,034.2	537.9
Seamounts						
Zone name	***Shallow/ min***	***Deep/ max***	***Range***	***Median***	***Mean***	***Standard deviation***
Bear	-1,088	-3,204	2,116	-2,255	-2,225.3	533.6
Mytilus	-2,382	-4,190	1,808	-3,653	-3,429.7	532.2
Physalia	-1,902	-3,691	1,789	-3,200	-3,054.2	405.6
Retriever	-1,946	-4,048	2,102	-3,561	-3,338.9	552.8
Gulf of Maine						
Zone name	***Shallow/ min***	***Deep/ max***	***Range***	***Median***	***Mean***	***Standard deviation***
Mount Desert Rock (Option 1)	-106	-203	97	-169	-162.4	22.5
Mount Desert Rock (Option 2)	-106	-203	97	-164	-160.8	27.0
Outer Schoodic Ridge	-144	-211	67	-172	-172.3	15.9
Western Jordan Basin - 114 Fathom Bump (Option 1)	-213	-251	38	-241	-237.7	7.8
Western Jordan Basin - 114 Fathom Bump (Option 2, #1)	-239	-247	8	-243	-242.9	1.8
Western Jordan Basin - 114 Fathom Bump (Option 2, #2)	-231	-248	35	-241	-238.8	7.0
Western Jordan Basin - 114 Fathom Bump (Option 2, #3)	-223	-239	16	-229	-229.5	4.0
Western Jordan Basin - 114 Fathom Bump (Option 2, #4)	-224	-235	11	-231	-229.7	3.5
Western Jordan Basin - 96 Fathom Bump (Option 1)	-188	-222	34	-209	-209.2	7.3
Western Jordan Basin - 96 Fathom Bump (Option 2)	-188	-222	34	-208	-207.6	10.1
Western Jordan Basin - 118 Fathom Bump (Option 1)	-221	-265	44	-242	-244.2	9.3
Western Jordan Basin - 118 Fathom Bump (Option 2)	-221	-239	18	-235	-232.5	5.7
Central Jordan Basin (Option 1)	-215	-232	17	-226	-225.3	4.2
Central Jordan Basin (Option 2, #1)	-221	-230	9	-227	-226.5	3.1
Central Jordan Basin (Option 2, #2)	-215	-230	15	-223	-223.8	5.0
Lindenkohl Knoll (Option 1)	-165	-256	91	-210	-209.8	16.9
Lindenkohl Knoll (Option 2, #1)	-188	-216	28	-200	-199.5	9.6
Lindenkohl Knoll (Option 2, #2)	-189	-248	59	-222	-218.2	17.5
Lindenkohl Knoll (Option 2, #3)	-198	-254	56	-229	-225.1	15.2

Map 48 – Spatial extent of high-resolution ACUMEN bathymetry data south of Georges Bank (blue shading)



The heavy dotted outline shows the spatial extent of the New England region, and the light dotted lines show the 300 and 2,000 m contours. Canyon coral zones are shown in solid black outline.

Map 49 – High slope areas in Oceanographer Canyon



Lighter to darker colors indicate progressively steeper slopes up to 30º. Green shows slopes between 30-36º, and pink shows slopes greater than 36º.

Table 49 – Area of high slope by management area. Analysis considers portions of management areas within the ACUMEN footprint only.

Management Area	Area of slope > 30° (km^2)[1]	Proportion of suitable high slope covered by management area (%)[2]
Tilefish GRAs (No Action)	15	9%
Monkfish-Mackerel/Squid/Butterfish Closures (No Action)	28	17%
Northeast Canyons and Seamounts Marine National Monument (No Action)	54	33%
Canyons (all 20 combined)	108	66%
300 m (Option 1)	164	100%
400 m (Option 2)	162	99%
500 m (Option 3)	156	95%
600 m (Option 4)	145	88%
900 m (Option 5)	103	63%
600 m minimum (Option 6)	139	85%
Empirically-derived (Option 7)	164	100%

[1] Considering just the area overlapping the ACUMEN data set.
[2] This is calculated by dividing the area of high slope covered by the management area by the total amount of high slope, which is 164 km^2.

Likelihood of interactions between corals and fishing activity

These coral and coral habitat data are then considered in the context of fishing effort and potential fishing gear effects to estimate the magnitude of impacts a zone might have on deep-sea corals. Each of the gear restriction options is discussed separately, from most to least restrictive, including:

- All bottom-tending gears,
- All bottom-tending gears, red crab traps allowed,
- All bottom tending gears, except traps of any type allowed,
- All mobile bottom-tending gears

In general, the coral zones are presently accessible to various fishing gear types, so the impacts analysis considered what the potential effects would be of excluding gears that are allowed under current management. In a small number of cases, the coral zones proposed are currently closed to fishing. This is mainly the case in areas overlapping the Northeast Canyons and Seamounts Marine National Monument, which encompasses the five canyon zones from Oceanographer Canyon to Lydonia Canyon, and all four seamount zones. In these locations, the impacts of coral zone restrictions are considered as additions to any existing restrictions. Mobile bottom-tending gears are currently excluded in portions of Veatch Canyon due to a Tilefish Gear Restricted Area, but the GRA does not fully overlap the coral zone.

It is difficult to assess the magnitude of spatial overlap between fishing effort and coral habitats with any degree of precision, given the current state of knowledge of coral and fishing distributions. The Northeast Fishery Observer Program has documented bycatch of corals in fishing gear (section 6.5.3), but at-sea observer sampling schemes are designed to estimate catch and bycatch rates of target species and stocks of concern, with coral bycatch as an incidental element of their data collection. Thus, these data cannot be used to estimate coral bycatch rates.

7.1.2 Managed species and essential fish habitat

In addition to deep-sea corals, various managed species occupy the coral zones. These species may benefit from gear restrictions that minimize impacts to habitats within the zones. In particular, seafloor habitats provide shelter and feeding opportunities for managed species. The magnitude of any benefits will depend on the degree of overlap with each species' distribution and the extent to which the species use habitat features vulnerable to impacts from fishing gears. The degree of overlap between essential fish habitat designations and each zone or group of zones is one metric for estimating the benefits that may be generated. These overlaps are explored in section 6.6 and discussed in the impacts analysis by zone or group of zones to estimate potential impacts on managed resources.

7.1.3 Human communities

The analysis of impacts on human communities characterizes the magnitude and extent of the economic and social impacts likely to result from the alternatives under consideration. National Standard 8 requires the Council to consider the importance of fishery resources to affected communities and provide those communities with continuing access to fishery resources, but it does not allow the Council to compromise the conservation objectives of the management measures. Thus, continued overall access to fishery resources is a consideration, but not a guarantee that fishermen will be able to use a particular gear type, harvest a particular species of fish, fish in a particular area, or fish during a certain time of the year.

A fundamental difficulty exists in forecasting economic and social change relative to fishery management alternatives when communities or other societal groups are constantly evolving in response to numerous external factors, such as market conditions, technology, alternate uses of waterfront, and tourism. Certainly, management regulations influence the direction and magnitude of economic and social change, but attribution is difficult with the tools and data available. While this analysis focuses generally on the economic and social impacts of the proposed fishing regulations, external factors may also influence change, both positive and negative, in the affected communities. In many cases, these factors contribute to a community's vulnerability and ability to adapt to new or different fishing regulations.

Data confidentiality

MSA §402(b), 16 U.S.C. 1881a(b) states that no information gathered in compliance with the Act can be disclosed, unless aggregated to a level that obfuscates the identity of individual submitters. The economic analysis in this amendment is thus aggregated to at least three reporting units, to preserve confidentiality. Any data with less than three reporting units is censored to comply with this federal law. Jonah and red crab data are pooled given the low number of individuals that harvest red crab and resultant confidentiality concerns. Additional standards are applied to reporting the fishing activity of particular states, regions, or fishing communities. To report landings revenue to a specific geographic location, the landings have been attributed to at least three fishing permit numbers and the landings must be sold to three dealer numbers. However, the dealers do not necessarily have to be located in the same specific geographic location. ACCSP requires that non-confidential data for a geographic location must include three dealers, three commercial fishermen, and three vessels.

Social impact factors

Sociocultural impacts include those at the fishery and fishing community levels, but also on the broader public. The social impact factors outlined below can be used to describe the potentially impacted fisheries, its sociocultural and community context and its participants. These factors or variables are considered relative to the management alternatives and used as a basis for comparison between alternatives. Use of these kinds of factors in social impact assessment is based on NMFS guidance (NMFS 2007) and other texts (e.g., Burdge 1998). Longitudinal data describing these social factors region-wide and in comparable terms is limited. While this analysis does not quantify the impacts of the management alternatives relative to the social impact factors, qualitative discussion of the potential changes to the factors characterizes the likely direction and magnitude of the impacts. The factors fit into five categories:

- *Size and Demographic Characteristics* of the fishery-related work force residing in the area; these determine demographic, income, and employment effects in relation to the work force as a whole, by community and region.
- *Attitudes*, *Beliefs*, *and Values* of fishermen, fishery-related workers, other stakeholders and their communities; these are central to understanding behavior of fishermen on the fishing grounds and in their communities.
- Effects of proposed actions on *Social Structure and Organization*; that is, changes in the fishery's ability to provide necessary social support and services to families and communities.
- *Non-Economic Social Aspects* of the proposed action or policy; these include life-style issues, health and safety issues, and the non-consumptive and recreational uses of living marine resources and their habitats.
- *Historical Dependence on and Participation* in the fishery by fishermen and communities, reflected in the structure of fishing practices, income distribution and rights (NMFS 2007).

Longitudinal data describing these social factors region-wide and in comparable terms are limited, though the recent surveys by the NEFSC/Social Sciences Branch are beginning to alleviate this. The academic literature provides multiple lists of potential social variables, but such lists should not be considered "exhaustive" or "a checklist" (e.g., IOCGP, 2003; Burdge, 2004).

The analysis evaluates the effects management alternatives may have on people's way of life, traditions, and communities. These social impacts may be driven by changes in fishery flexibility, opportunity, stability, certainty, safety, and/or other factors. While the social impacts of some measures under consideration could be experienced solely by one community group or another, it is more likely that impacts will be experienced across communities, fisheries, gear sectors, and vessel size classes.

While some management measures tend to produce certain types of social impacts it is not always possible to predict precise effects. There is also a wide variation in the acceptance of area closures among stakeholders based on the intended goals (e.g., reduce bycatch, protect spawning aggregations or habitats) of a possible closure (e.g., Pita et al. 2010). The difficulty in defining the social impacts of closed areas is inextricably tied to their variability and how they are perceived by stakeholders (Pomeroy et al. 2007). The *Attitudes, Beliefs, and Values* of those members of the public who are concerned with ocean conservation need to be acknowledged as well. Management measures that are perceived to contribute to conservation of resources are generally expected to have indirect, positive impacts for those stakeholders.

Also changes to the human environment often occur in small, incremental amounts and the character of a particular impact can be hidden by the gradual nature with which it occurs. As such, there is high uncertainty in the relative strengths of the impacts. Therefore, the discussion of social impacts for alternatives indicates the likely directional impacts of specific measures (e.g., positive, negative, or no impact). The analysis is generally qualitative in nature, because of the limitations of determining effects over the large geographic areas under consideration and across many fisheries.

General impacts of area closures on human communities

Area closures can have numerous social impacts across various fisheries and communities. For areas subject to new closures, as considered in this action, the most direct impacts would be on the vessels currently fishing in the areas subject to closures. Fishermen would be forced to modify where and how they fish (or cease fishing if no suitable fishing ground remains available), having a negative impact on the *Historical Dependence on and Participation* and the *Size and Demographic Characteristics* of the affected fisheries, because of a probable reduction in fishing opportunity, revenue, and employment. Negative social impacts would be expected in the *Non-Economic Social Aspects* of the fishery, as fishermen would have less flexibility in choosing where to fish.

The ability to adapt to closed areas is highly variable and largely dependent on the physical location of the closed areas. Less mobile fishermen may bear a heavier burden, as they are less able to easily switch harvest areas (out of closed areas, or into reopened areas). Smaller vessels will be less able to adapt to closures of areas near shore as their range is limited and they cannot easily target offshore areas. Any change in fishing behavior that attempts to employ a more mobile fishing strategy will have additional social costs, such as disruptions to family and community life as well as increasing the likelihood of safety risks. Increased risk can result when fishermen spend longer periods at sea to minimize steam time to and from fishing grounds, operate with fewer crew, and fish in poor weather conditions. Fishermen severely impacted by the new closed areas may leave fishing entirely or at least seek temporary opportunities in another fishery or gear type that is less affected by the management alternatives. Both possibilities would cause a change in the *Size and Demographics* of the different fisheries. The short-term impacts on markets, processing capability, and other infrastructure during the period of adjustment to the new closures may be such that shoreside resources may be impaired.

Shifting effort into areas that remain open may cause vessel crowding and gear conflicts, which are important concerns for many stakeholders. If an area is closed to some but not all fishing gears (e.g., closed to bottom trawls, but not to traps), fishermen that may remain active within a given area may experience indirect positive benefits via reduced gear conflicts – though fishermen active outside the area may have negative impacts due to crowding.

The public could be negatively impacted by decreases in seafood availability, which could occur due to area exclusions. The magnitude and sign of the net consumer benefit depends on the exact relationship between changes in quantities and prices, as well as substitutes for the species under consideration. Lee and Thunberg (2013) provide an example of how these relationships, and their corresponding welfare changes, can be estimated. However, without an estimate of the changes in landings directly due to area management, these models are inoperable. Even if specific estimates of changes in landings were available, models estimating consumer welfare do not currently exist for the full suite of impacted species.

There is also the potential for positive social impacts derived from new closures. Typically, the intent of a closure relates to the potential for future, long-term benefits on the improvement of ecosystem services or fish stocks. These benefits are difficult to analyze, because of the uncertainty associated with the magnitude of the benefit, how these benefits would be distributed among fishing communities, and the timing of these impacts.

7.1.3.1 Analysis of fishery impacts

The fishery impact analysis in this action, in general, uses recent effort and gross revenue generated from within an alternative area or group of areas to estimate the impact of closing the area(s) to fishing vessels, owners, and communities. A few approaches have been used to identify the potentially impacted fisheries, each with their own caveats and limitations, but together, they provide a general sense of recent fishing activity and indicate the importance of specific areas to particular fisheries and gear types. Fisheries or gear types that currently operate within a coral zone alternative area that would be restricted are expected to be negatively affected by an alternative that reduces access to the area. The magnitude of impact would depend on which areas would close and to which fisheries or gear types, and how vessel operators could respond to area closures by redirecting fishing effort elsewhere.

The following sources of information have been included and are described below:

- *VTR analysis:* A model using VTR and observer data to locate commercial fishing trips and estimate trip attributes (e.g., landings) spatially. An analysis of 2012-2014 for-hire and party boat VTR location data indicates that only 12 out of 86,054 trips (0.01%) reported fishing in any of the coral zones being considered. Of these 12 trips, 6 reported landing only pelagic species. Three permits reported these trips, for an average of 2/3 of a trip per permit per year. Given this minimal fishing activity, recreational fishing is not further assessed within this document.
- *VTR vs. VMS comparison:* For the subset of VTR trips with VMS, a model identifying more fine-scale spatial identification of fishing locations.
- *ASMFC survey:* A survey of Lobster Management Area 3 lobstermen to identify fishing effort by depth.
- *MEDMR lobster information*: Landings data to identify fishing trips, landings, and value of the Maine lobster fishery by management zone and distance from shore, combined with interview of lobstermen about the use of the Mt. Desert Rock and Outer Schoodic Ridge areas.
- *NEFMC coral workshop:* Input from fishery participants on fishing locations.

There are numerous caveats associated with revenue estimates. Redistribution of effort into other locations may mitigate negative effects, but alternative fishing choices are difficult to predict. Relocation may be challenging if other locations are already crowded with gear (e.g., the lobster pot fishery, which can be territorial in nature), or if it is difficult to catch the target species outside the coral zones (e.g., the deep-sea red crab fishery, where the target species distribution is restricted to very deep water). If effort can be redistributed outside coral zones, net losses to displaced fishermen will be dependent on changes in efficiency and costs of fishing in alternate fishing grounds. The impacts analysis explores, qualitatively, possible alternative fishing location choices, based on current distributions of effort.

While a relatively small fraction of revenue in a particular fishery may come from a particular coral zone, the revenue may be concentrated amongst a small number of individuals and/or communities. In general, revenue information is presented at an aggregate level across a management area or areas, but individual level effects are also explored.

Impacts may extend beyond the boundaries of coral zones as well. When deploying and fish their nets, mobile gear fishermen account for bathymetry, current, wind, and area restrictions. These factors may prevent them from fishing efficiently just outside a coral management area. For example, squid vessels typically have gear in the water, but not in contact with the bottom, while their vessel is above a canyon during net deployment and/or retrieval – as they prepare to trawl along an adjacent shelf. Preventing vessels from being within an area with gear deployed would mean that they may not be able to fish the non-restricted shelf areas immediately adjacent to a closed area.

The full impacts of this action would ripple through the economy (e.g, fuel, bait, ice suppliers). After the first point of sale, a host of other related industries, including seafood retailers, restaurants, transportation firms, all of their suppliers, and ultimately the consumers that frequent these establishments are also impacted by area management decisions. Because the primary focus in this document is on ex-vessel revenues, the information provided should be considered a partial analysis; optimally, broader societal impacts would be determined.

VTR analysis

Vessel trip reports (VTR) are a primary source of data used here to understand fishing location, revenue, days absent, and number of vessels that might be affected by a particular alternative. VTRs are required for all vessels fishing with a federal permit, unless the only federal permit is lobster (data available for the lobster fishery is explained in more detail below and includes VTR data for some but not all trips). For a trip where VTR is required, the vessel must submit a VTR for each gear type used and/or statistical area is fished in, including a single point location for where fishing occurred relative to that VTR. Previous studies indicate that this self-reporting underreports switches in gear type and statistical area (Palmer and Wigley 2007, 2009). Furthermore, and perhaps more importantly, given that commercial fishing trips can be quite long, a single spatial point is unlikely to adequately represent the actual footprint of fishing. Because of this, a statistical approach was used, referred in this action as the "VTR analysis," to better represent the footprint of fishing (DePiper 2014). This analysis was developed for the Omnibus Habitat Amendment (NEFMC 2017, Volume 4) and used for the Mid-Atlantic Coral Amendment (MAFMC 2016). The approach is briefly summarized here.

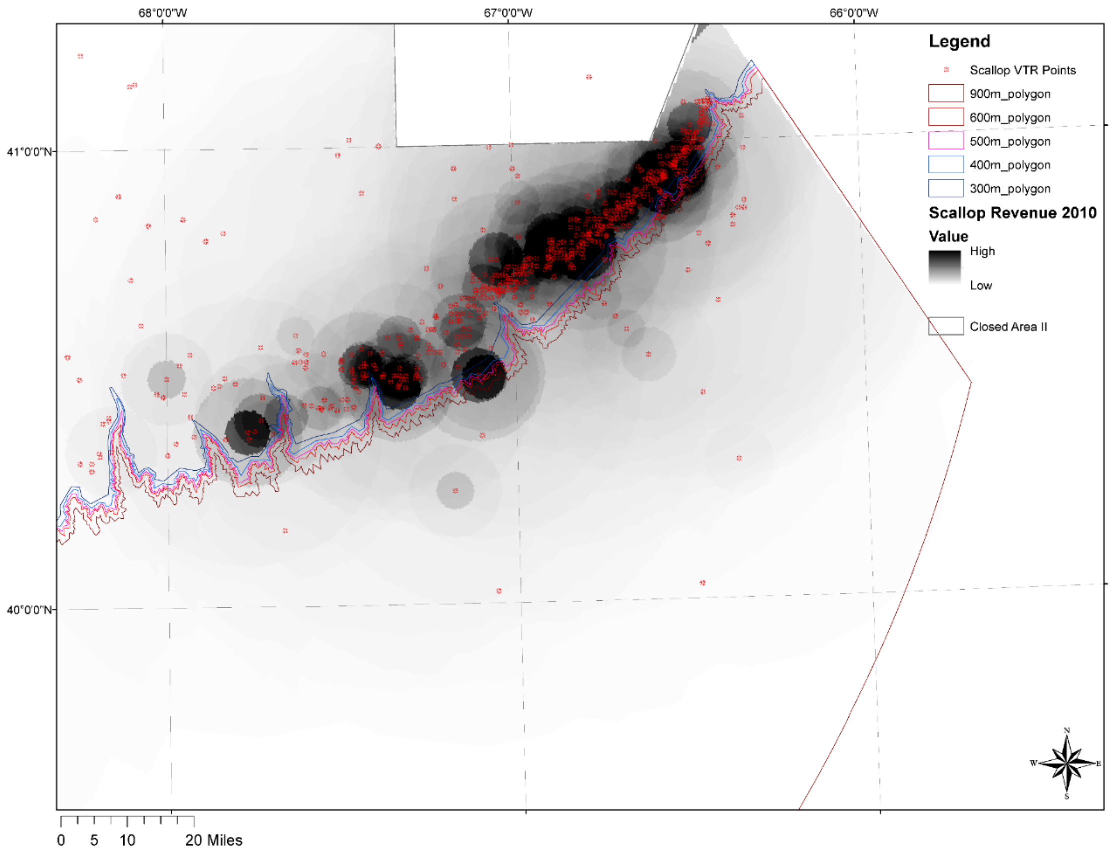
Model: A model was developed that compares the single, self-reported, VTR point locations, with more detailed haul-by-haul position data on the subset of VTR trips that were observed (DePiper 2014). On trips that carry an at-sea observer, the true spatial extent of fishing activity can be determined from haul-by haul data. With this model, trip attributes (e.g., revenue, days absent) can be distributed in concentric rings around the VTR point, proportional to the modeled probability of fishing. The size of the rings varies with trip characteristics such as gear type and number of days absent. For example, week-long trips have a larger footprint than day trips. Once every trip in the VTR database is spatially assigned using this approach, the resulting dataset can be queried and presented according to year, gear type, species caught, a particular geographic area (e.g., the coral zones under consideration in this amendment). Since VTRs do not include fish prices or revenue, the landed values associated with a particular trip were estimated using average monthly prices for the species from the dealer database, and all values are adjusted to January 2015 dollars for comparability across years.

For this analysis, the data are reported by calendar year (2010-2015), gear type, species, and management area. Pelagic species and gear types were excluded from the analysis because restrictions on pelagic gears are not included in the alternatives under consideration (section 4.3). Data are summarized by gear type to help analyze gear-specific measures. Summaries by species are provided to help distinguish particular fisheries that may use the same gear. For example, whiting (silver hake) and longfin squid are both harvested with bottom trawls, and lobster, Jonah crab, and deep-sea red crab are all captured in traps.

Caveats: The estimates of revenue, effort, or landings attributed to a particular management area are not exact. Despite the following reasons for discrepancy, VTR data are the most comprehensive data from which to assess fishing location and can informative about the importance of specific areas in terms of revenue generated, species targeted, and number of fishery participants. The VTR analysis maps in Appendix F are helpful for understanding the spatial uncertainties associated with VTR data. Nevertheless, the spatial resolution of the VTR data does not adequately support management at fine spatial scale, due to its imprecise nature.

1. For some fishing modes, there are limited haul-by-haul location data to develop a reliable effort/revenue distribution model. For example, the lobster fishery has a low at-sea sampling rate, and available data indicate that VTRs can be highly imprecise. Since lobster and bottom trawl trips were statistically indistinguishable, in terms of the distance between VTR points and observed hauls, the same statistical approach is used for these gear types to estimate fishing location around a particular VTR point.
2. Even for fisheries with relatively high observer coverage, the spatial imprecision of VTR points can lead to the assignment of revenue in unlikely locations. For example, because scallops command a high price per pound relative to other species, revenue from just a handful of trips with erroneous point locations may result in high revenue values inferred to a particular management area, relative to other species (Map 50). Although the depth range of Atlantic sea scallop on Georges Bank, in terms of commercial densities, is generally defined to be between 40 and 110 m depths, the VTR analysis identifies trips outside these bounds. This ancillary information casts doubts on whether the self-reported latitude-longitude point of the trip represents the actual location of fishing. However, we do not know the true location of the fishing activity where the data point should be represented. Further, deleting the data point altogether is inappropriate given that this generates an overall bias in the data. The statistical model employed, though imperfect, looks to account for this imprecision.
3. Some types of fishing are known to occur within a particular depth range, or fish along depth contours, so modelling a circular distribution of fishing effort around a VTR point attributes fishing to unlikely locations. For example, in the squid fishery along the continental slope, observer data (haul-by-haul) indicate that tows run along the slope in narrow bands. The modeled confidence interval sizes are large relative to the distance between depth contours on the continental slope, such that revenue/effort is inferred in water deeper than is almost certainly fished. Unfortunately, the modelling of this directionality is currently not possible.
4. Because VTRs are required for all vessels fishing under a federal permit, unless the only federal permit is lobster, only a portion of the lobster fishery is captured in the VTR data. Thus, VTR data underrepresent lobster revenue/effort. In Lobster Management Area 3, which overlaps the canyons and the offshore Gulf of Maine, the majority of lobster vessels are required to submit VTRs, whereas inshore, just 6% of vessels with federal lobster permits submit VTRs.

Map 50 – Example scallop VTR point locations, revenue heat map, and coral zones. Deep water points beyond the broad zone boundaries result in the attribution of revenue to even the 900 m zone, which is unrealistic for sea scallops.



Treatment of offshore lobster VTR revenue data: With the exception of lobster trap gear, all revenue data were taken directly from the VTR analysis. To account for caveat #4 above, the VTR analysis scales VTR-reported lobster revenue in the offshore areas (i.e., all areas except Mt. Desert Rock and Outer Schoodic Ridge). To peform the scaling, an ASMFC technical committee estimate was used to determine the upper bound of landings from LCMA 3. Specifically, total annual landings for the years 2010-2012 at the statistical area level were summed across the statistical areas overlapping LCMA 3[9] (data for individual statistical areas and years beyond 2012 were not provided to the PDT, as they have not been compiled for the lobster assessment or another analytical purpose and require significant work on the part of the individual states, and the lobster technical committee). Next, total VTR-based landings for LCMA 3 were estimated using spatial analysis of the confidence interval data (using LCMA 3 boundaries, rather than the overlapping statistical areas). The difference between the higher ASMFC estimate and the lower VTR estimate was divided by the total VTR estimate to determine the percentage by which the VTR data needed to be increased. The difference was an average

[9] Statistical areas that overlap LCMA 3: 464, 465, 522, 523, 524, 525, 526, 533, 534, 537, 541, 542, 543, 561, 562, 616, 622, 623, 624, 626, 627, 632.

of 24.20% across 2010-2012. This percentage was used to scale up lobster revenue estimates in all coral zones located within LCMA 3, for all years (2010-2015) covered in this analysis. This 24.20% increase was applied to all catches of lobster in lobster pot gear. Lobster catches in trawls or other gear types were not adjusted. Permit and trip data were not adjusted, only revenue, because upper bounds (i.e., ASMFC data) for the number of trips and active permits were not available.

Treatment of inshore lobster VTR revenue data: Inshore lobster VTR data have not been scaled, due to the general agreement that VTR provides insufficient coverage (6%) to adequately represent the spatial distribution of lobster fishing in state waters (section 7.2.5.3). Alternate approaches, described below and in an ASMFC memo (ASMFC 2017), were used to estimate the upper bounds of lobster revenue displaced from these zones.

Trips and permits by gear type: Another approach to estimating extent of fishing effort relative to the areas considered is number of trips and permits by gear type attributed to recent fishing in each area. The trip estimate is simply a count of the number of trips that overlap the management areas (including partial overlap). The permit estimate reflects the number of individual permits, by gear type, whose activity overlaps the areas. This roughly approximates the number of vessels that might be affected by a given alternative. Because it does not consider the probability associated with this overlap, it can be considered an upper bound on the number of trips and permits which might be impacted by the alternatives under consideration.

Revenue by species. Because some fishing gear is used to catch multiple species in distinct fisheries, revenue at the species level was also estimated for each alternative under consideration to characterize fishery impacts. Data are provided for the top ten species that generate revenue attributed to the areas.

Percent owner revenue: To help determine the importance of the areas under consideration, we calculatd the percent fishing revenue in a specific coral zone or zones, relative to a vessel owner's total annual revenue. The owner revenue data include only the owners with some degree of revenue from a given area, and the analysis compares their revenue derived from the area to their total revenue, for any species landed by the permit and captured in the VTR database, and for all gears associated with a particular owner. Thus, the percent owner revenue data indicate the importance of an area to potentially affected owners. These percentages were calculated for the most recent three years, 2013, 2014, and 2015. Boxplots (e.g., Figure 8) indicate the range of the percentages (the median value is indicated with a dark vertical bar, and outliers are indicated with open circles). In general, these percentages are very low, but there are outliers suggesting that for some individuals, these areas may be very important fishing grounds. Plots are provided for all bottom-tending gears, and mobile bottom-tending gears only.

VTR vs. VMS comparison

For some fisheries/permit types, Vessel Monitoring System (VMS) data provide a more refined spatial dataset than VTR or observer data. VMS data are used, as available, for a complementary analysis of fishing effort. Records and Demarest (2013) developed a logit model to determine a probability of fishing based on trip characteristics (e.g., vessel size, primary gear used on trip) and VMS poll (e.g., imputed vessel speed, depth fished, depth change, distance to known fishing hotspots). This model can then be used to assess the probability-weighted effort associated with each VMS poll. This approach classifies a trip based on the primary gear/landed fish combination and is thus not a full census of trips which could be attributed to each FMP. However, this classification avoids double-counting of effort. The availablility of VMS data for each fishery is summarized in Table 50.

Table 50 – Fisheries occurring within the areas under consideration in the Deep-Sea Coral Amendment, and their VTR and VMS data availability

Fishery	VTR data	VMS data
Lobster and Jonah crab	Yes, for vessels that hold other federal permits. In practice, most Area 3 vessels and few Area 1 vessels submit VTRs.	No requirement; very minimal coverage that would be triggered by requirements of other permits. Approximately 10 Area 3 vessels have VMS units (Bill Semrau, NOAA OLE, personal communication).
Multispecies, large mesh	Yes	Yes, except for Handgear A vessels using the IVR system, or Handgear B vessels.
Multispecies, small mesh (whiting)	Yes	No requirement specific to whiting fishing, but all vessels fishing for whiting must have an open access (K) or limited access (A-F) multispecies permit, and these do carry VMS requirements. There is no whiting VMS declaration, so vessels would be declared out of the multispecies fishery (DOF) while fishing for whiting. If vessels are also fishing under another permit during the trip that has a declaration requirement (e.g., squid or herring) they should declare into the VMS system according to those permits.
Squid, mackerel, or butterfish	Yes	Yes, for longfin/butterfish or Illex moratorium permits, or for Mackerel Tier 1-3 permits. Not for charter party, squid/butterfish incidental, or mackerel open access permits.
Red crab	Yes	Not required
Monkfish	Yes	Yes; required for Category C and D vessels participating in a Multispecies sector or DAS program, Monkfish Category F fishery, Multispecies or scallop permit fishing outside an exemption area or under monkfish DAS, any other permit that triggers VMS

Skate	Yes	No requirements associated with skate permit, but vessels must adhere to requirements of other permits.
Sea scallops	Yes	Yes, all vessels with a federal scallop permit must have VMS.

ASMFC survey

To better characterize offshore lobster and Jonah crab fishery effort, the Atlantic States Marine Fisheries Commission, at the NEFMC's request, collected data on lobster fishing activity in and around the canyons along the southern margin of Georges Bank. In February 2016, the ASMFC sent mail surveys to all (n=97) commercial lobster permit holders with a trap allocation in Area 3. The survey asked whether permits were fished in the area of interest (canyons and slope), how effort and revenues were distributed by depth, whether certain canyons were more important than others, whether patterns of activity changed by season, and whether information reported for 2014 and 2015 was likely to be representative of future patterns of activity.

Results of the survey were summarized by Whitmore et al. (2016). Of the 34 respondents (35%), 15 had fished in the canyon coral zone areas considered in this action and supplied information on effort and revenue by depth (Whitmore et al. 2016). Considering both lobster and Jonah crab harvest, respondents suggested that the majority of traps were set between 200-300 m, while the area between 100-200 m generated the greatest proportion of total revenue. Because only a portion of permit holders responded, estimates of fishing activity are not a census of Area 3 lobster fishing activity. Further, the survey results cannot be independently verified using the VTR or observer databases, because only a portion of the respondents submit VTRs, few lobster or Jonah crab trips are observed, and the survey questions go beyond information collected in VTRs. Regardless, the survey helps to paint a more complete picture of the offshore lobster and Jonah crab fishery when combined with the VTR-based analysis.

During early 2017, the Lobster Technical Committee used the input of these lobstermen combined with regional bathymetry data to estimate effort and revenue for the coral zones on the slope (i.e. broad zones and discrete canyon zones; Table 51). Their work is summarized in ASMFC 2017 (this memorandum also includes estimates of revenue and effort for the inshore GOM zones). The analysis combined total revenues for statistical areas overlapping potential coral zones with information about effort and revenue distribution by depth from the 2016 survey. For 2014 and 2015, 32.6% of effort and 27.9% of revenue was estimated to be derived from lobster fishing at depths ≥300 m. Although most of the effort and revenue is attributed to shallower depths, this result suggests that areas ≥300 m deep are important to the offshore lobster fishery.

Table 51 - Distribution of lobster and Jonah crab effort and revenue and proportion of habitat by depth in the region of interest

Depth (m)	Effort[a]		Revenue[a]		Proportion of habitat by depth in area of interest[b]	
<100	9.1%	67.4%	17.1%	72.1%	78.8%	97.0%
100-200	22.2%		28.7%		15.5%	
200-300	36.1%		26.3%		2.7%	
300-400	26.5%	32.6%	23.1%	27.9%	1.7%	3.1%
>400	6.1%		4.8%		1.4%	

Notes: Values are weighted towards responses from individuals who reported higher effort and revenue. Region of interest includes Statistical Areas 525, 526, 541, 543, 562, and 534 and 537 east of 70.55° longitude.
[a] Effort and revenue data are weighted responses to a survey of lobstermen.
[b] Does not include habitat ≥500 m.
Source: Adapted from Table 1, ASMFC (2017).

MEDMR data for the inshore GOM

The majority of Lobster Management Area 1 vessels do not hold other federal permits (i.e., are exempt from submitting VTRs), such that the VTR analysis underestimates fishing activity in the two coral zones located in LMA 1: Mount Desert Rock and Outer Schoodic Ridge. Within LMA 1, the Mt. Desert rock zone is located in Lobster Management Zone B, 3-12 nm from shore, while Outer Schoodic Ridge is located in Zone A, 12+ nm from shore. To better characterize inshore Gulf of Maine lobster fishery effort, the Maine Department of Marine Resources (MEDMR) has contributed, via the ASMFC Lobster Technical Committee, data on fishing trips, permits fished, value, and landings by Lobster Management Zone, including the proportion attributed to federally permitted vessels (Table 52). Dealer and port data were used to estimate 2015 lobster revenue for Lobster Management Zones A, B, and C. Harvester reports from 2011-2014 were then used to ascribe that zone's trips (Map 51), landings (Map 52), and revenue (Map 53) to three distances from shore (0-3, 3-12, 12+ nm; ASMFC 2017).

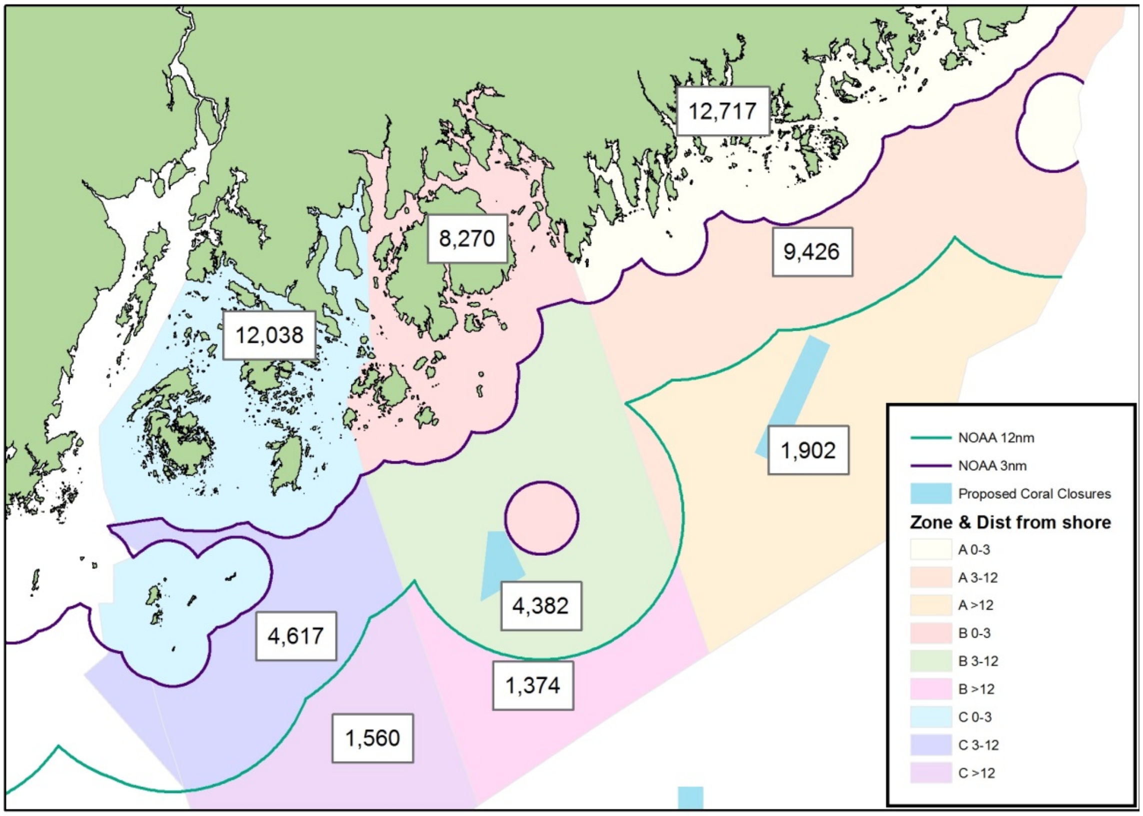
The Maine lobster fishery has no fleet-wide reporting requirements that provide data on the spatial resolution of fishing locations finer than the Zone level. The MEDMR harvester report data are not a census of lobster fishing activity, as they are submitted by about 10% of lobster permit holders, those chosen for a lobster logbook (10% of each license class in each zone). Lobster permit holders with a VTR requirement, through participation in another fishery, do not also have to submit harvester reports. Combined with dealer data (incl. all landings from a trip for each license that is assigned to zone by port of transaction), and assuming representativeness of the harvester reports, the data can help describe fishing effort by season, depth, and distance from shore in and around the two inshore coral zones (ASMFC, 2017).

Table 52 – Number of lobster permits, number of trips, revenue, and landings (lb) by permit type and Maine Lobster Management Zone (A, B, and C only), 2015

Permit numbers						
Zone	Federal No VTR	Federal w VTR	State Only	Total	Federal	% federal
A	271	28	664	963	299	31%
B	161	10	408	579	171	30%
C	160	10	604	774	170	22%
Trips						
Zone	Federal No VTR	Federal w VTR	State Only	Total	Federal	% federal
A	21,702	2,357	29,539	53,598	24,059	45%
B	13,098	991	17,933	32,022	14,089	44%
C	17,283	950	35,927	54,160	18,233	34%
Value						
Zone	Federal No VTR	Federal w VTR	State Only	Total	Federal	% federal
A	60,261,907	6,039,883	33,316,457	99,618,247	66,301,790	67%
B	39,009,830	3,671,325	28,076,911	70,758,066	42,681,155	60%
C	55,979,051	3,791,784	66,224,717	125,995,552	59,770,835	47%
Landings						
Zone	Federal No VTR	Federal w VTR	State Only	Total	Federal	% federal
A	15,054,051	1,543,886	9,056,975	25,654,912	16,597,937	65%
B	9,327,846	874,674	6,740,661	16,943,181	10,202,520	60%
C	13,631,809	910,528	17,079,316	31,621,653	14,542,337	46%

In the last two columns, federal and % federal combine VTR and non-VTR permits. Source: ASFMC (2017).

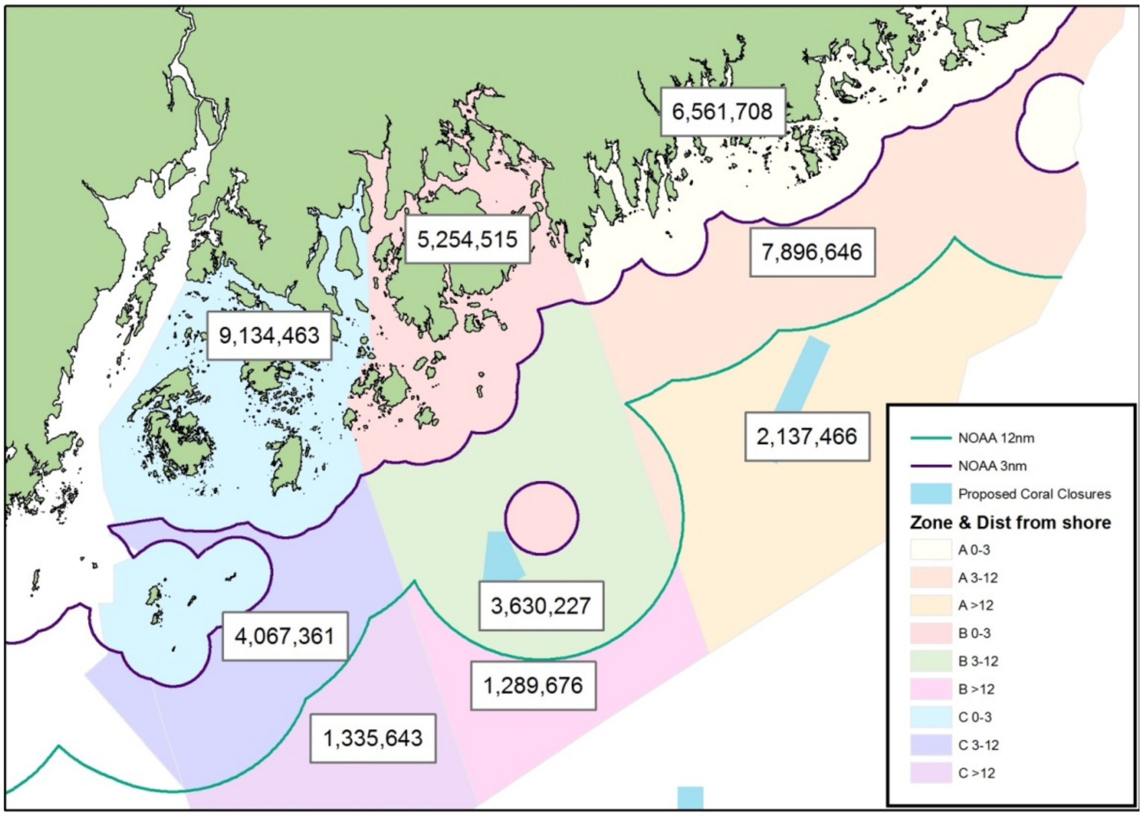
Map 51 – 2015 lobster trips taken by federal permit holders by distance from shore in Maine Lobster Management Zones A, B, and C



Total number of trips in each management zone was distributed among the distance from shore bands based on the 2011-2014 Maine Harvester Logbooks and the trip locations reported on federal VTRs. Average 2011-2014 percentages for each zone and distance from shore are shown below. *Source:* ASMFC (2017).

	0-3 nm	3-12 nm	12+ nm
Zone A	52.86%	39.18%	7.91%
Zone B	58.69%	31.10%	9.76%
Zone C	66.02%	25.32%	9.18%

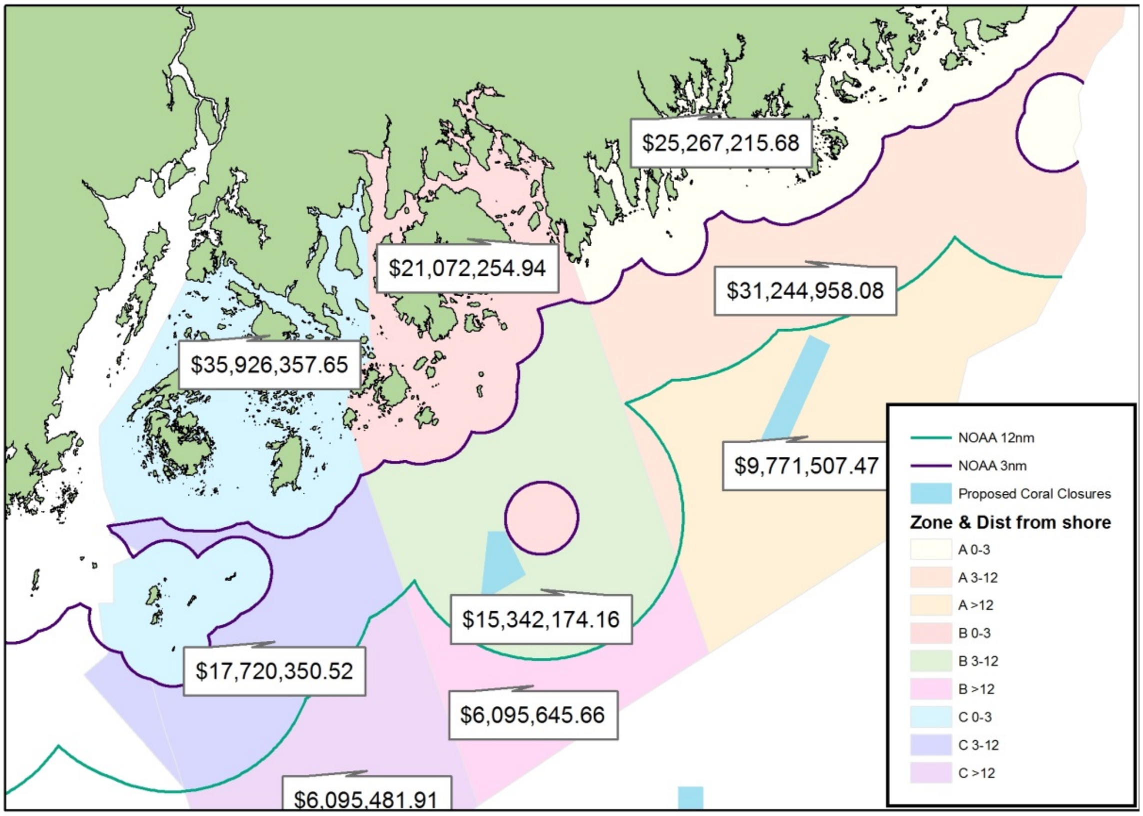
Map 52 – 2015 lobster landings (lbs.) by federal permit holders by distance from shore in Maine Lobster Management Zones A, B, and C



Total landings in each management zone was distributed among the distance from shore bands based on the 2011-2014 Maine Harvester Logbooks and the trip locations reported on federal VTRs. Average 2011-2014 percentages for each zone and distance from shore are shown below. *Source:* ASMFC (2017).

	0-3 nm	**3-12 nm**	**12+ nm**
Zone A	39.53%	47.58%	12.88%
Zone B	51.50%	35.58%	12.66%
Zone C	62.81%	27.97%	13.42%

Map 53 – 2015 lobster revenue for federal permit holders by distance from shore in Maine Lobster Management Zones A, B, and C



Total revenue in each management zone was distributed among the distance from shore bands based on the 2011-2014 Maine Harvester Logbooks and the trip locations reported on federal VTRs. Average 2011-2014 percentages for each zone and distance from shore are shown below. *Source:* ASMFC (2017).

	0-3 nm	3-12 nm	12+ nm
Zone A	38.11%	47.13%	14.74%
Zone B	49.37%	35.95%	14.28%
Zone C	60.11%	29.65%	10.20%

NEFMC Workshops

In March 2017, the NEFMC held two public workshops, in New Bedford, Massachusetts and Portsmouth, New Hampshire to:

1. Develop a detailed understanding of fishing practices in and around specific coral zones, and
2. Identify specific ways to modify coral zone boundaries in each location to balance fishing access and coral conservation.

The New Bedford workshop focused on the broad zones and discrete canyons, while the Portsmouth workshop focused on the zones in Jordan Basin and at Lindenkohl Knoll. About 47 people attended, including about 14 members and staff of the NEFMC or MAFMC, about 8 other state or federal staff, and about 35 members of the public including fishermen and representatives of fishing or environmental organizations

(NEFMC, 2017). While the input provided at the workshops is helpful information about which fisheries are active in the areas under consideration and how they may be impacted, it should be acknowledged that the information was not scientifically collected.

7.1.3.2 Analyis of fishing community impacts

The assessment of fishing community impacts relies on much of the same information used to identify impacts to fisheries, but the data are summarized at the community (i.e. port of landing or city of vessel registration) level rather than by target species or gear type. Potential impacts related to the port of landing include a loss of landings and revenue that can affect the fisheries infrastructure in the community. The city where the permit is registered is generally where the permit holder resides. Impacts to these communities may be widespread beyond fisheries related aspects of the communities. Permits are often registered in different cities than the ports where the vessels land, so the number of vessels cannot be added across community type as this may result in double counting vessels. The fishing communities most likely to be impacted, at least in the near-term, include those that have been the homeport or landing port to fishing vessels active in the areas included in the management alternatives.

For each alternative and its component options, the fishing communities that are potentially impacted by the management alternatives are identified and discussed. Specifically, this analysis identifies the states, regions, and fishing communities that would likely be impacted by the alternatives under consideration, based on the VTR analysis, which identifies recent (2010-2015) fishing activity in the coral zone areas under consideration in this action. For each coral zone, the results include:

- Landings revenue by state attributed to the coral areas.
- Within certain states, landings revenue by region attributed to the coral areas.
- Landings revenue by the top ten ports with landings attributed to the coral areas.
- Number of the fishing permits with landings revenue attributed to the coral areas.

The VTR analysis includes the fishing activity by vessels with federal fishing permits that submit VTRs, but this analysis may underrepresent the lobster fishery and has many caveats that may impact the accuracy of the data. The number of permits (i.e., vessels) impacted is included for a general representation of the impact to each community. It is important to remember that a single vessel can land in multiple ports, so each vessel may be included in more than one community at the port level. Background information on several communities is in section 6.8.1 and at: http://nefsc.noaa.gov/read/socialsci/communitySnapshots.php. In addition to the ports explicitly identified, other ports are impacted but cannot be detailed due to data confidentiality.

It is unlikely that this action would affect all identified communities to the same extent. The communities that are more dependent on fishing with the affected gear types would likely have more impacts than those that participate in a range of fisheries and gear types. Even among communities with similar dependence, there are likely to be different impacts since some alternatives have localized impacts. Additionally, the general level of vulnerability and resilience of a community will determine the magnitude of the impact. Social Vulnerability Indicators of each community are listed in the Affected Environment. These indices correspond to different components of social vulnerabilities that may affect communities. More information is available in Jepson and Colburn (2013) and at: http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/index.

7.1.3.3 Analysis of non-use values

The tradeoffs between use and non-use values derived from the deep-sea coral areas under consideration in this action are central to Council decision-making. The alternatives are considered in light of their expected benefits to corals and their potential short- and long-term costs to commercial fisheries and fishing communities. Because non-use value asssement is done qualitatively in this document, conclusions are summarized at the beginning of each "Impacts on human communities" section.

As a rare species, deep-sea corals have cultural value to society, including non-use values. *Existence value* is the utility gained from knowledge that these corals exist and will continue to exist into the future (Foley et al. 2010; Spurgeon, 1992). People derive satisfaction from knowing future generations would be able to experience this existence (i.e., bequest value). Thus, protection of deep-sea corals provides positive benefits to society, though these benefits are extremely hard to quantify. *Option value* is the utility gained from preserving a resource today for potential future use. It can also be argued coral reefs and their associated organisms have an *intrinsic value*, that they have a right to exist without any specific utility for mankind. These non-use values value may increase with the quality or uniqueness of a particular coral reef (Spurgeon, 1992).

Non-use values are difficult to measure, as they have a degree of subjectivity. Wallmo and Edwards (2008) found broad differences in how people value conservation associated with area management in New England. The values differ not only across individuals, in that they can be positive and negative, but also vary across allowable activities within conservation areas. Values such as these can thus only be estimated with very carefully crafted instruments that are specific to the circumstances under consideration, and would still be subject to hypothetical bias, in that the respondents understand and act upon the incentive to either overstate or understate their actual valuations (Wallmo and Edwards 2008, List and Gallet 2001, Harrison and Rutström 2008).

An indicator of public interest in deep-sea corals, and in ocean exploration generally, is the degree of public engagement online in opportunities to learn about and follow exploration expeditions. The NOAA office of Ocean Exploration reported that for 2014, a year in which the *R/V Okeanos Explorer* had exploratory cruises to the deep-sea canyons considered in this action (section 6.2), there was a record of 10.7M visits to the NOAA Ocean Explorer website (oceanexplorer.noaa.gov), over 680,000 visits to live video webpages (viewing expeditions live), over 47,600 Twitter followers, 15,500 Facebook likes, over 475,000 viewings of posted YouTube videos, and over 2M downloads of educational materials (NOAA, 2014). For 2016, there over 12M website visits and 4.3M live video feed views, a record-setting year. Social media participation increased as well (Bell et al, 2017).

7.1.4 Protected resources

Protected species (i.e., ESA listed and MMPA protected species) interaction risks are broadly related to the the amount of gear in the water, the time the gear is in the water (e.g., soak time, tow time), and the presence of protected species in the same area and time as the gear, with risk of an interaction increasing with increases of any or all these factors. Gear type is important, with some gear/species combinations having higher rates of observed or documented interaction, and other combinations having few or no observed or documented interactions (see section 6.9.3). Fishing activity is distributed spatially according to distribution of the target stock, but is controlled by closed areas, exemption area programs, permits that authorize fishing in particular management regions, etc. The spatial management alternatives considered in this amendment could change distribution patterns of fishing, which may influence the potential for regional fisheries to interact with protected resources. While fishermen may fish and set gear in different locations following the implementation of coral zones, these changes do not necessarily equate to increased protected species interactions. However, if shifts in effort result in more gear present for a longer period in areas of higher protected species occurrence, interaction risks are likely to increase.

Within the constraints of existing fishery management measures, vessel operators are expected to choose fishing locations that yield the largest harvest at the lowest costs. Additional fishery restrictions such as the coral management zones proposed in this amendment could cause operators to shift their fishing locations onto grounds that are sub-optimal relative to those fished at present. If there is a desire to maintain overall harvest levels, but catch rates decline, this could lead to increases in the amount of time that gear is in the water. This could take the form of longer or more tows made with mobile gears, or longer soak time or additional sets with fixed gear. However, because the coral management zones are relatively small (Gulf of Maine discrete zones), on the edge of productive grounds (broad zones, canyon discrete zones), or beyond the current footprint of fishing (seamount zones), the spatial management alternatives considerd in this amendment are not expected to lead to a substantial increase in fishing time, and any shifts in effort will likely occur locally. Additionally, as there are costs associated with an additional day of fishing (fuel, ice, food, additional wear and tear on the vessel), effort increases to make up for lower catch rates would be constrained by economic and practical limits. Specific considerations regarding changes in effort for the various coral zone alternatives under consideration are discussed further below.

In the canyon and slope region south of Georges Bank, the broad coral zones encompass a large geographic area, varying in size and extent based on their shallow (landward) boundary. Given the design of the broad zones (mimimum depth to the EEZ), if a broad zone were closed to particular gear types, effort with those gears would likely shift to depths shallower than the zone but would not extend into deeper waters. Effort shifts would be subject to both the depth distribution of the target stock as well as the need to avoid conflicts with other gear types. The depth intervals along which effort would shift are relatively narrow, with the distance at the sea surface between the shallowest (300 m) and deepest (900 m) broad zones being up to 10 miles in some areas, and under 2 miles along steeper portions of the slope. These distances are short relative to the range of movement of most protected resources. The Council's preferred management approach is a 600-meter minimum depth broad zone. However, if the discrete canyon zones were designated in the absence of a broad zone, effort would likely be concentrated in the intercanyon slope areas, at similar depths relative to current fishing practices. In locations where individual discrete canyons are adjancent or very closely spaced, effort would like shift into shallower waters inshore of the zones (i.e. depths of 100-300 m), or along the slope to locations where the canyons are more widely spaced.

In the inshore Gulf of Maine coral zones (i.e. Mt. Desert Rock and Outer Schoodic Ridge) the vast majority of fishing effort is associated with lobster traps (see Sections 7.2.5.3 and 7.2.6.3). Use of other bottom tending gears in both areas is negligible. These lobster trap vessels are permitted to fish in LCMA 1, and within specific state lobster zones (A-G) within LCMA 1. Up to half a vessel's traps can be set in an adjacent zone (e.g., A or C, if a vessel is permitted to fish in B), but the remaining effort must stay within the permitted zone. This means that if trap vessels were prohibited from fishing in one or both of the zones that they would be somewhat limited in terms of where they could set their traps. There are also practical limits on effort redistribution relative to the steaming distance from the vessel's home port. Thus, it seems reasonable to assume that if the Mt. Desert Rock zone were to close to lobster pots, most of that effort would be redistributed throughout other portions of Zone B, and that some effort would move into Zones A and C. Similarly, if the Outer Schoodic Ridge Zone were closed to lobster pots, effort would likely be redistributed throughout Zone A, but could shift to Zone B (Zone A is the furthest east, with no zones beyond it). If both coral zones were closed to lobster gear, effort would move throughout Zones A, B, and C.

Perhaps more importantly in terms of implications for protected resource interaction rates, these lobster management zones are already very heavily fished. Thus, it is reasonable to assume that there are few if any open fishing grounds within them that could be exploited by displaced vessels that do not currently have lobster gear present. The likely outcome of closing one of both of these zones to trap gear is that lobster pots would become more densely concentrated in existing fishing grounds, where protected resources are already encountering this gear type. Increased gear density could increase interaction rates, as densely set gear would be more difficult for protected species to avoid. On the other hand, closures would provide small areas without any trap gear present. The magnitude of these possible effort shifts is difficult to predict. Vessel trip reporting rates are low for the inshore GOM lobster fishery, and the spatial precision of harvester reporting is coarse. Lobstermen indicated that approximately 50 vessels use each of the zones, but it is not clear how much effort this represents in terms of number of traps in the water, and what the resulting vertical line density might be should effort redistribute.

In the offshore Gulf of Maine coral zones proposed in Jordan Basin and at Lindenkohl Knoll (Sections 7.2.7.3 and 7.2.8.3), the primary fishing types are lobster pot, multispecies gillnet, and multispecies bottom trawl. Multispecies bottom trawl and gillnet vessels are generally flexible to fish throughout the region but must have quota to cover their catches, which affects fishing location choice. Practical considerations such as distance from port also affect where a vessel operates. Because catches in and around the coral zones are typically deeper-water stocks such as pollock, redfish, and white hake, it is likely that effort would be redistributed into other relatively deep-water areas offshore, and not into inshore fishing grounds. Thus, the species of protected resources encountered would not be likely to change. The Jordan Basin and Lindenkohl Knoll zones make up a small fraction of Jordan and Georges Basins, respectively, such that extensive redistribution and changes in effort, relative to current operating conditions, is not expected. It is possible that catch rates could decline slightly if effort is shifted away from preferred tow/set locations due to coral zone closures, or if gear becomes more concentrated (i.e. more lobster pots in an area) due to closures.

The offshore lobster fishery in the Gulf of Maine is part of the LCMA 3 fishery. This permit allows vessels to fish in the offshore GOM, on Georges Bank, and in the canyons and along the slope. Fixed gear catches from these offshore areas are landed in NH and ME, with the largest percentage of fixed gear landings attributed to New Hampshire (Table 88 and Table 94). Pot/trap landings from the canyons and slope (also LCMA 3) are landed in MA and RI. This, combined with knowledge of industry participants gleaned from coral amendment workshops and other public meetings, suggests that lobster pot vessels fishing in the offshore GOM represent a distinct fleet from those vessels that fish south of Georges Bank. Thus, if offshore GOM coral zones are closed to fixed gears, it is most likely that lobster trap effort in the offshore GOM zones will shift to other grounds in the Gulf of Maine, and not to the canyons and slope, if offshore GOM coral zones are closed to fixed gears. Lobster pot vessels that fish the Gulf of Maine and the canyons move onto Georges Bank in the summer, but lobster occurrence on Georges Bank is seasonal. If the offshore Gulf of Maine zones were closed to lobster pot gear, the result would be areas where protected resources could occur without risk of entanglement, however due to the relatively small size of the offshore GOM coral zones (i.e. approximately 1-2 miles across), the magnitude of any change in interaction risk is likely minimal. In addition, the coral zones in Jordan Basin and at Lindenkohl Knoll make up a very small fraction of the GOM, such that extensive redistribution and changes in effort are not expected. Given this, relative to current operating conditions, new or elevated interaction risks to protected species are not expected to result from the designation of these offshore GOM coral zones.

7.2 Impacts of coral zones and associated fishing restrictions

7.2.1 Impacts of No Action (existing areas and fishing restrictions that provide protection for corals)

The No Action alternative (section 4.1) includes two closures with the same boundaries in both the Monkfish and Mackerel/Squid/Butterfish (MSB) FMPs, three closures in the Tilefish FMP, and the recently designated Northeast Canyons and Seamounts Marine National Monument. The monkfish and MSB closures in Oceanographer and Lydonia canyons are closed to vessels using days at sea in those fisheries. The tilefish gear restricted areas are in shallower parts of Oceanographer, Lydonia, and Veatch Canyons. These areas are closed to mobile bottom-tending gear. The Monument areas were closed to all commercial fishing on November 15, 2016, except red crab and lobster trap fisheries, closure of which will take effect up to seven years from the date of designation (i.e., no later than 2023).

For this impact analysis, the No Action closures have been grouped as follows:

- Monkfish/MSB/Tilefish Areas
- Northeast Canyons and Seamounts Marine National Monument

Because the fishery management closures and Monument overlap, the impacts described here cannot simply be added together. Note that none of the No Action areas were modified as part of this amendment, so all will continue as-is until modified by a future Council action (monkfish/MSB/tilefish areas) or by the federal government (monument).

7.2.1.1 Impacts on deep-sea corals

Generally, the No Action management areas, which overlap with one another in Lydonia and Oceanographer Canyons, have positive impacts on deep-sea corals. All of the designated areas include records of deep-sea corals from recent dives (Table 46) as well as earlier sampling (Table 45). Of all the management areas under consideration for the slope/canyons, the existing monkfish-mackerel/squid/butterfish closures are the most efficient 93% (Table 47) at encompassing areas predicted to be high suitability habitat for soft corals and have the largest percent area of high slope (7%, Table 49). The Tilefish Gear Restricted Areas and the Northeast Canyons and Seamounts Marine National Monument (Monument) extend into shallower areas as compared to the monkfish habitat closures in Lydonia and Oceanographer Canyons (Table 48), and therefore are less efficient at encompassing predicted soft coral habitats and areas of high slope. However, owing to the relatively large size of the Monument, the No Action areas in combination include over 18% of the predicted suitable soft coral habitat on the continental margin (considering just the New England region, Table 47), and 33% of the high slope areas (Table 49). Considering these absolute values, the No Action alternative has fewer positive impacts on corals as compared to any of the broad coral zone alternatives (59%-96% of suitable habitat along the slope, 75% for the preferred alternative), or compared to the 20 discrete canyon zones designated in combination (43% of suitable habitat). The same ranking between alternatives could be made based on the number of overlapping coral database records (Table 45) and area of high slope (Table 49). However, because the No Action areas are additive to any new designations recommended by the Council (i.e. the Option 6 broad zone), in practice the No Action areas enhance coral conservation above and beyond that provided by the Council's new coral zone recommendation.

Given the relatively shallow extent of the Tilefish GRAs and Monument which extends into depths fished by various gear types, the No Action areas do have a material effect on the distribution of bottom-tending gears. The Tilefish GRAs restrict all mobile bottom-tending gear, and the Monument includes broader restrictions, eventually to encompass the lobster and red-crab trap fisheries. Given that the No Action management areas in combination encompass just six of the 20 canyons along the New England continental margin, the expectation is that at least some of the effort from these areas is being prosecuted in similar depths in other locations within the canyons and on the slope. Thus, the No Action areas will afford fairly comprehensive protections for the corals in these six canyons (Veatch, Oceanographer, Filebottom, Chebacco, Gilbert, and Lydonia), but could lead to increased effort in other locations along the shelf break.

7.2.1.2 Impacts on managed species and essential fish habitats

The tilefish GRAs are specifically designed to prevent the impacts of mobile bottom-tending gear to tilefish burrow habitats in select canyons, and thereby improve productivity in the golden tilefish resource. While there are no known comparisons of tilefish habitat condition inside and outside these GRAs to assess how the designations may have improved habitat conditions for tilefish, it is assumed that they are having some positive impacts on tilefish habitats, and therefore indirectly on the tilefish resource. The GRAs are relatively shallow (to around 200 m) and as such also encompass habitat for redfish, halibut, pollock, white hake, witch flounder, red hake, silver hake, offshore hake, monkfish, smooth skate, thorny skate, barndoor skate, and red crab. The footprint of the GRAs is fairly small (371 km^2 for the Veatch, Oceanographer, and Lydonia GRAs combined) so they probably do not have substantial positive impacts on these other resources that have less specific habitat requirements as compared to tilefish. The monkfish/squid habitat management areas include deeper sections of two of these same canyons and similar restrictions on mobile bottom-tending gears. Similar species are likely to benefit from the monkfish/squid closure as the tilefish GRAs.

As described above, the canyon section of the national monument encompasses a range of depths from approximately 100 m along the shelf break to around 2000 m at the base of the slope. As such, many more species occupy the monument as compared to some of the deeper coral zones considered for designation in this action. In addition to those species listed above, the shallower areas of the monument are likely occupied by cod, haddock, ocean pout, little skate, and sea scallops. Because the monument is relatively large (over 2400 km^2) and has fairly comprehensive restrictions on fishing, save recreational effort, it is assumed to have positive impacts on the managed species that overlap it. The benefits are expected to accrue through habitat protections that enhance feeding, sheltering, and reproduction, which translate into overall enhanced productivity of fishery resources.

The seamount section of the monument includes much deeper water where only red crab has designated EFH, and likely provides fewer benefits for managed resources and their habitats, especially because there is not fishing on the seamounts. No net change in fishery impacts to habitats for red crab are expected to have occurred as a result of monument designation. This holds true for the areas of the broad zones that overlap the seamounts, and for the discrete seamount zones as well. Long term, the seamount section of the monument will prevent fishing from expanding into these areas, and thus this designation provides a positive, if precautionary, benefit to managed resources.

Overall, the various No Action management areas in combination are expected to have positive impacts on managed resources.

7.2.1.3 Impacts on human communities

Under No Action, the fishing restrictions that are associated with the two closures in the Monkfish and Mackerel/Squid/Butterfish (MSB) FMPs, three closures in the Tilefish FMP, and the Northeast Canyons and Seamounts National Monument would remain in effect. The Monument has been closed to all commercial fishing since November 2016, except for the lobster and red crab fisheries, which have seven years to cease operations within the Monument.

The impacts of No Action on human communities have been and are expected to continue to be slightly negative. Assuming the protection of habitats for managed species and deep-sea corals benefit these resources, conservation measures have indirect positive impacts on the managed fisheries and positive sociocultural impacts on the broader public. However, the displacement and redistribution of fishing activity would have negative impacts that counterbalance these positive effects.

Fishing activity within the No Action areas was evaluated using a range of data sources (section 7.1.3.1). There is evidence of only small amounts of mobile bottom-tending gear use around the existing tilefish, monkfish, and squid closures. Given the high VMS coverage for bottom trawl, scallop dredge, and separator and Ruhle trawls in these areas, for these gears the estimates of fishing activity for these gears are better assessed using VMS rather than VTR data. The currently low effort is unsurprising given that some of the areas have been closed since 2005, others since 2009 or 2016. Impacts analysis prepared for these areas at the time of their implementation suggested only slight negative effects at the time of closure. Combining these original findings with the small size of these management areas relative to the full extent of fishing grounds along the shelf break, the continued implementation of these closures will likely have slightly negative to negligible impacts on regulated fisheries.

For fixed gears, there is less data support. Given the low coverage of lobster pot fishing in the region, the ASMFC survey provides an upper bound (~$2.4-$2.8M), while VTR provides a lower bound ($0.7M), on the revenue generated from the trips and permits historically fishing within the Monkfish/MSB/Tilefish areas and the National Monument. For sink gillnets and clam dredges, only the VTR analysis is currently available. Although the estimates based on this analysis are highly uncertain, the percentage of revenue and effort, assessed at the owner and permit level respectively, consistently indicate a low level of fishing activity for the vast majority of individuals estimated to use these waters. However, a very small number of individuals seem to be using these areas more intensively. Thus, the impacts of the No Action areas on various fisheries employing both mobile and fixed bottom-tending gears are expected to be low negative, with negative impacts of closure for a small subset of vessels that use the areas more heavily.

Full implementation of trap fishing restrictions in the Monument will not occur for several more years. At present, it is difficult to determine if some fishermen would be precluded from fishing altogether, or if they will shift effort to other areas. The lobster fishery is particularly territorial (Acheson 1987; 2006), such that attempts to shift effort to nearby open fishing grounds may be difficult for those displaced by the closures. Input from industry members at the NEFMC coral workshops confirmed that this is true (NEFMC 2017). Lobster trap fishermen are not restricted under the tilefish, monkfish, and squid closures. Patterns of behavior in the lobster fishery suggest that there would be negative impacts on those with established fishing areas in the monument, and slightly negative impacts on those who fish nearby and attempt to relocate into new areas. Other segments of the lobster fishery, including those that fish offshore but on Georges Bank and in the Gulf of Maine, or those fishing in the inshore Gulf of Maine, are unlikely to be affected by these changes.

The red crab fishery is prosecuted differently from the lobster fishery, with many fewer participants setting traps along larger areas of the continental slope during each trip. Because the fishery is so small, there is no real competition between vessels, so the effects of spatial closures are related to how the closures might affect catch rates by concentrating effort in particular areas, rather than allowing effort to spread out over the full range of the stock. Red crab fishery participants have suggested that the prohibition on the use of red crab pots in the monument in 2023, will cause fishing effort to decrease east of the monument and increase activity west of the monument in the New England and Mid-Atlantic regions since it would be inefficient to set traps along the eastern part of the slope (Powell to Heezen Canyons), pass over the monument, and then continue setting traps west of the monument. It is difficult to evaluate this statement empirically, because there are presently no spatial closures that apply to the red crab fishery, and it is a very small industry and not studied extensively like the lobster fishery. Assuming fishing for red crab is limited across this entire range, the monument could have negative impacts on the red crab fishery. If effort continues east of the monument, these negative impacts would be reduced.

As mentioned above, to the degree that these closures provide habitat for fishery species, and therby serve to export production to nearby fishing grounds, there may be long-term benefits to fisheries and society, but these are difficult to project. The monument protects fishery resources, protected species, and sensitive habitats within its boundaries from exploitation and habitat impacts, as well as from other types of human impacts including oil and gas development. Thus, the monument has positive impacts on society more broadly, despite having negative to slightly negative impacts on affected fishery stakeholders.

Overall, the sociocultural impacts associated with maintaining the No Action areas are expected to be negative for fishermen and fishing communities, as it would maintain the status quo, which displaces fishing effort and revenues from the management areas. Some lobster effort may be particularly difficult to shift into other nearby grounds (section 7.2.1.3). With effort shifts, conflicts within or between fisheries would have a negative impact on the *Non-Economic Social* aspects and the *Attitudes, Beliefs, and Values* of fishery participants. In the case of red crab, the future closure of the monument to traps gear could affect catch rates in the fishery by confining activity to a smaller portion of the species' range. No Action may change the *Social Structure and Organization* of communities as well as *Historical Dependence on and Participation* in the fishery by individuals and communities.

On the other hand, deep-sea corals have cultural value to society, so affording them protection via both sets of management areas (monument and Council area) has positive impacts on the *Attitudes, Beliefs, and Values* of stakeholders towards management.

7.2.1.3.1 Potentially affected fisheries

Impacts analyses prepared at the time the No Action fishery management closures were designated are summarized briefly below. Data from the more recent 2010-2015 period are provided in the remainder of the section. Due to data limitations, it is impossible to know how much fishing activity has occurred historically within the No Action areas. Thus, multiple approaches are used to estimate past fishing activity, and thus characterize the potential fishery impacts of No Action.

Monkfish Areas: Since 2005, though Amendment 2 to the Monkfish FMP, fishing with any gear type while on a monkfish Day-at-Sea (DAS) in Lydonia and Oceanographer canyons (deeper than ~200 m) has been prohibited. At the time, the impacts analysis indicated that this closure was designed to "prevent an expansion of the offshore monkfish into the deeper (>200 m) portions" of these canyons, and that the directed fishery was not operating within the closure. Thus, no negative economic impacts to the directed fishery were associated with the closure. Specifically, in 2001, there were four non-directed trips with a combined monkfish revenue of $68,000 (NEFMC 2004, p. 41, 423). Thus, it is unlikely that the monkfish fishery was substantially impacted by closing Lydonia and Oceanographer canyons, and therefore continuing this closure under No Action would likely have negligible impact on that fishery.

Mackerel/Squid/Butterfish Areas: In 2008, Lydonia and Oceanographer Canyons (same boundaries as the monkfish closures) were closed to bottom trawl fishing for mackerel, squid, or butterfish in Amendment 9 to that FMP, with the intent of minimizing the adverse habitat impacts of those fisheries. At the time, the impacts analysis indicated that this closure would "have a minimal impact on revenues both for vessels and ports" (MAFMC, 2008; p, xi). Since it appears that the mackerel, squid, or butterfish fisheries were not substantially affected by the original closures, continuing them under No Action would likely have negligible impacts on the fishery.

Tilefish Areas: In 2008, Lydonia, Oceanographer, Veatch and Norfolk canyons were closed to all bottom-tending mobile gear in Amendment 1 to the Tilefish FMP with the intent of reducing impacts to known clay outcrop tilefish habitats. The VTR-based impacts analysis indicated that, in 2005, $207,096 in total revenue from all fisheries was derived from two of these canyons (Oceanographer and Veatch), and just $1,287 from tilefish. These totals were much smaller than what was derived from other canyons in the Mid-Atlantic that remained open through this action ($6M). As it appears that mobile bottom-tending gear fisheries were not substantially impacted by closing these areas, continuing this closure under No Action would likely have negligible impacts on these fisheries in the long-term. The tilefish fishery itself may experience positive impacts, assuming that protecting tilefish EFH improves the condition of the tilefish resource and thereby increases fishery production.

VTR analysis

Vessel Trip Report data were used to estimate recent (2010-2015) fishing activity within the No Action areas. The No Action Monkfish/MSB/Tilefish areas were in effect during the time period encompassed by this analysis, but the National Monument was implemented subsequently. Because a large number of lobster vessel operators are not required to submit VTRs (their vessels do not carry other federal permits), total lobster revenue was expanded (method explained in section 7.1.3). With the exception of lobster trap gear, revenues are unscaled. Maps of revenue by gear type and species are in Appendix F.

Revenue by gear: From 2010-2015, an annual average of $0.4M of fishing revenue is attributed to the area of the monkfish/squid/tilefish areas, with higher than average values in 2014 and 2015 (Figure 4). In terms of specific gears, revenue is primarily attributed to bottom trawls, lobster pots, other pots, and scallop/clam dredges; separator and Ruhle trawls and sink gillnet revenues are minor. The recent revenue attributed to fishing with mobile bottom-tending gear from these areas is about 47% of the total, or $207K annually. Since bottom trawl was prohibited in these areas during 2010-2015, comparison with the more spatially refined VMS data helps shed additional light on this finding.

More revenue (average $1.8M annually) was attributed to the Northeast Canyons and Seamounts Marine National Monument (Figure 5). Except for areas overlapping Lydonia and Oceanographer canyons, the monument was open to fishing during this period. In terms of specific gears, revenue is primarily attributed to bottom trawl, lobster pot, and scallop/clam dredges, with smaller contributions from separator and Ruhle trawls. During 2010-2015, there was a substantial scallop dredge fishery on the southeastern part of Georges Bank, close to, but not within, the monument boundary. The spatial imprecision of VTR data likely explains high scallop dredge revenues inferred to the monument. The recent revenue attributed to fishing with mobile bottom-tending gear from the monument area is about 62% of the total, or $1.1M annually.

Revenue by species: Lobster, Jonah crab, red crabs, and scallops are the highest value of the top ten species with landings attributed to the monkfish/squid/tilefish areas (Figure 6), although an increase in revenue from butterfish is evident in 2012-2015 (butterfish quotas have increased in recent years). Longfin squid is consistently in the top ten, but more variable from year to year. Silver hake, another small mesh trawl species, is also a consistent contributor to revenues from these areas. Other trawl-caught species include flounders, mackerel, and haddock. There have been recent increases in effort in the Jonah crab fishery, and revenues in the Jonah crab fishery are likely to remain above historic levels for the foreseeable future (Megan Ware, ASMFC, pers. comm., 2017). A spike in red crab revenue generated from the area occurred in 2014. Revenue from sea scallops was particularly prominent in 2015.

The Monument results (Figure 7) are similar in terms of many of the top ten species captured but emphasize sea scallop revenues to a greater extent than in the monkfish/squid/tilefish areas. The higher overall revenue from the monument is likely the result of the monument's larger size overall, and its extension into shallower areas of the continental shelf.

To determine how the 2005 closure of Oceanographer and Lydonia Canyons has impacted the monkfish fishery, monkfish revenues from the canyons within the monument were compared to those for the entire monument. Revenues from Filebottom, Chebacco, and Gilbert Canyons, plus Lydonia and Oceanographer Canyons, are summarized in Figure 61, p. 371. For these areas, monkfish was not within the top ten species landed by revenue, suggesting that despite the fishery having access to these canyons adjacent to the 2005 closures, the areas are not heavily fished. Considering the 15 canyons outside the monument (Figure 60), monkfish was within the top ten species, but only with a value of about $100,000 or less annually. Some of this revenue may be an artifact of the spatial imprecision of the VTR analysis, with true fishing locations in shallower waters.

Similarly, to determine how the 2008 closure of Oceanographer and Lydonia Canyons has impacted the mackerel, squid and butterfish fishery, revenues from the canyons within the monument can be compared to those for the monument as a whole (Figure 61, p. 371). The VTR analysis indicates that based on revenue, mackerel, squid, and butterfish were within the top ten species caught in the five canyons that overlap the monument, although revenues were limited to $120,000 or less annually. These moderate revenue estimates from canyons adjacent to the closures suggest slight negative impacts of the closed areas on these fisheries. Considering the 15 canyons outside the monument (Figure 60), annual revenues placed butterfish and squid within the top ten species during this period, about $250,000 or less annually (Figure 60). As stated previously, at least some of this revenue may be overestimated by the VTR analysis since actual fishing locations were likely in shallower waters.

Owners and permits: Between 2013 and 2015, the number of vessel owners with revenue attributed to the monkfish/squid/tilefish areas and the monument averaged 120 and 90 annually. For both sets of areas, the percent revenue for owners who fished within these regions is typically in the low single digit percentages, but higher for some individuals, with some outlier owners generating as much as 5-10% of their revenue in these areas. These data are summarized by management area and gear type, i.e. all bottom-tending gears or mobile bottom-tending gears only (Figure 8, Figure 9, Figure 10, and Figure 11). These results indicate that most of the potentially affected owners generate only a small fraction of their annual revenue from these areas, but a few owners derive a larger fraction of their annual revenue from the area. Comparing the results for all gears (Figure 8 and Figure 10) against the MBTG-only percentages (Figure 9 and Figure 11) indicates that the most highly exposed owners who fish within the monkfish/squid/tilefish areas tend to be pot fishermen, which is not surprising given the existing gear restrictions in these areas. This is in contrast with the monument, where a small number of owners employing mobile bottom-tending gears are highly exposed (outlier owners with 5-10% exposure).

VTR vs. VMS comparison: Table 53 shows how many of the trips overlapping the No Action areas from the VTR data are captured in the VMS data, and Table 54 summarizes hours fished, permits, and trips for fishing activities captured by VMS. Based on VTR, between 2010 and 2015, an average of 317 bottom trawl trips and 266 lobster pot trips overlapped the monument and 388 bottom trawl trips and 419 lobster pot trips overlapped the monkfish/squid/tilefish areas, making these the dominant gear types used on VTR-documented trips occurring in and around the No Action areas.

These VTR-based numbers can be compared to VMS data, with the caveat that VMS data are available for most trips with mobile gears, while coverage for fixed gears is poor. During 2010-2012, the percent of VTR trips with VMS data is high for scallop dredge (93-100%), bottom trawl (84-94%), and Separator and Ruhle trawl trips (71-84%; Table 53). For these gears, the VMS analysis represents fishing effort at a much more refined scale and covers the vast majority of trips in the region. The same cannot be said for lobster pot and other gears, whose low level of VMS coverage (0-16%) would result in greater error when extrapolating the VMS results. It is unknown whether these same levels of overlap between VMS and VTR trips existed prior to 2010, or during 2013 and beyond. Although the VTR data suggest gillnet use in the monkfish/squid/tilefish areas, bottom longline and gillnet VMS data have not been processed and there is no coverage in the VMS dataset (Table 53).

While more spatially precise than VTR data, VMS data are remain only a model of fishing distribution, and there are likely some errors in the attribution of specific VMS polling locations as fishing vs. non-fishing. The data are useful for understanding patterns of effort, despite these caveats. It should be noted that the majority of VMS transponders are programmed to send spatial coordinates once an hour. Given that bottom trawl vessels in the region tend to fish at a speed of 2-5 knots, while scallop dredges fish at 2-7 knots (Palmer and Wigley, 2007), there is potential for this VMS point analysis to underestimate the actual numbers of fishermen fishing within a relatively small region such as the monkfish/squid/tilefish areas. Although less of an issue with the larger monument, the VMS data indicate a mismatch between the size of the management areas under consideration and the spatial precision of the data available to assess the impacts of the areas.

In general, the more spatially refined analysis using VMS polling data indicates that only 15-35% of permits attributed to fishing in the No Action management areas by the VTR analysis had VMS points falling within the regions of interest, for gears with good coverage (Table 54). Although the magnitudes of effort estimated using VMS and VTR differ substantially, the interannual trends are generally consistent between the VTR and VMS analyses for trips and permits in the No Action areas. About 15% of VTR trips identified to be fishing within the monkfish/squid/tilefish areas have VMS points falling within those regions, and the probability-weighted hours fished indicates a relatively small amount of effort is being expended in these regions by bottom trawl, squid trawl, and in particular scallop dredges. This is intuitive, because these areas are currently closed to these gears.

The larger National Monument encompasses substantially more effort by bottom and squid trawls, although there is substantial inter-annual fluctuation. About 25% of trips identified in the VTR analysis as having fished in the monument between 2010 and 2012 have corresponding VMS polls falling within the same region. Trawl gears show the greatest degree of overlap with the management areas in terms of hours fished. Hours fished, permits, and trips are greater for the monument than the other management areas (Table 54), which is unsurprising as the monkfish/squid/tilefish closures prohibit bottom trawls. Considering the bottom trawl category (not squid, which is analyzed separately) in the monkfish/squid/tilefish areas, trips have increased slightly over time, while hours fished, permits, declined over the period 2005-2012. For bottom trawl in the monument, while hours fished, permits, and trips do fluctuate interannually, all three values declined over the period 2005-2012, with hours fished declining most sharply. Squid trawl hours fished, permits, and trips have also declined in both sets of areas, although interannual fluctuations are much more substantial in the squid fishery. The VMS data suggest that the monument is an important fishing ground squid gear during some years.

The relative magnitude of effort estimated between the monkfish/squid/tilefish areas and the monument are very similar between the VTR and VMS analyses. For 2010 to 2012, the ratio of revenue (VTR) and hours fished (VMS) in the monkfish/squid/tilefish areas to the revenue/hours fished in the monument ranges from 14-20% in the VTR and 9-20% in the VMS, for trawls. This indicates both VMS and VTR paint a similar picture regarding the relative amount of fishing across the two regions.

Comparing the results of the VTR analysis with hours fished in the VMS data (Table 54) deemphasizes the importance of scallop and clam dredge effort relative to the high VTR-based revenue in those fisheries. The scallop dredge ratios of VTR revenue to VMS hours fished conform less across the two analyses, with the VMS analysis indicating no real concentration of fishing effort in either of these two areas using this gear. This is expected given the depths at which sea scallops generally fish in commercial abundance (i.e., below 110 m). Whereas more hours are attributed to the larger Monument based on VMS, the total number of overlapping trips is higher for the No Action zones, which include Veatch Canyon as well. Regardless, the VMS-based hours fished for these gear types are very low, 1.34 hours per year/area, or less.

Little can be said about fixed gear overlaps based on VMS owing to the low coverage rates. Around 25 lobster vessels fished in the vicinity of these areas, with more permits being fished around the monkfish/squid/tilefish, which include Veatch Canyon, identified as an important lobster ground (Whitmore et al. 2016). Some use of gillnet gear is indicated in the monkfish/squid/tilefish areas only. This reflects the concentration of gillnet effort in offshore RI and southeastern MA, but not further to the east where the monument is located.

Figure 12 and Figure 14 provide the percentage of a permit's overall probability-weighted VMS effort for gears processed falling within the Monkfish/MSB/Tilefish areas and the Monument. Although this is expected to differ at least slightly from the percentage of VTR-derived owner revenue generated in each of these regions (Figure 8, Figure 10), due to the fact that multiple permits can belong to the same ownership group, there is substantial concurrence between the two metrics. In particular, both metrics indicate that the vast majority of individuals fishing within the monkfish/squid/tilefish areas expend under 1% of effort and generate less than 1% of total revenue in this region. For a similar majority, less than 5% of effort expended and total revenue generated is calculated to fall within waters of the National Monument.

Figure 13 and Figure 15 present the percentage of a permit's overall VMS-derived effort generated from MBTG only. A comparison with Figure 12 and Figure 14 highlights that the most exposed permit holders in the monkfish/squid/tilefish areas tend to be pot fishermen. This is not a surprise given the gear restrictions already in place in that area. The distribution of permit-level exposure for bottom-tending and mobile bottom-tending gears in the National Monument is more consistent, indicating that some MBTG fishermen are exerting a substantial portion of their effort within the bounds of the National Monument. These findings are consistent with the VTR-derived owner exposure (Figure 8-Figure 11).

ASMFC survey: The trap fishery for lobster and Jonah crab is not constrained by the monkfish/squid/tilefish areas, but the National Monument will be closed to this gear type starting in 2023. The ASFMC survey of Area 3 lobster permit holders (section 7.1.3.1) did not ask lobstermen to identify their fishing activity within the No Action monkfish/squid/tilefish areas specifically, but there is likely to be less gear conflict with mobile gear in these areas relative to areas of similar depth open to mobile gear. Thus, the monkfish/squid/tilefish may be important to lobstermen because mobile bottom-tending gears are prohibited. Veatch Canyon, which has a tilefish closure, is an area noted as being fished by many of the lobstermen who responded to the survey (Whitmore et al. 2016).

The survey did identify recent (2014-2015) fishing activity within the boundaries of the National Monument that will be closed to the fishery in the future. The results indicate that 12-14% of the offshore lobster fishery effort and 13-14% revenue ($2.4-2.8M annually) for the lobster and Jonah crab fishery comes from the area of the National Monument. This revenue is higher than that derived from the VTR analysis (about $0.7M annually, Figure 7).

Figure 4 – VTR-derived revenue by gear type attributed to the No Action Monkfish/MSB/Tilefish areas within Veatch, Oceanographer, and Lydonia Canyons, 2010-2015.

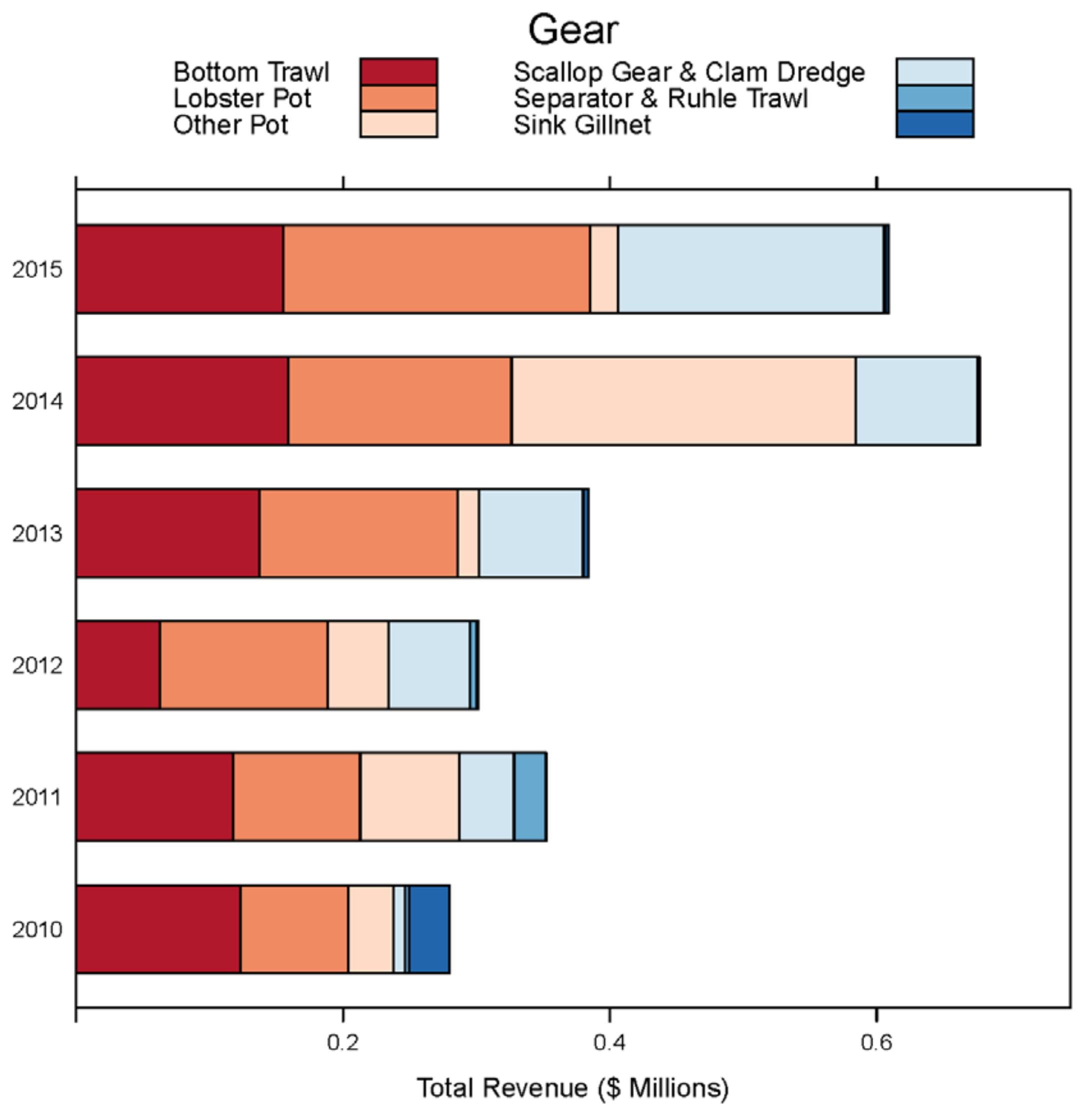


Figure 5 – VTR-derived revenue by gear type attributed to the Northeast Canyons and Seamounts Marine National Monument, 2010-2015.

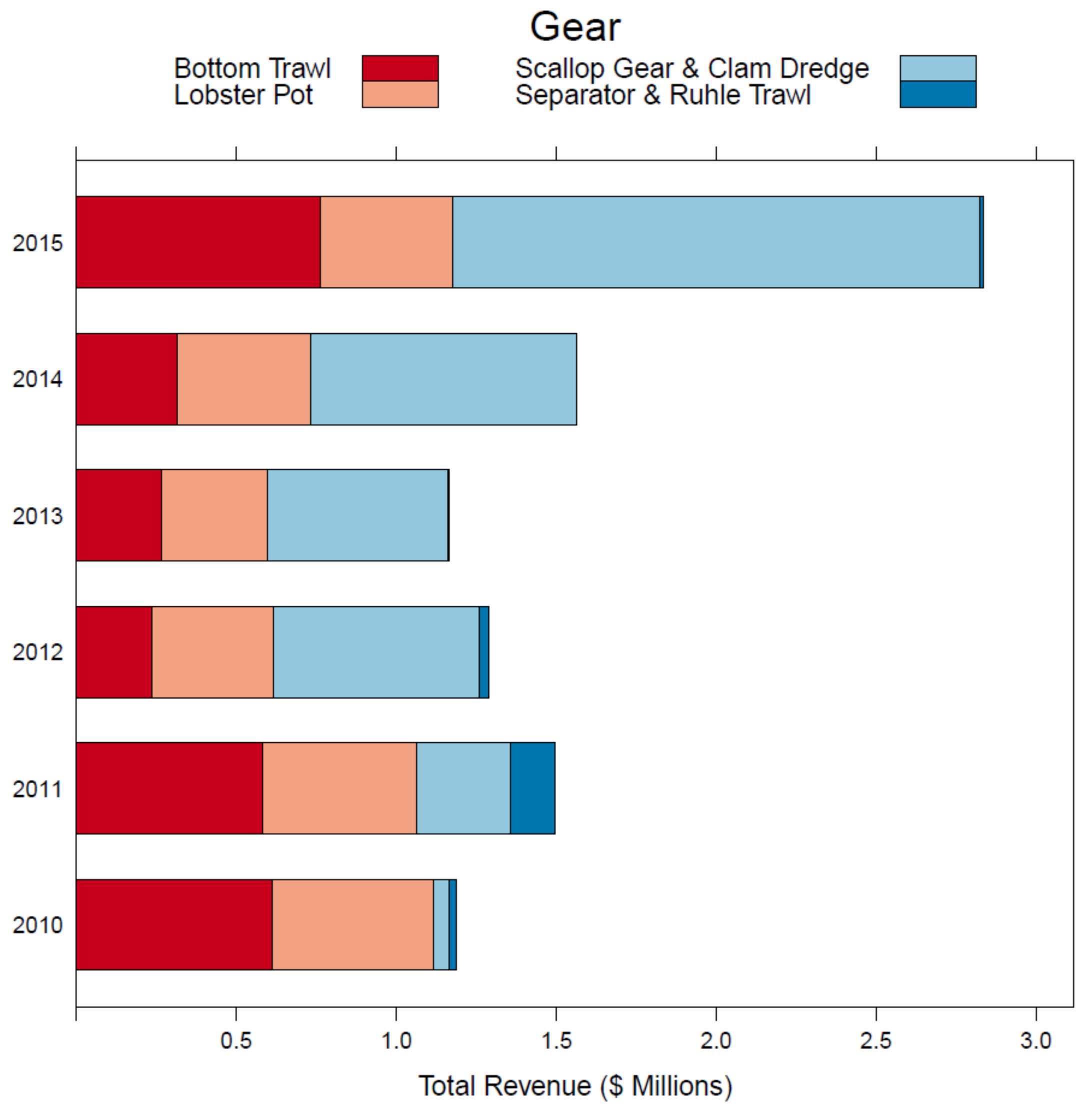


Figure 6 – VTR-derived revenue by species (top 10) attributed to the No Action Monkfish/MSB/Tilefish areas within Veatch, Oceanographer, and Lydonia Canyons, 2010-2015.

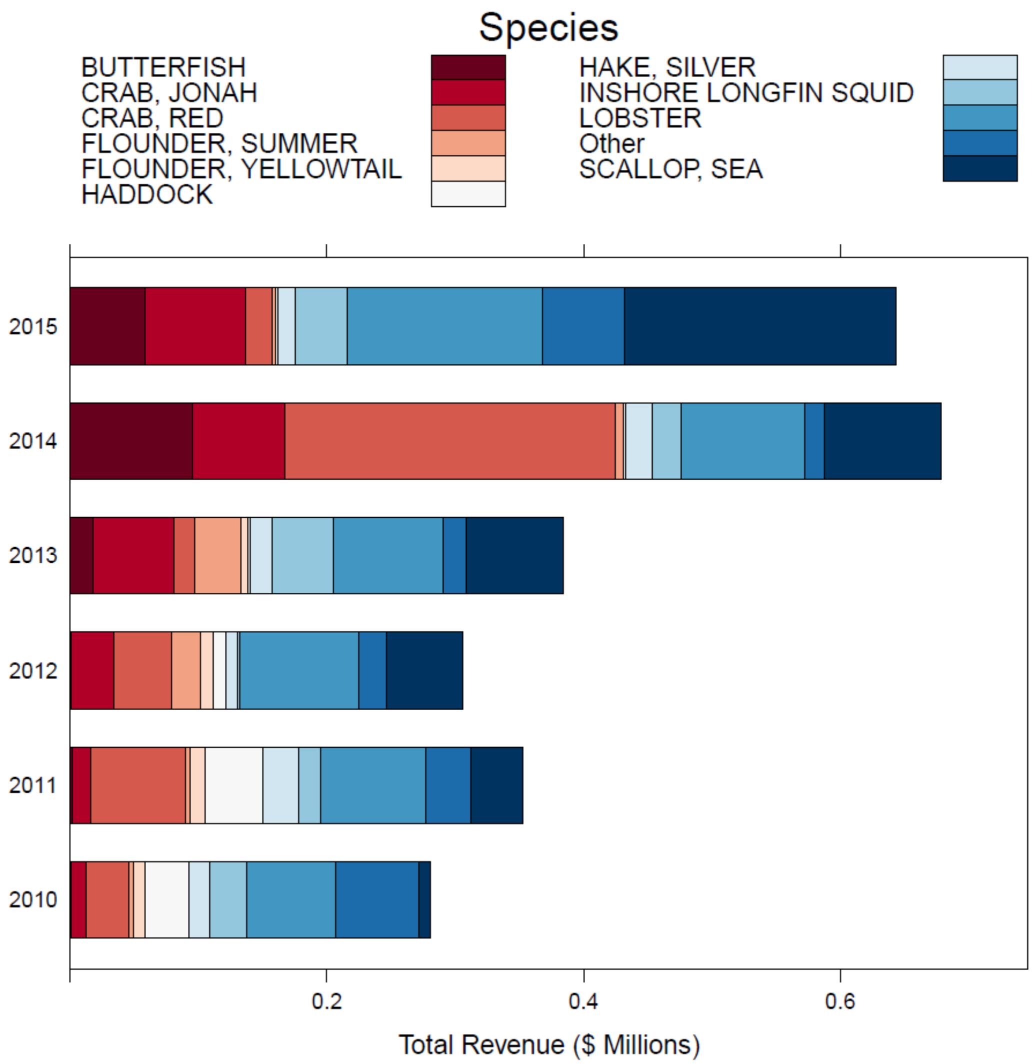


Figure 7 – VTR-derived revenue by species (top 10) attributed to the Northeast Canyons and Seamounts Marine National Monument, 2010-2015.

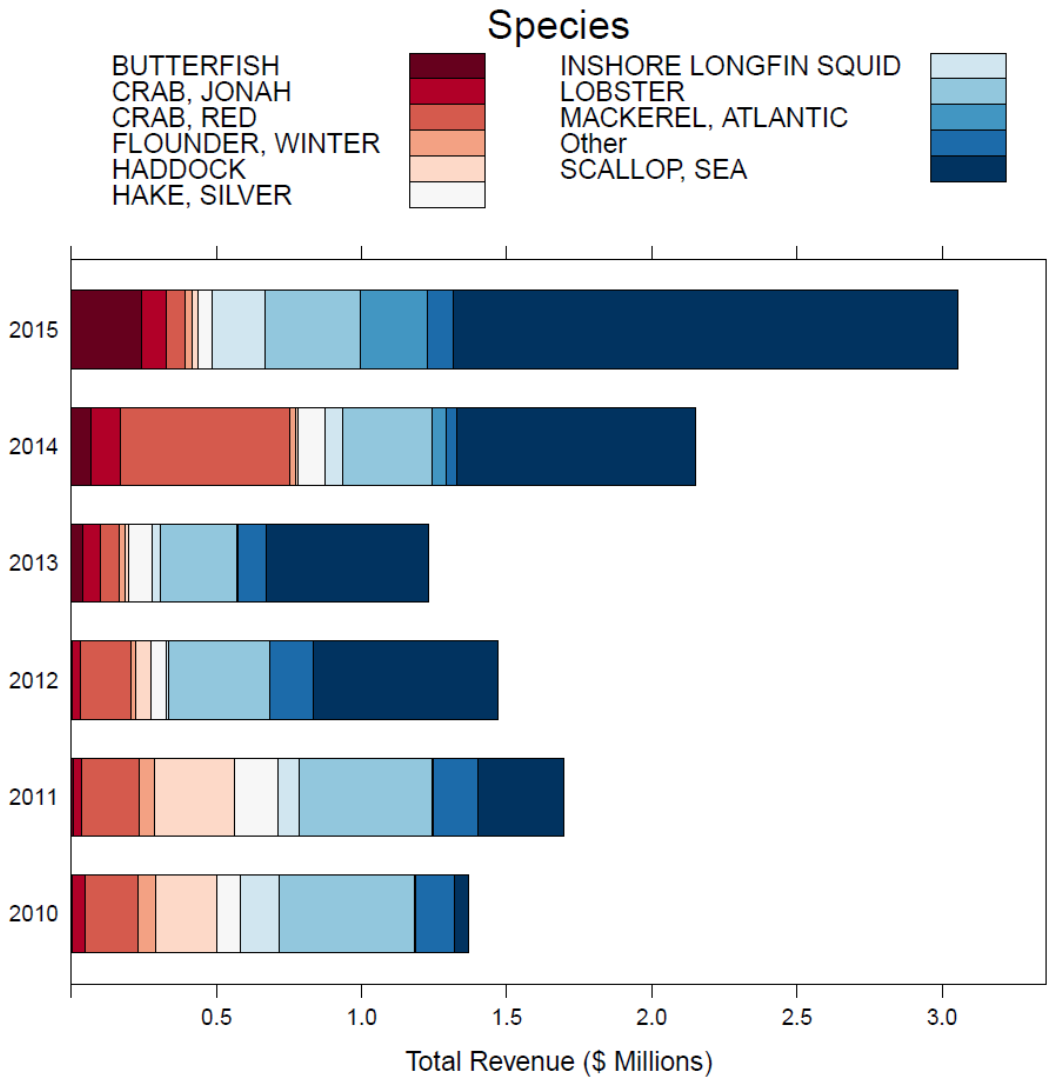
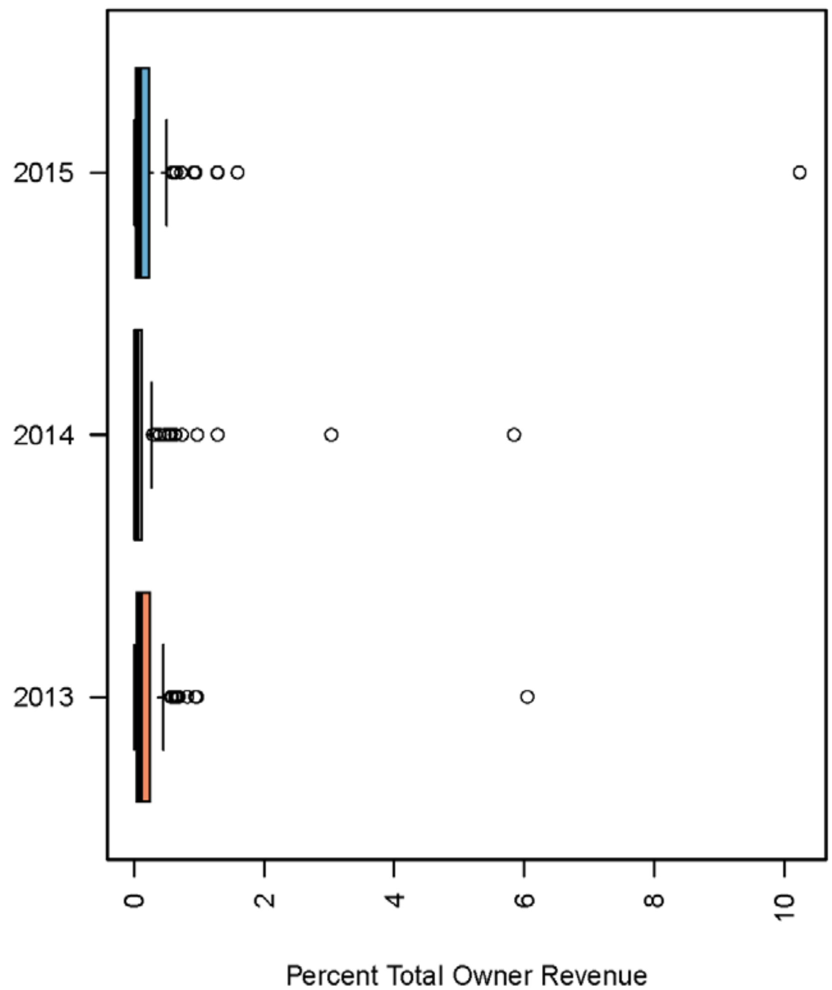
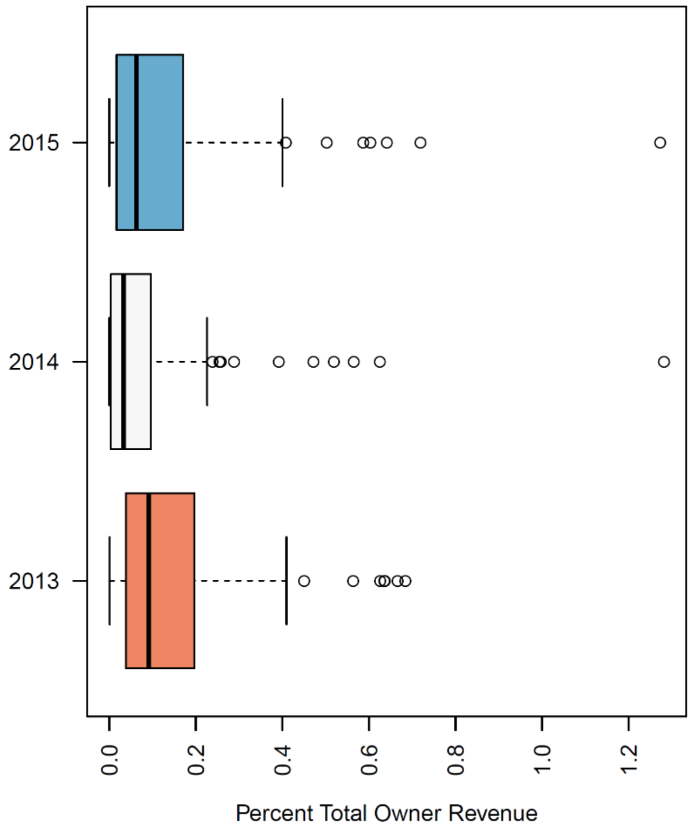


Figure 8 – VTR-derived percent of vessel owner revenue attributed to the No Action Monkfish/MSB/tilefish areas, 2013-2015.



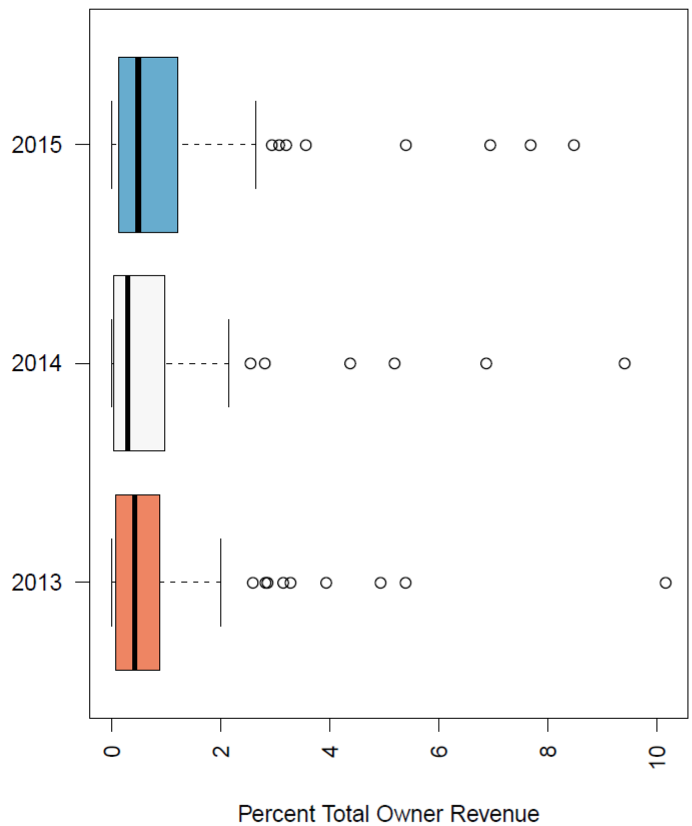
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 9 – VTR-derived percent of vessel owner revenue attributed to MBTG within the No Action Monkfish/MSB/tilefish areas, 2013-2015.



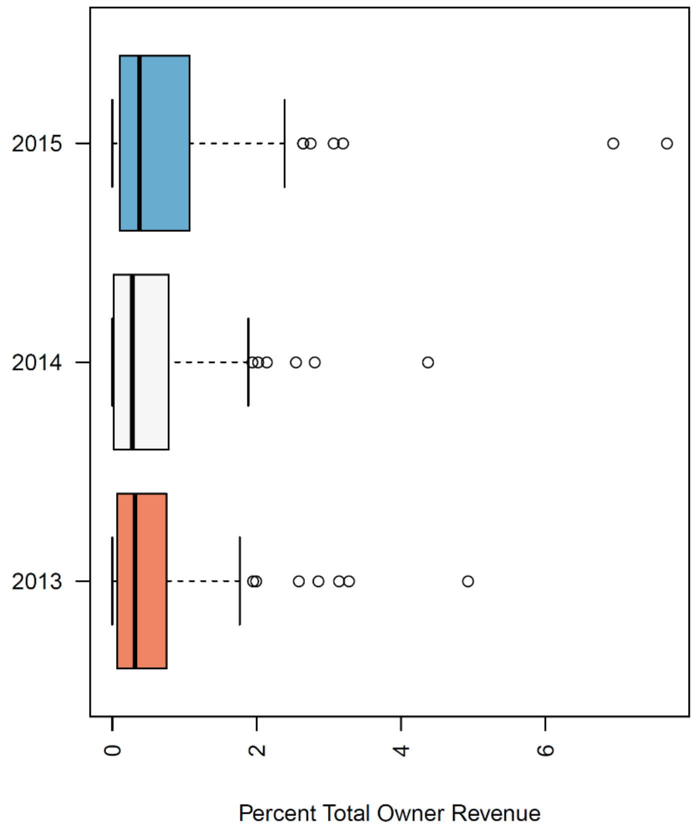
Note: Open circles are individual owners with a % total revenue 1.5 times above the 75% percentile.

Figure 10 – VTR-derived percent of vessel owner revenue attributed to the Northeast Canyons and Seamounts Marine National Monument, 2013-2015.



Note: Open circles are individual owners with a % total revenue 1.5 times above the 75% percentile.

Figure 11 – VTR-derived percent of vessel owner revenue attributed to MBTG within the Northeast Canyons and Seamounts Marine National Monument, 2013-2015.



Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Table 53 – Percentage of VTR trips by gear type attributed to the No Action management areas that have VMS coverage, 2010-2012.

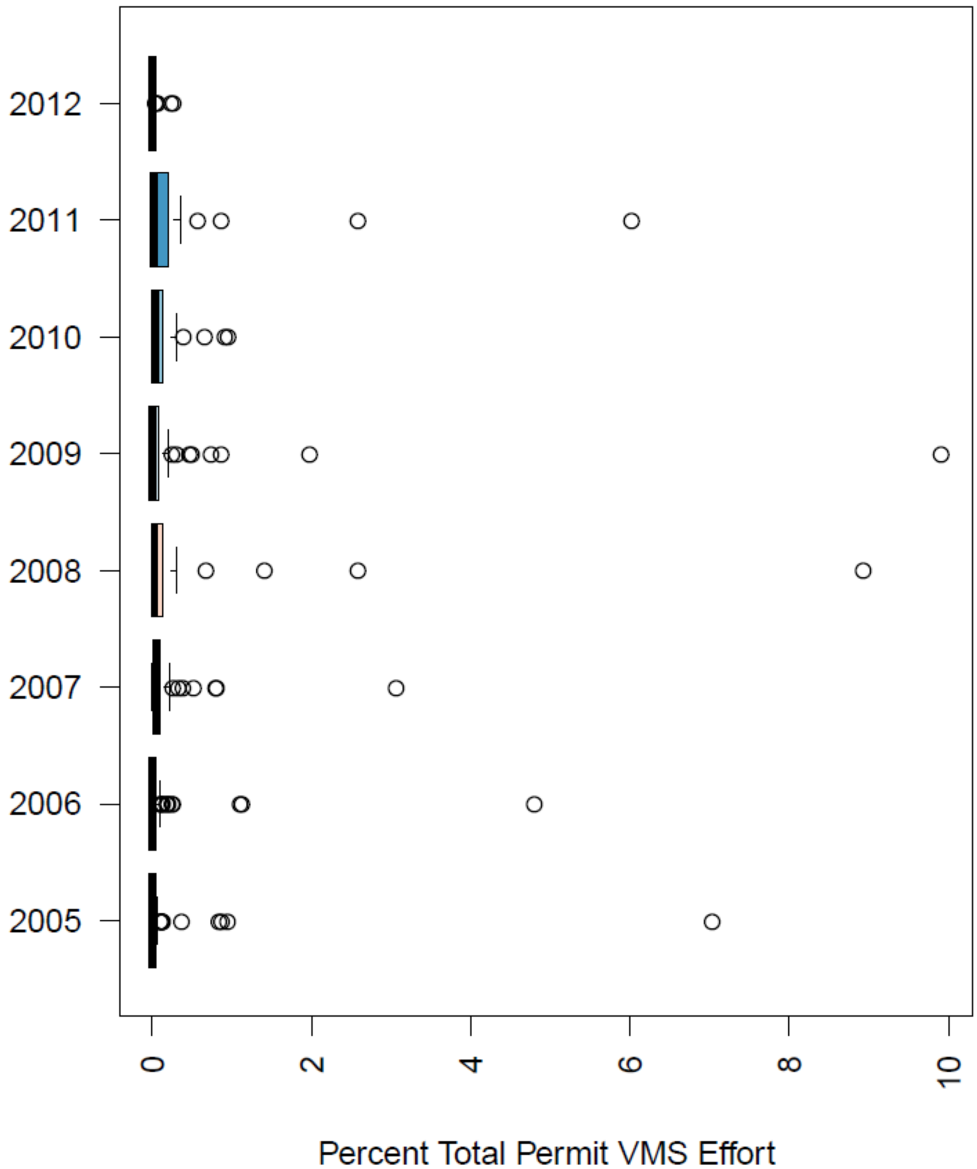
		No Action Monkfish Tilefish Areas				National Monument			
Gear	Year	Permits	VTR Trips	VMS Trips	Coverage	Permits	VTR Trips	VMS Trips	Coverage
Bottom Trawl	2010	117	575	539	94%	107	545	513	94%
Bottom Trawl	2011	99	481	430	89%	90	459	411	90%
Bottom Trawl	2012	100	351	296	84%	71	280	235	84%
Lobster Pot	2010	30	491	76	15%	21	309	49	16%
Lobster Pot	2011	30	420	28	7%	22	296	9	3%
Lobster Pot	2012	22	370	0	0%	18	257	1	0%
Scallop Gear & Clam Dredge	2010	8	8	8	100%	15	17	16	94%
Scallop Gear & Clam Dredge	2011	21	22	20	91%	27	30	28	93%
Scallop Gear & Clam Dredge	2012	29	35	35	100%	42	57	57	100%
Separator & Ruhle Trawl	2010	12	30	24	80%	14	40	30	75%
Separator & Ruhle Trawl	2011	30	110	92	84%	32	113	94	83%
Separator & Ruhle Trawl	2012	18	45	32	71%	19	46	33	72%
Other Pot	2010	4	27	0	0%	-	-	-	-
Other Pot	2011	3	20	0	0%	-	-	-	-
Other Pot	2012	5	31	0	0%	-	-	-	-
Sink Gillnet	2010	9	53	0	0%	-	-	-	-
Sink Gillnet	2011	7	29	0	0%	-	-	-	-
Sink Gillnet	2012	9	53	0	0%	-	-	-	-

Table 54 – VMS-derived estimates of effort (hours fished, permits, and trips) within the No Action management areas, by gear type

		No Action Monkfish Tilefish Areas			National Monument		
Gear	Year	Hours Fished	Permits	Trips	Hours Fished	Permits	Trips
Bottom Trawl	2005	19.32	20	39	614.52	50	149
Bottom Trawl	2006	48.51	25	44	373.21	49	101
Bottom Trawl	2007	57.70	46	71	756.01	55	127
Bottom Trawl	2008	23.41	23	61	433.21	31	103
Bottom Trawl	2009	22.14	19	70	256.56	36	137
Bottom Trawl	2010	40.54	33	85	243.10	37	132
Bottom Trawl	2011	51.33	18	53	305.25	22	91
Bottom Trawl	2012	7.99	11	41	105.40	17	73
Squid Trawl	2005	16.26	33	60	210.59	34	62
Squid Trawl	2006	27.19	32	70	32.41	23	41
Squid Trawl	2007	37.71	39	87	580.87	38	102
Squid Trawl	2008	8.02	8	13	3.84	5	5
Squid Trawl	2009	26.59	8	16	1.87	4	4
Squid Trawl	2010	9.46	10	21	187.75	10	17
Squid Trawl	2011	15.29	12	22	22.42	13	13
Squid Trawl	2012	1.71	6	7	2.71	3	3
Raised Footrope	2006	-	1	-	-	1	-
Trap	2005	1.83	3	5	13.76	3	5
Trap	2006	31.88	3	40	-	2	-
Trap	2007	22.53	3	28	-	2	-
Trap	2008	18.17	3	11	-	2	-
Trap	2009	10.11	3	17	-	1	-
Trap	2010	-	1	-	0.00	0	0
Trap	2011	-	2	-	-	2	-
GC Scallop	2006	-	1	-	-	1	-
GC Scallop	2009	0.00	0	0	-	1	-
GC Scallop	2011	0.00	0	0	-	1	-
GC Scallop	2012	-	1	-	-	1	-
LA Scallop	2005	0.16	25	28	0.20	9	10
LA Scallop	2006	0.18	28	35	1.34	28	40
LA Scallop	2007	0.00	0	0	1.05	3	3
LA Scallop	2008	0.00	0	0	-	1	-
LA Scallop	2009	0.22	12	12	0.56	13	13
LA Scallop	2011	0.73	8	9	0.73	7	7
LA Scallop	2012	0.09	9	9	0.14	9	9

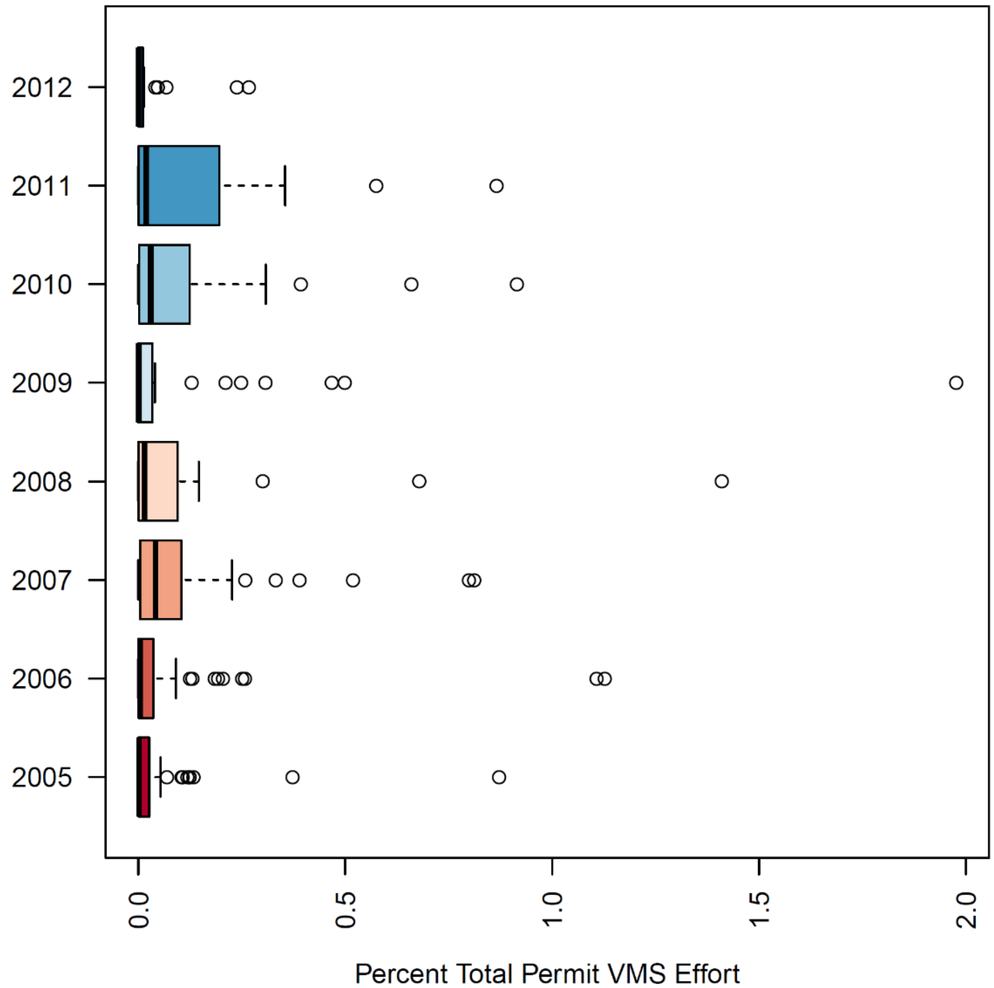
Note: LA and GC refer to limited access and limited access general category scallop gears, respectively.

Figure 12 – VMS-derived percent of total annual permit fishing activity attributed to the No Action Monkfish/MSB/tilefish areas between 2005 and 2012, all gear types in the VMS data.



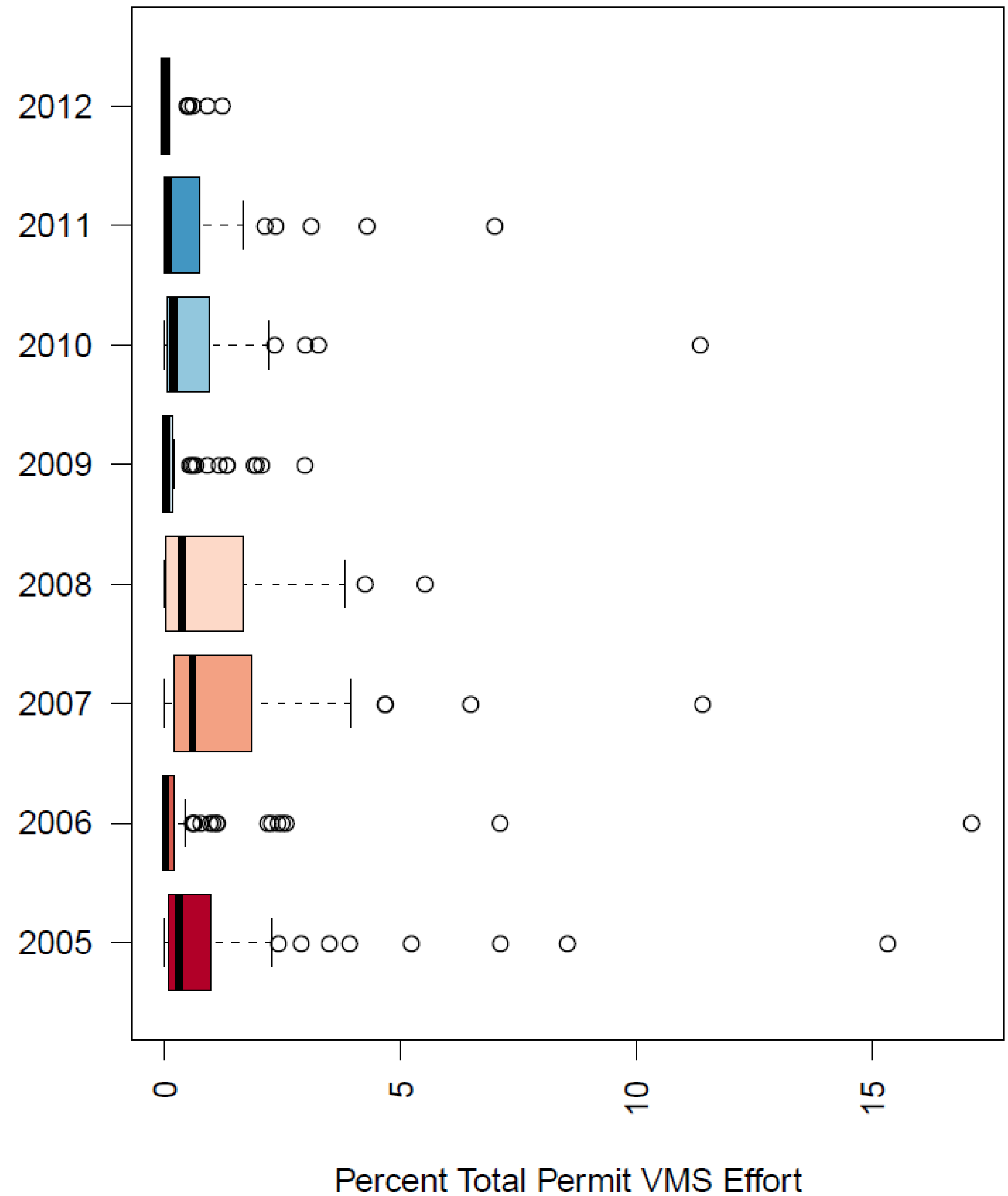
Note: Open circles are individual owners with a % total revenue 1.5 times over the 75% percentile.

Figure 13 – VMS-derived percent of total annual permit fishing activity attributed to the No Action Monkfish/MSB/tilefish areas between 2005 and 2012, mobile bottom-tending gears only.



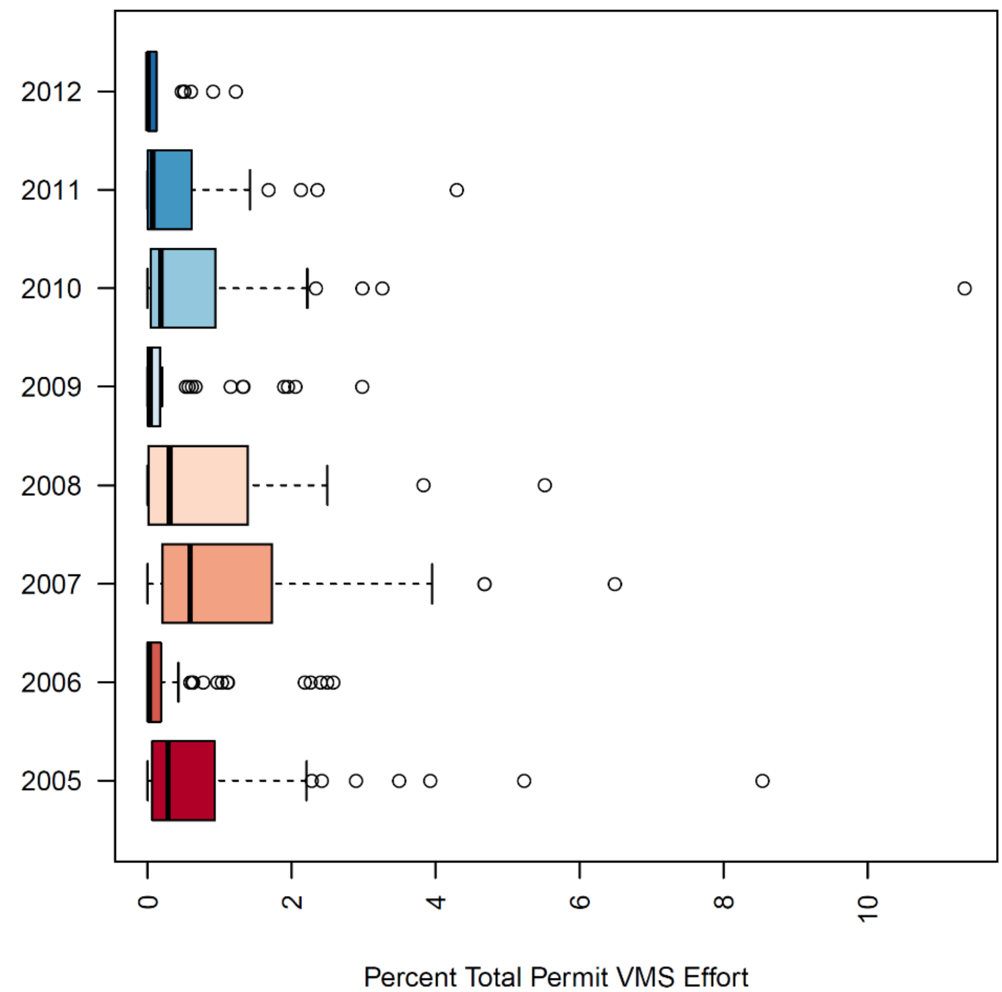
Note: Open circles are individual owners with a % total revenue 1.5 times over the 75% percentile.

Figure 14 – VMS-derived percent of total annual permit fishing activity attributed to the Northeast Canyons and Seamounts Marine National Monument between 2005 and 2012, all gear types in the VMS data.



Note: Open circles are individual owners with a % total revenue 1.5 times over the 75% percentile.

Figure 15 – VMS-derived percent of total annual permit fishing activity attributed to the Northeast Canyons and Seamounts Marine National Monument between 2005 and 2012, mobile bottom-tending gears only.



Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

7.2.1.3.2 Potentially affected fishing communities

General community impacts of the alternatives under consideration are described in section 7.1.3, which also describes the method, caveats, and data confidentiality standard used to develop Table 55 and Table 56, the revenues by state, region, and port attributed to recent fishing within the No Action coral zones.

No Action Monkfish/MSB/Tilefish Areas

Although the VTR analysis has some degree of error, it suggests that the fishing communities active within the No Action Monkfish/MSB/Tilefish Areas are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New York, Virginia, and other states (Table 55). The VTR analysis attributes recent (2010-2015) landings revenue to 45 ports and 411 permits, and 57% of this revenue to ports in Massachusetts. New Bedford (253 permits), Newport (9 permits), and Point Judith (61 permits) are among the top ten landing ports, and 28% of the revenue is attributed to other ports, indicating that the No Action areas may be particularly relevant for those three communities. According to the NMFS Community Vulnerability Indicators, New Bedford, Newport, and Narragansett (includes Point Judith) have a medium-high to high degree of engagement in commercial fishing. Of these three communities, Narragansett ranks highest in terms of reliance on commercial fishing, with a medium-high index, while Newport ranks lowest, with a low index.

The revenue attributed to Massachusetts and Rhode Island from the monkfish/squid/tilefish areas is about 0.05% and 0.19% of all revenue, respectively, for these states during 2010-2015 (ACCSP data, 2017). Though these are minor fractions, certain individual permit holders could have as much as 10% of their revenue attributed to fishing from these areas (Figure 8).

Table 55 – Landings revenue to states, regions, and top ports attributed to fishing within the No Action Monkfish/MSB/Tilefish Areas, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits 2010-2015[a]
	Total $	Average $	
Massachusetts	$1,500K	$250K	301
New Bedford	$1,332K	$222K	253
Sandwich	$109K	$18K	3
Gloucester	$31K	$5K	25
Other (n=13)	$28K	$5K	57
Rhode Island	$879K	$146K	70
Newport	$399K	$67K	9
Point Judith	$183K	$31K	61
Other (n=4)	$297K	$48K	12
Connecticut	$14K	$2K	10
New York	$73K	$12K	12
Montauk	$72K	$12K	10
New Jersey	$27K	$4K	14
Virginia	$60K	$10K	55
Newport News	$26K	$4K	29
Other (n=3)	$34K	$6K	33
North Carolina	$4K	$1K	27
Other state(s)[b]	$87K	$15K	15
Total	**$2,645K**	**$441K**	**407**

Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: VTR analysis.

Northeast Canyons and Seamounts Marine National Monument

Although the VTR analysis has some degree of error, it suggests that the fishing communities that may be active within the Northeast Canyons and Seamounts Marine National Monument are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New Jersey, New York, and other states (Table 56). The VTR analysis attributes recent landings revenue to 35 ports and 359 permits, and 67% of this revenue to ports in Massachusetts. New Bedford, (253 permits) Newport, (6 permits) and Sandwich (38 permits) are among the top ten landing ports, and 27% of the revenue is attributed other ports, indicating that the areas near the Monument may be particularly relevant for those three communities.

The revenue attributed to Massachusetts and Rhode Island from the National Monument is about 0.22% and 0.54% of all revenue, respectively, for these states during 2010-2015 (ACCSP data, 2017). Though these are minor fractions, certain individual permit holders could have as much as 10% of their revenue attributed to fishing from these areas (Figure 10, p.55).

Table 56 – Landings revenue to states, regions, and top ports attributed to fishing within the National Monument, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$7,316K	$1,219K	285
New Bedford	$6,426K	$1,071K	253
Sandwich	$485K	$81K	3
Gloucester	$241K	$40K	22
Other (n=11)	$164K	$27K	42
Rhode Island	$2,579K	$430K	44
Newport	$1,132K	$189K	6
Point Judith	$578K	$96K	38
Other (n=3)	$869K	$145K	5
Connecticut	$92K	$15K	6
New York	$241K	$46K	6
Montauk	$240K	$40K	5
New Jersey	$278K	$40K	8
Virginia	$67K	$11K	30
Other state(s)[b]	$396K	$66K	16
Total	**$10,969K**	**$1,828K**	**353**

Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: VTR analysis.

7.2.1.4 Impacts on protected resources

The protected resources potentially affected by this amendment are described in section 6.9.2, and the potential for interactions between these species and fishing gears are described in section 6.9.3. The extent to which continuing the No Action alternative may positively or negatively affect protected resources depends on the fisheries operating in the affected area, protected resources present in the area under management, fishing effort and gear types present in the affected area, and the potential nature of the interaction between the fisheries and protected resources occurring in the No Action areas (i.e., Monkfish/MSB and Tilefish areas (southern edge of Georges Bank), and Northeast Canyons and Seamounts Marine National Monument (see section 4.1). Many fishing effort changes associated with the No Action areas have already occurred, but ongoing shifts in pot/trap fishing for lobsters and red crab are expected upon full implementation of the fishing restrictions associated with the monument, sometime prior to 2023. It is assumed that effort that has been or will be displaced from the No Action areas generally remains in relatively deep water along the shelf break, such that species with primarily inshore/coastal distributions are unlikely to be affected by any past or future shifts in fishing activity associated with the No Action alternative. Thus, based on the information provided in section 6.9.2, the list of species that might be impacted by the No Action alternative (Table 57) is smaller than the list of species potentially affected by the amendment (Table 39).

Table 57 – Occurrence of protected resources in the No Action management areas

Species grouping	May occur in No Action areas
Large whales	North Atlantic right whale, humpback whale, fin whale, sei whale, minke whale, sperm whale
Small cetaceans	Risso's dolphin, short-beaked common dolphin, bottlenose dolphin (WNA Offshore Stock), pilot whales, Atlantic white sided dolphin, harbor porpoise
Pinnipeds	None; all primarily nearshore, coastal species
Turtles	Green, loggerhead, Kemp's ridley, and leatherback
Fishes	None; primarily coastal waters
Sources: http://seamap.env.duke.edu/, https://www.nefsc.noaa.gov/psb/surveys/; https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region; NMFS NEFSC FSB (2018)	

Section 7.2.1.3.1 describes fishing activity in and around the No Action areas. The major gear types are bottom trawl and lobster trap. Minor gear types include scallop dredge, sink gillnet, and red crab trap. Bottom trawls are already prohibited in all No Action areas. The result is that effort in these fisheries is likely somewhat more concentrated along other portions of the continenal margin than it would be in the absence of the No Action areas. Trap effort for lobster and perhaps to a lesser extent Jonah crab is likely to be redistributed along other portions of the continental margin once the monument closes to lobster pot fishing. This will occur during or prior to 2023.

Gillnet and scallop dredge effort are most likely to occur along the shallow edges of the No Action management areas. While VTR data suggest fairly high scallop revenues from the monument (scallops are a high value species), VMS data suggest that scallop dredge effort does not occur in large amounts within any of the No Action areas. This makes sense because the depth limit for commercial densities of scallops is right around the depth at which the monument begins. VMS data are not available for gillnets, but these are also a shallower water gear, used primarily inshore of the western canyons, and not strongly overlapping the No Action areas (see Appendix F). Gillnet revenue is only evident in the Monkfish/MSB/Tilefish closures, and not the monument, which suggests that effort is near the Veatch Canyon tilefish closure only. Because this gear is not managed as part of the tilefish closure, there will be no effort displacement under No Action. Red crab traps are used in deeper waters along the continental slope. As discussed in the introduction to section 7.2.1.3, red crab trap effort is likely to remain at similar depths but redistribute to the west once the monument closes to this gear type.

7.2.1.4.1 Large whales

Mobile bottom tending gears (i.e., bottom trawl and scallop dredge) operate in the No Action areas. From the period of 2010-2015, bottom trawl gear was one of the predominant types of fishing gears used in and around the No Action areas (see section 7.2.1.3.1 for details). Bottom trawl gear poses little to no interaction risk to any large whale species. Other than minke whales, there have been no observed or documented interactions between trawls and large whales (see section 6.9.3). From 2008-2015, estimated annual mortality attributed to the northeast bottom trawl fishery went from 7.8 to zero minke whales (see section 6.9.3.1.1). Scallop dredge activity occurs along the shallow edge of the monument. Large whale mortalities, serious injuries, or interactions have never been observed or documented in scallop dredge gear (see section 6.9.3). Thus, given that these gear types pose little to no interaction risk to large whales, continuing the fishing restrictions associated with the No Action areas is not expected to affect interaction risks between these mobile gears and large whales.

Gillnet and trap/pot gears, specifically the vertical lines associated with these gear types, pose the greatest entanglement risk to large whales (see section 6.9.3.1.1). The northeast sink gillnet and northeast/Mid-Atlantic lobster trap/pot fisheries are placed in Category I, which indicates “annual mortality and serious injury of a stock in a given fishery is greater than or equal to 50% of the PBR level (i.e., frequent incidental mortality and serious injury of marine mammals)”. Gillnet effort is minimal in the No Action areas, contributing just a small percentage of area revenues (see Figure 4), and not likely to be affected by continuing No Action. Lobster and red crab trap effort, however, will be displaced out of the monument and into adjacent fishing grounds no later than 2023.

Based on feedback provided at the March 2017 workshop (NEFMC 2017), any areas of the shelf break, canyons, and slope that are fishable with lobster pots likely already have gear in them. Lobster fishermen explained that individuals set their gear in known locations, consistently using the same areas over time, except that traps are set somewhat deeper in winter and shallower in summer. During 2010-2015, few hundred lobster pot trips a year are estimated to overlap the No Action areas (see section 7.2.1.3.1 for details). This suggests that during or prior to 2023 when fishing activity is displaced from the monument that gear may become more densely concentrated (more traps per unit area) in adjacent fishing grounds, assuming that these adjacent grounds can accommodate additional traps. If traps become more concentrated, it is assumed that vertical lines will also become more concentrated. If effort shifts to areas outside the monument and gear is more concentrated, interaction rates could increase slightly as it would be more difficult for whales to avoid gear if vertical line density increases. If increased trap density in areas outside the monument reduces catch rates per trap, this could lead to longer soak times, which could potentially increase interaction rates between gear and large whales. Note that any displaced lobster trap effort is unlikely to be redistributed along the shallow boundary of the monument that runs along the margin of Georges Bank because this depth (~100 m) is a transitional area for lobsters between their summer/fall distribution on top of the bank and their winter/spring distribution in deeper waters, and limited gear is set at this depth.

Alternatively, if adjacent fishing grounds cannot accommodate additional traps, and vessels are unable to find alternative locations to set their gear, this effort would be removed from the fishery, and lobster pot effort in the canyon/slope region could decline overall. If the total amount of trawls of traps in the water decreases because adjacent fishing grounds cannot accommodate additional gear, then the number of vertical lines in the water will also decrease. As the vertical line associated with pot/trap gear poses the greatest entanglement risk to large whales, any reduction in vertical line may result in a decrease in impacts to large whales. It is difficult to say conclusively if traps will be set closer together to accommodate gear displaced from the monument, or if effort will simply decline.

Strategies developed outside the fishery management plan process serve to reduce the likelihood of gear interactions with large whales. As described in section 6.9.3.1.1, the Atlantic Large Whale Take Reduction Plan provides regulatory and non-regulatory measures to reduce the risk of serious injury and mortality caused by accidental entanglement in trap/pot and gillnet gear. For trap/pot gear, these measures include a minimum of 20 traps per trawl, restrictions on floating buoy lines, prohibitions on wet storage of gear, and a requirement that groundlines be made of sinking line. In addition, buoys, flotation devices, or weights must be attached to the buoy line with a weak link, and gears must be marked according to guidelines in the plan. Further strategies to reduce the interations of large whales and fixed fishing gear, such as trap/pots, may be developed in the coming years before the monument closes as a result of increased management effort in this area over concern about North Atlantic right whales.

Given the discussion above about potential shifts in effort, and that ALWTRP measures are already in place to reduce serious injury and mortality, the impacts of continuing the No Action areas including further changes in fishing restrictions associated with the monument are uncertain but could range from negative to neutral.

7.2.1.4.2 Small cetaceans

Interaction risks for small cetaceans are described in section 6.9.3.1.2. No small cetacean mortalities, serious injuries, or interactions have been observed or documented in scallop dredge gear. Thus, scallop fishing is not expected to have an effect on small cetaceans.

Direct observations of fishing with trap/pot gear are limited, so interaction information for small cetaceans and trap/pot gear is partly inferred from evidence of gear on stranded animals. These stranding data suggest that trap/pot interaction rates with small cetaceans are low. While there is a take reduction plan for harbor porpoise, its restrictions apply to gillnets only, and gillnet effort distributions are not likely to be affected by the No Action alternative, as discussed above.

Interactions between small cetacean species and bottom trawl gear are of somewhat greater concern (see section 6.9.3.1.2). The northeast bottom trawl fishery is a category II fishery (83 FR 5349; February 7, 2018). According to Northeast Fishery Observer Program data, At-Sea Monitoring Program Data, and the 2017 marine mammal stock assessment report (Hayes et al.2018), small cetacean interactions with bottom trawl gear have been observed on Georges Bank; however, of these observed interactions, few have been observed along the continental margin south of Georges Bank where the No Action management areas are located. Furthermore, with respect to bottom trawl gear, continuation of the No Action areas will not place additional restrictions on this gear type beyond those already in place since the monument was designated in 2016. While bottom trawl effort may be slightly more concentrated along other parts of the shelf break as a result of the No Action management areas, it is unlikely that effort (number of trips, tows, or tow duration) has increased to compensate for area closures under No Action management, since the No Action areas comprise a relatively small proportion of the shelf break, and the species targeted with bottom trawls are mobile.

Strategies developed outside the fishery management plan process serve to reduce the likelihood of gear interactions with small cetaceans. There is a take reduction strategy for trawl gears to limit interactions with common dolphins and other small cetacean species. Voluntary measures include reducing the numbers of turns made by the fishing vessel and tow times while fishing at night and increasing radio communications between vessels about the presence and/or incidental capture of a marine mammal to alert other fishermen of the potential for additional interactions in the area.

Given the discussion above about potential shifts in effort, and that measures outside the fishery management plan process are designed to reduce interaction, the impacts of continuing the No Action areas including further changes in fishing restrictions associated with the monument are uncertain but could range from slightly negative to neutral.

7.2.1.4.3 Sea turtles

Sea turtles are at risk for interaction with various types of bottom tending gears used in and around the No Action management areas, as described in section 6.9.3.2. Bottom trawl gear poses an injury and mortality risk to sea turtles, specifically due to forced submergence (Sasso and Epperly 2006). Green, Kemp's ridley, leatherback, loggerhead, and unidentified sea turtles have been documented bycaught in bottom trawl gear, but most of these interactions have occurred in the Mid Atlantic (section 6.9.3.2). Continuation of the No Action areas will not place additional restrictions on this gear type beyond those already in place since the monument was designated in 2016. While bottom trawl effort may be slightly more concentrated along other parts of the shelf break as a result of the No Action management areas, it is unlikely that effort has increased due to No Action management (see discussion in previous section). Given this information, some level of negative impacts are likely under the No Action. However, relative to the waters of the Mid-Atlantic, sea turtle encounter rates are lower in the waters on or off of Georges Bank (i.e. No Action management areas; Murray and Orphanides 2013; http://seamap.env.duke.edu/). Based on the this, there is a low level of overlap between sea turtles and fisheries operating in the No Action management areas; this evidenced by the low numbers of sea turtles observed in fishing gear towed in these areas (NMFS NEFSC FSB 2018; Murray 2015a; Warden 2011a,b). Based on this, with respect to bottom trawl gear, the magnitude of negative effects to sea turtles are likely to be slight.

Hard-shelled sea turtle takes occur in the sea scallop dredge fishery but are predominantly observed in the Mid-Atlantic; leatherback interactions with this gear type have never been observed (see section 6.9.3.2). While gear modification requirements are in effect, they are located to the south of the areas encompassed by the No Action alternative, in areas where turtles are relatively more abundant. Given the distribution of takes noted above, and the limited overlap between the scallop dredge fishery and the monument, with respect to scallop dredge gear, slightly negative impacts on sea turtles are expected to result from continued implementation of the No Action management areas.

Leatherback, loggerhead, green, and Kemp's ridley sea turtles are known to interact with trap/pot gear, with interactions primarily associated with entanglement in vertical lines, although sea turtles can also become entangled in groundline or surface systems (see section 6.9.3.2 for more detailed information on interaction rates). Records of stranded or entangled sea turtles indicate that fishing gear wraps around the neck, flipper, or body of the sea turtle and severely restrict swimming or feeding, which can cause injuries and sometimes mortality immediately or at a later time (Balazs 1985, STDN 2016). Most of the documented trap gear interactions were with leatherbacks (STDN 2016). As described previously, trap gear could become more concentrated along other areas of the shelf break upon closure of the monument in 2023 (or sooner), thus increasing the density of vertical lines. If this concentration reduced catch rates, set times could increase, increasing the amount of time vertical lines are in the water. Both a greater concentration of vertical/groundlines and longer set durations could increase interaction rates. Thus, continued implementation of the No Action management areas could have slightly negative effects on sea turtles. Alternatively, if trap effort is reduced overall following implementation of the monument because there is no space to set additional trawls of traps, interactions with sea turtles might decline. Taking these factors into consideration, continued implementation of the No Action management areas could have slight negative to negative effects on sea turtles.

Overall, the impacts of No Action on sea turtles could range from negative to slightly negative.

7.2.2 Impacts of broad deep-sea coral zones and associated fishing restrictions

This alternative (section 4.2.1) would designate a large area of the shelf-slope and abyssal plain out to the EEZ as a deep-sea coral zone, with options for which gear types would be precluded from the zone (section 4.3, Table 58). There are five overlapping and mutually exclusive broad zone options under consideration, and only one may be selected by the Council. The options have their seaward boundary at the EEZ and their western boundary along the New England/Mid-Atlantic intercouncil boundary line. The landward boundaries are simplified versions of depth contours along the southern margin of Georges Bank, drawn by simplifying a depth contour derived from a 25 m spatial resolution bathymetry dataset, and are constrained to the depth contours 50 m shallower and deeper than the target depth. This alternative would be additive to No Action (i.e., Monkfish/MSB/Tilefish areas and the National Monument would remain in place) and could be selected in combination with other alternatives under consideration.

Broad zone landward boundary options are:

- Option 1: 300 m
- Option 2: 400 m
- Option 3: 500 m
- Option 4: 600 m
- Option 5: 900 m
- Option 6: 600 m minimum depth
- Option 7: Empirically-derived zone

Table 58 – Fishing restriction options relevant to the broad deep-sea coral zones

Fishing restriction options	Relevance to broad zones
Option 1: Prohibit all bottom-tending gears	Yes
Sub-option A: Exempt red crab fishery	Yes
Sub-option B: Exempt other trap fisheries	Yes
Option 2: Prohibit mobile bottom-tending gears	Yes

7.2.2.1 Impacts on deep-sea corals

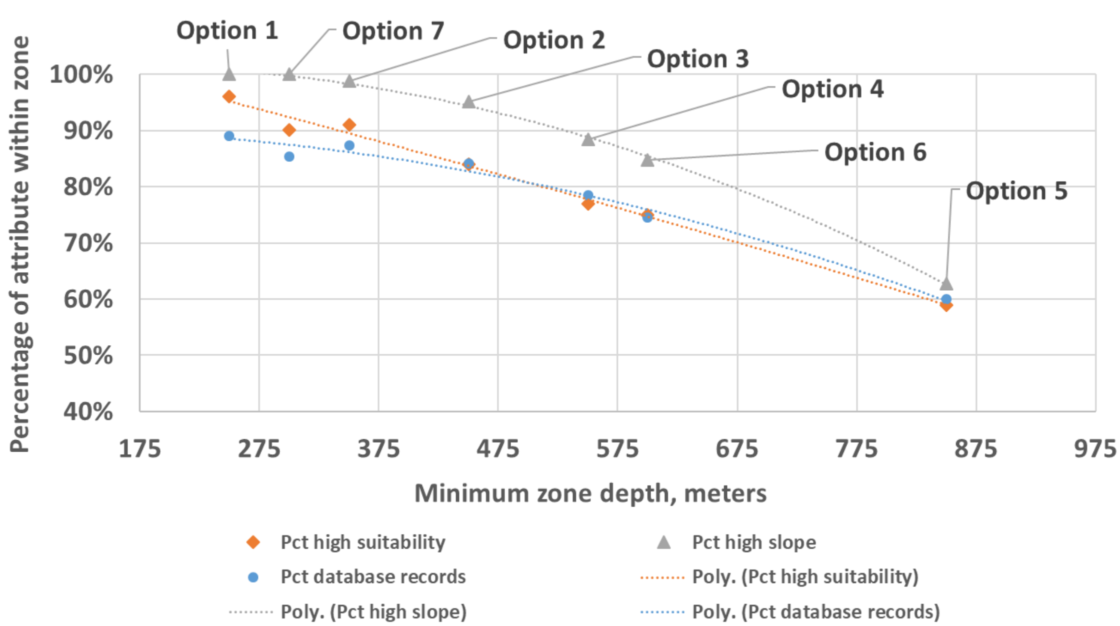
The broad zone options are extensive, covering the entire continental margin and the seamounts out to the EEZ boundary. Thus, the areas would provide comprehensive protection for coral habitats occurring throughout the New England portion of the continental margin, within the depths covered by each zone. The zones are nested, with the 900 m zone a subset of the 600 m zone, which is in turn a subset of the 500 m zone, and so on. The 600 m minimum zone (Option 6) is slightly smaller than the 600 m option (Option 4). The empirically-derived zone (Option 7) is closest in size and coral metrics to the 400 m zone. Data on coral distributions (Table 45), soft coral habitat suitability (Table 47), and area of high slope (Table 49) suggest that the positive impacts of the zone options on corals increase from the 900 m to the 300 m zone. These attributes are summarized in Table 59.

Table 59 – Summary of coral attributes for the broad zone options

Min. depth	Option#	# Coral records in zone[1]	% Coral records on continental margin	Area highly likely to be suitable habitat for soft corals in zone, km²	% High suitability habitat on continental margin	Area of high slope in zone, km²	% High slope on continental margin
250	Option 1 "300 m zone"	627	89%	4,582	96%	164	100%
350	Option 2 "400 m zone"	615	87%	4,354	91%	162	99%
450	Option 3 "500 m zone"	592	84%	4,042	84%	156	95%
550	Option 4 "600 m zone"	553	79%	3,700	77%	145	88%
850	Option 5 "900 m zone"	422	60%	2,821	59%	103	63%
600	Option 6 "600 m minimum zone"	525	75%	3,587	75%	139	85%
300	Option 7 "Empirically-derived zone"	601	85%	4,320	90%	164	100%

Note: Table 45 (coral records), Table 47 (habitat suitability), and Table 49 (high slope) have more details.
[1] There are roughly 1,100 records in this database for the entire New England region, 704 of which are below 100 m on the continental margin south of Georges Bank.

Figure 16 – Broad zone coral metric comparison. Data provided in Table 59.



Generally, all of the broad zone options would have positive impacts on corals, increasing with the size and shallowness of the zones and the extent of gear restrictions.

The 900 m zone, for example, encompasses about 60% of the high slope habitat, high suitability habitat, and historical database records from the continental margin, while the 300 m zone encompasses 100% of the high slope habitat and 96% of the high suitability habitat, and many of the coral database records (88%). The other depth options are intermediate to these. The 600 m zone, which has a boundary that falls between the 550 m and 650 m contours, encompasses 88% of the high slope habitat, 77% of the high suitability habitat, and 78% of the coral records along the continental margin. The 600 m minimum zone (Option 6) encompasses slightly fewer coral records, and less area of suitability habitat and high slope habitat relative to the 600 m zone, Option 4.

While the suitability model results are somewhat coarse resolution, and do not definitively indicate coral occurrence even in areas of high and very high predicted likelihood of occurrence, the high slope data appear to be more definitive, based on groundtruthing conducted during the exploratory surveys. Thus, the additional area of high slope encompassed by progressively shallower zone options likely represents additional coral habitats that would be set off limits from fishing. Specifically, Option 1 includes 164 km^2 of high slope habitat, while Option 2 includes slightly less high slope area (162 km^2) and Option 3 includes 156 km^2.

Option 7 was designed differently than the strictly depth-based zones, and as such its attributes cannot be directly nested with the other alternatives. Option 7 includes 601 out of 704 coral presence records (85%), 4,320 km^2 out of 4,973 km^2 of seafloor likely to be suitable habitat for soft corals (90%), and 164 km^2 (100%) of the known high slope habitat. By contrast, the preferred alternative Option 6 includes 525 (75%) of the coral records, 3,587 km^2 (75%) of the modeled suitable habitat, and 139 km^2 (85%) of the high slope area. Overall, Option 7 would protect more coral habitat than Options 4, 5, or 6, and protect similar amounts of coral habitat compared to Options 1, 2, and 3. Because the modified version of Option 7 was drawn to avoid areas of trawl gear fishing activity indicated by VMS data, it is unsurprising that 100% of the very high slope areas are encompassed, which is the same as Option 1, the 300 m zone. Habitat suitability and coral records percentages are slightly lower than Option 1 or Option 2, which is reasonable to expect as Option 7 is smaller.

When comparing across zones, the question becomes what is gained or lost by selecting shallower or deeper depths? In addition to less coverage of high slope habitat and other suitable habitats for soft corals at the deeper broad zone sites, dive transects conducted between the 600 m and 900 m zones confirm the presence of coral habitats in shallower areas. These shallower dives are described below. The remaining dive sites within the canyons occurred within the 900 m zone, i.e. deeper than 850 m. More details about the observations during these dives are provided in section 6.2.3.1. The dive locations are mapped in the section describing canyon alternatives (section 4.2.2.1).

- Veatch Canyon – Cruise HB1204 (2012), Dive 8 occurred in the area between 600 m and 900 m zones. This dive is just at the shallow edge of the 600 m and 600 m minimum zone boundaries. During this dive, only stony and soft corals were observed, and in a smaller percentage of the collected images compared with the other two dives in the canyon.

- Hydrographer Canyon – Cruise EX1304L1 (2013), Dive 6 occurred in the area between the 600 m and 900 m zones and falls within all zone options except Option 5, 900 m. During this dive, soft and stony corals were observed, including the stony coral *Lophelia pertusa*, which is relatively uncommon in New England.
- Dogbody Canyon – Cruise HB1504 (2015), Dive 1 occurred in the area between the 600 m and 900 m zones. Corals occurred but were uncommon at this site. The dive falls within Option 4 (600 m) but outside Option 6 (600 m minimum).
- Clipper Canyon – Cruise HB1504 (2015), Dive 19 occurred in the area between the 500 m and 600 m zones. Corals were sparsely distributed but could be locally abundant where found. Part of the dive track falls within Option 4, but it lies entirely outside Option 6.
- Sharpshooter Canyon – Cruise HB1504 (2015), Dive 16 occurred between the 600 m and 900 m zones, but no corals were observed.
- Welker Canyon – Cruise HB1504 (2015), Dive 13 occurred between the 600 m and 900 m zones. Corals were sparsely distributed but could be locally abundant where found. This dive is just at the shallow edge of the 600 m and 600 m minimum zone boundaries.
- Heel Tapper Canyon – Cruise HB1504 (2015), Dives 10 and 11 occurred between the 600 m and 900 m zones. At the shallower of the two dives, corals were sparse although locally abundant, and at the deeper site just shoal of the 900 m boundary, corals were abundant. The shallower dive is at the shallow edge and partly outside Option 6, but fully within Option 4.
- Oceanographer Canyon – A number of soft coral records collected with *DSV Alvin* occur between the 600 m and 900 m zones
- Filebottom Canyon – Cruise HB1504 (2015), Dive 7 occurred between the 600 m and 900 m zones. Corals were common and locally abundant. Part of the dive track is outside Option 6, but within Option 4.
- Chebacco Canyon – Cruise HB1504 (2015), Dive 4 occurred between the 600 m and 900 m zones. Corals were uncommon.
- Gilbert Canyon – Cruise HB1204 (2012), Dive 19, Dive 17 and a portion of Dive 14 occurred between the 600 m and 900 m zones. Corals were uncommon at Dives 14 and 19 but were common at the shallower Dive 17. Dive 19 is outside Option 6 (600 m minimum), but within Option 4 (600 m).
- Lydonia Canyon – Similar to Oceanographer, submersible collections indicated that soft corals occur in the area between the 600 m and 900 m zones.
- Munson Canyon – Cruise HB1302 (2013), Dives 14 and 15 occurred on the east and west walls, respectively. Corals occurred along both transects, and were abundant at the east wall site, but not the west wall site. Dive 14’s transect crosses the shallow boundaries of Options 4, 6, and 5.
- Nygren Canyon – Cruise EX1304L2 (2013), Dive 8 occurred between the 600 m and 900 m zones. Corals were present and there was a high diversity of fishes.
- Unamed Canyon – Cruise EX1304L2 (2013), Dive 10 occurred between the 500 m and 900 m zones. Corals occurred along the dive transect, including large

colonies of *L. pertusa*. The transect extends from the 500 m zone (Option 3) across the Option 4 and 6 zone boundaries.

- Heezen Canyon – Cruise EX1304L2 (2013), Dive 9 occurred between the 600 m and 900 m zones, at deeper depths, and corals were observed, including some very large colonies. During Cruise HB1402 (2014), at the Dive 1 site (depths of 569-668 m), vertical canyon walls were populated with numerous, large colonies of soft corals. The Dive 1 transect crosses the 600 m (Option 4) and 600 m minimum (Option 6) zone boundaries.

The extent to which these corals zones would be more precautionary, preventing the expansion of fishing further beyond the edge of the continental shelf in the future, vs. displacing existing fishing activity that could be impacting coral habitats, depends on the minimum depth of each zone and the type of fishing that might expand into deeper water in the future. Data provided in section 7.3.3 show how much overlap there is between fishing effort and the coral zones. Based on the feedback provided during the workshops, there is no or very limited fishing activity currently occurring in the 900 m zone. Thus, the 900 m zone (Option 5) is understood to be entirely precautionary, such that designation of the zone with any of the gear restriction options will have neutral impacts in terms of protection of coral habitats, at least in the short term. In the long term, a coral zone at this depth would prevent the expansion of fishing activities into deeper water and could therefore begin to have positive benefits. Positive, indirect benefits of such a designation could also result from increased public awareness of coral habitats, which could lead to increased demand for research on coral habitats and their ecological role.

Workshop participants suggested that lobster trapping occurs to 550 m, at least seasonally, but that other gear types are used to a maximum depth of 500 m, or less. This means that only red crab traps are presently fished within the Option 4/600 m (minimum depth of 550 m) and Option 6/600 m minimum zones. The red crab fishery is broad in geographic scope but limited in size (number of traps and vessels). Designating either of these zones as a closure to all bottom-tending gears, with an exemption for red crab traps, would have a neutral impact relative to baseline conditions, as fishing activities within the zones would not be forced to change from their presently understood distribution. In terms of precautionary management, designating either zone as a closure to all bottom tending gears with an exemption for the red crab fishery would have positive impacts, because the expansion of fishing into known coral habitats would be prohibited. Larger positive impacts would be associated with Option 4 vs. Option 6, based on the scores on the three coral metrics (coral presence records, area of predicted suitable habitat, and area of high slope). As a precautionary measure, Option A (bottom-tending gear restriction) would have positive impacts relative to Option B (mobile bottom-tending gear restriction only), because Option B would not preclude the expansion of trap, gillnet, and longline fisheries into the coral zone. Given the current distribution of fishing, these are hypothetical future impacts.

Based on VTR and VMS data and feedback received at the workshops, fishing activity decreases with increasing depth between 250 m (shallowest extent of Option 1, 300 m zone) and 550 m (generally deeper than the Option 3, 500 m zone boundary, and the minimum depth of Option 4, 600 m zone). These depths encompass activity in the lobster trap fishery, trawl fisheries for whiting and squid, and some gillnet and longline fishing for monkfish and tilefish, respectively. Aside from the lobster fishery, workshop participants suggested that the maximum depth fished by other gears is around 500 m. Given these activities, the 300 m, 400 m, and 500 m zones are expected to displace fishing with bottom tending gears that could have negative effects on coral habitats. This effort displacement would occur along the entire continental margin of New England, considering the spatial extent of these zones. Thus, designation of broad zones at 300 m, 400 m, or 500 m would have positive impacts on coral habitats occurring with the zones. As these zone boundaries increase in depth, there is a reduction in the amount of protection that would be provided to to deeo-sea corals and their habitat (Table 58, Figure 16).

Comparing zone options 1, 2, and 3, the overall trend of increasing coral protection associated with progressively shallower zones is clear. Relative to baseline conditions, zone 1 with fishing restriction option 1 will have the greatest positive impacts to corals, and zone 3 with fishing restriction option 2 will have the lowest positive impacts to corals. It is a bit difficult to evaluate the distribution of corals in relatively shallow waters given that exploratory survey work was generally focused in deeper areas, but corals were documented at shallower dives (see list above by canyon). On some dives, corals were found at low densities, but in other places local abundance was high. Given the deeper depth distribution of the larger, structure forming stony corals and the black corals, these shallower zones will mostly benefit soft corals.

7.2.2.2 Impacts on managed species and essential fish habitats

While there is interest in conservation of deep-sea corals for their own sake, i.e. their existence value, corals do provide habitat for fishes and other invertebrates. The species managed by the regional fishery management councils and Atlantic States Marine Fisheries Commission tend to be shallower water species. Thus, the shallowest broad zone at 300 m is the one most likely to encompass both corals and managed fishery resources that may use these corals as habitat. Progressively deeper zones encompass habitats used by fewer managed resources. Because the broad zones include vast areas of the abyssal plain, the vast majority of all of the broad zones by area are outside the depth ranges occupied by managed species.

Many benthic species managed by New England and Mid-Atlantic Fishery Management Councils are distributed entirely landward of the continental slope depths encompassed by the broad coral zones, but others do occur along the slope (Table 21). These include redfish, halibut, white hake, witch flounder, red hake, offshore hake, monkfish, smooth skate, thorny skate, barndoor skate, and red crab. Progressively shallower broad zones will encompass additional habitat for these species. By protecting benthic habitats from the adverse effects of fishing, all of the broad zones will have some degree of indirect, slightly positive impact on managed resources. but the shallower zones (Options 1, 2, 3, and 7) will have greater positive impacts. Except for offshore hake, small mesh groundfish (silver and red hake) occur in shallower waters than are encompassed by the 600 m and 600 m minimum zones (Options 4 and 6). Acadian redfish is also distributed outside the boundaries of Options 4 and 6. Thus, Options 4 and 6 afford protection for habitats occupied by a smaller range of species. Only a few managed fishery species, including witch flounder, monkfish, and red crab, are expected to occur within the deepest 900 m zone (Option 5). Therefore, this option likely has slight positive, indirect impacts on managed resources.

In addition to depth, the fishing restriction option associated with any given zone will affect the magnitude of positive impacts expected. A more comprehensive restriction on all mobile bottom-tending gears (Option 1) will have the greatest positive impact on managed species and their habitats. It is unlikely that an exemption for red crab traps (Option 1, Sub-option A) would have any significant effect on the magnitude of impacts because of the limited amount of effort associated with the fishery. An exemption that would allow lobster traps to be used (Option 1, Sub-option B) would reduce the magnitude of positive impacts. Option 2 would prohibit only mobile bottom-tending gears. This would reduce the magnitude of positive impacts relative to Option 1 with no exemptions, and would likely have similar impacts to Option 1, Sub-option B, as effort with other fixed gears including gillnets and longlines appear to be minimal in the coral zones as described in section 7.2.2.3 below. As a reminder, for boundary option 7, only gear restriction Option 2 was considered.

Because there are no dedicated fishery resource surveys on the continental slope, depth ranges for these species are somewhat poorly understood. It is possible that preferred depth ranges will change as ocean temperatures change in the future, as depth and temperature are closely related. This will likely affect fishing effort distributions, subject to management restrictions such as coral protection zones. Given these potential changes, the long-range projections about the benefits of different broad zones to managed species are uncertain.

7.2.2.3 Impacts on human communities

Under this alternative, a broad coral zone would be established along the southern margin of Georges Bank, with seven boundary options, plus options for which gear types would be precluded from the zone. This alternative would be additive to No Action (i.e., Monkfish/MSB/Tilefish areas and the National Monument would remain in place) and could be selected in combination with the overlapping discrete canyon and seamount zone alternatives under consideration.

The impacts of the broad coral zones on human communities are expected to be slightly negative in general, but only for the fisheries and communities that would be affected. Option 1 (300 m zone) would be substantially more constraining than Option 5 (900 m zone). These negative impacts would be additive to the negative fishery impacts of No Action. As with No Action, it is difficult to determine if fishermen would be precluded from fishing altogether or be able to shift effort to other areas.

The impacts to the fishing industry are expected to be negative, but less negative the deeper the broad zone option selected. The VTR and ASMFC analyses suggest that between $3.4M and $6.5M a year is generated from the 300 m broad zone. The uncertainty increases as depth increases, due to a divergence of the ASMFC survey and VTR results. For the 400 m broad zone, the estimates are expected to fall between $1.2M and $4.6M, as derived from the ASMFC and VTR analyses, respectively. The VTR estimates are taken as an upper bound on the estimate of revenue derived from lobster pots within the broad zones, and likely overstate revenue generated in the deepest broad zones.

Although the VTR and VMS provide similar exposure at the permit and ownership level for the 300 m broad zone, VMS likely presents a more realistic picture of fishing effort by bottom trawls, scallop gear and clam dredges, and separator and Ruhle trawls at deeper depths. The VMS data suggest effort for these gears drops off quickly in deeper water. For example, only an average of 3% of the VMS-derived effort estimated to fall within the 300 m broad zone also occurs within the 600 m broad zone.

VMS data are not included here for the gillnet, bottom longline, and other gear categories as they have not been processed. Nevertheless, the VTR analysis suggests that only a very small amount of bottom longline and gillnet activity occurs within the broad zones. Though the other gear category does suggest relatively substantial revenue from the broad zones in certain years, this revenue is primarily generated from scallops. Given previous discussions regarding the depth distribution of scallops, Since it is known that the scallop fishery does not extend on to the continental slope, this estimate is due to the imprecision of the VTR data rather than actual fishing activity.

VMS coverage for MBTG trips with VTR locations overlapping the Option 7 area is high (Table 60) and can be used to assess the spatial extent of fishing within the region. The VMS analysis suggests very low levels of overlap by MBTG with Option 7 and suggests that the VTR analysis (Figure 23, Figure 30) overestimates exposure. The same can be said for Option 6, suggesting that the estimates should provide valid relative estimates of overlap across these alternatives. As expected, because it encompasses additional area, Option 7 has more MBTG revenue and effort attributed to it than Option 6.

Notably, many of the top 20 exposed owners in the 2013-2015 VTR data have no VMS data in the years covered by the analysis (the VMS dataset used to tabulate hours fished goes through 2012 only and a direct match for the same time period cannot be established). Trips by these permits are predominantly (i.e., ~65% of revenue) landing silver hake, inshore longfin squid, and butterfish. Thus, although individuals with VMS coverage have much lower VMS exposure estimates when compared to VTR estimates, there seems to be a systematic under-representation for the most highly exposed owners in the VMS data evaluated here, concentrated on fishing for species known to occur along the shelf break. This adds uncertainty to the analysis. Nevertheless, Option 7, when applied to only MBTG, is expected to have neutral to slightly negative impacts to fishermen.

The sociocultural impacts associated with establishing a broad coral zone are expected to be negative for fishermen and fishing communities, and negative relative to No Action. With effort shifts, conflicts within or between fisheries would have a negative impact on the *Non-Economic Social* aspects and the *Attitudes, Beliefs, and Values* of fishery participants. Establishing the zone may change the *Social Structure and Organization* of communities as well as *Historical Dependence on and Participation* in the fishery by individuals and communities. The industry input from the NEFMC coral workshops was that having a depth-based coral zone would be simpler for fishermen to work with, as opposed to closing discrete canyons (NEFMC 2017), so in this regard, there may be more positive impacts on *Attitudes, Beliefs, and Values* of the fishermen towards management. Deep-sea corals have cultural value to society, so affording them protection has positive impacts on the *Attitudes, Beliefs, and Values* of stakeholders towards management.

7.2.2.3.1 **Potentially affected fisheries**

Relative to the No Action areas, the broad zones encompass a greater fraction of the continental slope and canyon region south of Georges Bank. Due to data limitations, it is impossible to know the true amount of fishing activity that has occurred within the broad zone areas. Multiple approaches are used to estimate fishing activity, and thus characterize the potential fishery impacts of the broad zone coral protection alternatives.

VTR analysis

Vessel Trip Report data were used to estimate recent (2010-2015) fishing activity within the broad zone areas. With the exception of lobster trap gear, revenue results were unscaled. Because a large number of lobster vessel operators are not required to submit VTRs (their vessels do not carry other federal permits), total lobster revenue was expanded (method explained in section 7.1.3). As expected, due to their larger size, more gear types, species fished, and fishery revenue is attributed to the broad zones relative to the No Action areas. Maps of revenue by gear type and species in Appendix F give a sense for which species and gears intersect with the broad zones.

As with the No Action areas, bottom trawl, lobster pot, other gear, and scallop/clam dredge gears are the major revenue generators in these broad zones. Longline gear is also attributed to the broad zones and encompass enough vessels that confidentiality concerns do not preclude reporting, as with the No Action zones. The ‘other gear’ category shows a spike in 2014, which is due to increased revenue from red crabs.

Revenue by gear: Broad zone revenues by gear type are summarized in Figure 17 (Option 1), Figure 18 (Option 2), Figure 19 (Option 3), Figure 20 (Option 4), Figure 21 (Option 5), Figure 22 (Option 6), and Figure 23 (Option 7). Total bottom-tending gear revenue attributed to the 300 m broad zone option, and affected by fishing restriction Option 1, is about $10-15M annually, averaging $12M (Figure 17). As expected, total revenue decreases progressively with depth of the broad zone options; about $7-11M (annually) is attributed to the 900 m zone, averaging $8M (Figure 21). The majority of the revenue is attributed to lobster pot gear, which would be exempted under fishing restriction Option 1, Sub-option B. While most of the value is likely due to lobster, this revenue includes other species such as Jonah crab landed with lobster pots. In the 300 m zone, lobster gear revenue is estimated at $5-7M annually based on these data, followed by bottom trawl revenue (Figure 17). The relative proportions of lobster pot and bottom trawl are similar across all broad zones. In the 300 m zone, scallop gear and clam dredges contribute $2-3M in revenue during most years. These values decline slightly with zone depth. In reality, neither scallops nor clams occur in any abundance at the depths of the broad zones (≥ 250 m). Thus, the revenues attributed are likely generated in shallower waters, but attributed to the broad zones due to spatial imprecision in the VTR data. There is also uncertainty in the depth contours in a few locations (e.g., just west of the EEZ boundary), but the imprecision in the VTR data is likely the more important reason for the inference of dredge revenues in the broad zones. The recent revenue attributed to fishing with MBTG from the 300 m zone, and thus affected by fishing restriction Option 2, averages 44% of the total, or $5M annually.

Between 2010 and 2015, based on the VTR data, an average of 840 bottom trawl trips fished within the vicinity of Option 7, making it the dominant MBTG. Scallop and clam dredge trips follow (128 trips), and Separator & Ruhle Trawl is substantially lower (averaging 85 trips). Permit numbers (i.e., number of vessels overlapping the area) across gear types follow similar patterns, though there is substantial interannual variability in both trips and permits.

Revenue by species: Broad zone revenues by species are summarized in Figure 24 (Option 1), Figure 25 (Option 2), Figure 26 (Option 3), Figure 27 (Option 4), Figure 28 (Option 5), Figure 29 (Option 6), and Figure 30 (Option 7). The largest revenue estimates are attributed to lobster, Jonah and red crab, silver hake, longfin squid, and sea scallop. Fishing restriction Option 1 Sub-option A would mitigate the impact on the red crab fishery, while fishing restriction Option 1 Sub-option B would mitigate the impact on Jonah and red crab, as well as lobster. Other species (within the top ten) include butterfish, summer flounder, haddock, and monkfish, and all have some interannual variation. Revenue from butterfish is only notable during the years 2013-2015. Because allocations in the butterfish fishery have increased, these recent numbers are expected to better reflect conditions moving forward. As noted previously, there was a spike in red crab revenue during 2014. While total revenue across all species declines from the 300 m to the 900 m zones, the relative proportions by species are similar - consistent with revenue by gear type. Fishing restriction Option 2 would see the crustaceans replaced in the top ten with yellowtail flounder, Illex squid, and skates.

The top ten species by landed value for Options 6 and 7 are consistent with those of the other broad zones, excepting the addition of Atlantic Mackerel and removal of Skates for Option 7. Annual MBTG revenue attributed to Option 7 averages 12% higher than Option 6. This revenue is dominated by bottom trawl (67% of estimated revenue), followed by scallop gear and clam dredge (31% of estimated revenue), with minor revenue attributed to separator and Ruhle trawls (2% of estimated revenue). Given prevailing knowledge of scallop depth distributions, and spatial imprecision of bottom trawl VTRs, there is a strong likelihood that the VTR derived revenue estimate is high, and VMS data are used below to further assess effort distribution. As the same can be said for Option 6, the estimates should provide valid relative estimates of exposure across these alternatives, though the magnitude is expected to be imprecise.

Owners and permits: Total unique permits attributed to the 300 m broad zone option averages 376 annually. As expected, total permits decrease progressively with depth of the broad zone options; with an annual average of 325 attributed to the 900 m zone. Since 2012, the number of scallop permits with revenue attributed to the broad coral zones is around 200 annually, or about half of the total. While this could indicate that a substantial fraction of the fishery (which currently has around 350 full-time-equivalent permits) operates in the vicinity of the coral zones, as noted above, this may be an artifact of the VTR analysis. Trawl and lobster trap trip totals are similar (noted above), but the lobster trips are attributed to fewer unique permits. For example, during 2014 and 2015, fishing with about 50 lobster trap permits vs. 100 bottom trawl permits per year is attributed to the broad zones. Fishing restriction Option 1 Sub-option B would mitigate any impacts on the lobster pot fishery.

Percent revenue by owner across all gear types is summarized in Figure 31 (Option 1), Figure 32 (Option 2), Figure 33 (Option 3), Figure 34 (Option 4), Figure 35 (Option 5), and Figure 36 (Option 6). Similar plots for just mobile bottom-tending gears are shown in Figure 37 (Option 1), Figure 38 (Option 2), Figure 39 (Option 3), Figure 40 (Option 4), Figure 41 (Option 5), Figure 42 (Option 6), and Figure 43 (Option 7). For all gears combined, the number of permit owners with revenue attributed to the 300 m coral zone fishing restriction Option 1 averages 222 annually, decreasing to an average of 197 in the 900 m zone. Across all six broad zones, considering all bottom-tending gears, or just mobile bottom-tending gears, the median percent of total annual revenue for permit owners attributed to fishing within the broad zones hovers around zero.

However, there are outliers, regardless of zone depth, whose inferred percent annual revenue values are between 5-10%, and over 60% in a few cases. Acknowledging that the VTR data are spatially imprecise; these larger percentages indicate that, at the owner level, there are some fishing businesses that focus a significant fraction or even a majority of their annual effort in the vicinity of the coral zones. When focusing solely on revenue generated from MBTG, consistent with fishing restriction Option 2, the number of permit owners in the 300 m coral zone drops to an average of 168 owners, while the 900 m broad zone averages 148 owners. Although the overall magnitude of exposure is somewhat less, the MBTG exposure levels again indicate low levels of exposure for the majority of owners, with a small number of permit holders estimated to have generated a substantial portion of their revenue from the broad zones.

VTR vs. VMS comparison

Between 2010 and 2015, total VTR trips with some portion of their spatial footprint, and thus, revenue, attributed to the 300 m broad zone option averages 2,190 annually. As expected, the total number of trips decreases progressively with depth of the broad zone options; an annual average of 1,893 is attributed to the 900 m zone. The number of trips using bottom trawl and lobster traps, attributed to each broad zone, is roughly equivalent and comprise the majority of trips. A few hundred trips per year are taken with scallop gear, clam dredge, and sink gillnet that are estimated to overlap the broad zones. A smaller number of trips overlap that are using separator and Ruhle trawls, bottom longlines, and other gears.

For each broad zone, the percent of VTR trips with Vessel Monitoring System (VMS) data in 2010-2012 is high for scallop dredge (85-97%), bottom trawl (87-94%), and Separator and Ruhle trawl trips (71-85%; Table 60). For these gears, the VMS analysis represents fishing effort at a much more refined scale than VTR and covers the vast majority of trips in the region. The same cannot be said for lobster pot and other gears, whose low level of VMS coverage (0-15%) could result in substantial misrepresentation when extrapolating the VMS results to the entire fleet.

Figure 44 through Figure 57 show the percentage of a permit's effort (hours fished) that overlap the coral zones. Data for all bottom tending gears are in Figure 44 (Option 1), Figure 45 (Option 2), Figure 46 (Option 3), Figure 47 (Option 4), Figure 48 (Option 5), Figure 49 (Option 6), and Figure 50 (Option 7). Figure 51 (Option 1), Figure 52 (Option 2), Figure 53 (Option 3), Figure 54 (Option 4), Figure 55 (Option 5), Figure 56 (Option 6), and Figure 57 (Option 7) present the permit-level MBTG effort exposure, as derived from VMS data, which would be affected by fishery gear restriction Option 2. Similar to the VTR percent revenue by owner plots, the percentage effort values are generally very low, with a small number of outliers.

Given the high VMS coverage for bottom trawl, scallop & clam dredge, and separator and Ruhle trawls in this region, the estimates of fishing activity exposed for these gears are better assessed through VMS rather than VTR. Due to the low coverage of lobster pot fishing in the region, the VMS provides a lower bound, while VTR provides an upper bound, on the uncertainty regarding the trips and permits historically fishing within the broad zones under consideration. For sink gillnets and bottom longline, only the VTR analysis is currently available.

Some differences between these VMS results and the VTR data presented in Figure 31 to Figure 43 would be expected, given the latter are calculated at the owner group level, which can include multiple permits. For the 300 m broad zone, the VTR analysis indicates that the vast majority of owner groups have below 5% of their revenue falling within this option between 2013 and 2015, although some owners are exposed at a much higher level. A comparison with the VMS analysis of permit-level effort falling within the management action indicates a somewhat lower level of dependence on this region for 2005 – 2012, except 2008, which is more consistent with the VTR.

Generally, the VMS data suggest a much steeper decline between broad zones, in terms of hours fished, when compared with the decline shown in the VTR (Table 61). This is likely due to the spatial imprecision of the VTR, which does not support differentiating areas with boundaries so close together. Pot/trap effort also shows a fairly steep decline across the 300-900 m zones in the VMS data, but sample sizes are fairly small, so it is difficult to ascertain whether these results apply more broadly across all fishermen using traps, including those whose vessels do not have VMS polling. The low VMS coverage rate for trap gear is a source of substantial uncertainty regarding the overall exposure metric as derived from this dataset. In contrast, VMS data provide useful information about scallop dredge effort. VMS estimates of scallop dredge hours fished are very low in all broad zones, despite relatively substantial revenue estimates in the VTR data. Given the complete VMS coverage in the scallop fishery, this suggests that the broad coral zones are not actually important scallop grounds, but rather, lie adjacent to fishing grounds in shallower water on Georges Bank. Although the most highly exposed permits tend to be fishing with pot gear, there are a small number of individuals employing substantial MBTG effort within the 300 m broad zone, in particular. The MBTG effort drops off more quickly than the lobster pot effort when moving into successively deeper coral zone options.

Of note is that some of the most highly exposed individual owners identified in the 2010-2015 VTR data set were not covered in the VMS data set, which includes data from 2005-2012. For example, in the 300 m broad zone, 19 of the top 20 exposed MBTG owners in 2013, 14 of the top 20 in 2014 and 10 of the top 20 in 2015 are not represented in the VMS data (Figure 51-Figure 57). The vast majority of revenue on these owners' trips are generated from species known to occur along the shelf break. For example, in the 300 m broad zone, 60% of these owners' revenue is generated from silver hake and inshore longfin squid. Although the under-representation of the most exposed owners in the VMS generates additional uncertainty, both the VMS and VTR analyses consistently indicate some small number of individuals highly exposed to the 300 m broad zone option. It is also likely that the drop-off in effort as represented in the VMS likely represents the relative exposure of fisheries to these zone options more realistically than the VTR analysis.

Of trips with a match in the VMS and VTR datasets, the VMS data indicates only 11% of bottom trawl trips and 30% of permit holders have polls within the bounds of Option 7. Although the VMS indicates that at least 23% of the scallop and clam dredge trips and 25% of permits identified in the VTR report VMS polls within Option 7, the probability-weighted fishing effort expended by both LA and GC scallop vessels in the region averages very close to zero. Bottom trawl effort is also very low, when compared to the gear's total fishing effort (Table 62).

Figure 50 shows the percentage of a permit's MBTG effort estimated to fall within Option 7 durign the period 2005-2012. VMS presents a very low exposure relative to the VTR (Figure 43). As summarized earlier in this memo, of note is that 19 of the top 20 exposed owners in 2013, 10 of the top 20 in 2014, and 7 of the top 20 in 2015 have no VMS data in those years. Trips by these permits are predominantly (~65% of revenue) landing silver hake, inshore longfin squid, and butterfish. Thus, although individuals with VMS coverage have much lower VMS exposure estimates when compared to VTR estimates, there does seem to be a systematic under-representation for the most highly exposed owners in the VMS, and the exposure is concentrated on fishing for species known to occur along the shelf break, which adds uncertainty to the analysis.

ASMFC survey

The ASFMC survey of Area 3 lobster permit holders (section 7.1.3.1) indicates that, for the offshore component in 2014 and 2015, 33% of effort and 28% of revenue ($3.4-4.5M) was estimated to be derived from lobster fishing at depths below 300 m (Table

51). For depths below 400 m, fishing effort and revenue drops off to 6.1% and 4.8% ($0.8-1.2M), respectively. It was estimated that the 300-400 m depth interval may have the highest density of fishing activity for the offshore fishery. The revenue estimates from the survey roughly approximate the results of the VTR analysis for the 300 m zone (Figure 24) but are lower for the 400 m zone (Figure 25). Notably, of the 19 respondents who indicated that they fished in the area of interest, 42% set their deepest traps in waters shallower than 400 m (ASMFC 2017).

Although Option 7 would not restrict lobster fishing, a MBTG restriction may allow for the expansion of the lobster fishery into previously trawled areas. Although Option 7 was designed to be outside the current footprint of the trawl fisheries, the VTR and VMS data suggest that there may be some overlap.

The ASMFC survey results rely on a small, voluntary sample of self-reported data. Thus, it is difficult to know how the results accurately represent the fishery as a whole. Lobstermen reported that they have fished the same areas for many years; each lobsterman tends to remain in his own territory. This is consistent with the VMS analysis, which indicated that a small number of permit owners rely on the broad zones for a substantial portion of their total revenue (Figure 31).

NEFMC workshops

The industry input from the NEFMC coral workshops was that, due to the distribution of target species, the trawl fishery is active out to depths of about 500 m, the lobster fishery to 550 m, and the red crab fishery to 800 m. However, vessels tending fixed gear could be located in deeper waters, due to the length of fixed gear end lines necessary for fishing these depths, slope steepness or ocean conditions. Mobile gear fishing vessels could also be located in deeperwaters while setting out or hauling back gear. A coral scientist indicated that a reason why exploratory dives do not occur shallower than about 490 m is due to the potential for interaction with fishing vessels (NEFMC, 2017). Thus, the following options may be most constraining for the fisheries (without a specific gear exemption): Options 1 and 2 for the trawl fishery, Options 1-3 for the lobster fishery, and Options 1-4 and 6 for the red crab fishery.

The workshop discussed the potential to adjust effort relative to a closure. Shifting effort to areas remaining open may be difficult for displaced fishermen. The industry attendees indicated that the trawl and lobster fishermen have developed agreements over time about sharing fishing grounds, so it may be difficult for lobstermen to fish in shallower depths. Due to the distribution of red crab, its fishery shifts seasonally along the shelf edge and is less constrained by potential gear conflicts. The participants indicated that the lobster fishery is territorial; a specific area (e.g., canyon) may only have been fished by a handful of lobstermen (NEFMC, 2017), an observation consistent with Acheson (2006) and the VTR analysis that indicates that there are a small number of vessel owners that are particularly dependent on the areas under consideration (Figure 31 to Figure 35).

Option 7 may have little actual overlap with the MBTG fisheries, despite overlap in the VTR and VMS data, as it was developed by combining these stated depths with information about the occurrence of fishing activity in specific locations. In areas where fishing with MBTG was not indicated, the Option 7 boundary is shallower than the maximum depth fished by MBTG (500 m), as suggested at the workshops.

Impacts additive to Restricted Gear Areas I – IV

The Restricted Gear Areas I-IV on the southwestern flank of Georges Bank (section 6.7, Map 43) are intended to reduce gear conflicts as lobster vessels move their traps to follow the seasonal migration of lobsters (deeper waters in winter, shallower in summer). The seaward areas prohibit trawl gear in winter and trap gear in summer, and the landward areas the reverse, prohibiting trawl gear in summer and trap gear in winter.

The overlap of the broad coral zones with the GRAs decreases with depth:

- The southern portions of the deeper Restricted Gear Areas I and II overlap the 300 m broad coral zone. If the 300 m zone option is selected, the fishery impacts would depend on which fishing gear restriction option is also selected. If mobile bottom-tending gear is prohibited 300 m or deeper, the available area for the summer trawl fishery in Areas I and II narrows to between the boundary with Areas III and IV and the 300 m broad zone boundary. If trap gear is prohibited 300 m or deeper, the available area for the trap fishery narrows in winter, to between the boundary with Areas III and IV and the 300 m broad zone boundary. The 400 m broad coral zone is generally deeper than the southern boundaries of Gear Restricted Areas I and II. If the 400 m zone option is selected, the fishery impacts would, again, depend on which fishing gear restriction option is selected, but the areas within Areas I and II available for the trap fishery in winter and trawl fishery in summer would be reduced by a small amount.
- The 500-900 m zones are almost entirely deeper than the Restricted Gear Areas, so the areas within the Areas available to mobile and fixed gear would not change if one of these options is selected – though the available area outside would.

With these fishing area reductions, there may be increased gear conflict among mobile and fixed gear fishermen, perhaps more than between gear types, as the Gear Restricted Areas - measures to separate the gear types - would continue. Any effort shifts that may result from selecting one of these options would be limited by these existing restrictions.

The Option 7 coral zone is deeper than the Restricted Gear Areas, except for small sections of the zone in certain locations that overlap with areas I and II. These areas of overlap are in the heads of Veatch, Hydrographer, Dogbody, and Clipper Canyons, as well as small areas between Veatch and Hydrographer Canyon. Veatch Canyon is within the Tilefish Gear Restricted Area, so it is already closed to mobile bottom tending gear. Option 7 would have additional fishery impacts within the other areas. Where mobile bottom-tending gear would be prohibited by Option 7, the available area for the summer trawl fishery in Area I narrows. The areas available for the winter trawl fishery (Areas III and IV) would not be impacted by Option 7.

Figure 17 – VTR-derived revenue by gear type attributed to the Option 1 300 m broad coral zone, 2010-2015.

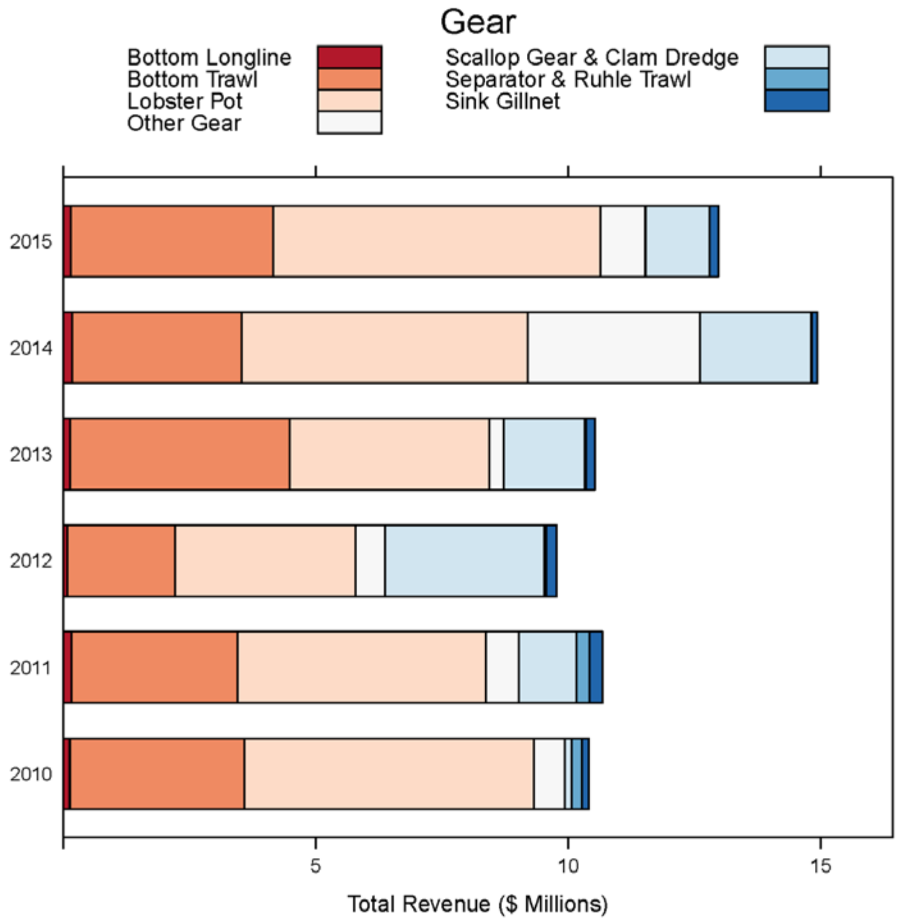


Figure 18 – VTR-derived revenue by gear type attributed to the Option 2 400 m broad coral zone, 2010-2015.

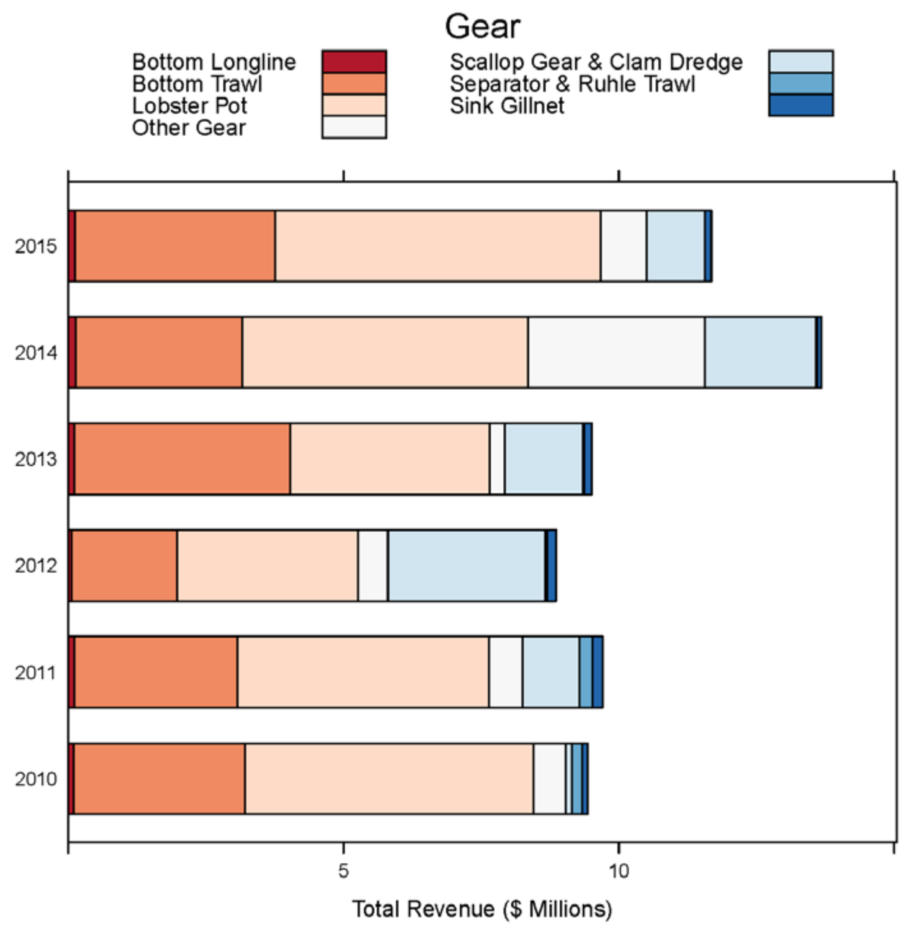


Figure 19 – VTR-derived revenue by gear type attributed to the Option 3 500 m broad coral zone, 2010-2015.

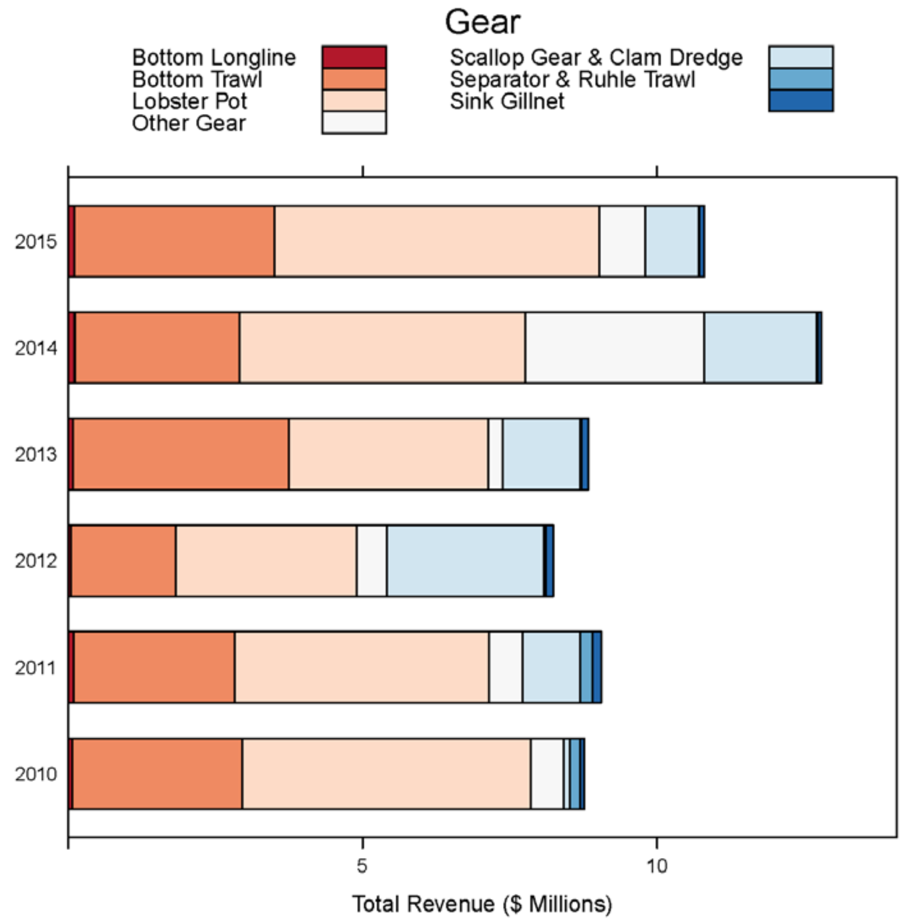


Figure 20 – VTR-derived revenue by gear type attributed to the Option 4 600 m broad coral zone, 2010-2015.

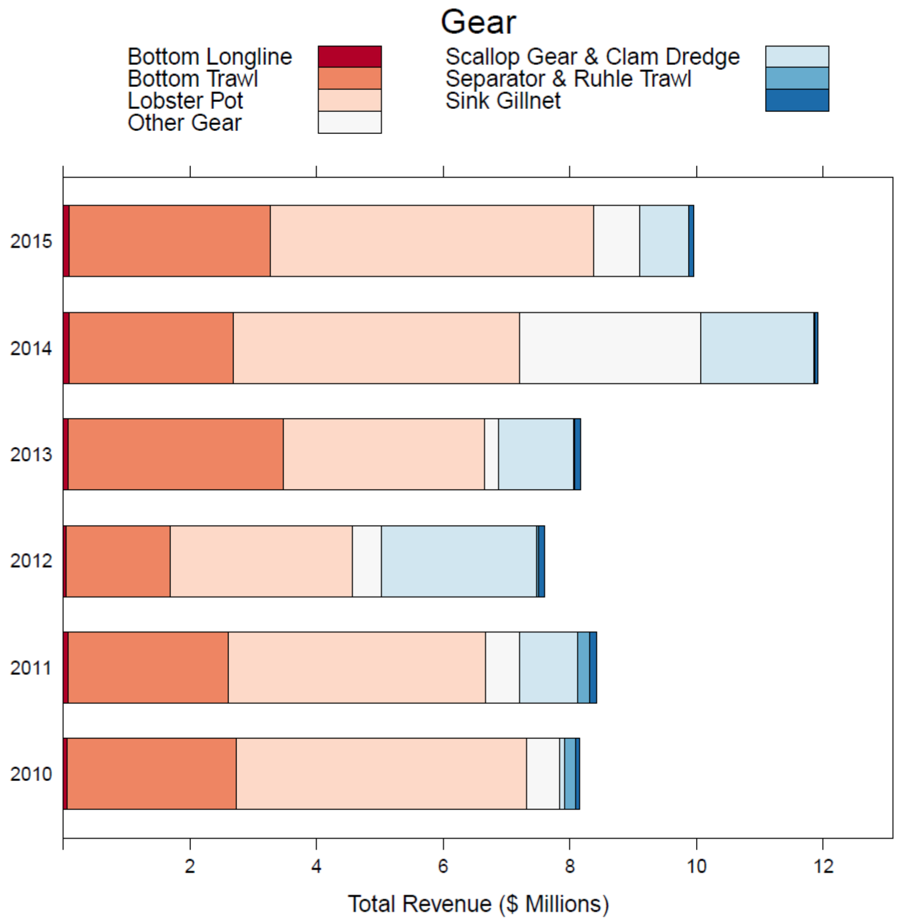


Figure 21 – VTR-derived revenue by gear type attributed to the Option 5 900 m broad coral zone, 2010-2015.

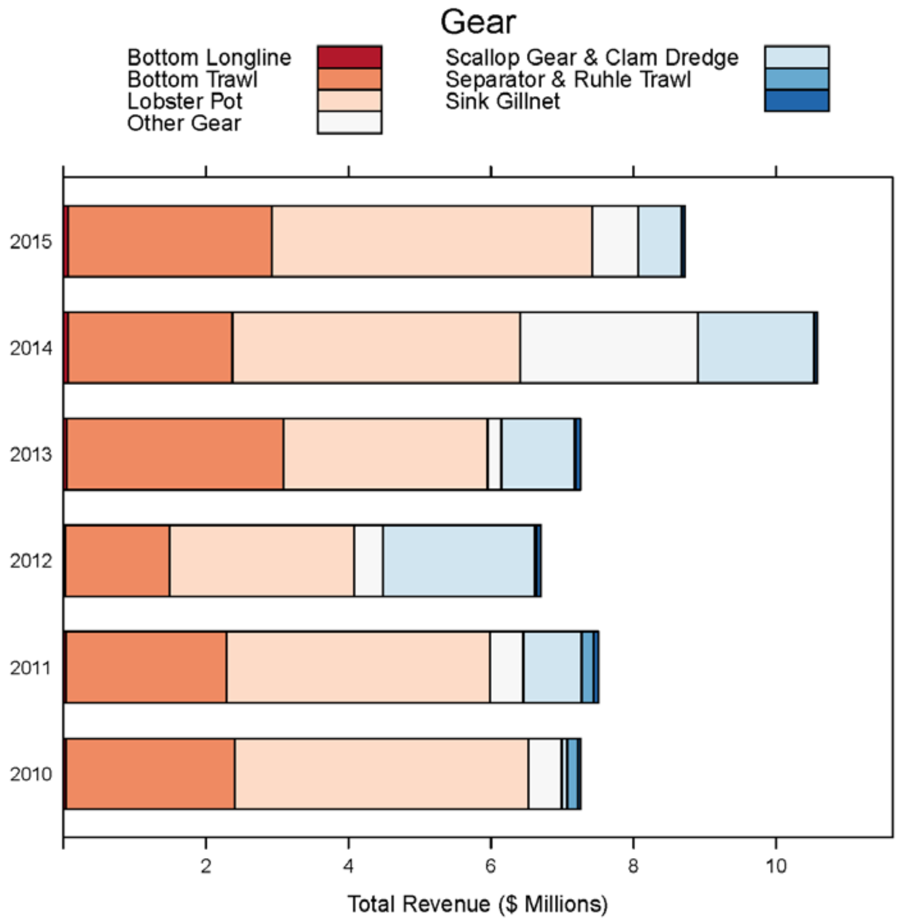


Figure 22 – VTR-derived revenue by gear type attributed to the Option 6 600 m minimum broad coral zone, 2010 – 2015.

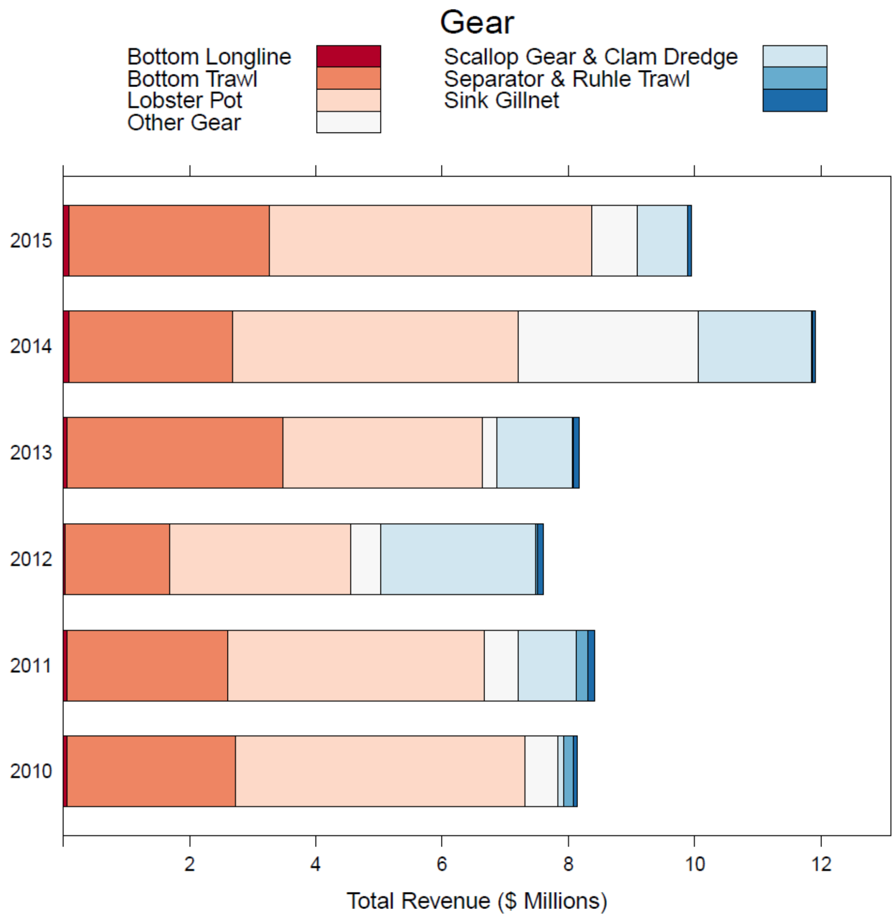


Figure 23 – VTR-dereived revenue by gear type attributed to Option 7 coral zone, 2010-2015. MBTG only.

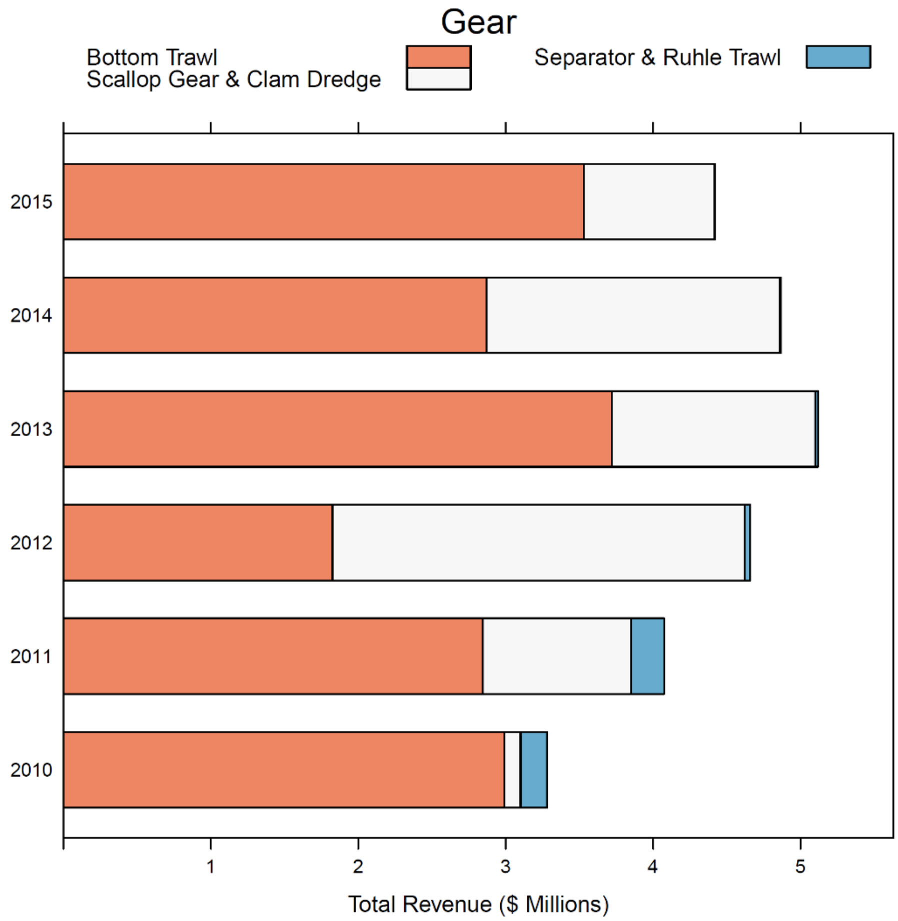


Figure 24 – VTR-derived revenue by species (top 10) attributed to the Option 1 300 m broad coral zone, 2010-2015.

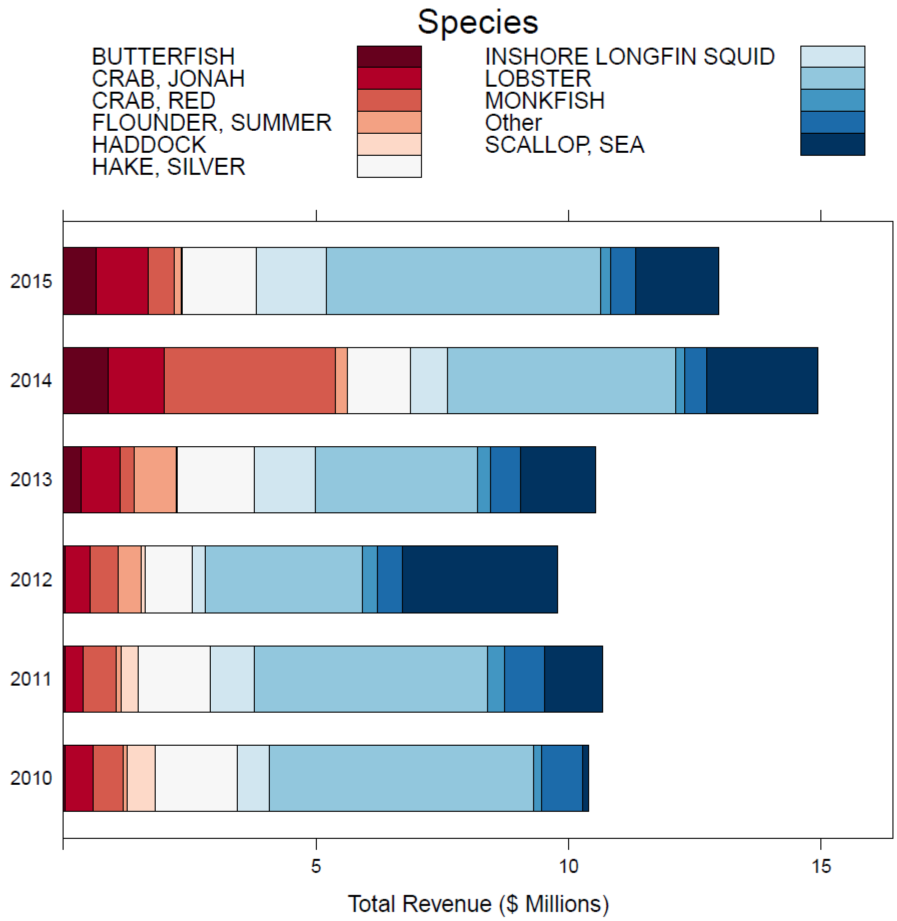


Figure 25 – VTR-derived revenue by species (top 10) attributed to the Option 2 400 m broad coral zone, 2010-2015.

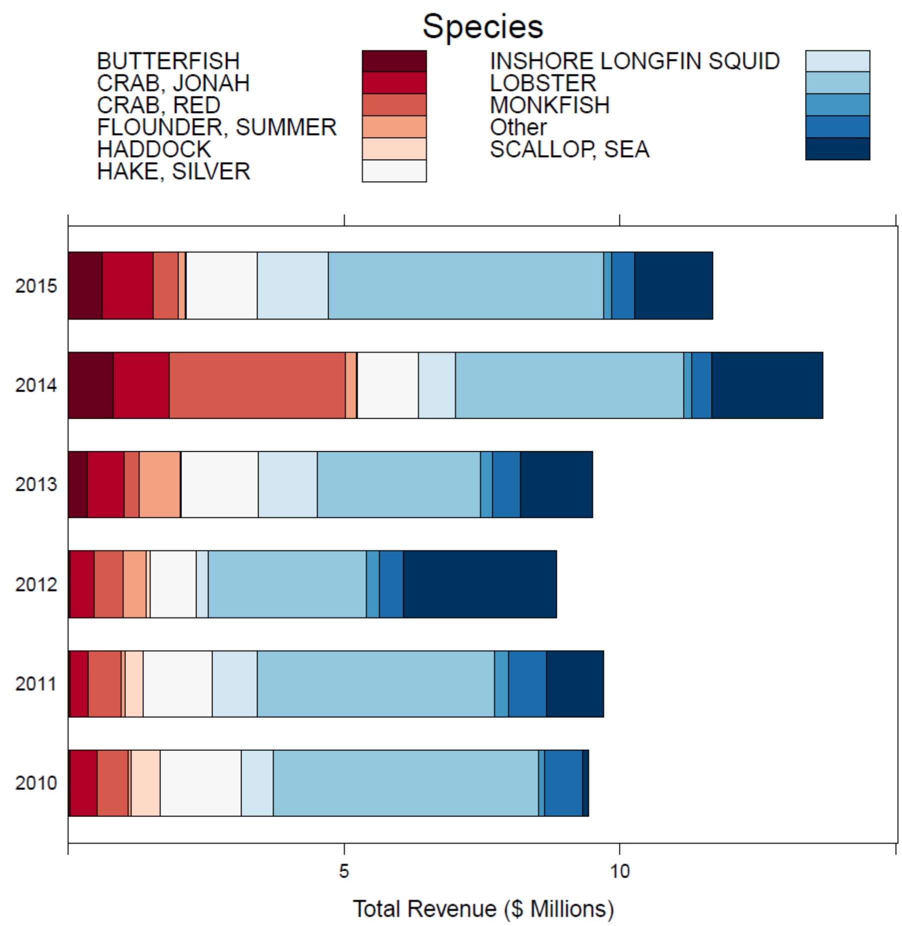


Figure 26 – VTR-derived revenue by species (top 10) attributed to the Option 3 500 m broad coral zone, 2010-2015.

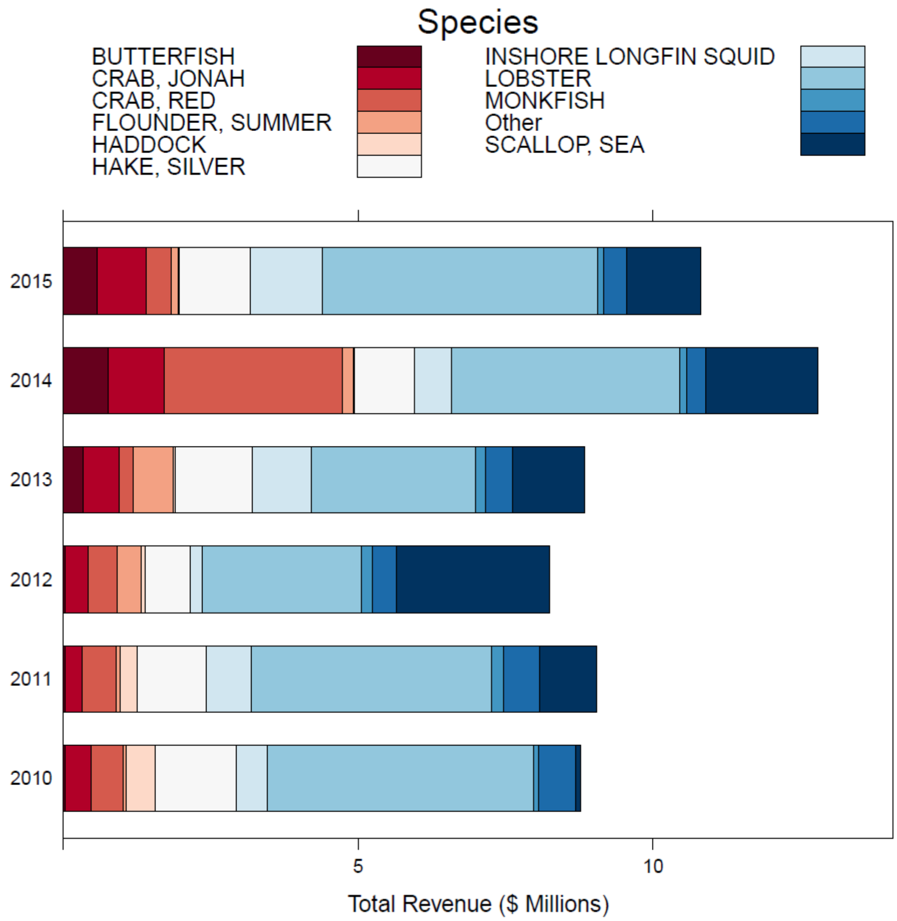


Figure 27 – VTR-derived revenue by species (top 10) attributed to the Option 4 600 m broad zone, 2010-2015.

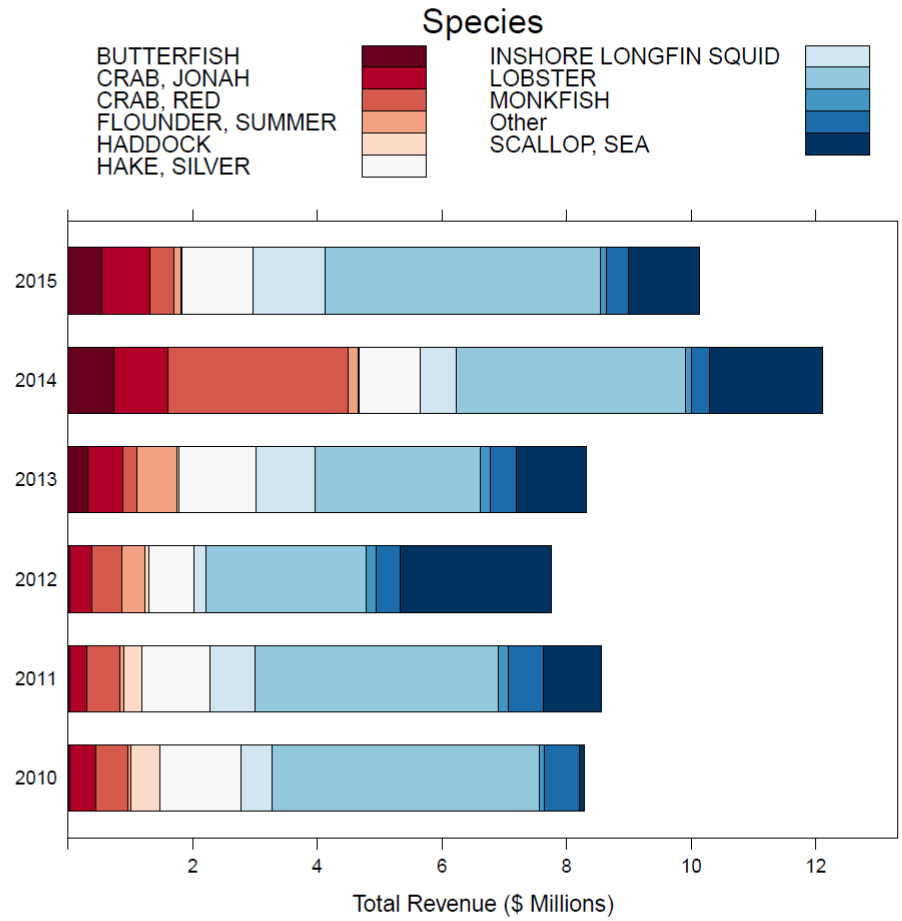


Figure 28 – VTR-derived revenue by species (top 10) attributed to the Option 5 900 m broad zone, 2010-2015.

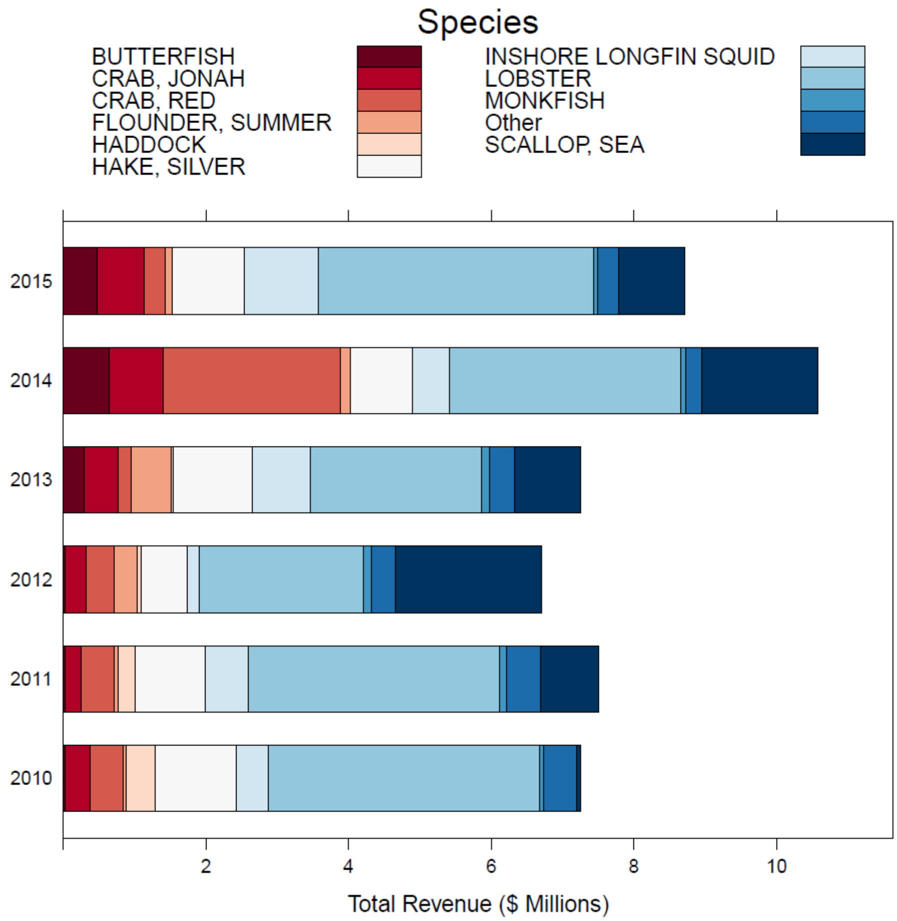


Figure 29 – VTR-derived revenue by species (top 10) attributed to the Option 6 600 m minimum broad zone, 2010-2015.

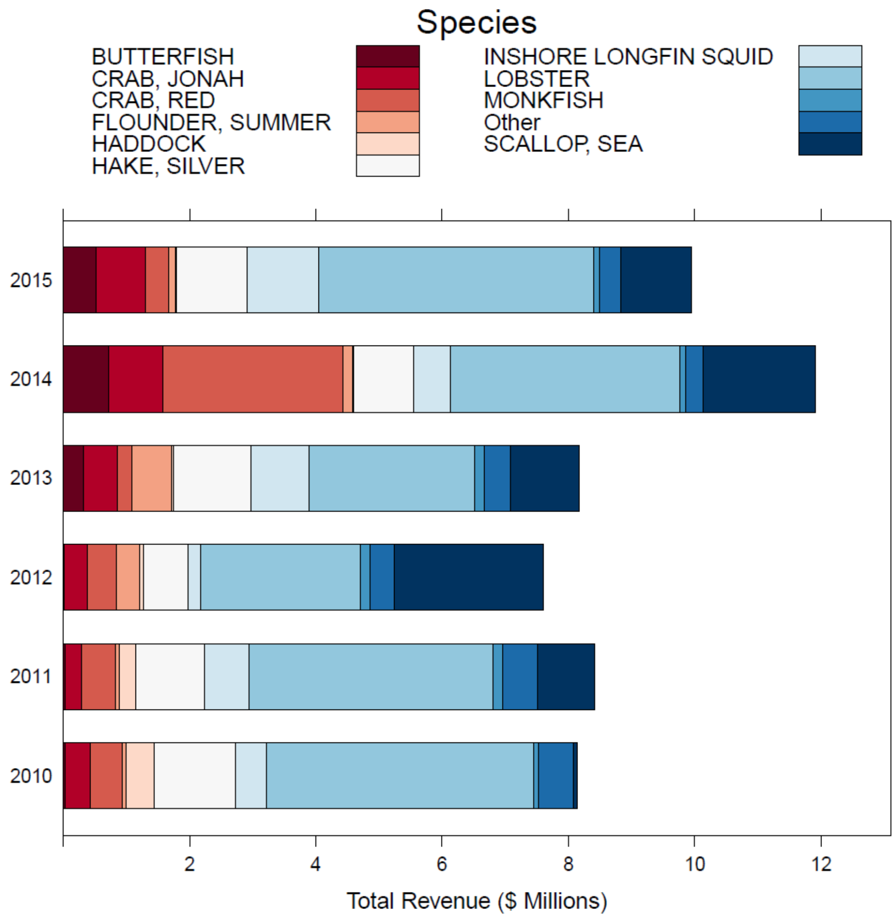


Figure 30 – VTR-derived revenue by species (top 10) attributed to the Option 7 coral zone, 2010-2015. MBTG only.

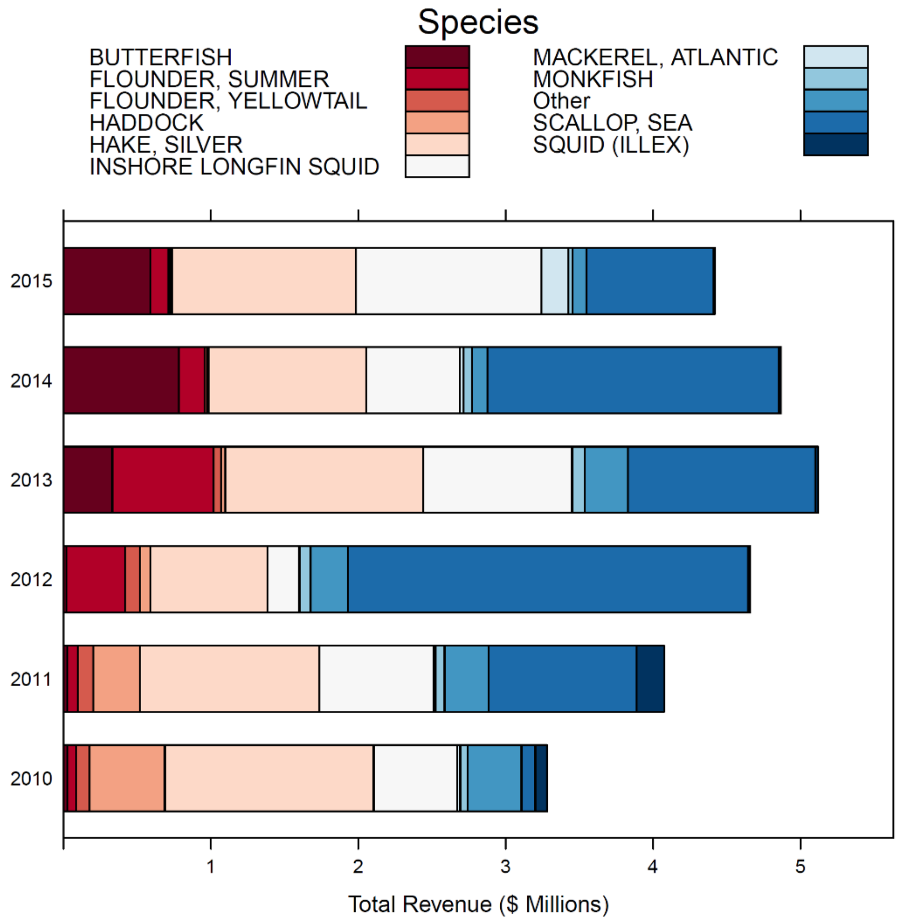
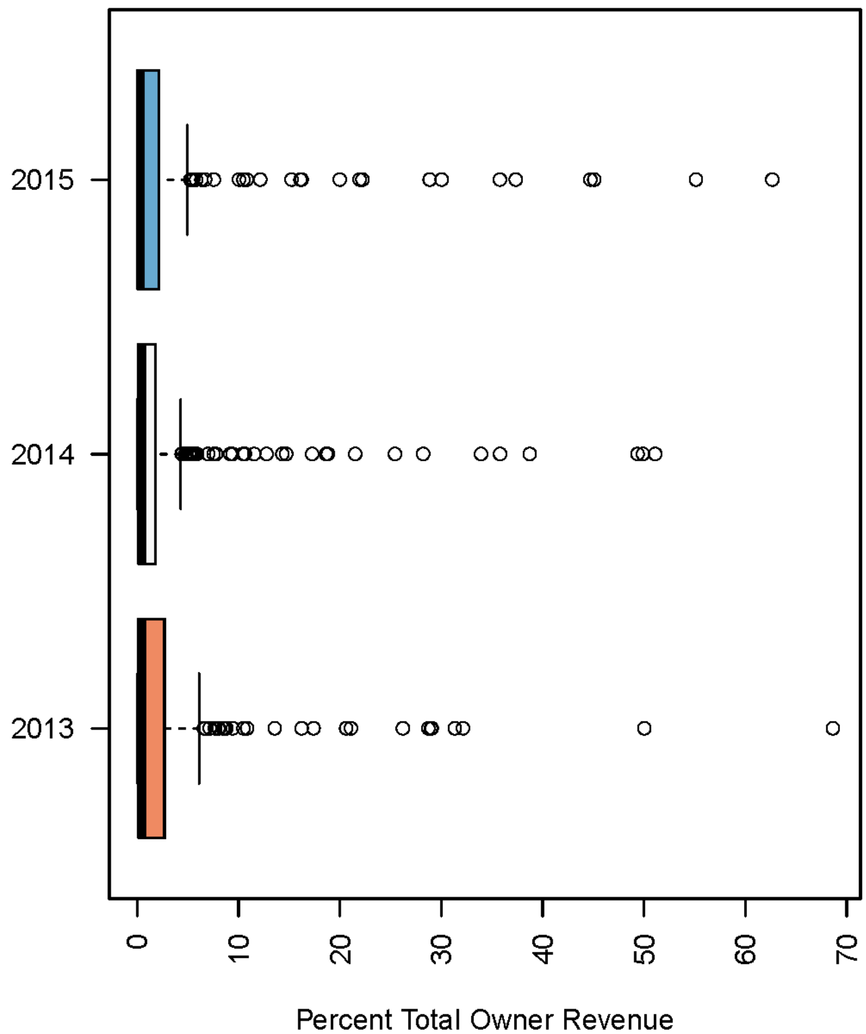
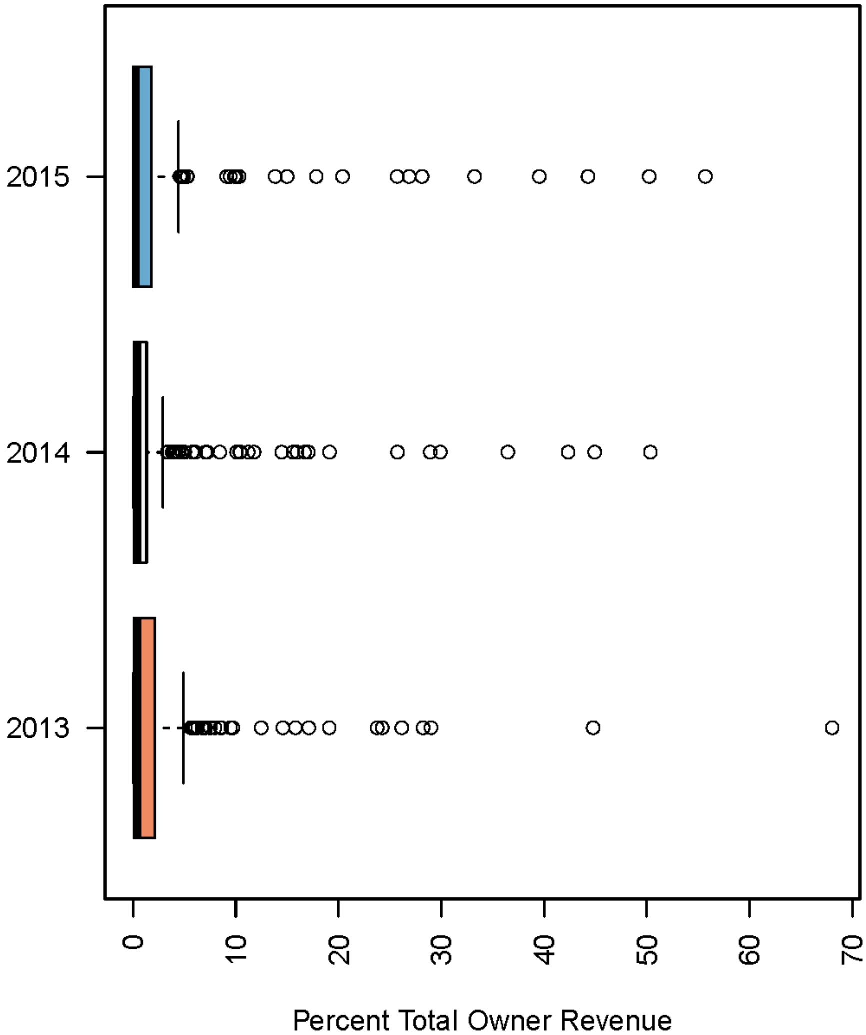


Figure 31 – VTR-derived percent of vessel owner revenue attributed to the Option 1 300 m broad coral zone, 2013-2015.



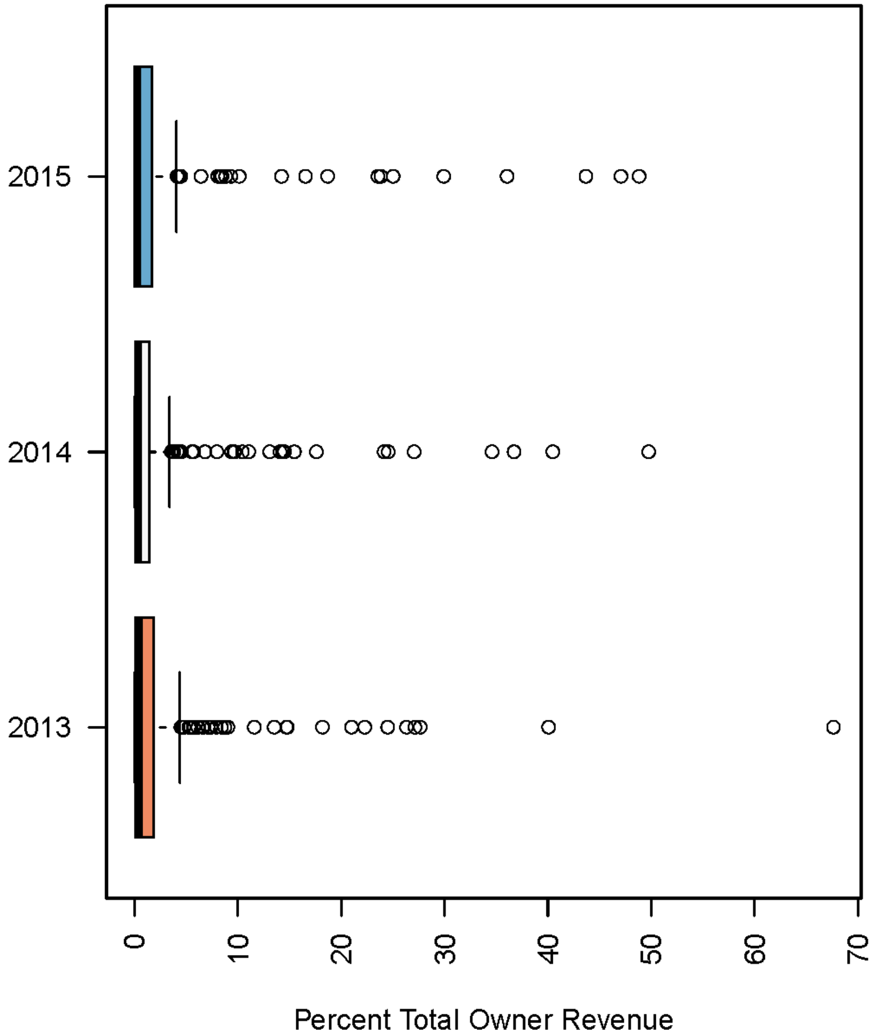
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 32 – VTR-derived percent of vessel owner revenue attributed to the Option 2 400 m broad coral zone, 2013-2015.



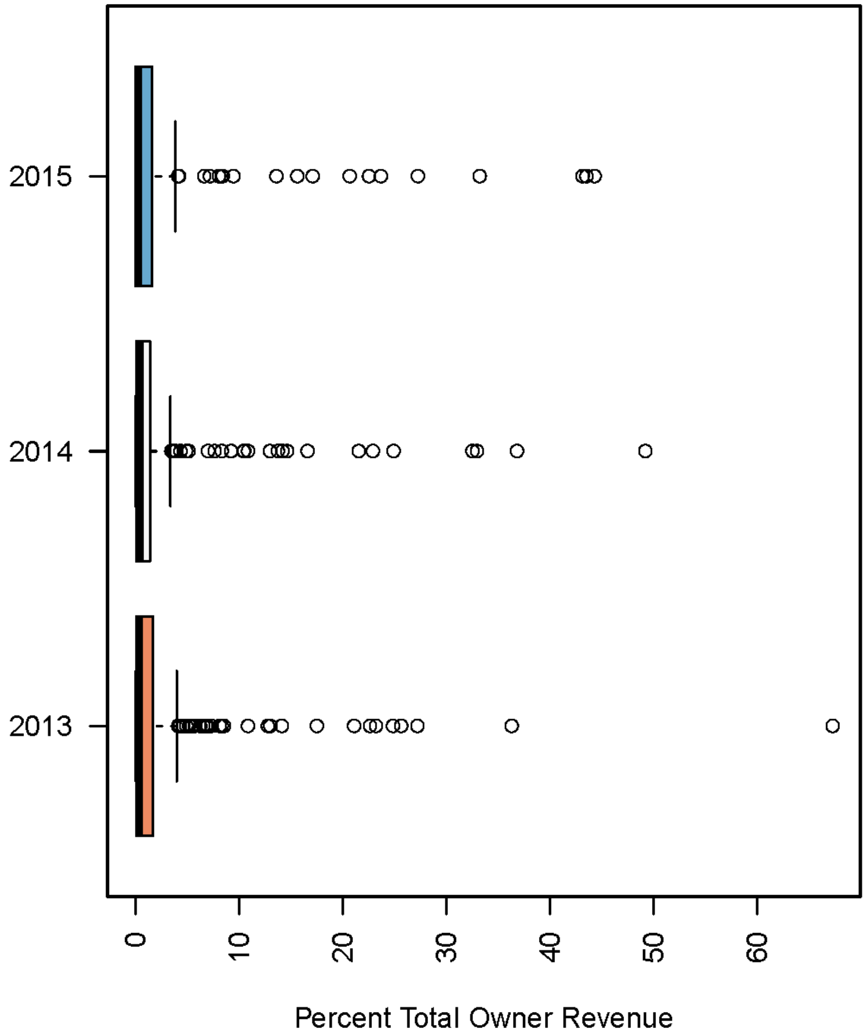
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 33 – VTR-derived percent of vessel owner revenue attributed to the Option 3 500 m broad coral zone, 2013-2015.



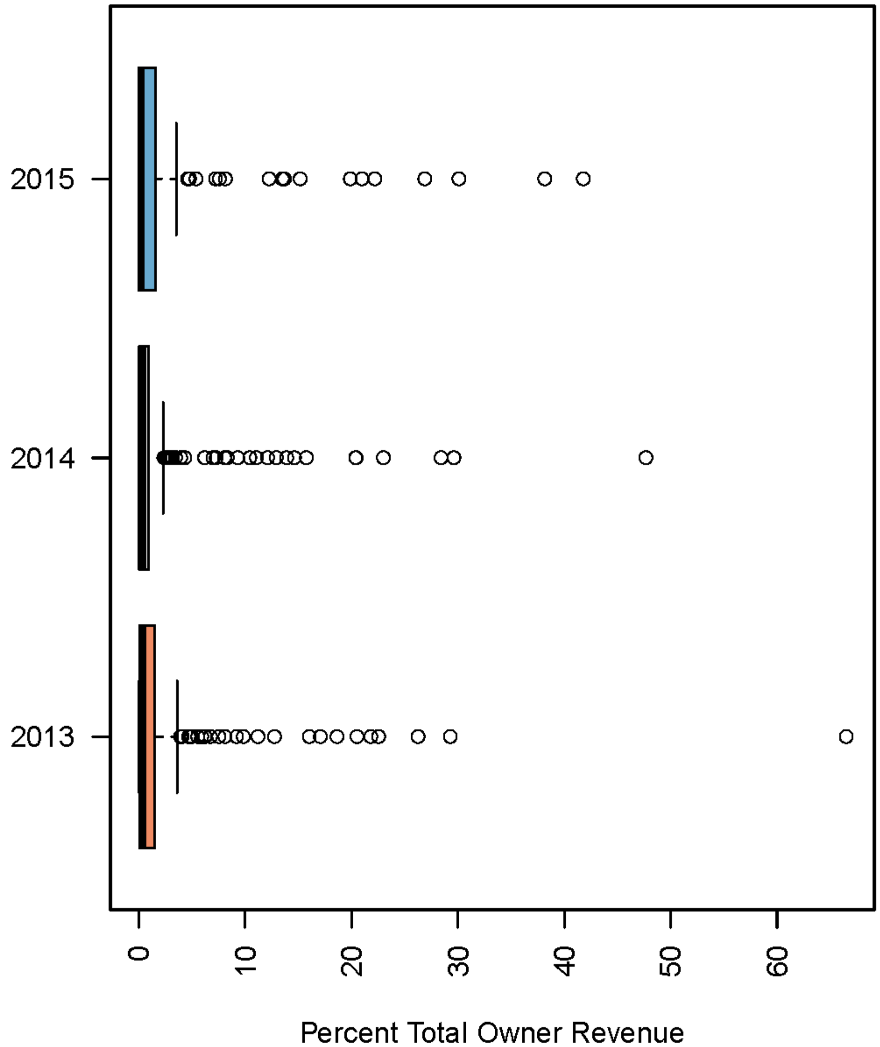
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 34 – VTR-derived percent of vessel owner revenue attributed to the Option 4 600 m broad coral zone, 2013-2015.



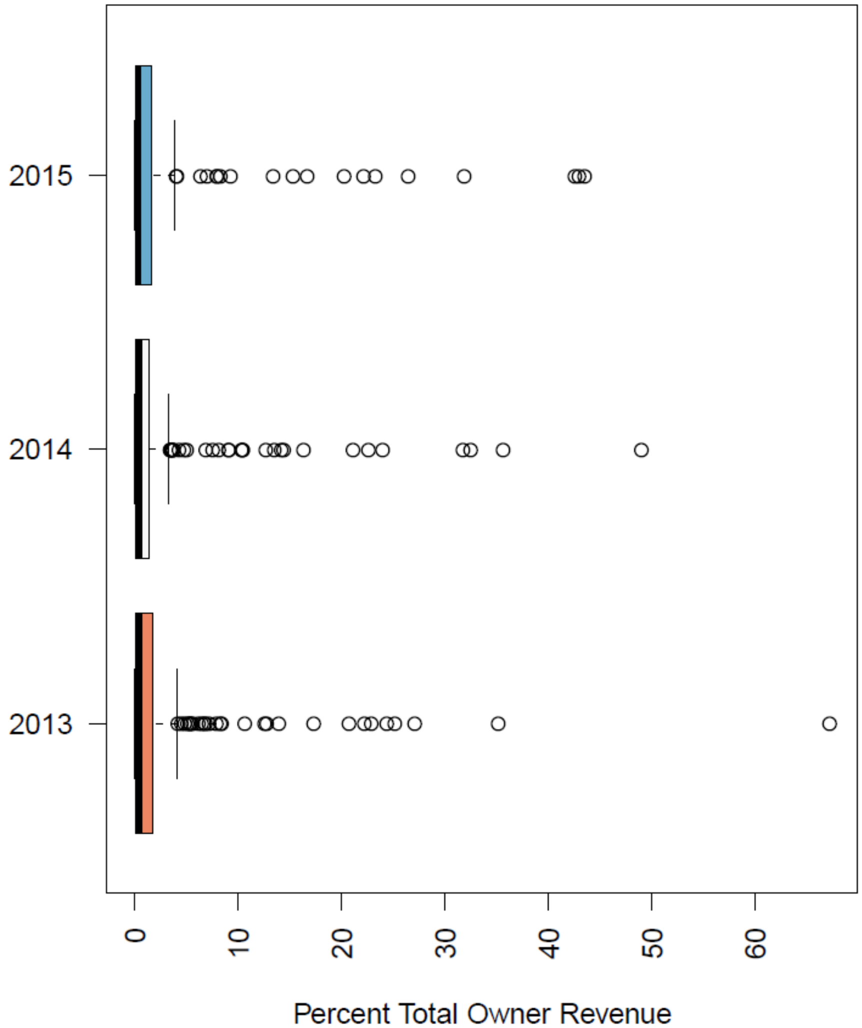
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 35 – VTR-derived percent of vessel owner revenue attributed to the Option 5 900 m broad coral zone, 2013-2015.



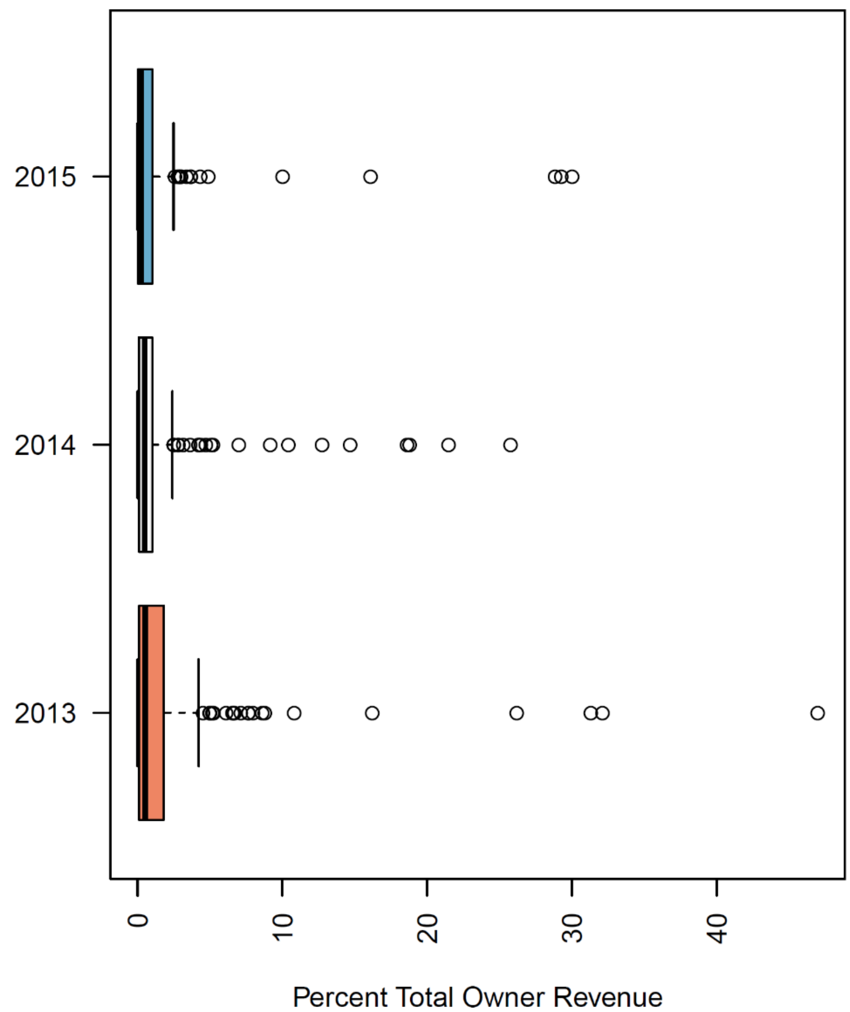
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 36 – VTR-derived percent of vessel owner revenue attributed to the Option 6 600 m minimum broad coral zone, 2013-2015.



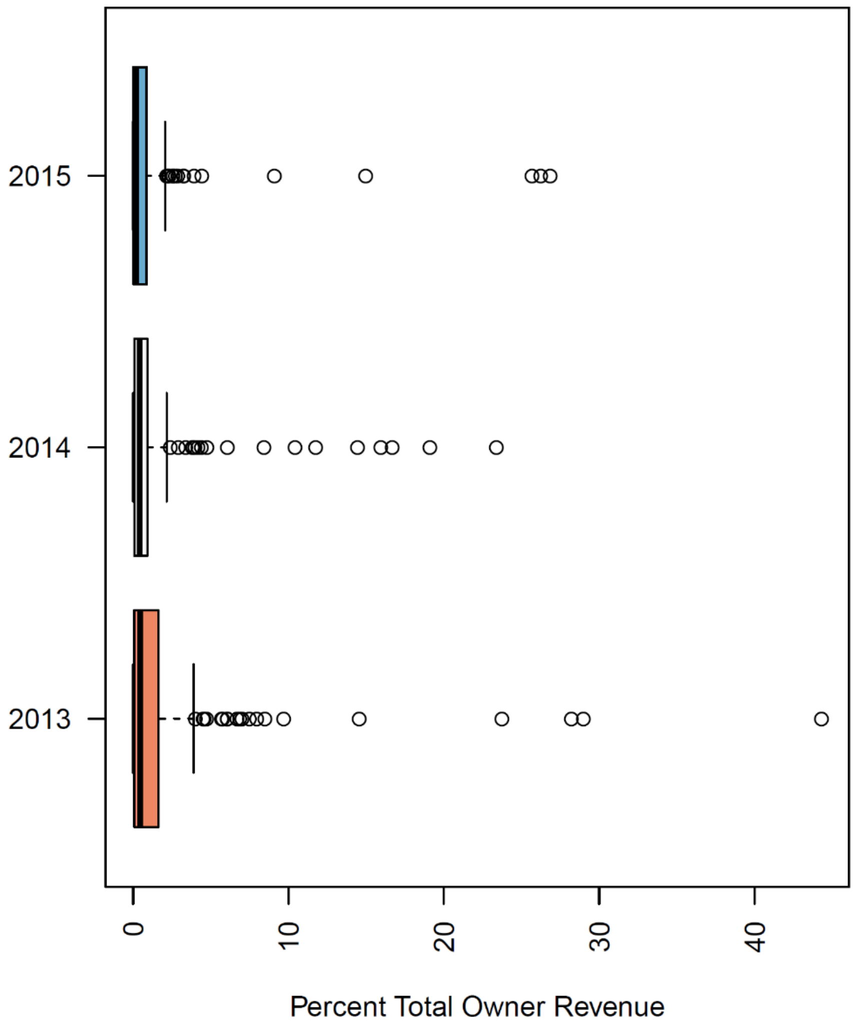
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 37 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 1 300 m broad coral zone, 2013-2015.



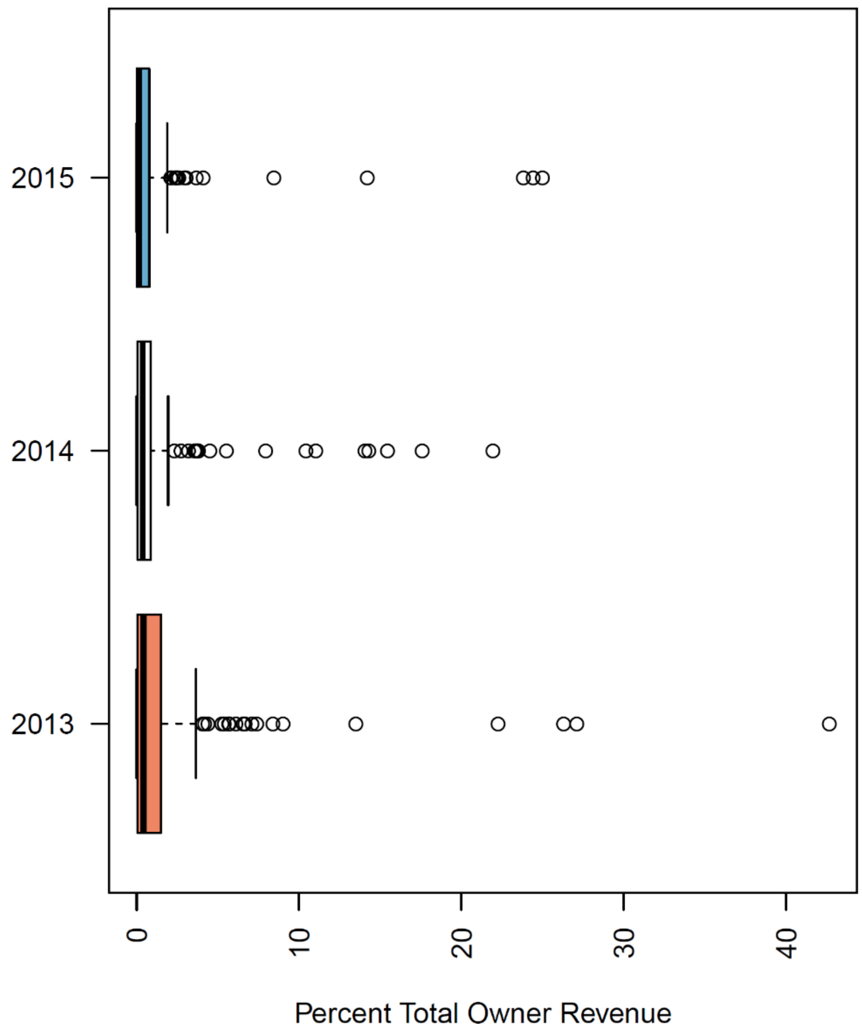
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 38 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 2 400 m broad coral zone, 2013-2015.



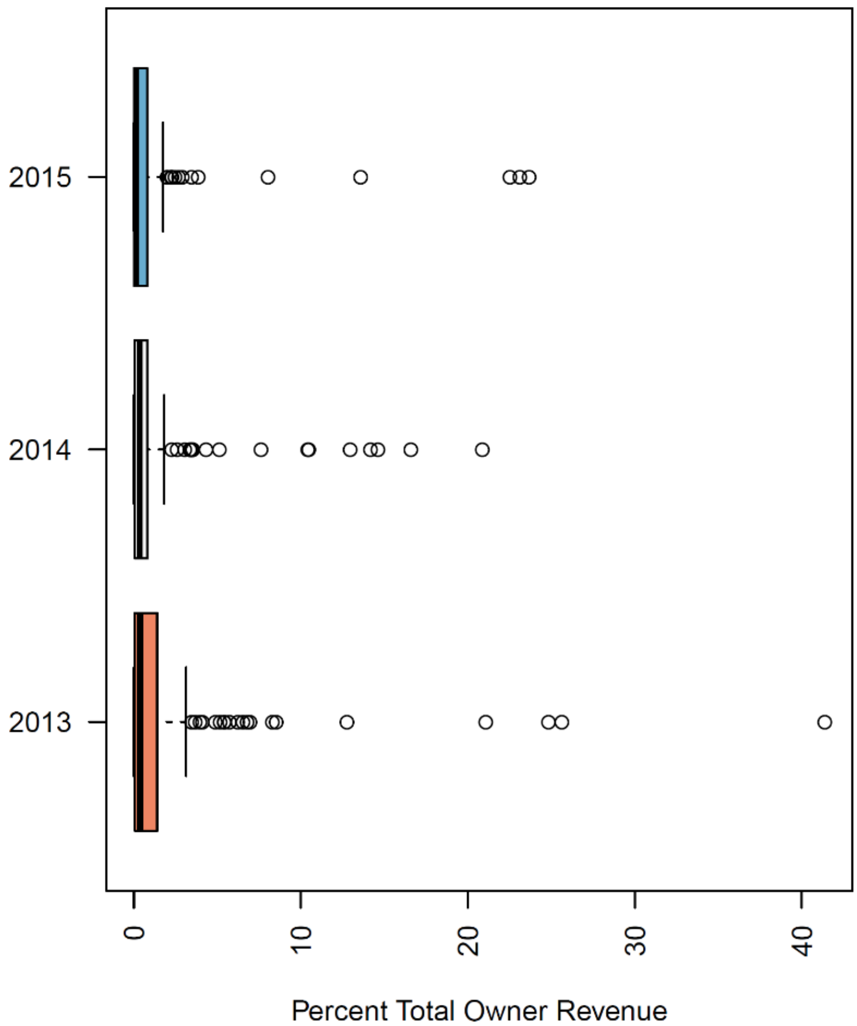
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 39 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 3 500 m broad coral zone, 2013-2015.



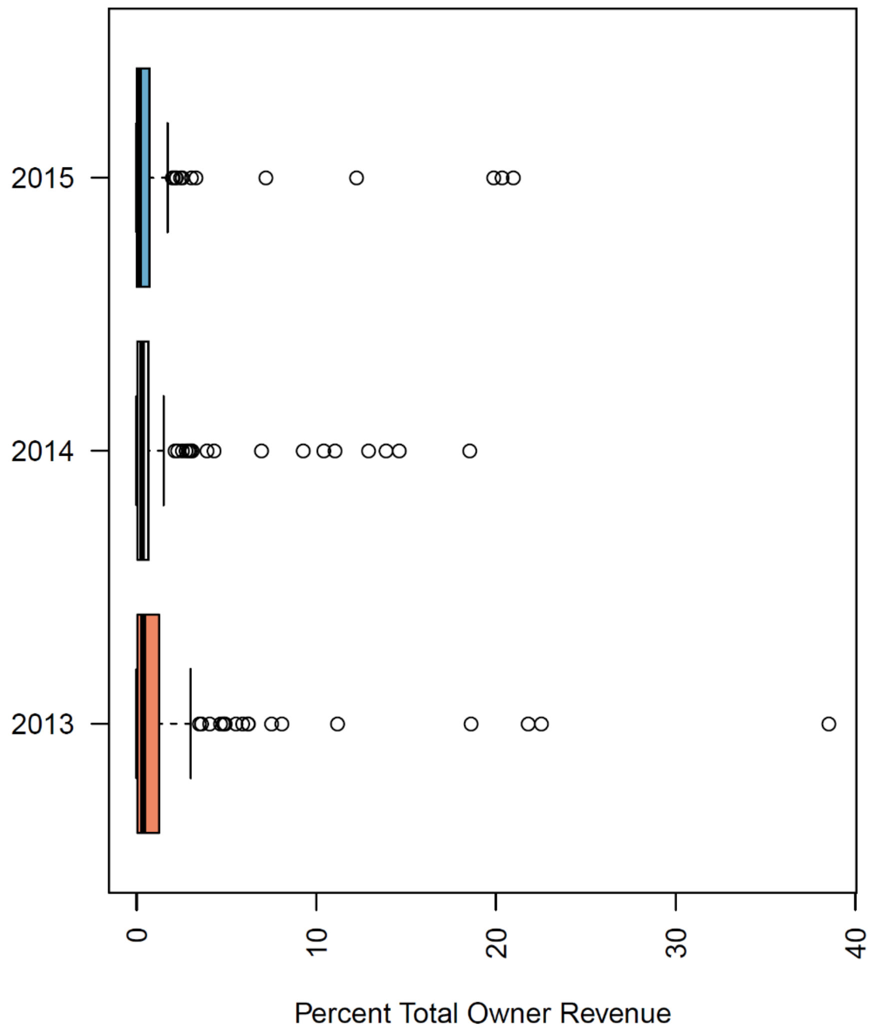
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 40 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 4 600 m broad coral zone, 2013-2015.



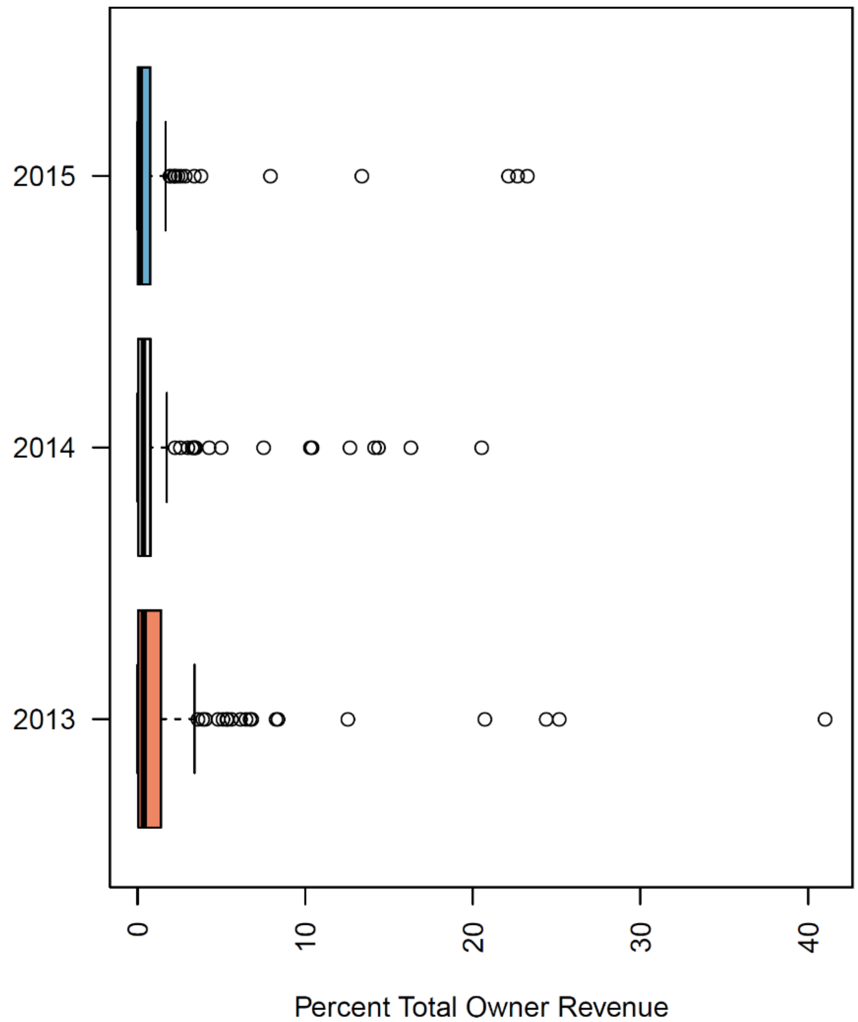
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 41 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 5 900 m broad coral zone, 2013-2015.



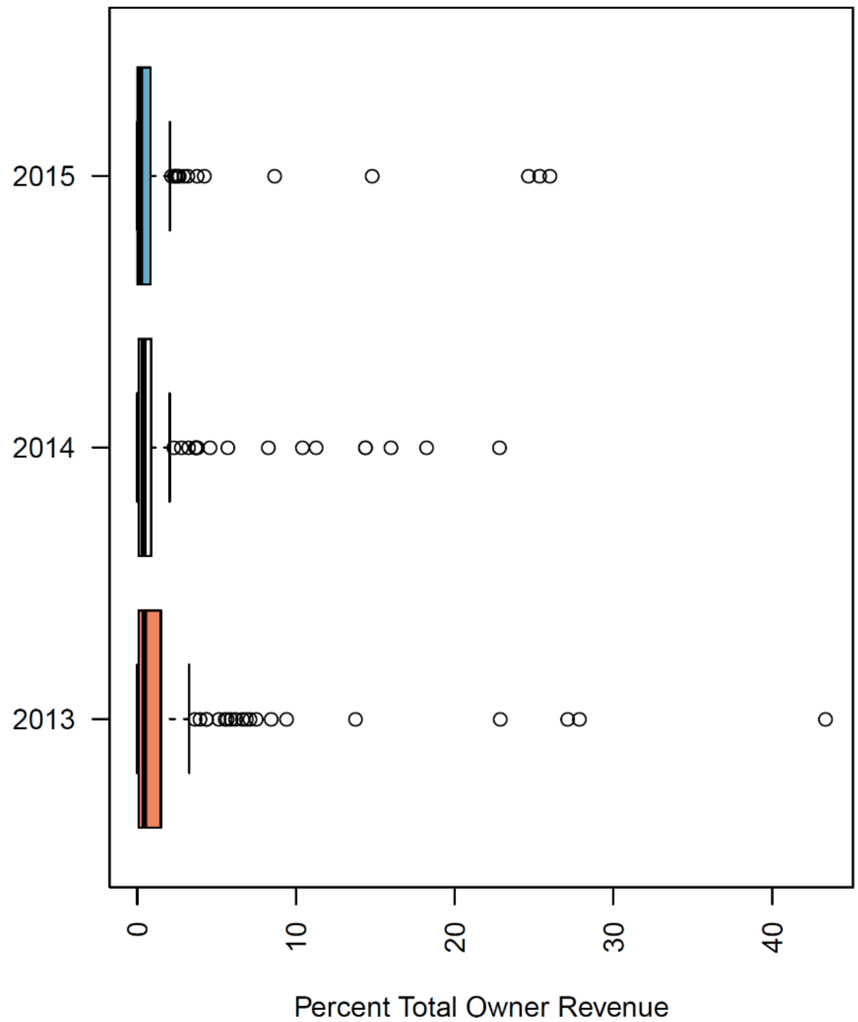
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 42 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 6 600 m Minimum broad coral zone, 2013-2015.



Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 43 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 7 broad coral zone, 2013-2015.



Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Table 60 – Percentage of VTR trips, by gear type attributed to the broad coral zones south of Georges Bank, that have VMS coverage, 2010-2012. Option 6, the preferred alternative, is shown in both sections of the table for comparison with other alternatives.

		Option 1 (300 m)				Option 2 (400 m)				Option 3 (500 m)				**Option 6 (600 m min)**			
Gear	Year	Permits	VTR Trips	VMS Trips	Coverage	Permits	VTR Trips	VMS Trips	Coverage	Permits	VTR Trips	VMS Trips	Coverage	**Permits**	**VTR Trips**	**VMS Trips**	**Coverage**
Bottom Trawl	2010	137	1005	946	94%	136	987	928	94%	131	961	903	94%	**131**	**927**	**872**	**94%**
Bottom Trawl	2011	129	881	794	90%	128	867	785	91%	125	848	768	91%	**121**	**816**	**739**	**91%**
Bottom Trawl	2012	142	744	644	87%	141	723	626	87%	138	704	612	87%	**135**	**670**	**581**	**87%**
Separator & Ruhle Trawl	2010	20	73	55	75%	20	72	54	75%	20	71	53	75%	**20**	**69**	**51**	**74%**
Separator & Ruhle Trawl	2011	33	136	115	85%	33	136	115	85%	33	133	112	84%	**33**	**131**	**111**	**85%**
Separator & Ruhle Trawl	2012	20	49	35	71%	20	49	35	71%	20	49	35	71%	**20**	**49**	**35**	**71%**
Scallop Gear & Clam Dredge	2010	31	32	30	94%	21	22	20	91%	18	18	16	89%	**17**	**17**	**15**	**88%**
Scallop Gear & Clam Dredge	2011	94	116	112	97%	88	110	106	96%	82	99	95	96%	**74**	**88**	**84**	**95%**
Scallop Gear & Clam Dredge	2012	210	291	282	97%	199	276	268	97%	193	262	254	97%	**193**	**256**	**248**	**97%**
Lobster Pot	2010	53	965	144	15%	51	947	139	15%	51	928	137	15%	**51**	**918**	**137**	**15%**
Lobster Pot	2011	46	805	73	9%	45	788	72	9%	45	779	71	9%	**45**	**778**	**71**	**9%**
Lobster Pot	2012	44	734	58	8%	44	725	58	8%	43	717	55	8%	**42**	**707**	**55**	**8%**
Sink Gillnet	2010	25	-	-	0%	25	-	-	0%	25	-	-	0%	**24**	**163**	**0**	**0%**
Sink Gillnet	2011	36	-	-	0%	35	-	-	0%	34	-	-	0%	**33**	**262**	**0**	**0%**
Sink Gillnet	2012	30	-	-	0%	29	-	-	0%	28	-	-	0%	**27**	**180**	**0**	**0%**
Bottom Longline	2010	6	-	-	0%	6	-	-	0%	6	-	-	0%	**6**	**47**	**0**	**0%**
Bottom Longline	2011	6	-	-	0%	6	-	-	0%	6	-	-	0%	**6**	**37**	**0**	**0%**
Bottom Longline	2012	8	-	-	0%	8	-	-	0%	8	-	-	0%	**8**	**32**	**0**	**0%**
Other Gear	2010	5	32	0	0%	5	32	0	0%	5	32	0	0%	**3**	**13**	**0**	**0%**
Other Gear	2011	5	24	0	0%	5	24	0	0%	5	24	0	0%	**3**	**5**	**0**	**0%**
Other Gear	2012	9	47	0	0%	8	46	0	0%	8	46	0	0%	**7**	**17**	**0**	**0%**

		Option 4 (600 m)				Option 5 (900 m)				**Option 6 (600 m min)**				Option 7 (Empirical)			
Gear	Year	Permits	VTR Trips	VMS Trips	Coverage	Permits	VTR Trips	VMS Trips	Coverage	**Permits**	**VTR Trips**	**VMS Trips**	**Coverage**	Permits	VTR Trips	VMS Trips	Coverage
Bottom Trawl	2010	131	935	880	94%	130	882	832	94%	**131**	**927**	**872**	**94%**	132	968	910	94%
Bottom Trawl	2011	121	824	747	91%	118	784	710	91%	**121**	**816**	**739**	**91%**	124	848	768	91%
Bottom Trawl	2012	135	678	589	87%	132	644	563	87%	**135**	**670**	**581**	**87%**	138	706	614	87%
Separator & Ruhle Trawl	2010	20	69	51	74%	20	60	46	77%	**20**	**69**	**51**	**74%**	20	71	53	75%
Separator & Ruhle Trawl	2011	33	131	111	85%	33	127	107	84%	**33**	**131**	**111**	**85%**	33	135	114	84%
Separator & Ruhle Trawl	2012	20	49	35	71%	20	48	34	71%	**20**	**49**	**35**	**71%**	20	49	35	71%
Scallop Gear & Clam Dredge	2010	17	17	15	88%	13	13	11	85%	**17**	**17**	**15**	**88%**	19	20	18	90%
Scallop Gear & Clam Dredge	2011	74	89	85	96%	54	65	62	95%	**74**	**88**	**84**	**95%**	82	100	96	96%
Scallop Gear & Clam Dredge	2012	193	256	248	97%	176	232	224	97%	**193**	**256**	**248**	**97%**	194	265	257	97%
Lobster Pot	2010	51	918	137	15%	51	847	127	15%	**51**	**918**	**137**	**15%**				
Lobster Pot	2011	45	778	71	9%	44	764	65	9%	**45**	**778**	**71**	**9%**				
Lobster Pot	2012	42	707	55	8%	42	696	55	8%	**42**	**707**	**55**	**8%**				
Sink Gillnet	2010	24	-	-	0%	22	-	-	0%	**24**	**163**	**0**	**0%**				
Sink Gillnet	2011	33	-	-	0%	30	-	-	0%	**33**	**262**	**0**	**0%**	Not analyzed for Option 7			
Sink Gillnet	2012	27	-	-	0%	27	-	-	0%	**27**	**180**	**0**	**0%**				
Bottom Longline	2010	6	-	-	0%	6	-	-	0%	**6**	**47**	**0**	**0%**				
Bottom Longline	2011	6	-	-	0%	6	-	-	0%	**6**	**37**	**0**	**0%**				
Bottom Longline	2012	8	-	-	0%	8	-	-	0%	**8**	**32**	**0**	**0%**				
Other Gear	2010	5	32	0	0%	5	32	0	0%	**3**	**13**	**0**	**0%**	0	-	-	-
Other Gear	2011	5	24	0	0%	5	24	0	0%	**3**	**5**	**0**	**0%**	0	-	-	-
Other Gear	2012	8	46	0	0%	8	46	0	0%	**7**	**17**	**0**	**0%**	0	-	-	-

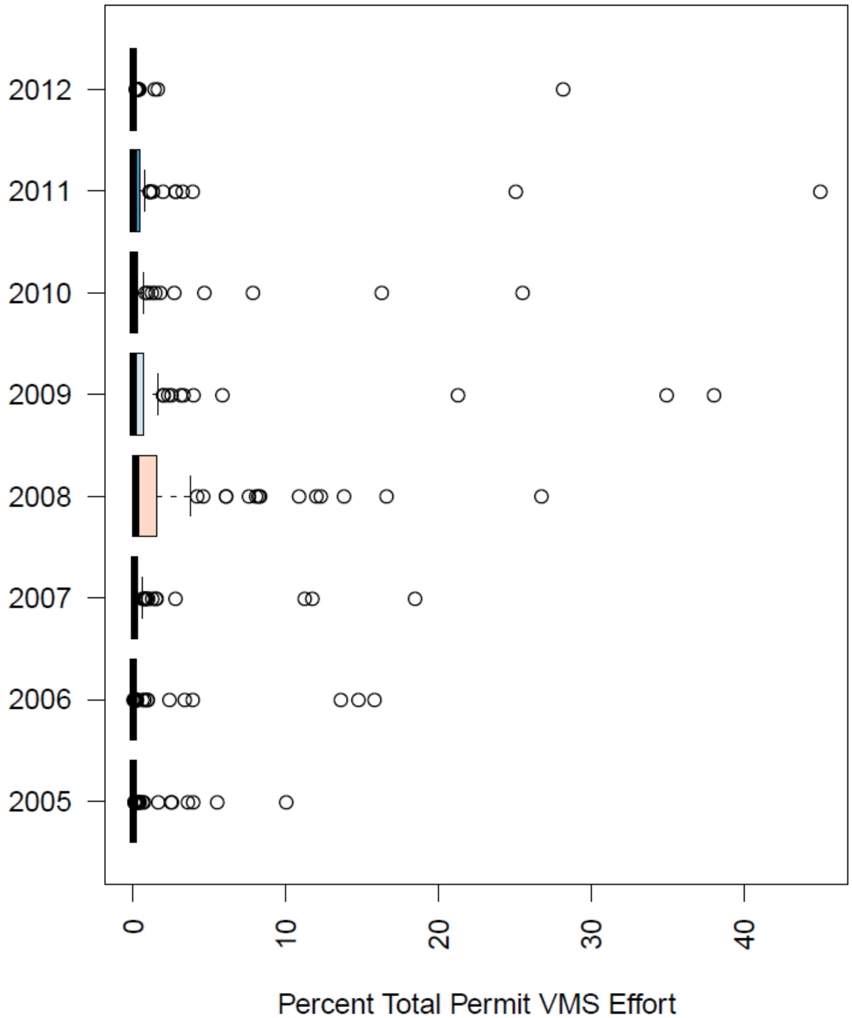
Table 61 – VMS estimates of effort (total hours fished, trips, and permits) within the broad zones, by gear type. Options 1-3 are compared to 6, the preferred alternative.

		Option 1 (300m)			Option 2 (400 m)			Option 3 (500 m)			**Option 6 (600 m min)**		
Gear	Year	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits	**Hours Fished**	**Trips**	**Permits**
Bottom Trawl	2005	218.63	54	27	26.23	32	22	7.74	18	16	**1.84**	**11**	**9**
Bottom Trawl	2006	184.01	66	32	33.60	44	24	6.75	35	21	**0.48**	**13**	**11**
Bottom Trawl	2007	258.02	128	54	24.94	61	35	12.86	36	23	**8.78**	**18**	**12**
Bottom Trawl	2008	1442.01	143	52	249.90	101	40	22.89	61	30	**3.91**	**31**	**20**
Bottom Trawl	2009	489.07	118	37	222.19	90	35	26.19	56	26	**10.25**	**24**	**16**
Bottom Trawl	2010	391.78	137	43	180.78	95	34	32.04	64	27	**20.57**	**47**	**19**
Bottom Trawl	2011	379.99	91	33	70.28	66	28	20.40	43	20	**12.31**	**29**	**15**
Bottom Trawl	2012	114.18	85	38	24.12	61	34	7.31	46	27	**5.29**	**28**	**18**
Squid Trawl	2005	11.50	59	30	4.44	40	22	3.01	33	19	**1.44**	**21**	**15**
Squid Trawl	2006	40.33	96	42	5.90	73	35	2.89	52	28	**1.27**	**33**	**21**
Squid Trawl	2007	40.61	123	43	21.16	94	38	11.14	68	31	**5.73**	**45**	**22**
Squid Trawl	2008	8.27	16	11	2.18	14	10	0.26	12	9	**0.14**	**11**	**8**
Squid Trawl	2009	43.92	25	8	15.64	24	7	7.80	19	5	**2.74**	**17**	**5**
Squid Trawl	2010	11.98	30	11	2.74	23	10	0.89	18	8	**0.20**	**13**	**7**
Squid Trawl	2011	35.59	23	10	8.19	21	10	5.41	19	10	**2.09**	**15**	**7**
Squid Trawl	2012	5.45	12	10	2.47	10	8	0.51	8	7	**0.18**	**4**	**4**
Pot/Trap	2005	11.11	5	3	3.84	5	3	2.13	5	3	**-**	**-**	**2**
Pot/Trap	2006	319.91	81	6	104.47	69	4	30.63	61	4	**21.62**	**64**	**5**
Pot/Trap	2007	337.25	75	3	130.95	66	3	46.65	62	3	**25.51**	**56**	**4**
Pot/Trap	2008	350.63	57	5	140.42	49	5	49.60	44	5	**27.50**	**34**	**3**
Pot/Trap	2009	275.17	50	5	85.65	39	4	30.72	30	3	**17.82**	**29**	**4**
Pot/Trap	2010	307.01	62	4	125.77	56	4	44.03	51	3	**23.62**	**48**	**4**
Pot/Trap	2011	260.73	44	4	98.56	37	3	32.57	29	3	**16.67**	**26**	**4**
Pot/Trap	2012	216.55	36	3	-	-	1	-	-	1	**-**	**-**	**2**
LA Scallop	2005	0.06	77	58	0.05	71	57	0.04	53	64	**0.03**	**61**	**50**
LA Scallop	2006	0.47	151	68	0.14	138	65	0.07	63	131	**0.03**	**118**	**59**
LA Scallop	2007	0.02	26	23	0.01	25	23	0.00	19	20	**0.00**	**15**	**14**
LA Scallop	2008	0.04	17	16	0.00	17	16	0.00	14	15	**0.00**	**10**	**9**
LA Scallop	2009	5.13	31	29	0.94	30	28	0.36	27	29	**0.17**	**28**	**27**
LA Scallop	2010	0.41	37	35	0.18	35	33	0.04	28	28	**0.01**	**23**	**23**
LA Scallop	2011	0.19	27	20	0.04	26	19	0.03	19	23	**0.01**	**21**	**18**
LA Scallop	2012	0.56	39	31	0.46	34	28	0.44	27	32	**0.02**	**28**	**24**

Table 62 – VMS estimates of effort (total hours fished, trips, and permits) within the broad zones, by gear type. Options 4, 5, and 7 are compared to 6, the preferred alternative.

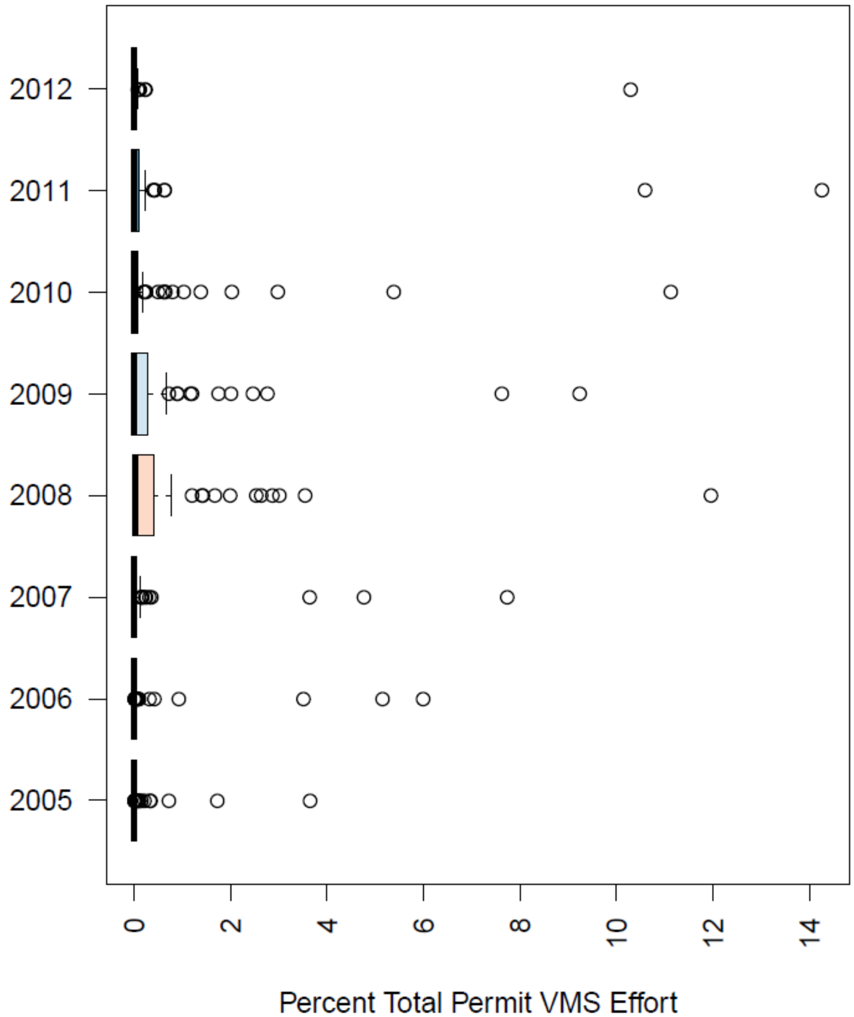
		Option 4 (600 m)			Option 5 (900 m)			**Option 6 (600 m min)**			Option 7 (Empirical)		
Gear	Year	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits	**Hours Fished**	**Trips**	**Permits**	Hours Fished	Trips	Permits
Bottom Trawl	2005	1.85	12	10	0.17	4	4	**1.84**	**11**	**9**	18.88	27	19
Bottom Trawl	2006	0.75	18	15	0.00	5	4	**0.48**	**13**	**11**	6.74	37	21
Bottom Trawl	2007	9.13	20	14	5.37	11	9	**8.78**	**18**	**12**	16.41	48	26
Bottom Trawl	2008	4.43	30	19	0.80	12	8	**3.91**	**31**	**20**	34.85	68	32
Bottom Trawl	2009	12.89	32	18	6.07	14	9	**10.25**	**24**	**16**	45.03	70	29
Bottom Trawl	2010	21.98	52	23	12.86	17	7	**20.57**	**47**	**19**	41.48	87	31
Bottom Trawl	2011	12.70	32	15	7.49	11	6	**12.31**	**29**	**15**	23.62	54	20
Bottom Trawl	2012	5.44	35	22	2.10	15	11	**5.29**	**28**	**18**	8.74	58	30
Squid Trawl	2005	1.44	24	17	0.26	7	9	**1.44**	**21**	**15**	3.03	35	20
Squid Trawl	2006	1.71	37	23	0.56	11	18	**1.27**	**33**	**21**	4.06	60	29
Squid Trawl	2007	6.34	51	26	3.27	16	28	**5.73**	**45**	**22**	16.34	90	37
Squid Trawl	2008	0.16	12	9	0.02	4	5	**0.14**	**11**	**8**	0.28	13	9
Squid Trawl	2009	3.05	17	5	0.88	5	15	**2.74**	**17**	**5**	7.75	22	6
Squid Trawl	2010	0.20	13	7	0.02	3	4	**0.20**	**13**	**7**	1.67	19	9
Squid Trawl	2011	2.63	15	7	0.12	7	9	**2.09**	**15**	**7**	5.37	19	10
Squid Trawl	2012	0.32	4	4	0.06	3	3	**0.18**	**4**	**4**	0.53	8	6
Pot/Trap	2005	-	-	2	-	-	1	**-**	**-**	**2**			
Pot/Trap	2006	18.26	51	4	4.36	32	3	**21.62**	**64**	**5**			
Pot/Trap	2007	24.61	51	3	7.33	36	3	**25.51**	**56**	**4**			
Pot/Trap	2008	31.85	37	3	12.04	26	3	**27.50**	**34**	**3**			
Pot/Trap	2009	20.24	28	3	-	-	2	**17.82**	**29**	**4**	Not analyzed for Option 7		
Pot/Trap	2010	-	-	2	-	-	2	**23.62**	**48**	**4**			
Pot/Trap	2011	19.18	27	3	-	-	2	**16.67**	**26**	**4**			
Pot/Trap	2012	-	-	1	-	-	1	**-**	**-**	**2**			
LA Scallop	2005	0.03	51	62	0.01	49	60	**0.03**	**61**	**50**	0.04	64	53
LA Scallop	2006	0.04	60	121	0.02	57	106	**0.03**	**118**	**59**	0.06	131	64
LA Scallop	2007	0.00	15	16	0.00	9	10	**0.00**	**15**	**14**	0.00	19	18
LA Scallop	2008	0.00	11	12	0.00	6	7	**0.00**	**10**	**9**	0.00	14	13
LA Scallop	2009	0.06	27	28	0.01	25	26	**0.17**	**28**	**27**	0.30	28	27
LA Scallop	2010	0.01	25	25	0.00	16	16	**0.01**	**23**	**23**	0.03	29	28
LA Scallop	2011	0.02	18	21	0.00	13	13	**0.01**	**21**	**18**	0.03	24	19
LA Scallop	2012	0.02	25	29	0.01	21	23	**0.02**	**28**	**24**	0.28	31	26

Figure 44 – VMS-derived percent of total annual permit fishing effort attributed to the Option 1 300 m broad zone between 2005 and 2012.



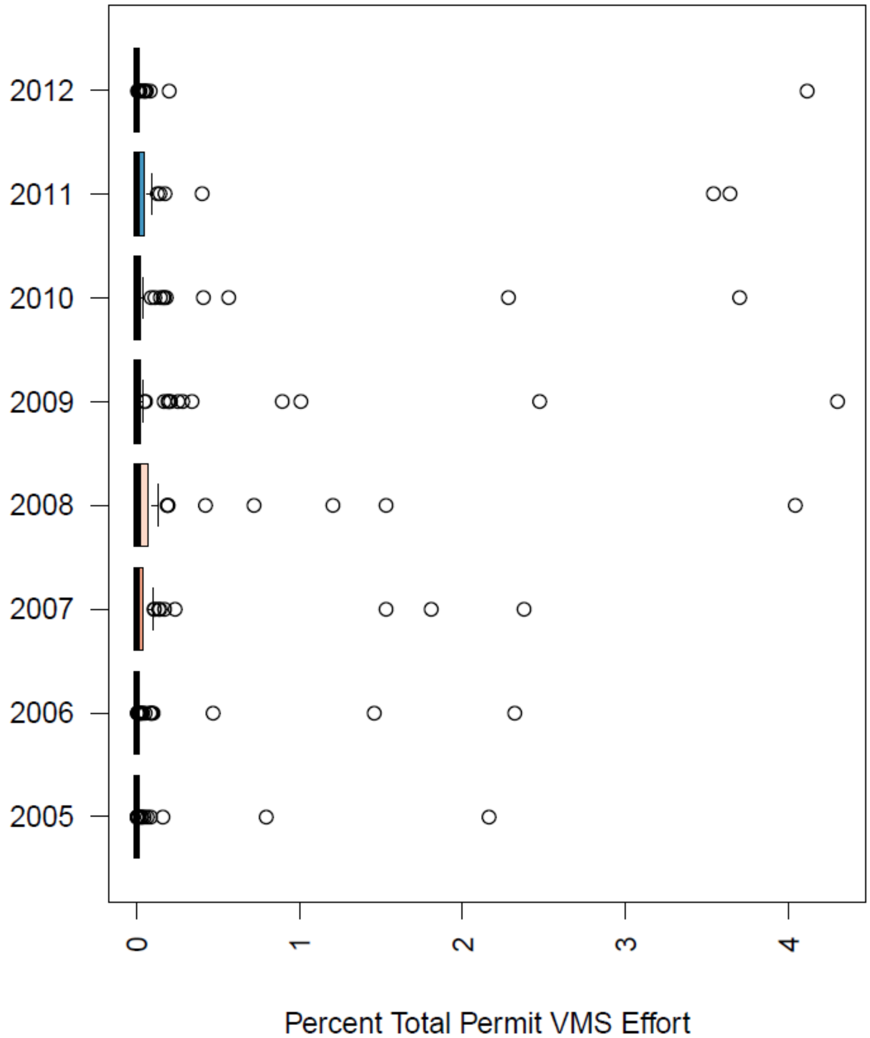
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 45 – VMS-derived percent of total annual permit fishing effort attributed to the Option 2 400 m broad zone between 2005 and 2012.



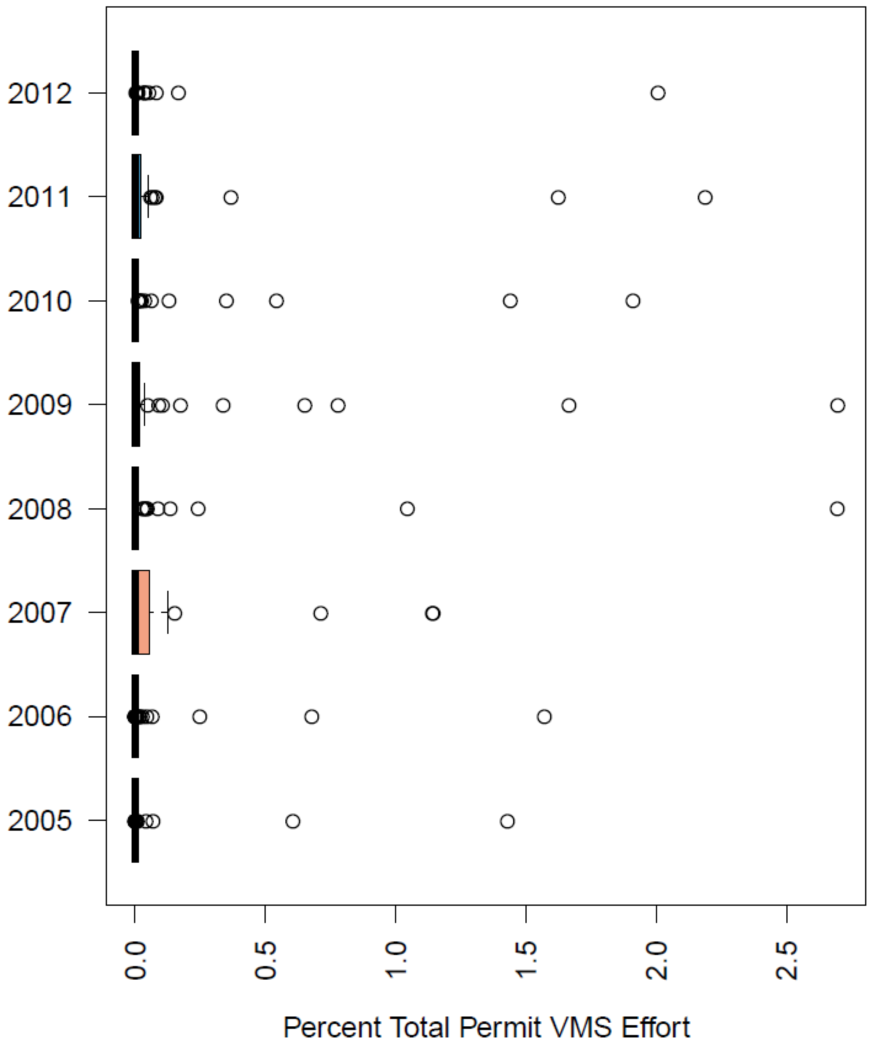
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 46 – VMS-derived percent of total annual permit fishing effort attributed to the Option 3 500 m broad zone between 2005 and 2012, as derived from VMS



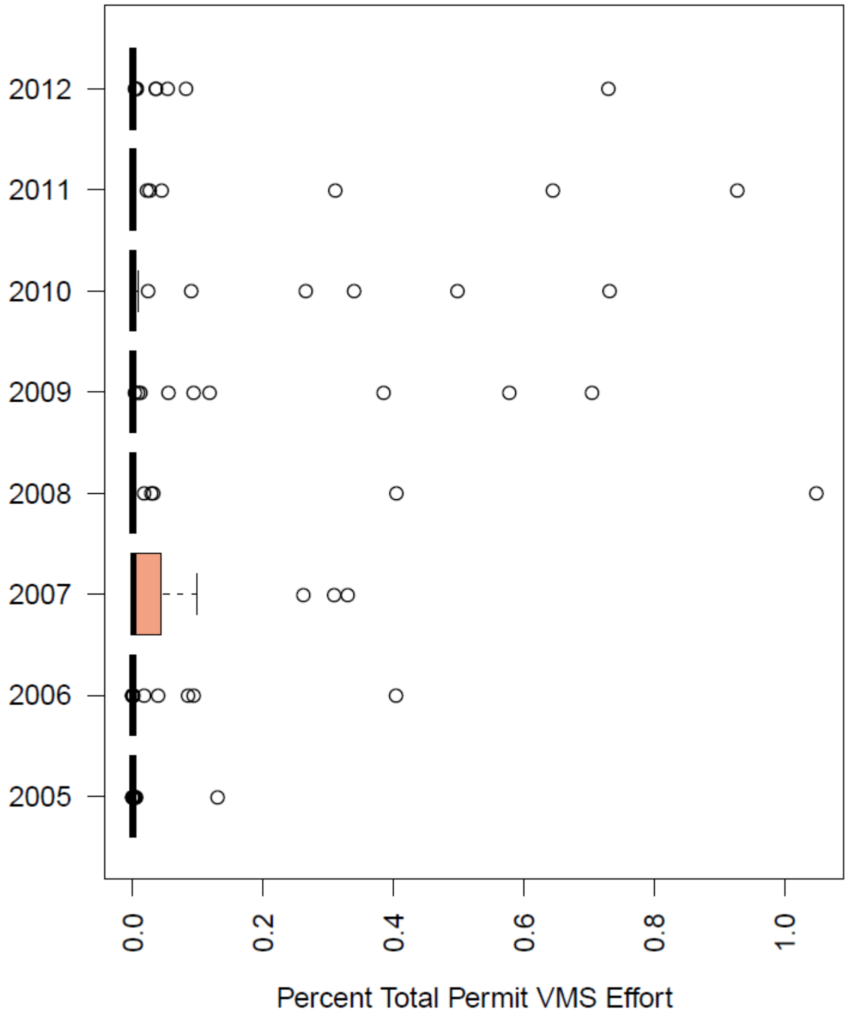
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 47 – VMS-derived percent of total annual permit fishing effort attributed to the Option 4 600 m broad zone between 2005 and 2012.



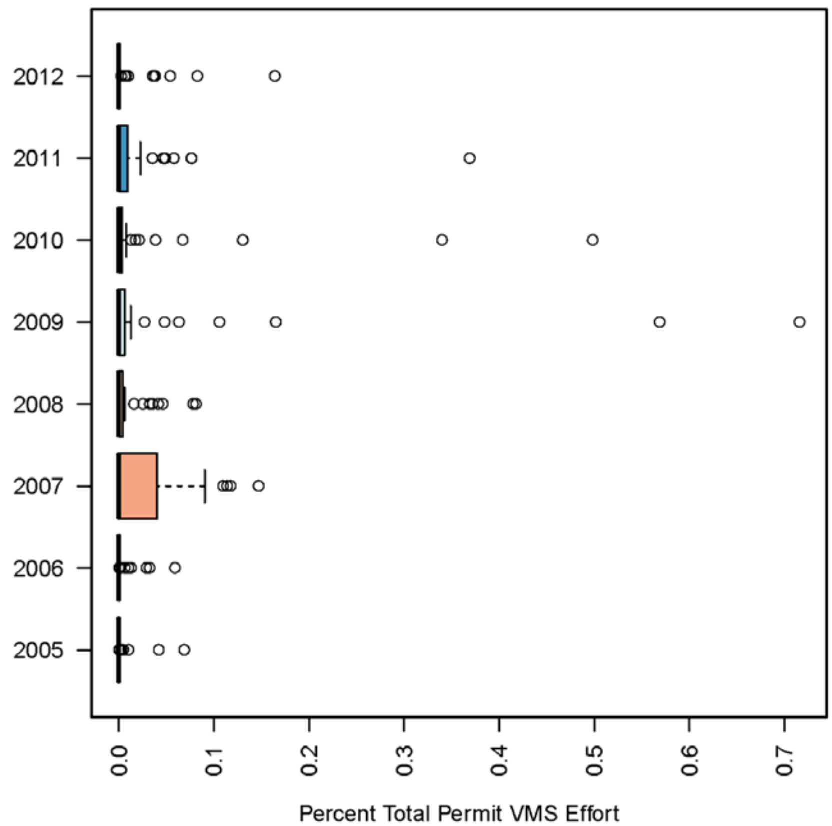
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 48 – VMS-derived percent of total annual permit fishing effort attributed to the Option 5 900 m broad zone between 2005 and 2012.



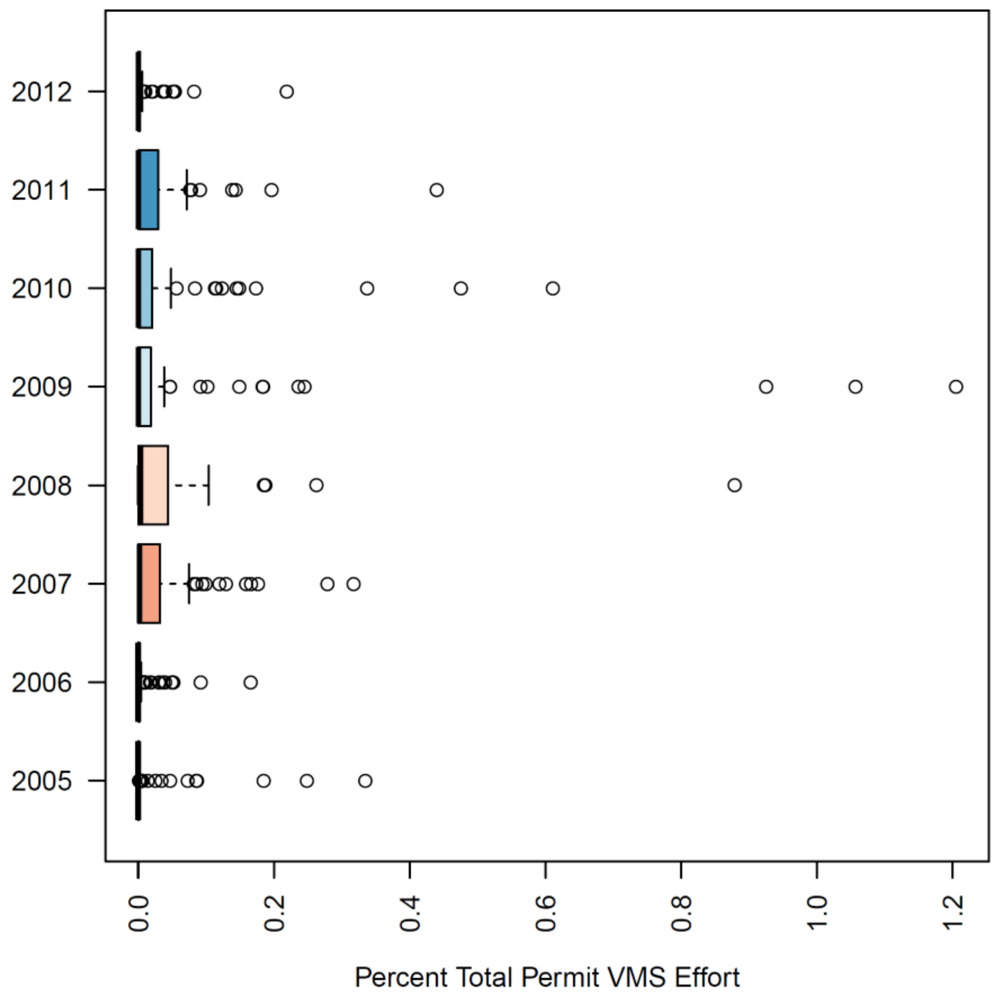
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 49 – VMS-derived percent of total annual permit fishing effort attributed to the Option 6 600 m minimum broad zone between 2005 and 2012.



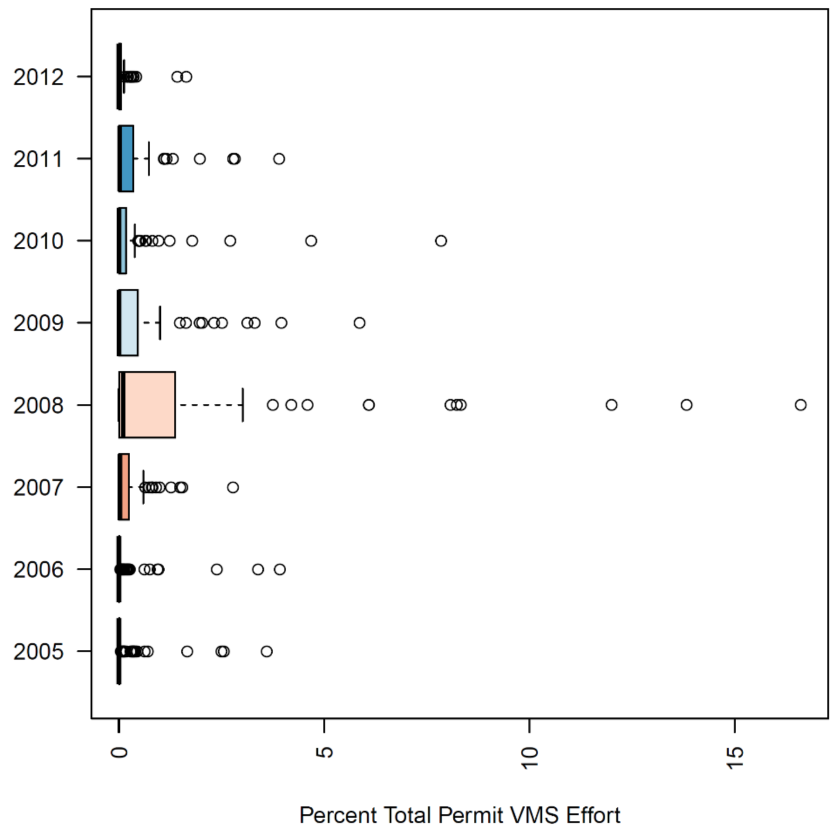
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 50 – VMS-derived percent of total annual permit fishing effort attributed to the Option 7 broad zone between 2005 and 2012. Includes mobile bottom-tending gears only.



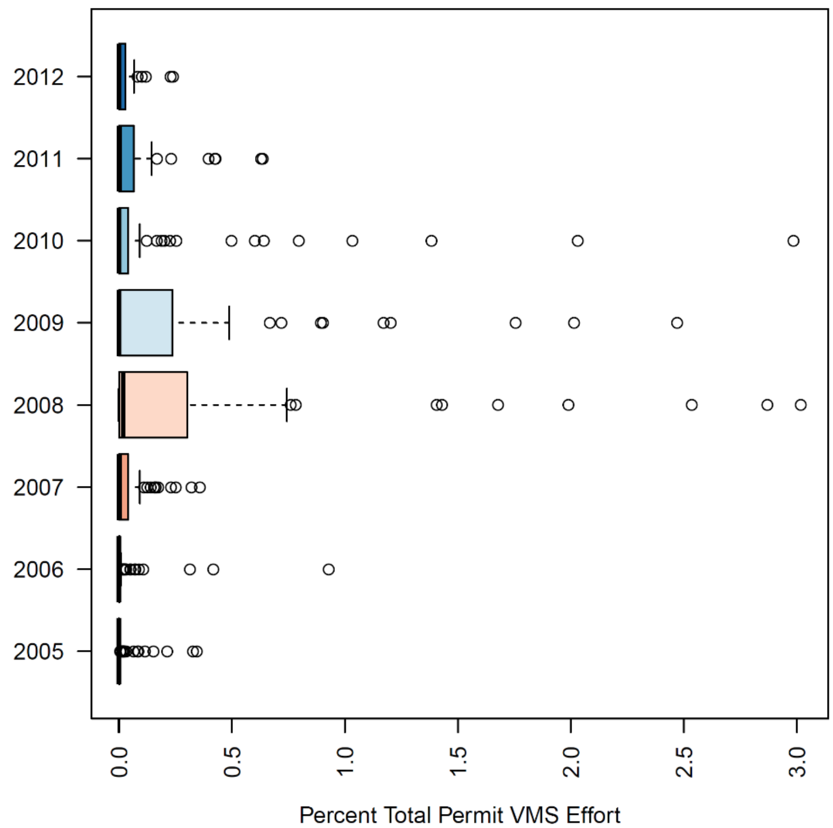
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 51 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 1 300 m broad zone between 2005 and 2012.



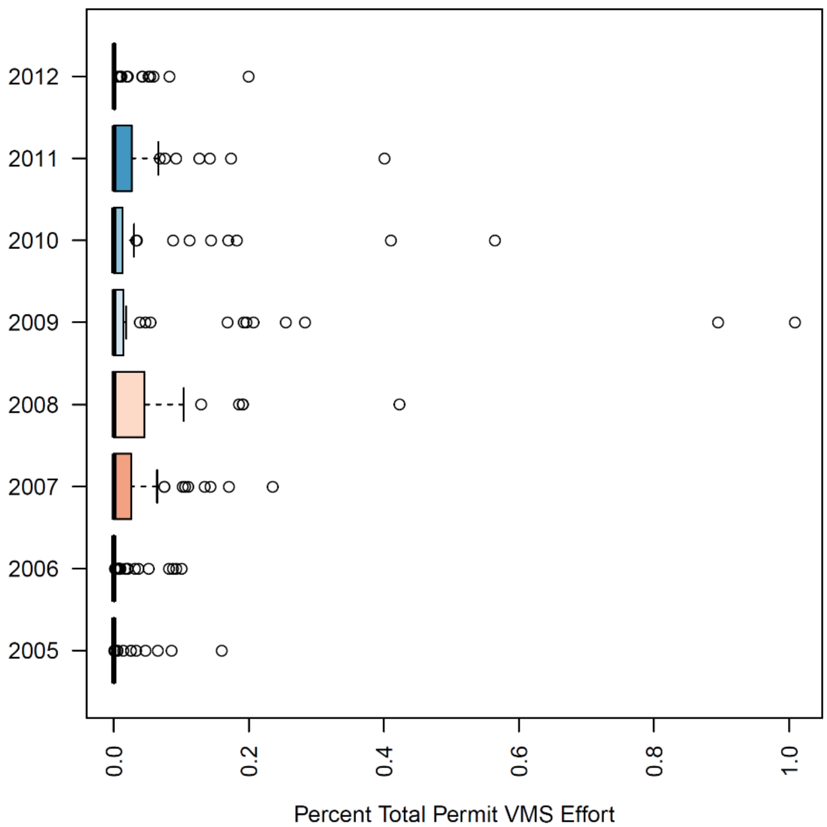
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 52 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 2 400 m broad zone between 2005 and 2012.



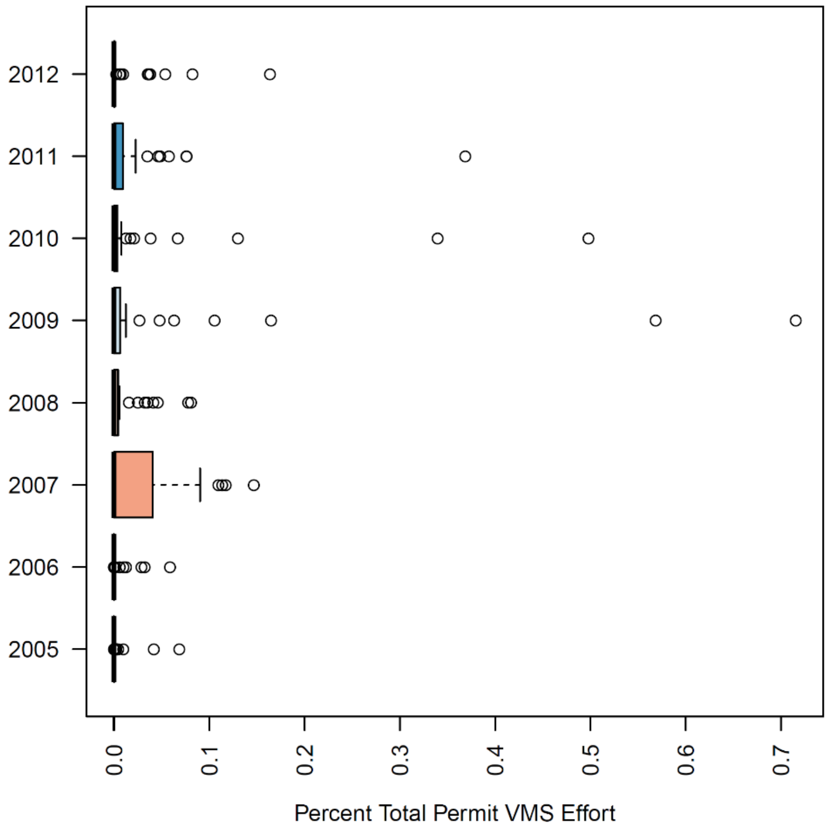
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 53 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 3 500 m broad zone between 2005 and 2012.



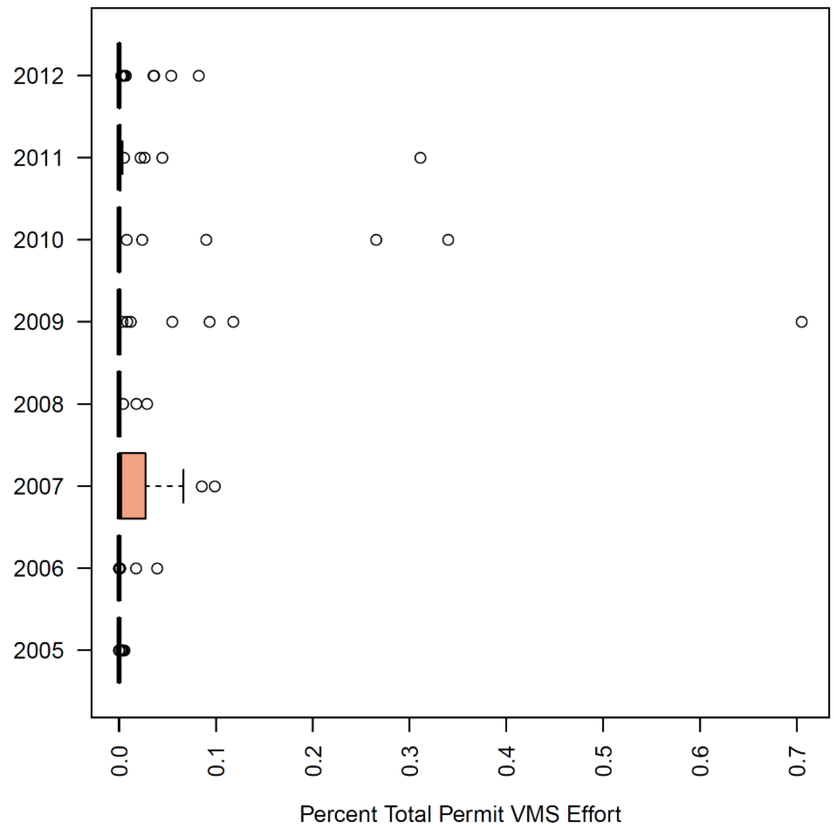
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 54 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 4 600 m broad zone between 2005 and 2012.



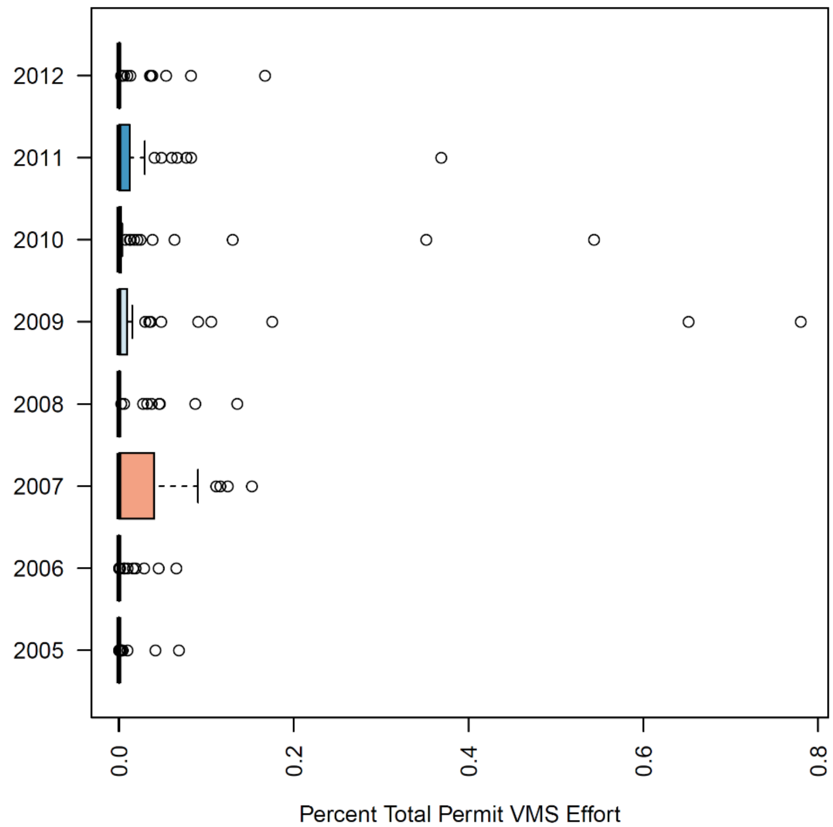
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 55 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 5 900 m broad zone between 2005 and 2012, as derived from VMS



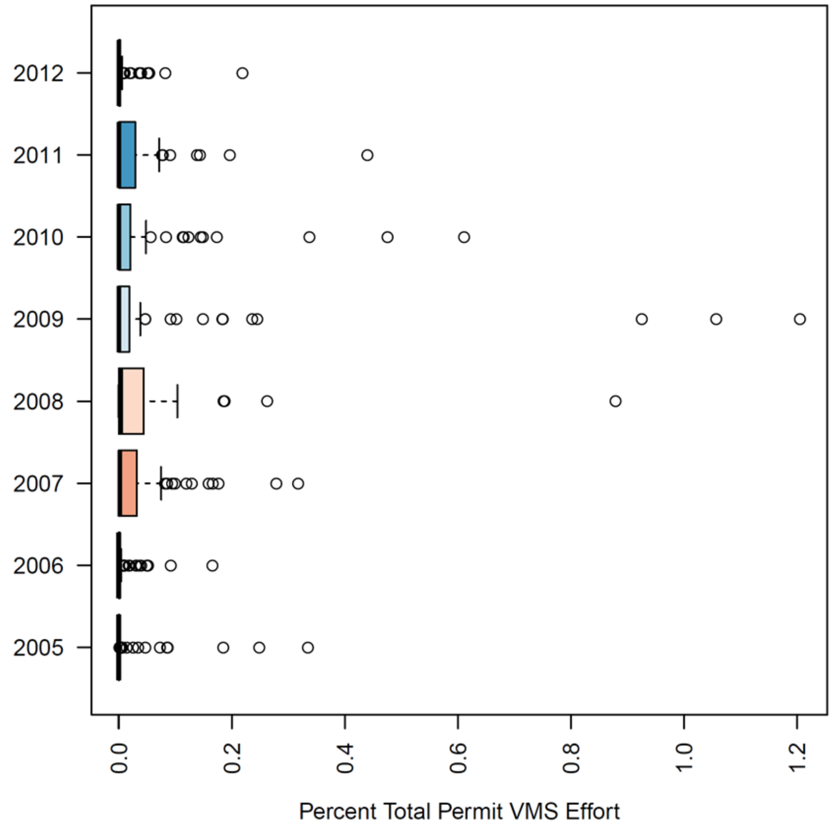
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 56 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 6 600 m minimum broad zone between 2005 and 2012



Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 57 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 7 broad zone between 2005 and 2012.



Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

7.2.2.3.2 Potentially affected fishing communities

General community impacts of the alternatives under consideration are described in section 7.1.3, which also describes the method, caveats, and data confidentiality standard used to develop Table 63 to Table 67, the revenue attributed (using the VTR analysis) to recent fishing within the coral broad zone options.

The VTR analysis indicates that for each of the broad zones considered, New Bedford, Massachusetts and Newport and Pt. Judith, Rhode Island are among the top landing ports that may be impacted. These are some of the closer ports, distance-wise, to the broad zones. Landings from just three permits are attributed to ports in Maine. One explanation is that the lobster management rules prevent a vessel from fishing in both LCMA 1 and 3, so very few lobster vessels from Maine fish in Area 3 (ASMFC 2017). According to the NMFS Community Vulnerability Indicators, the commercial fishing engagement indicator is high for New Bedford and Narragansett (includes Point Judith) and medium-high for Newport (Table 30). Of these three communities, Narragansett ranks highest in terms of reliance on commercial fishing, with a medium-high index, while Newport ranks lowest, with a low index.

Option 1: 300 m broad zone

Although the VTR analysis has some degree of error, it suggests that the fishing communities that could be impacted by the 300 m Broad Zone option are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New York, and other states.

The VTR analysis attributes recent landings revenue to 58 ports and 665 permits (Table 63), and 60% of this revenue to ports in Massachusetts. New Bedford (394 permits), Newport (19 permits), and Point Judith (96 permits), are among the top ten landing ports, and 37% of the revenue is attributed to other ports, indicating that this zone may be particularly relevant for those three communities. The revenue attributed to Massachusetts and Rhode Island from the 300 m Broad Zone is about 1.3% and 4.0% of all revenue, respectively, for these states during 2010-2015 (ACCSP data, 2017). Though these are small fractions, certain individual permit holders could have as much as 70% of their revenue attributed to fishing from this area (Figure 31, p. 317).

Table 63 – Landings revenue to states, regions, and top ports attributed to fishing within the 300 m Broad Zone, 2010-2015. All bottom tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Maine	$0.0M	$0.0M	3
Massachusetts	$41.3M	$6.9M	477
North of Cape	$1.7M	$0.3M	52
Gloucester	$1.6M	$0.3M	36
Other (n=4)	$0.1M	$0.0M	23
Cape & Islands	$8.5M	$1.4M	50
South of Cape	$31.1M	$5.2M	420
New Bedford	$30.6M	$5.1M	394
Other (n=3)	$0.5M	$0.1M	34
Connecticut	$1.3M	$0.2M	25
Rhode Island	$19.0M	$3.2M	118
Newport	$9.3M	$1.5M	19
Point Judith	$4.1M	$0.7M	96
Tiverton	$1.5M	$0.2M	3
Other (n=4)	$4.1M	$0.8M	17
New York	$2.7M	$0.5M	31
Montauk	$2.5M	$0.4M	26
Other (n=5)	$0.2M	$0.0M	7
New Jersey	$1.2M	$0.2M	58
Virginia	$1.8M	$0.3M	110
North Carolina	$0.2M	$0.0M	48
Other[b]	$1.7M	$0.3M	13
Total	**$69.3M**	**$11.5M**	**666**

Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: VTR analysis.

Option 2: 400 m broad zone

Although the VTR analysis has some degree of error, it suggests that the fishing communities that could be impacted by the 400 m Broad Zone option are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New York, and other states (Table 64).

The VTR analysis attributes recent landings revenue to 57 ports and 658 permits, and 59% of this revenue to ports in Massachusetts. New Bedford (385 permits), Newport (19 permits), and Point Judith (94 permits), are among the top ten landing ports, and 36% of the revenue is attributed other ports, indicating that this zone may be particularly relevant for those three communities. The revenue attributed to Massachusetts and Rhode Island from the 400 m Broad Zone is about 1.1% and 3.7% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 70% of their revenue attributed to fishing from this area (Figure 32, p. 318).

Table 64 – Landings revenue to states, regions, and top ports attributed to fishing within the 400 m Broad Zone, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Maine	$0.0M	$0.0M	3
Massachusetts	$37.4M	$6.2M	472
North of Cape	$1.6M	$0.3M	50
Gloucester	$1.5M	$0.2M	36
Other (n=4)	$0.1M	$0.1M	23
Cape & Islands	$7.6M	$1.3M	52
South of Cape	$28.2M	$4.7M	406
New Bedford	$27.9M	$4.6M	385
Other (n=3)	$0.3M	$0.1M	33
Rhode Island	$17.5M	$2.9M	117
Newport	$8.9M	$1.5M	19
Point Judith	$3.6M	$0.6M	94
Other (n=5)	$5.0M	$0.8M	20
Connecticut	$1.1M	$0.2M	23
New York	$2.3M	$0.4M	31
Montauk	$2.1M	$0.3M	26
Other (n=5)	$0.2M	$0.1M	7
New Jersey	$1.1M	$0.2M	57
Virginia	$1.6M	$0.3M	107
North Carolina	$0.2M	$0.0M	47
Other[b]	$1.6M	$0.3M	13
Total	**$62.9M**	**$10.5M**	**659**

Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: VTR analysis.

Option 3: 500 m broad zone

Although the VTR analysis has some degree of error, it suggests that the fishing communities that could be impacted by the 500 m Broad Zone option are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New York, and other states (Table 65). The VTR analysis attributes recent landings revenue to 55 ports and 647 permits, and 59% of this revenue to ports in Massachusetts. New Bedford, (383 permits) Newport, (19 permits) and Point Judith, (91 permits) are among the top ten landing ports, and 35% of the revenue is attributed other ports, indicating that this zone may be particularly relevant for those three communities. The revenue attributed to Massachusetts and Rhode Island from the 500 m Broad Zone is about 1.1% and 3.5% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 70% of their revenue attributed to fishing from this area (Figure 33, p. 319).

Table 65 – Landings revenue to states, regions, and top ports attributed to fishing within the 500 m Broad Zone, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$34.8M	$5.8M	464
North of Cape	$1.5M	$0.2M	51
Gloucester	$1.4M	$0.2M	36
Other (n=4)	$0.1M	$0.0M	20
Cape & Islands	$7.1M	$1.2M	47
South of Cape	$26.3M	$4.4M	402
New Bedford	$26.0M	$4.3M	383
Other (n=3)	$0.3M	$0.1M	31
Rhode Island	$16.4M	$2.7M	114
Newport	$8.5M	$1.4M	19
Point Judith	$3.3M	$0.5M	91
Other (n=5)	$4.6M	$0.8M	16
Connecticut	$1.1M	$0.2M	22
New York	$2.0M	$0.3M	31
Montauk	$1.8M	$0.3M	26
Other (n=5)	$0.2M	$0.0M	9
New Jersey	$1.0M	$0.2M	54
Virginia	$1.5M	$0.2M	105
North Carolina	$0.2M	$0.0M	47
Other[b]	$1.5M	$0.3M	15
Total	**$58.5M**	**$9.7M**	**647**

Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).

Option 4: 600 m broad zone

Although the VTR analysis has some degree of error, it suggests that the fishing communities that could be impacted by the 600 m Broad Zone option are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New York, and other states (Table 66).

The VTR analysis attributes recent landings revenue to 56 ports and 643 permits, and 59% of this revenue to ports in Massachusetts. New Bedford (400 permits), Newport (19 permits), and Point Judith (90 permits), are among the top ten landing ports, and 35% of the revenue is attributed other ports, indicating that this zone may be particularly relevant for those three communities. The revenue attributed to Massachusetts and Rhode Island from the 600 m Broad Zone is about 1.0% and 3.3% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 70% of their revenue attributed to fishing from this area (Figure 34).

Table 66 – Landings revenue to states, regions, and top ports attributed to fishing within the 600 m Broad Zone, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$32.8M	$5.5M	461
North of Cape	$1.4M	$0.2M	48
Gloucester	$1.3M	$0.2M	34
Other (n=4)	$0.1M	$0.0M	19
Cape & Islands	$6.6M	$1.1M	46
South of Cape	$24.8M	$4.1M	402
New Bedford	$24.4M	$4.1M	400
Other (n=3)	$0.4M	$0.0M	30
Rhode Island	$15.6M	$2.6M	112
Newport	$8.2M	$1.4M	19
Point Judith	$3.0M	$0.5M	90
Other (n=4)	$4.4M	$0.7M	14
Connecticut	$1.0M	$0.2M	22
New York	$1.8M	$0.3M	31
Montauk	$1.7M	$0.3M	26
Other (n=5)	$0.1M	$0.0M	7
New Jersey	$1.0M	$0.2M	51
Virginia	$1.4M	$0.2M	104
North Carolina	$0.2M	$0.0M	46
Other[b]	$1.4M	$0.2M	15
Total	**$55.1M**	**$9.2M**	**643**

Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: VTR analysis.

Option 5: 900 m broad zone

Although the VTR analysis has some degree of error, it suggests that the fishing communities that could be impacted by the 900 m Broad Zone option are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New York, and other states (Table 67).

The VTR analysis attributes recent landings revenue to 52 ports (627 permits), and 59% of this revenue to ports in Massachusetts. New Bedford (364 permits), Newport (16 permits), and Point Judith (88 permits), are among the top ten landing ports, and 34% of the revenue is attributed other ports, indicating that this zone may be particularly relevant for those three communities. The revenue attributed to Massachusetts and Rhode Island from the 900 m Broad Zone is about 0.87% and 2.9% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 70% of their revenue attributed to fishing from this area (Figure 35).

Table 67 – Landings revenue to states, regions, and top ports attributed to fishing within the 900 m Broad Zone, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$28.4M	$4.7M	445
North of Cape	$1.2M	$0.2M	48
Gloucester	$1.2M	$0.2M	34
Other (n=2)	$0.0M	$0.0M	17
Cape & Islands	$5.7M	$1.0M	47
South of Cape	$21.4M	$3.6M	386
New Bedford	$21.2M	$3.5M	364
Other (n=3)	$0.2M	$0.1M	27
Rhode Island	$13.9M	$2.3M	108
Newport	$7.7M	$1.3M	16
Point Judith	$2.6M	$0.4M	88
Other (n=4)	$3.6M	$0.6M	12
Connecticut	$0.8M	$0.1M	19
New York	$1.5M	$0.2M	30
Montauk	$1.4M	$0.2M	24
Other (n=5)	$0.1M	$0.0M	7
New Jersey	$0.8M	$0.1M	48
Virginia	$1.2M	$0.2M	102
North Carolina	$0.1M	$0.0M	45
Other[b]	$1.2M	$0.2M	15
Total	**$48.0M**	**$8.0M**	**627**

Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential.
[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: VTR analysis.

Option 6: 600 m minimum broad zone

Although the VTR analysis has some degree of error, it suggests that the fishing communities that could be impacted by the 600 m minimum Broad Zone option are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New York, and other states (Table 67).

The VTR analysis attributes recent landings revenue to 55 ports and 643 permits, and 59% of this revenue to ports in Massachusetts. New Bedford (380 permits), Newport (19 permits), and Point Judith (90 permits), are among the top ten landing ports, and 35% of the revenue is attributed other ports, indicating that this zone may be particularly relevant for those three communities. The revenue attributed to Massachusetts and Rhode Island from the 600 m minimum Broad Zone is about 1.0% and 3.2% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 70% of their revenue attributed to fishing from this area (Figure 34).

Table 68 – Landings revenue to states, regions, and top ports attributed to fishing within the 600 m minimum Broad Zone, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$32.1M	$5.4M	460
North of Cape	$1.4M	$0.2M	49
Gloucester	$1.3M	$0.2M	34
Other (n=4)	$0.1M	$0.0M	20
Cape & Islands	$6.5M	$1.1M	46
South of Cape	$24.3M	$4.1M	399
New Bedford	$24.0M	$4.0M	380
Other (n=3)	$0.4M	$0.1M	30
Rhode Island	$15.4M	$2.6M	112
Newport	$8.2M	$1.4M	19
Point Judith	$3.0M	$0.5M	90
Other (n=4)	$4.4M	$0.7M	14
Connecticut	$1.0M	$0.2M	22
New York	$1.8M	$0.3M	30
Montauk	$1.7M	$0.3M	25
Other (n=5)	$0.1M	$0.0M	7
New Jersey	$1.0M	$0.2M	51
Virginia	$1.4M	$0.2M	104
North Carolina	$0.2M	$0.0M	45
Other[b]	$1.4M	$0.2M	14

Total	**$54.2M**	**$9.0M**	**643**
Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential. [a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states. [b] Includes confidential state(s). *Source:* VTR analysis.			

Table 69 – Landings revenue to states, regions, and top ports attributed to fishing within the 600 m minimum Broad Zone, 2010-2015. Mobile bottom-tending gears only.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$13.8M	$2.3M	381
North of Cape	$0.4M	$0.1M	38
Cape & Islands	$0.0M	$0.0M	17
South of Cape	$13.5M	$2.2M	345
New Bedford	$13.4M	$2.2M	334
Other (n=14)	$0.1M	$0.0M	73
Rhode Island	$5.1M	$0.9M	81
Point Judith	$1.8M	$0.3M	72
Other (n=4)	$3.3M	$0.6M	12
Connecticut	$1.0M	$0.2M	20
New London	$0.5M	$0.1M	4
Stonington	$0.5M	$0.1M	18
New York	$1.1M	$0.2M	18
Montauk	$1.1M	$0.2M	13
Other (n=4)	$0.0M	$0.0M	5
New Jersey	$0.9M	$0.1M	45
Cape May	$0.4M	$0.1M	26
Other (n=2)	$0.5M	$0.0M	19
Virginia	$1.4M	$0.2M	104
Newport News	$0.6M	$0.1M	47
Hampton	$0.4M	$0.1M	37
Other (n=2)	$0.4M	$0.0M	28
North Carolina	$0.2M	$0.0M	45
Other[b]	$1.4M	$0.2M	14
Total	**$23.6M**	**$3.9M**	**512**
Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential. [a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states. [b] Includes confidential state(s). *Source:* VTR analysis.			

Option 7: Empirically-derived zone

Although the VMS comparison suggests that the VTR results are an overestimate, VTR data suggest that the fishing communities that could be impacted by the Option 7 coral zone are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New York, Virginia and other states. Presented here are estimates of recent state and port participation in fisheries attributed to the Option 7 coral zone.

The VTR analysis attributes recent MBTG landings revenue to 44 ports, and 60% of this revenue to ports in Massachusetts. New Bedford, Point Judith, and Montauk are among the top ten landing ports, and 30% of the revenue is attributed to other ports, indicating that this zone may be particularly relevant for those three communities. The revenue attributed to Massachusetts and Rhode Island from the Option 7 zone is about 0.5% and 1.2% of all revenue, respectively, for these states during 2010-2015 (ACCSP data, 2017). Though these are small fractions, certain individual permit holders could have as much as 40% of their revenue attributed to fishing from this area.

The average revenue for 2010-2015 attributed to fishing with MBTG within the revised Option 7 boundary is $4.4M. Again, this total is likely an overestimate and includes $1.3M from scallop fishing.

Table 70 – Landings revenue to states, regions, and top ports attributed to fishing within Option 7 (updated), 2010-2015 – MBTG ONLY

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$15.7M	$2.6M	381
North of Cape	$0.4M	$0.1M	38
Cape & Islands	$0.0M	$0.0M	17
South of Cape	$15.2M	$2.5M	347
New Bedford	$15.1M	$2.6M	337
Other (n=3)	$0.1M	$0.0M	14
Rhode Island	$5.7M	$1.0M	80
Point Judith	$2.0M	$0.3M	72
Other (n=4)	$3.6M	$0.7M	12
Connecticut	$1.1M	$0.2M	20
New London	$0.6M	$0.1M	4
Stonington	$0.5M	$0.1M	18
New York	$1.3M	$0.2M	18
Montauk	$1.3M	$0.2M	14
Other (n=4)	$0.0M	$0.0M	5
New Jersey	$1.0M	$0.2M	47
Cape May	$0.5M	$0.1M	27
Other (n=2)	$0.5M	$0.1M	20
Virginia	$1.5M	$0.3M	105
Newport	$0.7M	$0.1M	48
News	$0.8M	$0.2M	65
Other (n=3)			
North Carolina	$0.2M	$0.0M	46
Other[b]	$0.0M	$0.0M	4
Total	**$26.4M**	**$4.4M**	**508**
Notes: Ports listed are the top 10 ports by landing revenue that are non-confidential.			

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: VTR analysis

7.2.2.4 Impacts on protected resources

The protected resources potentially affected by this amendment are described in section 6.9.2, and the potential for interactions between these species and fishing gears are described in section 6.9.3. The extent to which the broad zone options may positively or negatively affect protected resources depends on the protected resource species present in the areas proposed for management, the nature of the interaction between the fisheries and protected resources occurring in the areas, the effects of the broad zone options on fishing distributions, the magnitude of potential effort displacement, and whether the areas to which effort is displaced are likely to have greater, lesser, or roughly the same interaction rates as would occur within current fishing grounds.

The major gear types fished in and around the broad zones are bottom trawl and lobster trap. Red crab traps are fished in the zones as well, but the magnitude of this effort cannot be detailed due to confidentiality considerations. Impacts are expected to be similar to lobster traps. Minor gear types include bottom longline, scallop/clam dredge, sink gillnet, and separator and Ruhle trawl. As noted in the No Action section, bottom trawl effort for squid, whiting, butterfish, and other demersal fishes is already prohibited in existing fishery management closures and in the monument but occurs along other sections of the shelf break. Once the monument closes to lobster pot fishing during or prior to 2023, trap fishing for lobster, Jonah crab, and red crab is likely to be redistributed along other portions of the continental margin. The potential for trap effort redistribution is detailed in section 7.2.1.4.

It is assumed that effort that might be displaced from any of the broad zones would generally remain in relatively deep water along the shelf break, vs. being redistributed to other parts of the region. Larger shifts in effort would be expected with the shallower broad zone options and little to no shifts in effort are expected with the deeper options. Specifically, Options 1-3 (300, 400, 500 m zones) could shift bottom trawl and lobster trap effort into shallower waters. Based on discussions at the Council’s coral workshops in March 2017, it is likely that the Options 4-6 (600 m, 600 m minimum, and 900 m zones) would not affect the distribution of bottom trawl or trap gear much if at all. Option 7 was designed to freeze the footprint of bottom trawl effort such that displacement of this gear would likely be limited under Option 7 (this option would not apply to trap gears).

In addition to differences in expected effort shifts based on the depth of the broad zone, more extensive gear restrictions would result in more substantial effort shifts. Option 1 would close a designated broad zone to all bottom tending gears, with sub-options to exempt (a) the red crab trap fishery, and/or (b), the use of lobster traps. Gear restriction Option 2 would be less restrictive, closing the area to bottom trawls only (and dredges, but as noted previously dredge use in the broad coral zone depths is unlikely to occur).

Given these expected localized effort shifts, protected species occurring inshore are unlikely to be affected by the implementation of any broad zone option. Thus, the list of species that might be impacted by the broad zones (Table 71) is smaller than the list of species potentially affected by the amendment (Table 39).

Table 71 – Occurrence of protected resources in the broad deep-sea coral zones

Species grouping	May occur in the broad deep-sea coral zones
Large whales	North Atlantic right whale, humpback whale, fin whale, sei whale, minke whale, sperm whale.
Small cetaceans	Risso's dolphin, short-beaked common dolphin, bottlenose dolphin (WNA Offshore Stock), pilot whales, Atlantic white sided dolphin, harbor porpoise.
Pinnipeds	None; all primarily nearshore, coastal species.
Turtles	Green, loggerhead, Kemp's ridley, and leatherback
Fishes	None; primarily coastal waters.
Sources: http://seamap.env.duke.edu/, https://www.nefsc.noaa.gov/psb/surveys/; https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region; NMFS NEFSC FSB (2018)	

7.2.2.4.1 Large whales

Bottom trawl is one of the predominant types of fishing gears used in and around the broad zones over the period from 2010-2015 (see section 7.2.2.3.1 for details). However, interaction risks between large whales and trawl gears are low. Other than minke whales, there have been no observed or documented interactions between trawls and large whales (see section 6.9.3). Bottom trawls would be restricted in all broad zones, regardless of fishing gear restriction option selected, and effort could be redistributed in response to broad zone options 1 (300 m), 2 (400 m), or 3 (500 m). However, given little to no interaction risk posed by bottom trawls, designation of any of the broad zones with any of the gear restriction options is not expected to affect interaction risks between these mobile gears and large whales. Based on analysis of VMS data, scallop and clam dredges are not expected to be fished at broad zone depths, as discussed in section 7.2.2.3.1, although these gears are identified in proximity of the broad zones in the VTR/logbook analysis.

Gillnet and trap/pot gears, specifically the vertical lines associated with these gear types, pose the greatest entanglement risk to large whales (see section 6.9.3.1.1). The northeast sink gillnet and northeast/Mid-Atlantic lobster trap/pot fisheries are placed in Category I, which indicates "annual mortality and serious injury of a stock in a given fishery is greater than or equal to 50% of the PBR level (i.e., frequent incidental mortality and serious injury of marine mammals)". Gillnet effort is minimal in the broad zones, regardless of which one is selected, contributing just a small percentage of area revenues (see Figure 17 through Figure 22), and not likely to be affected by designation of any of the broad zones. Lobster pot effort, however, is likely to be redistributed in response to designation of the shallower broad zones as closures to all bottom-tending gears. This redistribution would be avoided with a trap exemption from the bottom-tending gear restriction (Sub-Option B). These changes in fishing effort could influence interaction rates between lobster pots and large whales, as described below.

As discussed previously, effort redistribution would be limited by the distribution of lobsters. The depth band ~100 m is a transitional area for lobsters between their summer/fall distribution on top of the bank and their winter/spring distribution in deeper waters, and gear is not typically set in this depth zone.

During 2010-2012, somewhere between 696-965 lobster pot trips a year are estimated to overlap the broad zones (see Table 60 in section 7.2.2.3.1 for details). However, given the uncertainty in spatial distribution of effort associated with VTR data, discussions with the fishing industry are likely a more useful indicator of the maximum depths fished with lobster trap gear. Based on feedback provided at the March 2017 workshop (NEFMC 2017), lobster traps are set along the shelf break to depths of approximately 550 m. This means that Options 4 (600 m), 5 (900 m), and 6 (600 m minimum) are unlikely to affect the distribution of lobster pot effort and thus interation rates between pots and large whales. Option 7 and Options 1-3 with trap exemptions (gear restriction Sub-Option B) would not restrict lobster pot gears. Thus, the remainder of the discussion about lobster pots and large whales focuses on boundary Options 1-3 with gear restriction Option 1.

Because the Option 1 (300 m zone) is larger and shallower than Option 2 (400 m) and in turn Option 2 is larger than Option 3, Option 1 would have the largest effect on fishing effort and Option 3 would have the least effect. The responses of the lobster fishery to designation of one of these zones are difficult to estimate. Discussions at the Council's workshop indicted that any areas of the shelf break, canyons, and slope that are fishable with lobster pots likely already have gear in them. Lobster fishermen explained that individuals set their gear in known locations, consistently using the same areas over time, except that traps are set somewhat deeper in winter and shallower in summer. As noted previously there is an upper depth limit beyond which traps are not set (~100 m is a transitional area for lobsters and limited gear is set at this depth). Given these patterns, and assuming that spacing between traps along a trawl doesn't change, broad zone designation could have the effect of reducing the number of traps in the water, because the deeper traps from each trawl could not be set inside the coral zones. While the number of traps per trawl might decrease, the number of vertical lines would likely remain the same under this scenario.

Another response to the zones could be to set trawls at a closer spacing than is presently used. This would allow lobstermen to fish the same number of traps but in a smaller area. This would maintain current numbers of vertical lines, but they would be spaced more closely. Trap reductions or more densely set traps could be accompanied by longer soak times if changes to spacing affect catchability of lobsters and there is a desire to maintain catch levels. This would lead to a longer duration of vertical line presence in the water column. Longer fishing times or more densely concentrated traps could both contribute to increased interaction rates between trap gears and large whales.

Strategies developed outside the fishery management plan process serve to reduce the likelihood of gear interactions with large whales (see section 6.9.3.1.1 and summary in section 7.2.1.4.1). Given the discussion above about potential shifts in effort, and that ALWTRP measures are already in place to reduce serious injury and mortality, the impacts of the broad zones could be negative to neutral for Options 1-3, gear restriction Option 1. Impacts are expected to be neutral to No Action for Options 1-3, if lobster traps are exempted, or for Options 4-7, regardless of gear restriction. In other words, negative impacts associated with existing interations will continue, but interaction rates are not expected to change. Amongst the broad zones with potentially negative impacts, Option 1 (300 m) would be expected to have the largest magnitude of negative impacts, then Option 2 (400 m), and then Option 3 (500 m).

7.2.2.4.2 Small cetaceans

Interaction risks for small cetaceans are described in section 6.9.3.1.2. No small cetacean mortalities, serious injuries, or interactions have been observed or documented in scallop dredge gear. Thus, scallop fishing is not expected to have an effect on small cetaceans. Direct observations of fishing with trap/pot gear are limited, so interaction information for small cetaceans and trap/pot gear is partly inferred from evidence of gear on stranded animals. These stranding data suggest that trap/pot interaction rates with small cetaceans are low. While there is a take reduction plan for harbor porpoise, its restrictions apply to gillnets only, and gillnet effort distributions are not likely to be affected by the broad zone alternatives, as discussed above.

Interactions between small cetaceans and bottom trawl gear are of somewhat greater concern (see section 6.9.3.1.2). The northeast bottom trawl fishery is a category II fishery with respect to some small cetaceans, including Risso's dolphin, short-beaked common dolphin, harbor porpoise, and bottlenose dolphin (WNA Offshore Stock). According to Northeast Fishery Observer Program and At-Sea Monitoring Program Data, and the 2017 marine mammal stock assessment report (Hayes et al.2018), small cetacean interactions with bottom trawl gear have been observed on Georges Bank; however, of these observed interactions, few have been observed along the continental margin south of Georges Bank where the broad zones are located. Therefore, although the potential exists for interactions in the bottom trawl fishery, any negative impacts on small cetaceans that result from spatial shifts in trawl effort out of any designated broad zone are likely to be slight.

Regardless, there may be a small risk of increased interaction rates if trawl gear usage becomes more concentrated spatially, due to implementation of the coral zones. During 2010-2012, somewhere between 700-1,000 bottom trawl trips a year are estimated to overlap the broad zones (see Table 60 in section 7.2.2.3.1 for details). However, given the uncertainty in spatial distribution of effort associated with VTR data, discussions with the fishing industry are likely a more useful indicator of the maximum depths fished with bottom trawls. During the Council's workshops, participants in trawl fisheries along the shelf break indicated that they fished to depths of 500 meters, at most. This suggests that Options 1-3 (300 m, 400 m, 500 m zones) could influence the distribution of bottom trawl gear fishing along the edge of the shelf. The expected effect of Options 1-3 would be that fishing activity could move into slightly shallower depths than previously fished so that vessels could avoid entering the broad zones with fishing gear deployed. While it is unlikely that effort would increase as a result of broad zone designations, if fishing activities become more concentrated this could make gear avoidance more difficult for small cetaceans, and thereby increasing the potential for interactions. This could be due to closer spacing between tows, increased tow duration, or both.

There is a take reduction strategy for trawl gears to limit interactions with dolphins and other cetacean species. Voluntary measures include reducing the numbers of turns made by the fishing vessel and tow times while fishing at night and increasing radio communications between vessels about the presence and/or incidental capture of a marine mammal to alert other fishermen of the potential for additional interactions in the area.

Given the discussion above about potential shifts in effort, and that measures outside the fishery management plan process are designed to reduce interaction, the impacts of designating a broad coral zone are uncertain but could be slightly negative for Options 1-3. Impacts of Options 4-7 would be expected to be neutral relative to No Action (i.e. potentially slightly negative). Because trawl gear is the major concern for small cetaceans, and it would be prohibited in the coral zones under any of the gear restriction options, these impacts are expected to be the same, regardless of whether the areas are closed to all bottom tending gears (with or without trap exemptions), or only mobile bottom tending gears. Amongst the broad zones with potentially negative impacts, Option 1 (300 m) would be expected to have the largest magnitude of negative impacts, then Option 2 (400 m), and then Option 3 (500 m).

7.2.2.4.3 Sea turtles

Sea turtles are at risk for interaction with various types of bottom tending gears used in and around the broad coral zones, as described in section 6.9.3.2. Bottom trawl gear poses an injury and mortality risk to sea turtles, specifically due to forced submergence (Sasso and Epperly 2006). Green, Kemp’s ridley, leatherback, loggerhead, and unidentified sea turtles have been documented bycaught in bottom trawl gear, but most of these interactions have occurred in the Mid Atlantic (section 6.9.3.2). Turtle excluder devices allow for escapement but are only required in the southern fishing grounds for summer flounder, where turtles are relatively more abundant. Broad zone Options 1-3 would be expected to have some effects on the distribution of fishing effort with trawl gear, as described in section 7.2.2.4.2. Thus, with respect to bottom trawl gear, potential negative impacts to sea turtles are expected. However, relative to the waters of the Mid-Atlantic, sea turtle encounter rates are lower in the waters on or off of Georges Bank (i.e. proposed Broad Zone areas; Murray and Orphanides 2013; http://seamap.env.duke.edu/). Based on the this, there is a low level of overlap between sea turtles and fisheries operations in the areas proposed as broad zones; this evidenced by the low numbers of sea turtles observed in fishing gear towed in these area (NMFS NEFSC FSB 2018, Murray 2015a; Warden 2011a,b). Based on this, and and given the potential changes in trawl fishing in responses to these broad zone options, the magnitude of negative effects to sea turtles are likely to be slight.

Leatherback, loggerhead, green, and Kemp's ridley sea turtles are known to interact with trap/pot gear, with interactions primarily associated with entanglement in vertical lines, although sea turtles can also become entangled in groundline or surface systems (see section 6.9.3.2 for more detailed information on interaction rates). Records of stranded or entangled sea turtles indicate that fishing gear wraps around the neck, flipper, or body of the sea turtle and severely restrict swimming or feeding, which can cause injuries and sometimes mortality immediately or at a later time (Balazs 1985, STDN 2016). Most of the documented trap gear interactions were with leatherbacks (STDN 2016). As described in section 7.2.2.4.1, trap gear could become more concentrated under Options 1-3 (300 m, 400 m, and 500 m zones), provided that trap gear is not exempted (gear Option 1, Sub-Option B, or gear Option 2). If this concentration reduces catch rates, set times could increase. Alternatively, fewer traps might be set, but soak times could increase. Both a greater concentration of vertical/groundlines and longer set durations could increase interaction rates. Thus, designation of of broad zone Option 1, 2, or 3 with trap restrictions could have slightly negative effects on sea turtles.

Overall, the impacts of the broad zone alternatives on sea turtles could range from slightly negative to neutral, relative to No Action. Neutral impacts relative to No Action are expected for Options 4-7, which are not expected to have redistributional effects on fishing activity. Amongst the broad zones with potentially negative impacts relative to No Action, Option 1 (300 m) would be expected to have the largest magnitude of negative impacts, then Option 2 (400 m), and then Option 3 (500 m).

7.2.3 Impacts of canyon coral zones and associated fishing restrictions

This alternative would designate coral zones within 20 submarine canyons off the southern boundary of Georges Bank, with options for which gear types would be precluded from the zones (section 4.3, Table 72). From west to east, these canyons are: Alvin, Atlantis, Nantucket, Veatch, Hydrographer, Dogbody, Clipper, Sharpshooter, Welker, Heel Tapper, Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia, Powell, Munson, Nygren, Kinlan (previously an unnamed canyon), and Heezen. This alternative would be additive to No Action (i.e., Monkfish/MSB/Tilefish areas and the National Monument would remain in place) and could be selected in combination with other alternatives under consideration.

Table 72 - Fishing restriction options relevant to the canyon coral zones

Fishing restriction options	Relevance to canyon zones
Option 1: Prohibit all bottom-tending gears	Yes
Sub-option A: Exempt red crab fishery	Yes
Sub-option B: Exempt other trap fisheries	Yes
Option 2: Prohibit mobile bottom-tending gears	Yes

The canyons are placed into two groups for analysis:

- "Discrete Monument Canyons" - canyons that overlap the National Monument (Oceanographer, Filebottom, Chebacco, Gilbert, and Lydonia), and
- "Discrete Non-Monument Canyons" - canyons that do not overlap (remaining 15 canyons).

This grouping is because, once the National Monument fishing restrictions are fully implemented for trap fisheries (no later than 2023), Monument fishing restrictions will exceed those that might be associated with the coral zones.

7.2.3.1 Impacts on deep-sea corals

The type of coral data available for the canyons is the same as the broad zones. The canyons encompass known coral habitats, as determined by recent and older coral occurrence records (Table 46 and Table 45), as well as areas of high slope and modeled suitable habitat (Table 49 and Table 47). In general, the canyon zones are a subset of the 300 m broad zone, although in some of the canyons the minimum depth is deeper, around 400 m, and in a few cases the discrete zones are shallower, approaching 200 m (Table 48). As expected, in aggregate, the canyons protect a smaller area of coral habitat (as indicated by the suitability model and slope data, relative to all of the broad zones being considered. This is not surprising as suitable habitat occurs outside the canyons on the slope, and considering just the suitability model footprint, the canyon zones cover much less area (2,651 km^2 vs. 10,148-13,097 km^2 for the broad zones). Combining the size of the zones with the suitable habitat area, the suitable habitat efficiency index (last column in Table 47), is much higher for the discrete canyons than the broad zones (77% vs. 35% for the 300 m and 400 m broad zones, down to 28% for the 900 m broad zone).

One area where the canyons perform better than the broad zones is that the canyons encompass a slightly larger area of high slope than the deepest broad zone at 900 m (108 km^2 or 65% of the high slope area, vs. 102 km^2 or 62%). In terms of comparing the canyon zones to the deeper (600 m, and especially 900 m) broad zones, the recent dives and tows highlighted in the broad zone impacts section (7.2.2.1) are relevant here as well, as they all occurred within the canyons.

Generally, the discrete canyon zones would have a positive impact on deep-sea corals. A relatively straightforward conclusion is that designating the canyon zones alone would have fewer positive impacts as compared to designating a broad zone at either 300 m or 400 m. The discrete canyons are generally a subset of those two zones and designating just the canyons would not afford protection for coral habitats on the continental slope. Assessing tradeoffs between the canyon zones and the deeper broad zones (500 m, 600 m, and 900 m) is less straightforward. As noted above, the canyon zones encompass less coral habitat than the much larger broad zones, regardless of broad zone depth. But, high suitability habitats, including areas of high slope, tend to be concentrated in the canyons, and coral habitats in the shallower portions of the canyons would not be protected through the designation of a deeper broad zone.

7.2.3.2 Impacts on managed species and essential fish habitats

The canyon zones would protect corals, fishes, and other species across a comprehensive range of depths, generally between 300 m and 2,000 m (Table 48). As noted in the previous section on broad zones, shallower depths in this range along the continental slope south of Georges Bank provide habitat for redfish, halibut, white hake, witch flounder, red hake, offshore hake, monkfish, smooth skate, thorny skate, barndoor skate, and red crab.

The canyon zones in combination are expected to have slight positive impacts on managed species and their habitats. Similar to the discussion of impacts to corals in the previous section, the canyon zones will have a smaller magnitude of positive impacts on managed resources and their habitats than the 300 m or 400 m broad zones, as the canyon zones are generally a subset of these two broad zones, with a few exceptions in the heads of the largest canyons, e.g., Hydrographer. Compared to or if designated in addition to the deeper broad zones (500-900 m), the canyon zones will protect fish habitats in shallower waters. These shallower areas could be particularly important for tilefish, which prefer particular consolidated mud sediments in waters to 300 m depth. In general, managed species and EFH tend to occur in the shallower areas of the slope and canyons, so the canyon zones would likely have similar impacts on managed species and EFH as the 500-900 m broad zones, but they would have fewer positive impacts on corals than the broad zones.

7.2.3.3 Impacts on human communities

Under this alternative, coral zones would be established within 20 distinct canyons along the southern margin of Georges Bank, with options for which gear types would be precluded from the zones. This alternative would be additive to No Action (Monkfish/MSB/Tilefish areas and the National Monument would remain in place) and could be selected in combination with a broad zone, and along with the discrete seamount zones alternative.

The impacts of the canyon coral zones on human communities are expected to be low negative in general, but negative for the fisheries and communities that would be affected, to the degree that fisheries are constrained. These negative impacts would be additive to the negative fishery impacts of No Action, as fishing in 15 additional canyons would be restricted. As with No Action, it is difficult to determine if fishermen would be precluded from fishing altogether or be able to shift effort to other areas. The lobster fishery is particularly territorial (Acheson 1987; 2006), such that efforts to shift effort to areas remaining open may be difficult for those displaced by the closures. To the degree that these closures would provide habitat for fishery species, there may be long-term benefits to fisheries and society, but these are difficult to predict.

The impacts to the fishing industry are expected to be negative. The VTR and ASMFC analysis provide bounds on the uncertainty surrounding the amount of lobster revenue being generated from the discrete zones, between $0.6M and $1.8M annually. High levels of VMS coverage for scallop dredge trips in the region suggest VMS data provides a more precise spatial analysis when compared to the VTR analysis and suggests there is no substantial scallop effort in the canyons. Though the VMS analysis does indicate bottom trawl effort in the canyons, the percentage of total effort expended per permit this represents is low for the vast majority of individuals fishing in the vicinity of the canyons. Nevertheless, when non-Monument and Monument discrete canyon zones are summed, both the VMS and VTR analyses indicate that a substantial percentage of VMS-derived effort at the permit level (~10 – 20%) and VMS-derived revenue at the owner level (~10 – 25%) is derived from the discrete canyon zones. Pots are apparently used in the canyons to a greater extent than MBTG, suggesting that a restriction on the use of pots (Option 2) would subsantially reduce theimpacts of fishing.

The sociocultural impacts associated with establishing the canyon zones are expected to be negative for fishermen and fishing communities, and negative relative to No Action. With effort shifts, conflicts within or between fisheries would have a negative impact on the *Non-Economic Social* aspects and the *Attitudes, Beliefs, and Values* of fishery participants. Establishing the zone may change the *Social Structure and Organization* of communities as well as *Historical Dependence on and Participation* in the fishery by individuals and communities. Deep-sea corals have cultural value to society, so affording them protection has positive impacts on the *Attitudes, Beliefs, and Values* of stakeholders towards management.

7.2.3.3.1 **Potentially affected fisheries**

Relative to the broad zones, the discrete canyon zones encompass a much smaller area, only the 20 largest canyons vs. the entire shelf/slope region to the EEZ. Generally, the discrete canyon zones are a subset of the 300 m broad zone, although they do extend into shallower waters in a few of the largest canyons. Due to data limitations, it is impossible to know the true amount of fishing activity that has occurred within the canyons. Thus, multiple approaches are used to estimate fishing activity, and thus characterize the potential fishery impacts of this alternative. For analytical purposes, the canyons were grouped into Monument (5 canyons) and non-Monument (15 canyons).

VTR analysis

Vessel Trip Report data were used to estimate recent (2010-2015) fishing activity within the broad zone areas. With the exception of lobster trap gear, revenue results were unscaled. Because a large number of lobster vessel operators are not required to submit VTRs (their vessels do not carry other federal permits), total lobster revenue was expanded (method explained in section 7.1.3.1). As expected, more gear types, species fished, and fishery revenue is attributed to the canyons (as a whole) relative to the No Action areas, because the canyons in combination comprise a broader area of the shelf/slope region. Given the spatial resolution of the VTR analysis, individual trips may be attributed to both the Monument and non-Monument canyons. Maps of revenue by gear type and species are in Appendix F).

Revenue by gear: Total revenue attributed to the non-Monument canyons by bottom-tending gear, and thus exposed to fishing restriction Option 1 is $1.7-2.7M annually, averaging $2.1M (Figure 58), and annual revenue attributed to the Monument canyons is between $170-400K, averaging $298K (Figure 59). Because the 20 canyons combined cover the same east-west extent along the shelf break as the broad zones, the mix of species and gear types are similar, and are more diverse than those attributed to the No Action areas. In the 15 non-Monument canyons, bottom trawl (averaging $560 K) and lobster pot (averaging $870 K, exempted under fishing restriction Option 1 Sub-option B) are the primary revenue generators, except for relatively high scallop gear/clam dredge revenue in 2012, and other gear revenue in 2014. This other gear revenue is due primarily to increased revenue from red crabs, which are fished in the western portion of the area (Figure 58). The recent revenue attributed to fishing with mobile bottom-tending gear from these canyons averages 45% of the total, or $1.09 million annually. In the Monument canyons, lobster pots (averaging $60K) and bottom trawls (averaging $85K) are the major sources of revenue, with other gear and scallop gear/clam dredge important in 2014 (other gear) and 2012/2015 (dredge gears), respectively (Figure 59). The recent revenue attributed to fishing with mobile bottom-tending gear from the Monument canyons averages 54% of the total, or $160K annually, with the remaining $930K being generated from the non-Monument canyons.

Revenue by species: The mix of species revenue attributed to the non-Monument canyons (Figure 60), in particular, is similar to those attributed to the broad zones (Figure 24), although total revenue is less. The broad zones and non-Monument canyons have nine of the top ten species in common, including butterfish, Jonah and red crab, silver hake, longfin squid, lobster, and sea scallop. Red crab would be exempted from this alternative under fishing restriction Option 1 Sub-option A, while all crustaceans would be exempted under both the fishing restriction Option 1 Sub-option B and Option 2. In the non-Monument canyons, summer flounder, golden tilefish, and monkfish fall into the top ten, and in the Monument canyons, haddock and Atlantic mackerel fall into the top ten (Figure 61). Scallops, flounders, and butterfish are not known to occur in particularly deep water, so their association with the canyon zones may be due to the imprecision of the VTR, rather than representing actual landings within the borders of the canyon zones alternative. Under fishing restriction Option 1 Sub-option B and Option 2, crustaceans would be replaced by yellowtail, haddock, and skates in the non-Monument canyons and cod, yellowtail flounder, and winter flounder in the Monument canyons top ten species.

Owners and permits: The number of vessel owners with 2013-2015 revenue attributed to the non-Monument and Monument canyons annually averages 220 and 78, respectively (Figure 62 and Figure 63). Across both areas, median percent annual revenue at the owner level hovers around zero. However, there are outliers whose inferred percent annual revenue values are between 2-25% for the non-Monument canyons, and 0.5-2.5% for the Monument canyons. These outliers indicate that, at the owner level, there are some fishing businesses that likely focus their effort on fishing in and around the canyons. The percentage of revenue generated from MBTG is presented in Figure 54 and Figure 65, which indicate that the most highly exposed owners tend to employ traps. This, in turn, means that fishing restriction Option 2 would mitigate the highest impacts expected from the discrete canyon alternatives, particularly for the non-Monument canyons.

VTR vs. VMS comparison

An analysis of VMS coverage for VTR trips occurring in the vicinity of the discrete canyon zones can be found in Table 73. Total trips attributed to the non-Monument canyons from the VTR analysis averages 2,100 annually. Fewer trips have been taken in the Monument canyons, with an average of 600 trips annually. The number of trips using bottom trawl and lobster traps, attributed to each canyon inside and outside the

Monument, is roughly equivalent and comprise the majority of trips. In the non-Monument canyons, the overlap is up to around 1,000 trips per year for both lobster and bottom trawl. The number of trips in the Monument canyons for each gear type is lower, 200-300 trips per year. Unlike the revenue data, where scallop gear/clam dredge data constitute a large fraction of total revenue during some years, the trip metric deemphasizes these gears. This makes sense; scallops are a high value species meaning a small number of trips in the region could generate a substantial revenue number.

An average of 370 unique permits are estimated to have fished in the non-Monument canyons. As expected, fewer permits have been fished in the Monument canyons, averaging 140 unique permits annually. The total numbers of permits associated with the non-Monument canyons are similar to those associated with the broad zones, which is intuitive as the areas overlap. In most years, it appears that a large fraction of the scallop fleet (100-200 scallop or clam permits, out of about 350 scallop permits) fishes near the non-Monument discrete zones. For the Monument, no fishing was attributed to gillnets, longlines, and separator or Ruhle trawls.

Both VTR and VMS data are available for 2010, 2011, and 2012. For both the Monument and non-Monument canyons, the majority of mobile bottom-tending gear trips from this period have both VTR and VMS data (90-100% scallop and clam dredge, 83-94% bottom trawl, Table 73). For these gears, the VMS analysis represents fishing effort at a much more refined spatial scale than VTR and covers the vast majority of trips in the region. The same cannot be said for lobster pot, whose low level of VMS coverage (0-15%) could result in spatial bias when extrapolating to the entire fleet. It is unknown whether these same levels of overlap between VMS and VTR trips existed prior to 2010 (i.e. in the period before the VTR analysis timeframe), since VMS requirements have changed over time.

Given the high VMS coverage for bottom trawl and scallop and clam dredge, estimates of fishing activity attributed to the Monument and non-Monument canyons is better assessed through VMS rather than VTR. Total hours fished in scallop dredge gear in the canyons is very low (Table 75), further substantiating the assumption that the canyons are not important scallop fishing grounds. Due to the low coverage of lobster pot fishing in the region, the VMS provides a likely low bound, while VTR provides an upper bound, on the uncertainty regarding the trips and permits recently fishing within the canyons. For sink gillnets and bottom longline, only the VTR analysis is currently available. For bottom trawl, an average of 13% of VTR trips and 18% of permits covered by VMS have VMS polls falling within the Monument Canyons, while in the non-Monument Canyons the numbers are 11% of trips and 28% of permits. Although overall effort is relatively low, there is a sizeable spike in bottom trawl effort in the non-Monument canyons during 2008.

For all bottom-tending gears combined, the vast majority of the ownership groups and permits estimated to have only a small amount of their total activity (~1% and < 1% respectively) within the discrete canyons off Georges Bank (Figure 66 and Figure 67). These figures show VMS-derived effort attributed to the discrete canyons as a percentage of the total effort for each permit calculated to be fishing in the region. Some differences between these results and the VTR data presented in Figure 62 and Figure 63 would be expected, given the latter are calculated at the owner group level, which can include multiple permits. Nevertheless, there is substantial agreement between the estimates. Both the VTR and VMS estimates suggest 20 – 25% as the upper bound on the entities with the highest exposure to the proposed canyon management areas. Thus, although the majority of individuals fishing within the Georges Bank discrete coral zones would be expected to undergo low negative impacts of fishing gear restriction Option 1 of this alternative, there are a small number of individuals for which the impacts would be much more negative.

Similarly, Figure 68 and Figure 69 show the VMS-derived effort attributed to the discrete canyons, but for mobile bottom-tending gears only. For the monument discrete canyons, the exposure of permits using MBTG is very low, indicating neutral to only slightly negative impacts due to the alternative under fishing gear restriction Option 2. For the non-Monument canyons, the analysis suggests very low exposure rates for most individuals, with even outliers exerting less than 5% of their effort in the area encompassed by this Alternative, even during the spike in effort during 2008. This suggests the area abuts grounds more intensively fished, with a large number of individuals expending only a small amount of effort in the offshore discrete canyon zones.

ASMFC survey

The ASFMC survey of Area 3 lobster permit holders (section 7.1.3.1) indicates that, for the offshore component in 2014 and 2015, 9-11% of effort and 7-9% of revenue ($1.4-1.8M) was estimated to be derived from lobster fishing within the discrete canyons. The analysis did not distinguish Monument (n=5) from non-Monument (n=15) canyons (ASMFC 2017). The entire Monument, including areas outside its five canyons, was estimated to have 13-14% of effort and 12-14% of revenue ($2.4-2.8M), more than all 20 canyons combined.

The ASMFC survey results rely on a small sample, voluntary sample of self-reported data. Thus, it is difficult to know how the results accurately represent the fishery as a whole. Lobstermen reported that they have fished the same areas for many years; each lobsterman tends to remain in his own territory. This is consistent with the VMS analysis, which indicated that a small number of permit owners rely on the canyons for a substantial portion of their total revenue (Figure 62, Figure 63).

NEFMC workshops

The industry input from the NEFMC coral workshops was that, due to the distribution of target species, the trawl fishery is active out to depths of about 500 m, the lobster fishery to 550 m, and the red crab fishery to 800 m. However, with the length of fixed gear end lines necessary for fishing these depths, and depending on slope steepness, vessels could be located in deeper waters while tending their gear. A coral scientist indicated that a reason why exploratory dives do not occur shallower than about 490 m is due to the potential for interaction with fishing vessels (NEFMC, 2017).

The workshop discussed the potential to adjust effort relative to a closure. Shifting effort to areas remaining open may be difficult for displaced fishermen. The industry attendees indicated that fishing occurs in both the canyons and on the slope between canyons. The trawl and lobster fishermen have developed agreements over time about sharing fishing grounds, so it may be difficult for lobstermen to fish solely in shallower depths. Due to the distribution of red crab, its fishery shifts seasonally along the shelf edge and is less constrained by potential gear conflicts. The participants indicated that the lobster fishery is territorial; a specific area (e.g., canyon) may only have been fished by a handful of lobstermen (NEFMC, 2017), an observation consistent with Acheson (2006) and the VTR analysis that indicates that there are a small number of vessel owners that are particularly dependent on the areas under consideration (Figure 31 to Figure 35).

In terms of gears fished, the industry attendees indicated that trap fisheries include lobster, Jonah crab, and red crab fisheries; longline fisheries include tilefish; and trawl includes whiting, monkfish, squid, and butterfish. Each of these fisheries is within the top ten species by landed revenue that the VTR analysis attributed to the non-Monument discrete canyons (Figure 60). Fishing in the westernmost canyons (e.g., Alvin and Atlantis) is similar to fishing in the mid-Atlantic canyons, with the trawl fishery targeting squid, whiting, and monkfish. The tilefish fishery occurs primarily in the heads of the canyons (NEFMC, 2017).

Impacts additive to Restricted Gear Areas I - IV

The Restricted Gear Areas I-IV on the southwestern flank of Georges Bank (section 6.7, Map 43) are intended to reduce gear conflicts as lobster vessels move their traps to follow the seasonal migration of lobsters (deeper waters in winter, shallower in summer). The seaward areas prohibit trawl gear in winter and trap gear in summer, and the landward areas the reverse, prohibiting trawl gear in summer and trap gear in winter.

The overlap of the canyon coral zones with the GRAs is as follows:

- The shallower Restricted Gear Areas III and IV have very little spatial overlap with coral zones, except for Area IV at the head of Hydrographer Canyon.
- The deeper Restricted Gear Areas I and II overlap the heads of the canyon zones. Specifically, Area II overlaps the head of Alvin Canyon, and Area I overlaps the head of Atlantis, Nantucket, Veatch, and Hydrographer Canyons, as well as small portions of Dogbody and Clipper Canyons.

If the canyon coral zone alternative is selected, the fishery impacts would depend on which fishing gear restriction option is also selected. If mobile bottom-tending gear is prohibited in the canyons, the available area for the summer trawl fishery in Areas I and II narrows to exclude the canyons. If trap gear is prohibited 300 m or deeper, the available area for the trap fishery narrows in winter in Areas I and II to exclude the Canyons. The fishing permissible in Area IV (trap in summer, trawl in winter) would be precluded from the area that overlaps Hydrographer Canyon. With these fishing area reductions, there may be increased gear conflict among mobile and fixed gear fishermen, perhaps more than between gear types, as the Gear Restricted Areas - measures to separate the gear types - would continue. Any effort shifts that may result from selecting one of these options would be limited by these existing restrictions.

Figure 58 – Revenue by gear type attributed to the discrete non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), 2010-2015, as derived from VTR.

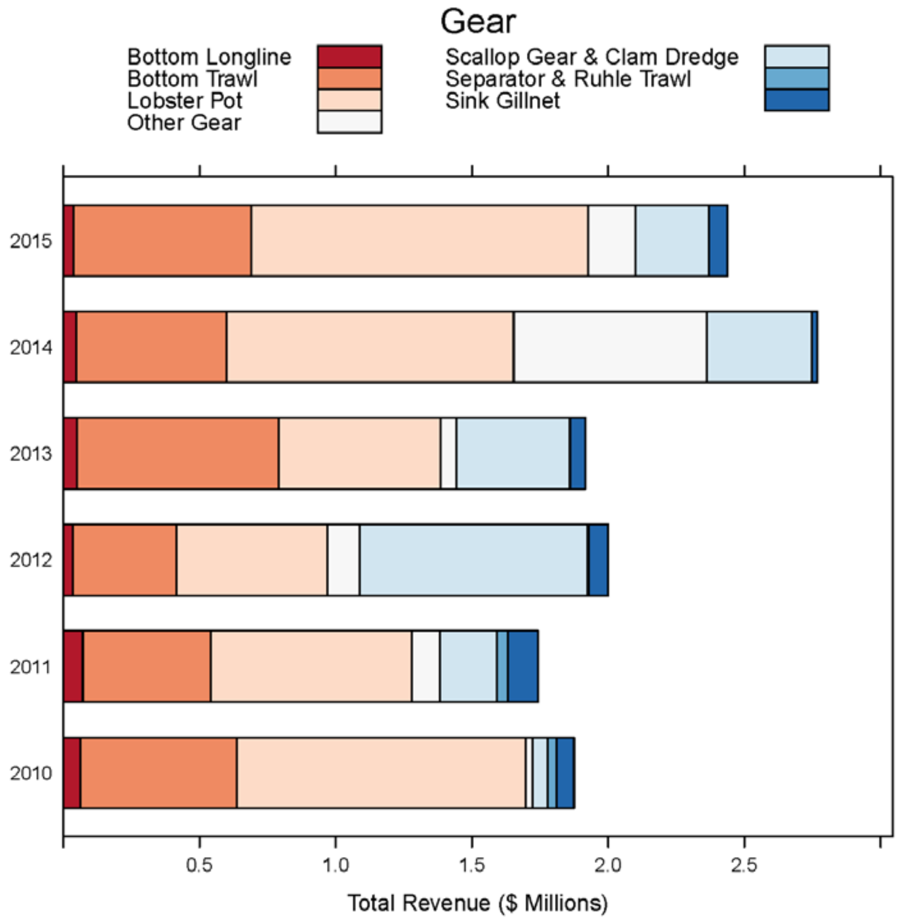


Figure 59 – Revenue by gear type attributed to the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), 2010-2015, as derived from VTR.

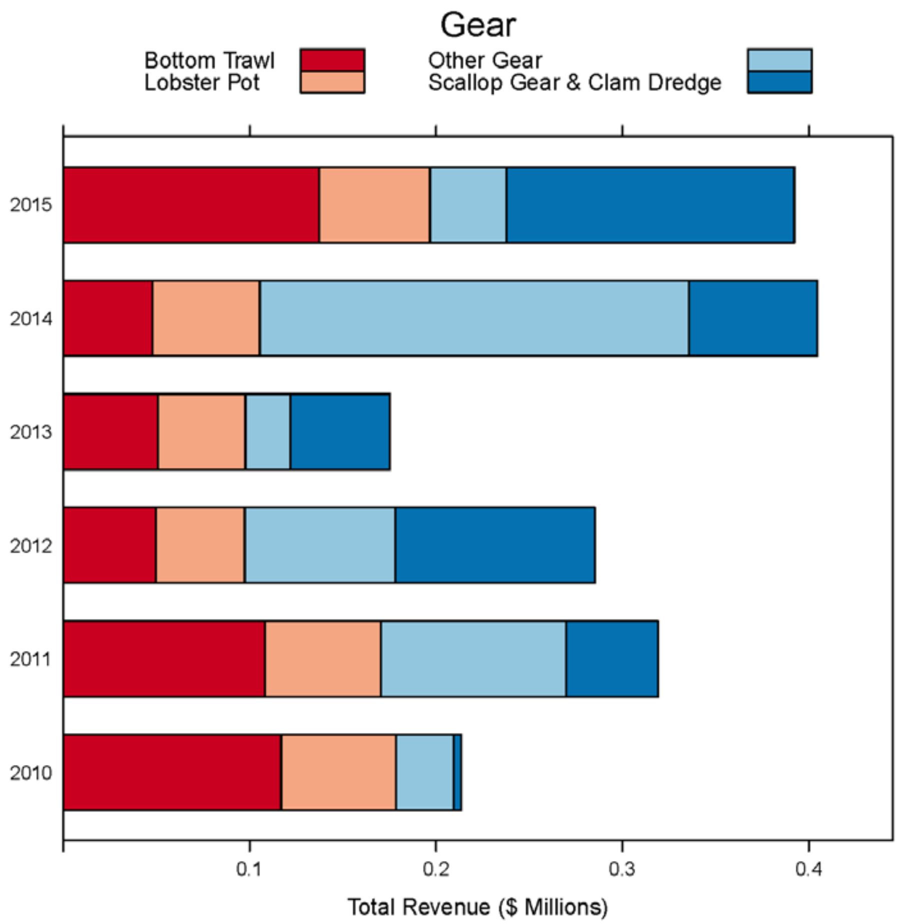


Figure 60 – Revenue by species (top 10) attributed to the discrete non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), 2010-2015, as derived from VTR.

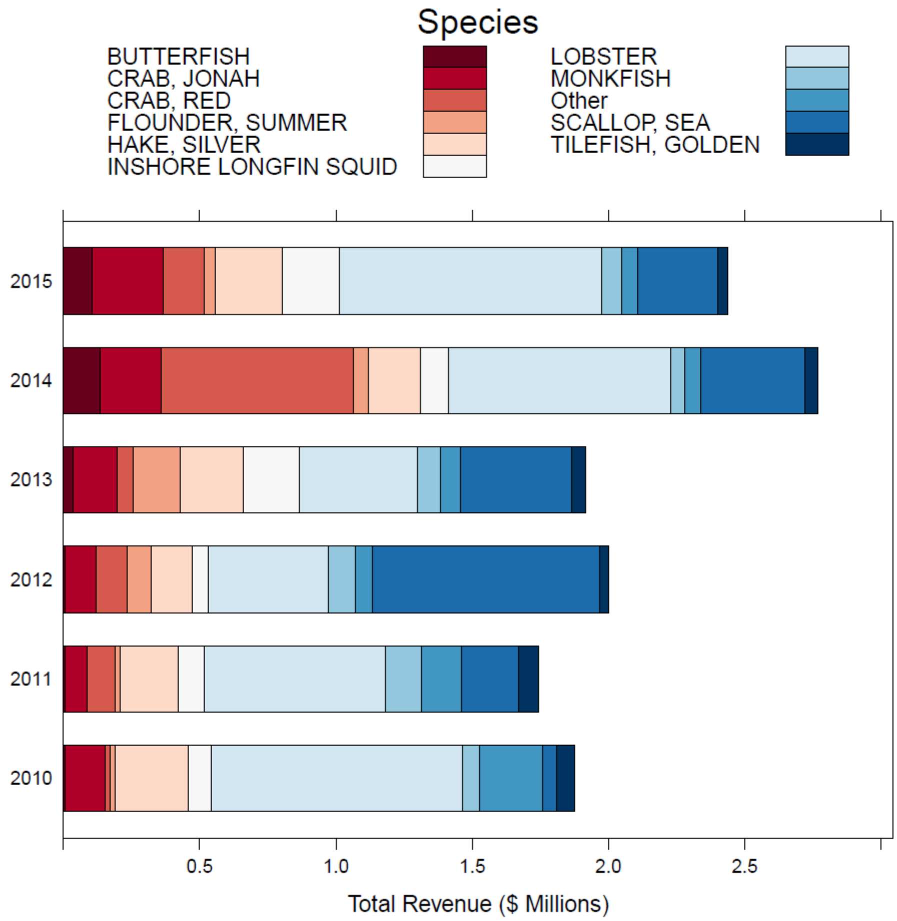


Figure 61 – Revenue by species (top 10) attributed to the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), 2010-2015, as derived from VTR.

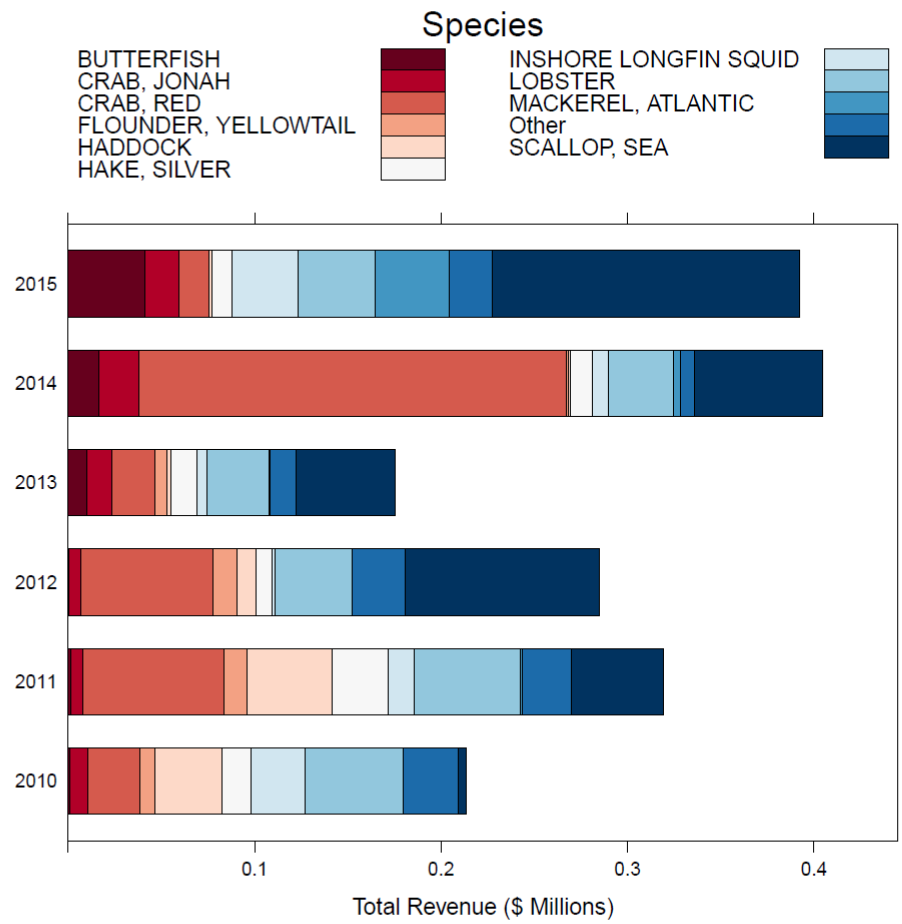


Figure 62 – Percent of vessel owner revenue attributed to the discrete non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), 2013-2015, as derived from VTR.

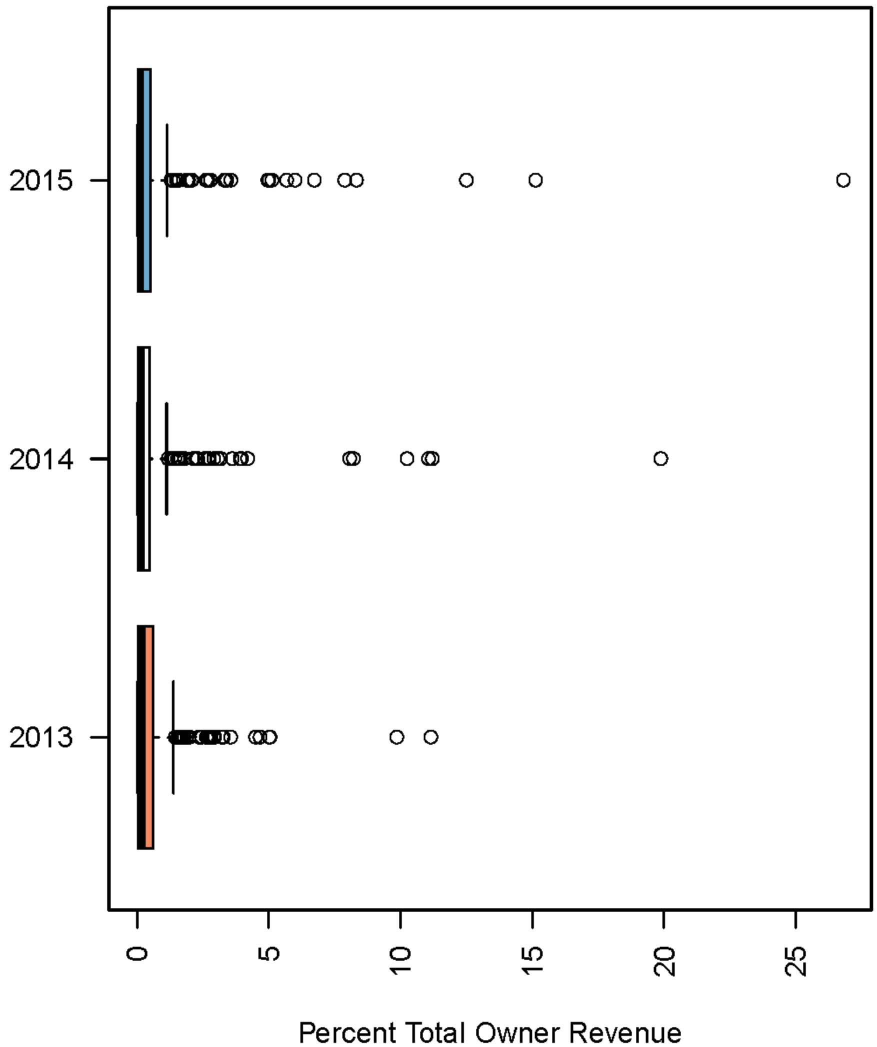


Figure 63 – Percent of vessel owner revenue attributed to the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), 2013-2015, as derived from VTR.

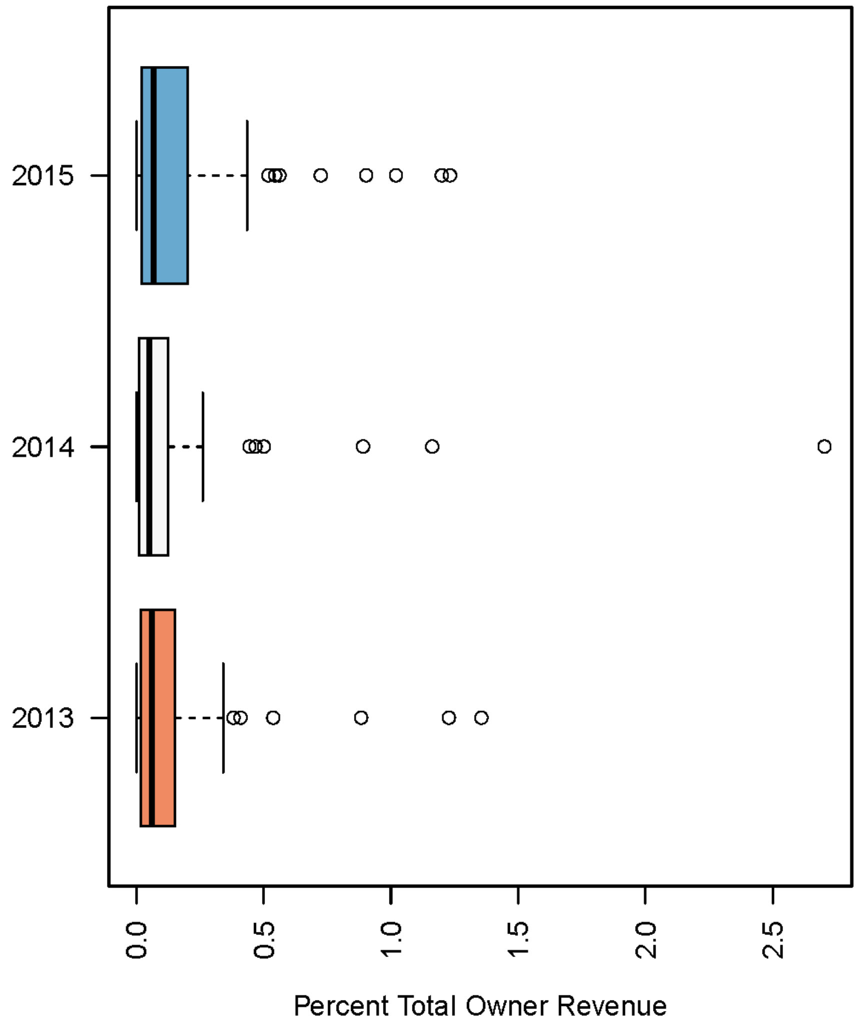


Figure 64 – Percent of vessel owner revenue attributed to MBTG in the discrete non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), 2013-2015, as derived from VTR

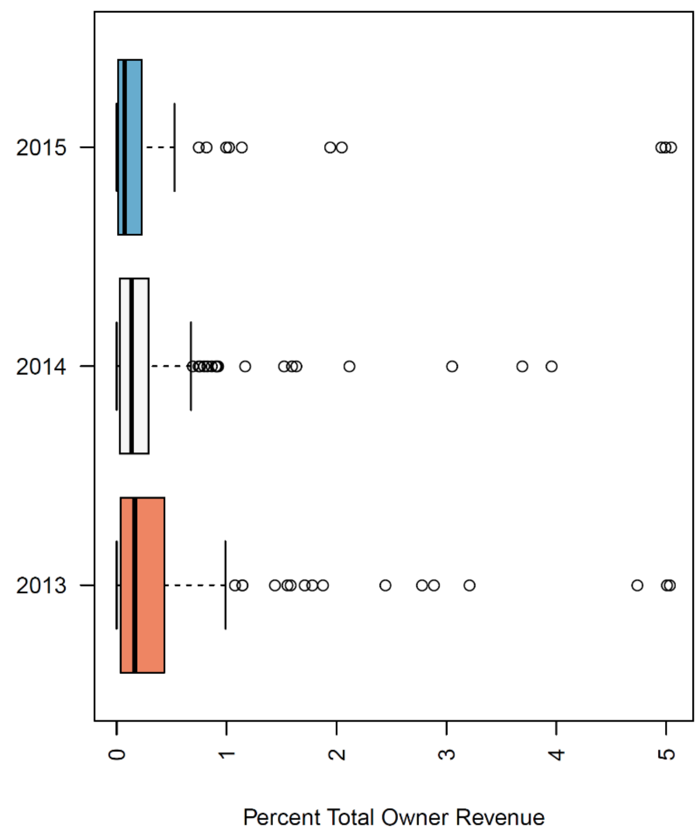


Figure 65 – Percent of vessel owner revenue attributed to MBTG in the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), 2013-2015, as derived from VTR.

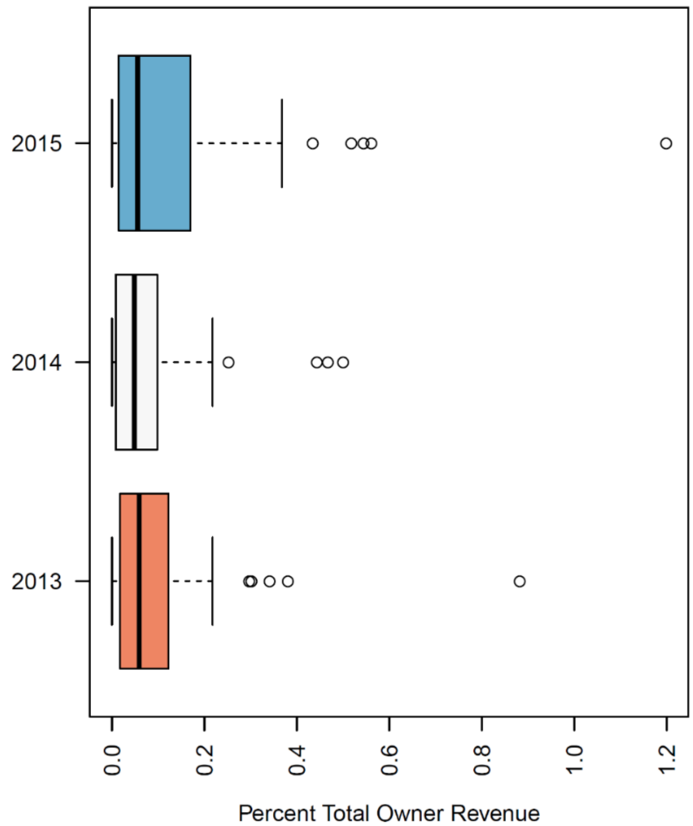


Table 73 - Percentage of VTR trips, by gear type attributed to the discrete canyon coral zones south of Georges Bank, that have VMS coverage, 2010-2012.

		Monument Canyons			Non-Monument Canyons		
Gear	Year	VTR Trips	VMS Trips	Coverage	VTR Trips	VMS Trips	Coverage
Bottom Trawl	2010	486	457	94%	973	914	94%
Bottom Trawl	2011	415	371	89%	849	765	90%
Bottom Trawl	2012	242	200	83%	720	621	86%
Lobster Pot	2010	255	37	15%	944	140	15%
Lobster Pot	2011	244	8	3%	782	70	9%
Lobster Pot	2012	222	0	0%	726	58	8%
Other Gear	2010	34	24	71%	23	0	0%
Other Gear	2011	115	83	72%	24	0	0%
Other Gear	2012	68	29	43%	46	0	0%
Scallop Gear & Clam Dredge	2010	7	7	100%	35	34	97%
Scallop Gear & Clam Dredge	2011	21	19	90%	116	113	97%
Scallop Gear & Clam Dredge	2012	32	32	100%	281	273	97%
Bottom Longline	2010	-	-	-	50	0	0%
Bottom Longline	2011	-	-	-	36	0	0%
Bottom Longline	2012	-	-	-	39	0	0%
Separator & Ruhle Trawl	2010	-	-	-	70	52	74%
Separator & Ruhle Trawl	2011	-	-	-	127	107	84%
Separator & Ruhle Trawl	2012	-	-	-	47	33	70%
Sink Gillnet	2010	-	-	-	207	0	0%
Sink Gillnet	2011	-	-	-	297	0	0%
Sink Gillnet	2012	-	-	-	207	0	0%

Table 74 – VMS estimates of effort (total hours fished, trips, and permits) within the discrete canyon zones south of Georges Bank, by gear type.

		Monument Canyons			Non-Monument Canyons		
Gear	Year	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits
Bottom Trawl	2005	2.08	17	9	40.55	38	23
Bottom Trawl	2006	0.27	14	8	39.71	63	34
Bottom Trawl	2007	3.02	27	21	88.21	122	53
Bottom Trawl	2008	6.47	32	12	327.99	121	48
Bottom Trawl	2009	5.62	49	12	113.41	89	34
Bottom Trawl	2010	10.95	55	20	110.12	107	40
Bottom Trawl	2011	8.31	37	11	83.59	60	31
Bottom Trawl	2012	3.74	25	6	30.45	60	34
GC Scallop	2006	0.00	0	0	-	-	1
GC Scallop	2011	-	-	1	-	-	1
GC Scallop	2012	-	-	1	-	-	1
LA Scallop	2005	-	-	1	0.08	67	51
LA Scallop	2006	0.00	9	8	0.22	141	68
LA Scallop	2007	0.00	0	0	0.01	27	24
LA Scallop	2008	0.00	0	0	0.00	17	16
LA Scallop	2009	0.00	0	0	2.39	30	28
LA Scallop	2010	0.00	0	0	0.08	34	32
LA Scallop	2011	-	-	1	0.27	28	21
LA Scallop	2012	-	-	1	0.33	36	29
Squid Trawl	2005	0.79	21	15	9.36	50	26
Squid Trawl	2006	0.25	28	17	15.35	81	37
Squid Trawl	2007	8.01	58	30	30.63	94	39
Squid Trawl	2008	-	-	2	4.26	16	11
Squid Trawl	2009	-	-	2	22.74	24	8
Squid Trawl	2010	5.14	12	6	7.20	24	9
Squid Trawl	2011	0.27	4	4	11.63	21	8
Squid Trawl	2012	-	-	1	1.84	12	10
Pot/Trap	2005	0.97	3	5	7.12	5	3
Pot/Trap	2006	-	-	2	153.27	88	5
Pot/Trap	2007	-	-	1	144.70	82	4
Pot/Trap	2008	-	-	2	121.23	65	5
Pot/Trap	2009	-	-	1	97.25	63	5
Pot/Trap	2010	0.00	0	0	117.68	83	5
Pot/Trap	2011	-	-	2	87.14	55	4
Pot/Trap	2012	0.00	0	0	62.24	42	3

Figure 66 – Percent of total annual permit fishing activity attributed to the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), between 2005 and 2012, as derived from VMS.

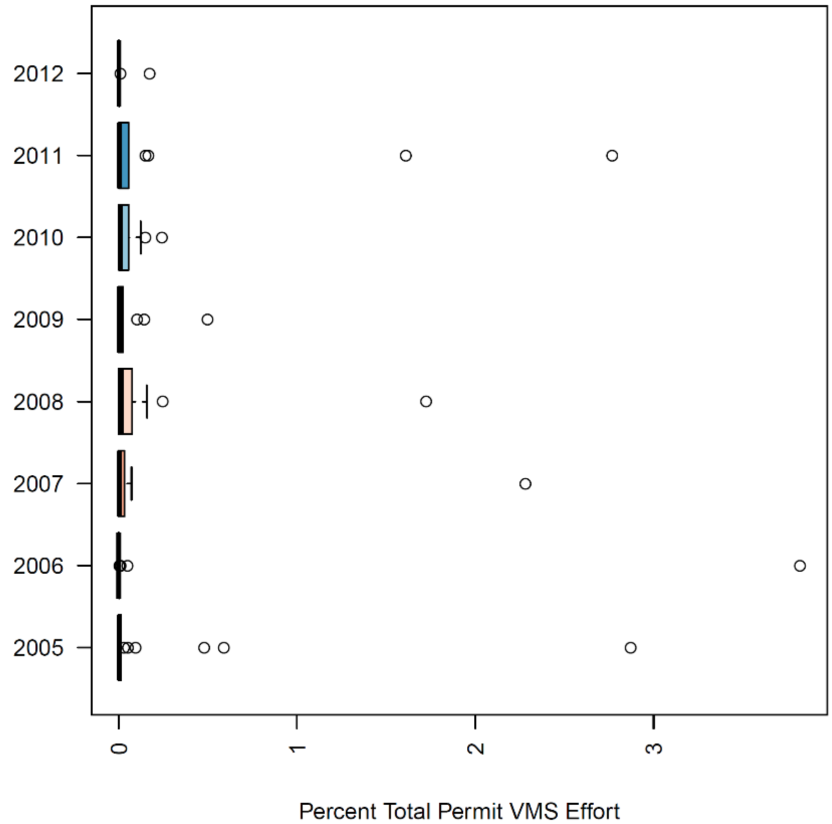


Figure 67 – Percent of total annual permit fishing activity attributed to the non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), between 2005 and 2012, as derived from VMS.

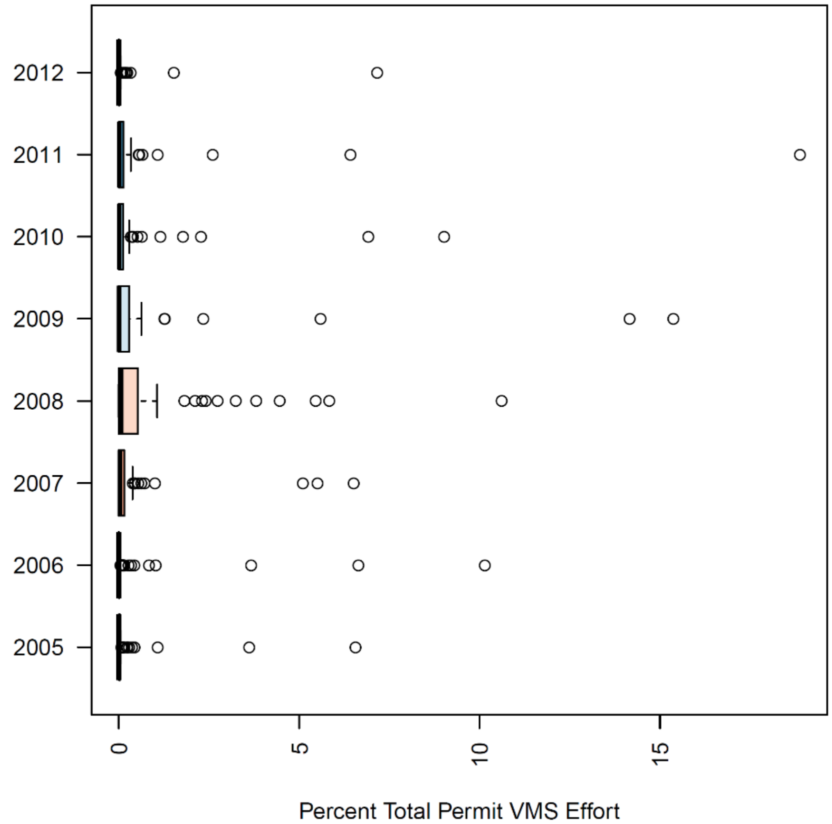


Figure 68 – Percent of total annual permit fishing activity attributed to MBTG within the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), between 2005 and 2012, as derived from VMS.

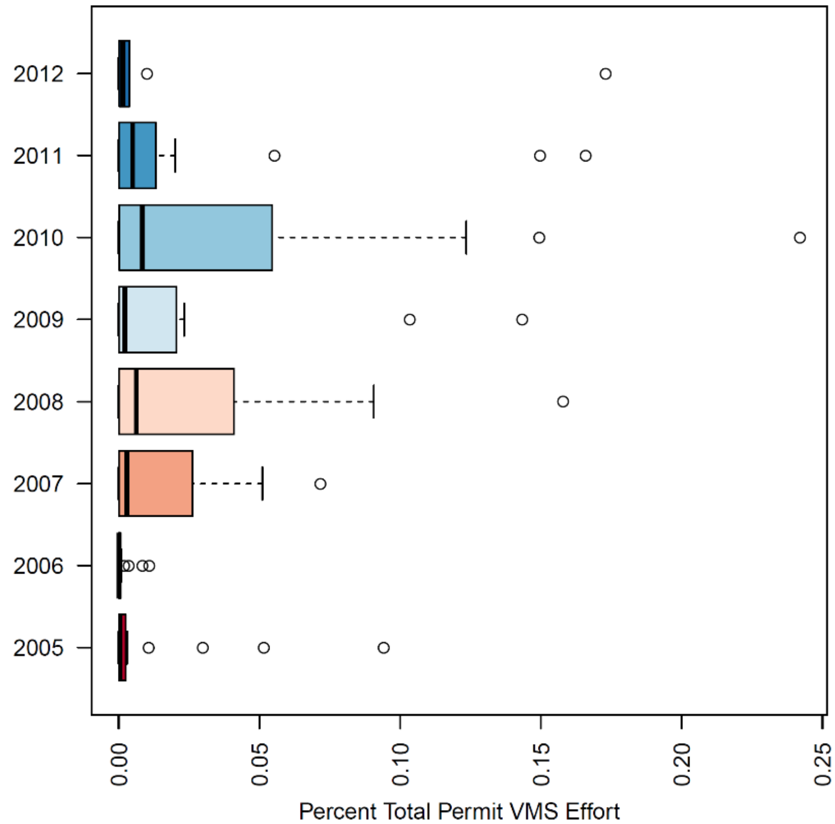
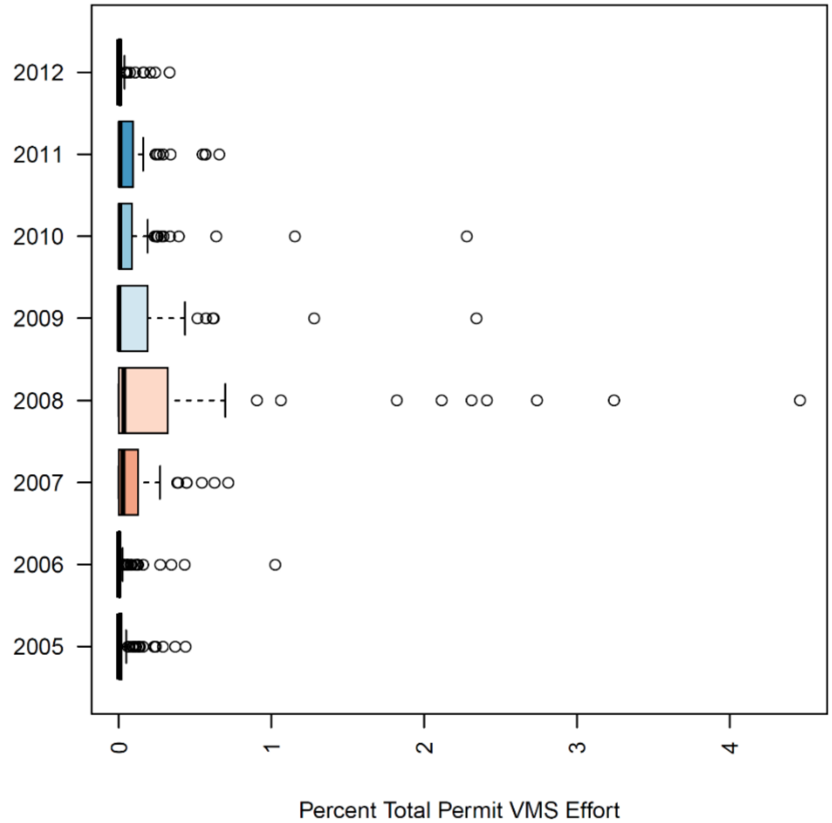


Figure 69 – Percent of total annual permit fishing activity attributed to MBTG within the non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), between 2005 and 2012, as derived from VMS.



7.2.3.3.2 Potentially affected fishing communities

General community impacts of the alternatives under consideration are described in section 7.1.3, which also describes the method, caveats, and data confidentiality standard used to develop Table 75 and Table 76, the revenue attributed (using the VTR analysis) to recent fishing within the canyon coral zone alternatives. The revenue attributed to Massachusetts and Rhode Island from the Discrete Non-Monument Canyons is about 0.25% and 0.60% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 25% of their revenue attributed to fishing from this area (Figure 48, p. 271).

Discrete Monument Canyons

Although the VTR analysis has some degree of error, it suggests that the fishing communities that may be impacted by the Discrete Monument Canyons (included within No Action) are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New Jersey, and other states (Table 75).

Table 75 - Landings revenue to states, regions, and top ports attributed to fishing within the canyon coral zones overlapping the National Monument, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$1,198K	$200K	248
New Bedford	$1,032K	$172K	216
Sandwich	$112K	$19K	3
Gloucester	$35K	$6K	20
Other (n=8)	$19K	$3K	29
Rhode Island	$341K	$57K	42
Point Judith	$100K	$17K	37
Newport	$84K	$14K	5
Other (n=2)	$157K	$26K	4
Connecticut	$13K	$2K	6
New York	$48K	$8K	5
Montauk	$48K	$8K	5
New Jersey	$99K	$16K	6
Virginia	$12K	$2K	26
Other[b]	$78K	$13K	15
Total	**$1,790K**	**$298K**	**312**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).

The VTR analysis attributes recent landings revenue to 29 ports and 312 permits, and 67% of this revenue to ports in Massachusetts. New Bedford (216 permits), Sandwich (3 permits), and Point Judith (37 permits) are among the top ten landing ports, and 31% of the revenue is attributed to other ports, indicating that this zone may be particularly relevant for those three communities, which are some of the closer ports, distance-wise, to the canyons. The revenue attributed to Massachusetts and Rhode Island from the Discrete Monument Canyons is about 0.04% and 0.07% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 3% of their revenue attributed to fishing from this area (Figure 63).

According to the NMFS Community Vulnerability Indicators, the commercial fishing engagement indicator is high for New Bedford and Narragansett (includes Point Judith) and medium for Sandwich (Table 30). Of these three communities, Narragansett ranks highest in terms of reliance on commercial fishing, with a medium-high index, while Sandwich ranks lowest, with a low index.

Discrete Non-Monument Canyons

Although the VTR analysis has some degree of error, it suggests that the fishing communities that may be impacted by the Discrete Non-Monument Canyons (additive to No Action) are primarily located in Massachusetts, with lesser activity attributed to ports in Rhode Island, New Jersey, and other states (Table 76). The revenue attributed to Massachusetts and Rhode Island from the Discrete Non-Monument Canyons is about 0.25% and 0.60% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 25% of their revenue attributed to fishing from this area (Figure 48, p. 271).

The VTR analysis attributes recent landings revenue to 59 ports and 661 permits, and 65% of this revenue to ports in Massachusetts. New Bedford (385 permits), Point Judith (96 permits), and Newport (17 permits) are among the top ten landing ports, and 39% of the revenue is attributed other ports, indicating that this zone may be particularly relevant for those three communities. The revenue attributed to Massachusetts and Rhode Island from the Discrete Non-Monument Canyons is about 0.25% and 0.60% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 25% of their revenue attributed to fishing from this area (Figure 62).

According to the NMFS Community Vulnerability Indicators, the commercial fishing engagement indicator is high for New Bedford and Narragansett (includes Point Judith) and medium-high for Newport (Table 30). Of these three communities, Narragansett ranks highest in terms of reliance on commercial fishing, with a medium-high index, while Newport ranks lowest, with a low index.

Table 76 – Landings revenue to states, regions, and top ports attributed to fishing within the canyon coral zones not overlapping the National Monument, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$8,230K	$1,372K	470
North of Cape	$263K	$44K	50
Gloucester	$250K	$42K	36
Other (n=4)	$13K	$2K	22
Cape Cod & Islands	$1,738K	$290K	50
Sandwich	$305K	$51K	5
Other (n=14)	$1,433K	$239K	45
South of Cape	$6,229K	$1,038K	405
New Bedford	$6,074K	$1,012K	385
Other (n=3)	$6,229K	$26K	33
Rhode Island	$2,862K	$477K	118
Point Judith	$867K	$145K	96
Newport	$867K	$145K	17
Tiverton	$569K	$95K	3
Other (n=4)	$559K	$92K	13
Connecticut	$234K	$39K	25
New York	$670K	$111K	31
Montauk	$611K	$102K	26

New Jersey	$202K	$34K	60
Virginia	$363K	$60K	107
North Carolina	$49K	$8K	47
Other[b]	$127K	$21K	15
Total	**$12,738K**	**$2,123K**	**661**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: VTR analysis.

7.2.3.4 Impacts on protected resources

The discrete canyon zones encompass the same geographic range as the shelf-slope break region of the broad coral zone, except that they are focused on the areas within major canyons only, and do not include the intercanyon slopes or minor canyon areas. The gears fishing in or near the canyon zones that might be displaced by their designation are the same as for the broad zones, lobster pot, red crab pot, and bottom trawl. Thus, the impacts of the discrete canyon zones on protected resources are expected to be very similar to those identified for the broad zones, but with a smaller likelihood of increased interaction rates.

As with the broad zone options, the extent to which designation of discrete canyon zones may positively or negatively affect protected resources depends on the protected resource species present in the areas proposed for management, the nature of the interaction between the fisheries and protected resources occurring in the areas, the effects of the discrete canyon zone alternative on fishing distributions, the magnitude of potential effort displacement, and whether the areas to which effort is displaced are likely to have greater, lesser, or roughly the same interaction rates as would occur within current fishing grounds. The list of species that might be impacted by the discrete canyon zones is the same as for the broad zones (Table 71) and is smaller than the list of species potentially affected by the amendment (Table 39).

The VTR analysis (Figure 58, Figure 59) identifies the major gear types fished in and around the canyon zones as bottom trawl, lobster trap, scallop/clam dredge, and other gears that cannot be detailed due to confidentiality considerations, however the VMS analysis (Table 74) suggests that dredge use in the canyon zones is very limited. Minor gear types include separator and Ruhle trawls, bottom longline, and sink gillnet. In terms of the effort encompassed, the canyon zones can be thought of as a subset of the 300 m broad zone, although they extend slightly shallower in some locations. Thus, any effort redistribution effects will be correspondingly less than the 300 m broad zone. As noted in the No Action section, bottom trawl effort for squid, whiting, butterfish, and other demersal fishes is already prohibited in existing fishery management closures and in the monument, such that effort in these fisheries is likely somewhat more concentrated along portions of the continental margin not currently under management. Trap effort is likely to be redistributed once the monument closes to lobster and red crab pot fishing, no later than 2023.

More extensive gear restrictions would result in more substantial effort shifts. Option 1 would close the canyon zones to all bottom tending gears, with sub-options to exempt (a) the red crab trap fishery, and/or (b), the use of lobster traps. Gear restriction Option 2 would be less restrictive, closing the canyons to bottom trawls only (and dredges, but as noted previously dredge use in the canyon zones is unlikely to occur).

7.2.3.4.1 Large whales

Other than minke whales, which are not expected to overlap substantially with the canyon zones or adjacent grounds to which effort would be displaced, there have been no observed interactions with trawls and large whales (see section 6.9.3.1.1). Thus, despite any changes in bottom trawl activity associated with designation of canyon coral zones, designation of canyon zones is not expected to influence interaction rates between bottom trawls and large whales.

Gillnet and trap/pot gears, specifically the vertical lines associated with these gear types, pose the greatest entanglement risk to large whales (see section 6.9.3.1.1). Gillnet effort is minimal in the canyon zones, contributing just a small percentage of area revenues (see Figure 58 and Figure 59), and not likely to be materially affected by the designation. Lobster pot effort, however, is likely to be redistributed if the canyon zones were closed to all bottom-tending gears (Option 1), provided that an exemption for lobster traps is not provided (Sub-Option B). These changes in fishing effort could influence interaction rates between lobster pots and large whales, as described below. As discussed previously, effort redistribution would be limited by the distribution of lobsters. The depth band ~100 m is a transitional area for lobsters between their summer/fall distribution on top of the bank and their winter/spring distribution in deeper waters, and gear is not typically set in this depth zone. Effort redistribution would also be limited by the availability of areas not already fished by other lobstermen. If the grounds between the canyon zones cannot accommodate additional traps, effort (and therefore the number of vertical lines in the water column) could decline, and the potential for interactions between lobster pots and large whales could decrease. Given the potential for effort displacement and the existing distribution of lobster gear in all known fishable areas, it is very unlikely that lobster trap effort would increase as a result of designating coral zones in the canyons.

On the other hand, if the number of traps in the water remains constant, but gear is slightly more concentrated, interactions could increase as it would be more difficult for whales to avoid vertical lines in more heavily fished locations. The magnitude of red crab trap usage in the canyon zones cannot be detailed specifically due to confidentiality considerations, but impacts are likely similar to those associated with lobster pot gear. Modulating any increased concentration in gear associated with designation of coral zones are the measures in the Atlantic Large Whale Take Reduction Plan, which designed to reduce interaction rates in trap fisheries, such as lobster and red crab. These measures are described in section 6.9.3.1.1.

Given the discussion above about potential shifts in effort, and that ALWTRP measures are already in place to reduce serious injury and mortality, the impacts of designating canyon zones on large whales are uncertain but could range from negative to slightly negative.

7.2.3.4.2 Small cetaceans

Interaction risks for small cetaceans are described in section 6.9.3.1.2. Direct observations of fishing with trap/pot gear are limited, so interaction information for small cetaceans and trap/pot gear is partly inferred from evidence of gear on stranded animals. These stranding data suggest that trap/pot interaction rates with small cetaceans are low. While there is a take reduction plan for harbor porpoise, its restrictions apply to gillnets only. Gillnet fishing activity is understood to be very minor in the canyon zones (see section 7.2.3.3.1). With respect to these fixed gears, designation of the canyon zones is not expected to have an effect on interaction rates with small cetaceans.

Interactions between small cetaceans and bottom trawl gear are of somewhat greater concern (see section 6.9.3.1.2). However, few of the observed interactions between small cetaceans and bottom trawls have been observed along the continental margin south of Georges Bank where the canyon zones are located. Therefore, although the potential exists for interactions in the bottom trawl fishery, any negative impacts on small cetaceans that result from spatial shifts in trawl effort are likely to be slight.

Regardless, there may be a small risk of increased interaction rates if trawl gear usage becomes more concentrated spatially, due to implementation of the canyon coral zones. During 2010-2012, somewhere between 700-1,000 bottom trawl trips a year are estimated to overlap the canyon zones (see Table 73 in section 7.2.3.3.1 for details). The canyon areas are steep, and in large part not fishable with trawl gears, but effort that is occurring in the heads of the canyons could be shifted into shallower waters. To the extent that fishing activity becomes spatially concentrated, it could become more difficult for small cetaceans to avoid interactions with gear, and thus designation of the canyon zones could have slight negative effects on these species. The magnitude of these effects would be less than for the Option 1-3 broad zones, as the canyon zones only encompass a fraction of the shelf break as compared to the broad zones.

Overall, the impacts of designating discrete canyon zones on small cetaceans are expected to be slightly negative. Because bottom trawl gear is the main concern for small cetaceans and would be prohibited regardless of gear restriction option selected, impacts to these species are expected to be the same for gear Options 1 and 2.

7.2.3.4.3 Sea turtles

Sea turtles are at risk for interaction with various types of bottom tending gears used in and around the broad coral zones, as described in section 6.9.3.2. Bottom trawl gear poses an injury and mortality risk to sea turtles, specifically due to forced submergence (Sasso and Epperly 2006). Green, Kemp’s ridley, leatherback, loggerhead, and unidentified sea turtles have been documented bycaught in bottom trawl gear, but most of these interactions have occurred in the Mid Atlantic (section 6.9.3.2). Designation of the canyon coral zones would be expected to have some effects on the distribution of fishing effort with trawl gear, as described in section 7.2.3.4.2. Thus, with respect to bottom trawl gear, potential negative impacts to sea turtles are expected. These effects are expected to be slight, given that bottom trawl/turtle interactions are less common in New England vs. Mid-Atlantic waters, and that shifts in effort are likely to be relatively minor, with effort occurring in slightly shallower waters near the heads of the canyons but still along the shelf break.

Leatherback, loggerhead, green, and Kemp's ridley sea turtles are known to interact with trap/pot gear, with interactions primarily associated with entanglement in vertical lines, although sea turtles can also become entangled in groundline or surface systems (see section 6.9.3.2 for more detailed information on interaction rates). Records of stranded or entangled sea turtles indicate that fishing gear wraps around the neck, flipper, or body of the sea turtle and severely restrict swimming or feeding, which can cause injuries and sometimes mortality immediately or at a later time (Balazs 1985, STDN 2016). Most of the documented trap gear interactions were with leatherbacks (STDN 2016). As described in section 7.2.3.4.1, trap gear could become more concentrated if the canyon zones are designated, provided that trap gear is not exempted (gear Option 1, Sub-Option B, or gear Option 2). This could lead to spatial concentration of vertical lines in the water column. If gear concentration reduces catch rates, soak times could increase, which would increase the duration over which vertical lines are present in the water column. Alternatively, fewer traps might be set, but soak times could increase. Both a greater concentration of vertical/groundlines and longer set durations could increase interaction rates. Thus, designation of the canyon zones with trap restrictions could have slightly negative effects on sea turtles.

Overall, the impacts of the canyon zone alternatives on sea turtles could be slightly negative as a result of changes in the spatial distribution of fishing effort associated with both bottom trawl and trap gears.

7.2.4 Impacts of seamount coral zones and associated fishing restrictions

This alternative would designate coral zones for the four seamounts within the U.S. EEZ: Bear, Retriever, Physalia, and Mytilus (section 4.2.2.2), with options for which gear types would be prohibited from the zones (section 4.3, Table 77). The seamount zones do not overlap one another, but all of these discrete seamount zones are fully encompassed within the Northeast Canyons and Seamounts Marine National Monument and are fully contained within each broad zone (section 4.2.2.2). This alternative would be additive to No Action (i.e., Monkfish/MSB/Tilefish areas and the National Monument would remain in place) and could be selected in combination with other alternatives under consideration.

Table 77 - Fishing restriction options relevant to the seamount coral zones

Fishing restriction options	Relevance to seamount zones
Option 1: Prohibit all bottom-tending gears	Yes
Sub-option A: Exempt red crab fishery	Yes
Sub-option B: Exempt other trap fisheries	Yes
Option 2: Prohibit mobile bottom-tending gears	Yes

7.2.4.1 Impacts on deep-sea corals

Corals have been recorded on the seamounts in both older and recent data (Table 45 and Table 46). All four types of corals are known to occur within the four seamount zones. The seamounts are not within the footprint of the habitat suitability model. Because fishing does not occur on the seamounts at present, and considering the restrictions associated with the overlapping monument designation, designating discrete seamount zones would have neutral to slightly positive impacts. Seamount zone designations would represent a precautionary approach that would serve to highlight the fact that coral habitats occur at these sites. Increased awareness of seamount habitats through the Council process could have indirect positive impacts, perhaps by encouraging additional scientific study at the sites.

7.2.4.2 Impacts on managed species and essential fish habitats

With the exception of red crab and perhaps shortfin squid, Council-managed species are not known to occur on the seamounts, and fishing is not known to occur on the seamounts. Thus, designation of coral zones on the seamounts is likely to have neutral to slightly positive impacts on managed resources and their habitats.

7.2.4.3 Impacts on human communities

Under this alternative, coral zones would be established around four seamounts, with options for which gear types would be prohibited from the zones. The zones are within the National Monument (already included under No Action) and could be selected in combination with other alternatives under consideration.

The impacts of the seamount zones on human communities are expected to be negligible, and neutral relative to No Action. Some fishing activity is attributed to the seamount zones, but this is likely due to imprecise VTR reporting. No fishing with mobile or fixed bottom-tending gears is known to occur over the seamounts. As with No Action, it is difficult to determine if fishermen would be prevented from fishing altogether or be able to shift effort to other areas. To the degree that these closures provide habitat for fishery species, there may be long-term benefits to fisheries and society, but these are difficult to project.

The impacts to the fishing industry are expected to be negligible. Both the VTR and VMS analyses suggest that fishing with bottom-tending gear does not occur frequently within the seamount zones, if at all. Despite high VMS coverage for bottom trawl trips in the vicinity of the seamounts, not a single VMS poll is estimated to have fallen within the region. Additionally, given the relatively large area of the seamount alternative, the low VTR-derived revenue values for lobster pots and other gearss versus the number of trips and permits estimated to apply in the vicinity of the seamounts suggests there is a low probability that these trips actually occurred in the region.

The sociocultural impacts associated with establishing the seamount zones are expected to be negligible for fishermen and fishing communities, and neutral relative to No Action. No (or very little) fishing effort is currently occurring in the seamount zones, though this alternative would prevent the expansion of fisheries or the development of new fisheries in these areas. Deep-sea corals have cultural value to society, so affording them protection from future fisheries has positive impacts on the *Attitudes, Beliefs, and Values* of stakeholders towards management.

7.2.4.3.1 Potentially affected fisheries

While fishery data suggest some effort within seamount zones, this may be due to spatial imprecision in the data. VMS analysis in particular suggests that fishing on the seamounts with bottom-tending gear does not occur with any frequency. Thus, designation of the seamount zones is expected to have very slight to no impact on the fishery.

VTR analysis

Vessel Trip Report data were used to estimate recent (2010-2015) fishing activity within the seamount areas. With the exception of lobster trap gear, revenue results were unscaled. Because a large number of lobster vessel operators are not required to submit VTRs (their vessels do not carry other federal permits), total lobster revenue was expanded (method explained in section 7.1.3). Maps of revenue by gear type and species are in Appendix F.

Some fishing activity is attributed to the seamount zones, but this is likely due to imprecise VTR reporting, as discussed below. Assuming fishing does not, in fact, occur on the seamounts, revenue inferred to the seamount zones comes from two sources. Either, the trips actually occurred in shallower areas, but were reported as occurring on the seamounts, or, small fractions of revenue associated with trips centered in shallower waters are attributed to the seamount areas. Both of these possibilities are evident in the maps of revenue by gear type and species are in Appendix F.

Revenue by gear: Annual revenue by fishing attributed to the seamount coral zones ranges from $30K-65K, averaging $46K (Figure 70). Given the large size of the seamount area, this range suggests the area is not a major center of fishing activity. This is consistent with the prevailing wisdom that the distance from shore and depth make the seamounts less than ideal fishing locations. Revenue is attributed to bottom trawl, lobster pots, and other gears (not detailed due to data confidentiality). Both fishing restriction Option 1 B and Option 2 would mitigate any impacts on the lobster pot fishing in the area.

Revenue by species: The mix of species caught during the trips attributed to the seamount zones is the same as those associated with the canyon and broad zones (Figure 73). This is unsurprising given the caveats about spatial imprecision. Fishing restriction Option 1A would exempt red crab fishing from restrictions in the Seamounts, while Option 1B would similarly exempt lobster and Jonah crab fishing. Fishing restriction Option 2 would mitigate any impacts on the crustacean fisheries and leave an average annual total of $16K estimated to be generated annually by other species.

Percent revenue by owner: An annual average of 22 vessel owners are estimated to generate revenue within the seamounts. Consistent with the interpretation that the seamounts are adjacent to active fishing grounds, and the revenue associated with them is likely due to inaccurate VTR locations or spatial imprecision in VTR data, the percent of annual owner revenues associated with these trips are near zero (Figure 74).

VTR vs. VMS comparison

An average of 180 VTR trips are attributed to the seamounts annually, with most trips employing lobster pot gear. Total permits attributed to the seamounts are about 25-60 annually, and these are primarily associated with bottom trawl gear. The low revenue estimates from these trips and the large area of the seamount zones indicates that there is a relatively low probability of fishing activity occurring in the region.

For the seamount zones, the percent of VTR trips with Vessel Monitoring System (VMS) data in 2010-2012 is high for bottom trawl gear (82-96%, Table 78). The VMS coverage is high enough for bottom trawl trips that the data are preferred over VTR in assessing trip activity within the seamount zones. There are no VMS points (all gears) between 2005 and 2012 that fall within the seamount zone, indicating that bottom trawl effort is very unlikely to be centered on the Seamounts. The VMS coverage of lobster pot and other gear is low enough to be unclear whether the data are representative of the larger fleet. For this reason, the activity derived from VMS data can serve as a lower bound, and VTR analysis an upper bound, for these gears. At an ownership group, the upper bound is under 1.5% of revenue generated, with the vast majority of ownership groups expected to have under 0.2% of revenue potentially displaced by the seamounts alternative. The lower bound across all entities would be 0%, given that no VMS-derived effort has been estimated to fall within the seamounts region between 2005 and 2012.

ASMFC survey

The ASFMC survey of Area 3 lobster permit holders (section 7.1.3.1) did not collect data for fishing in depths below 500 m (ASMFC 2017). Thus, the survey provides little insight into fisheries on the seamounts.

NEFMC workshops

The industry members present at the NEFMC coral workshops indicated that the fisheries they are familiar with all occur at depths above the shallowest depth of the seamounts (1,100 m; NEFMC, 2017). This input is consistent with other information that fishing on the seamounts is minimal to nonexistent.

Figure 70 – Revenue by gear type attributed to the four seamount coral zones, 2010-2015, as derived from VTR.

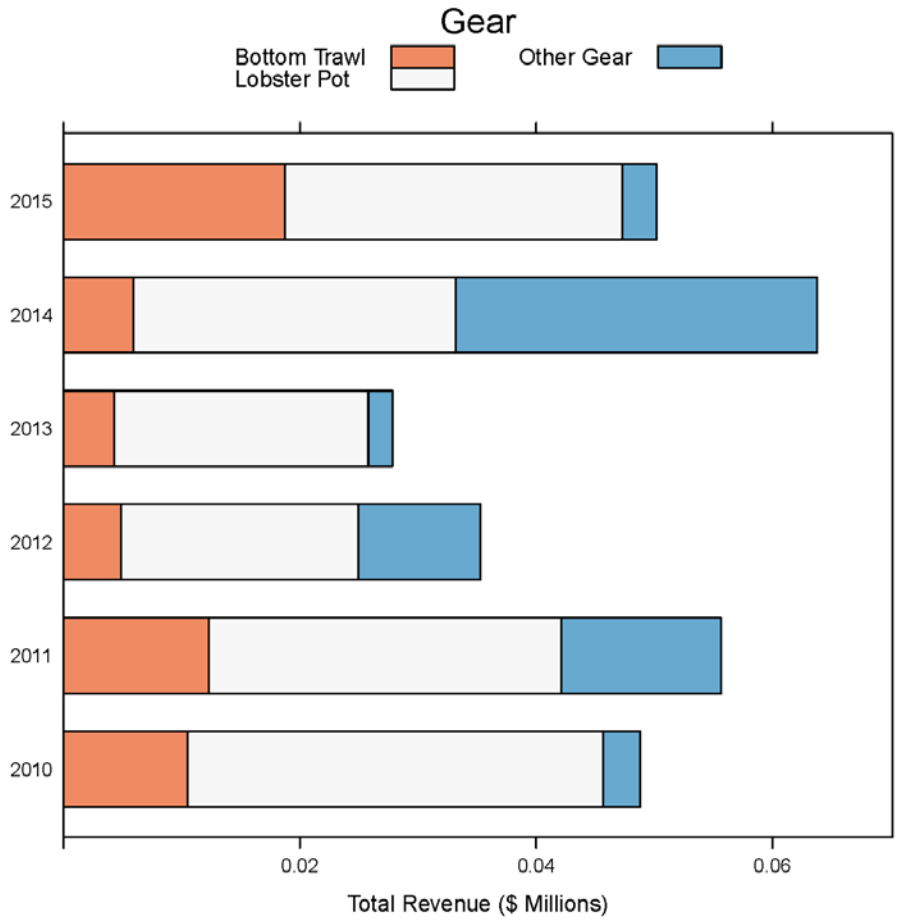


Figure 71 – Trips by gear type attributed to the four seamount coral zones, 2010-2015, as derived from VTR.

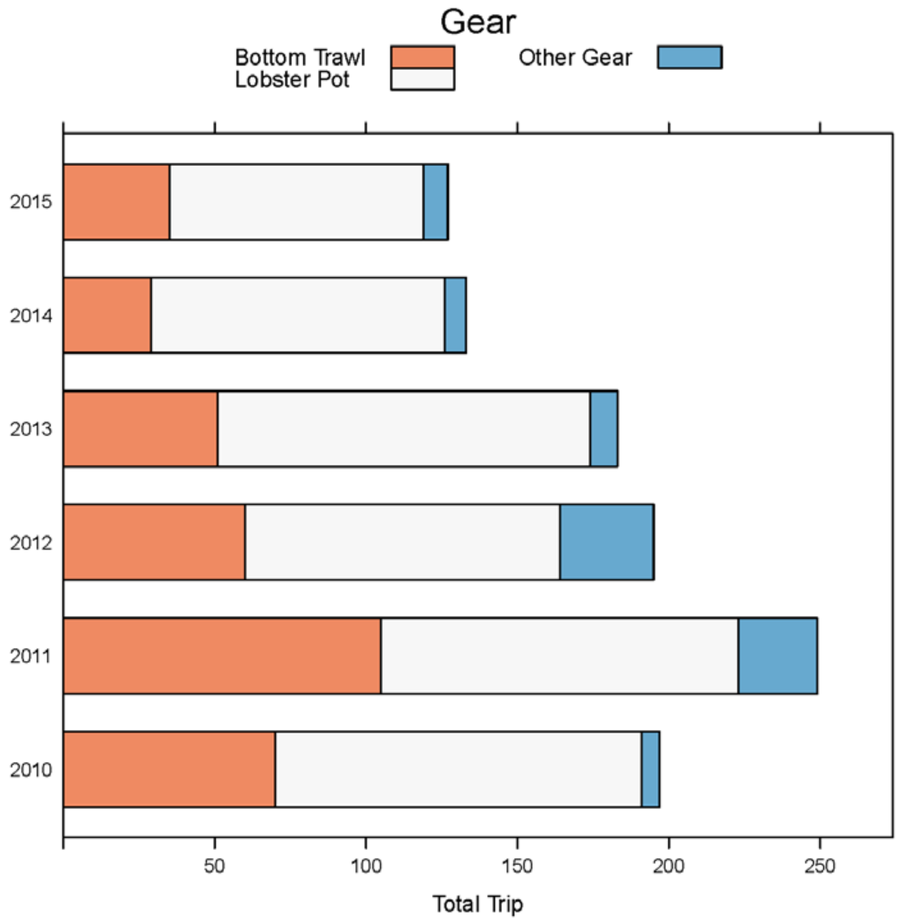


Figure 72 – Permits by gear type attributed to the four seamount coral zones, 2010-2015, as derived from VTR.

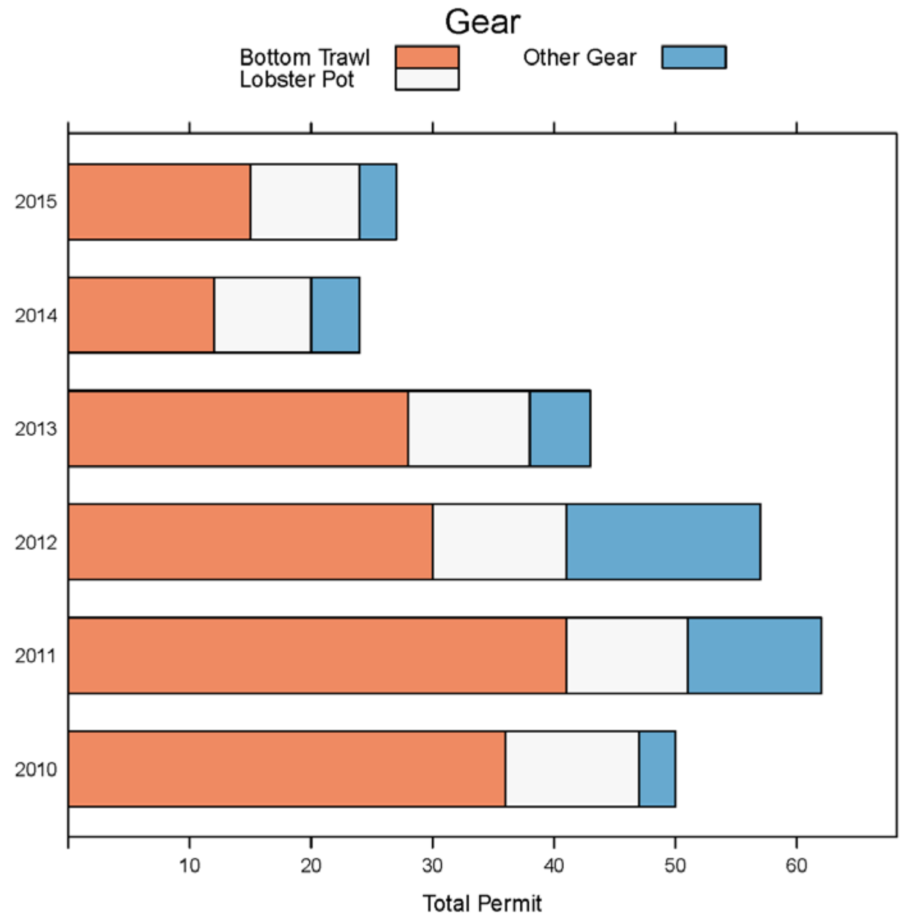


Figure 73 – Revenue by species (top 10) attributed to the four seamount coral zones, 2010-2015, as derived from VTR.

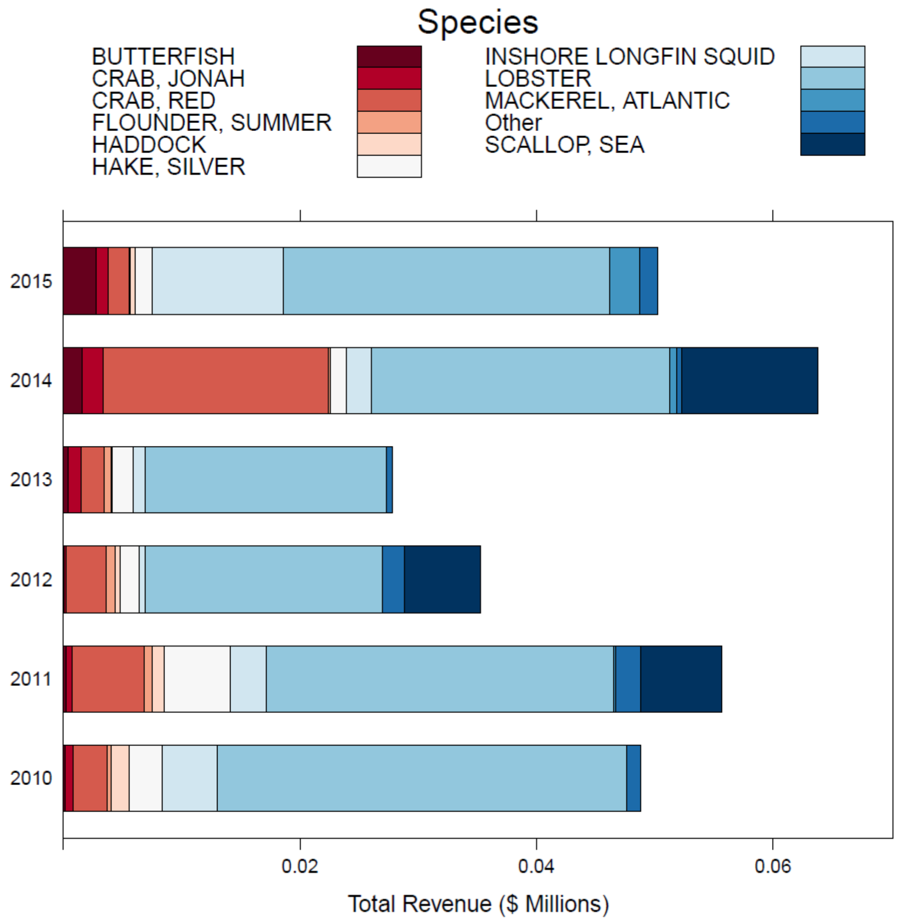


Figure 74 – Percent of total owner revenue attributed to the seamount coral zones, 2013-2015, as derived from VTR.

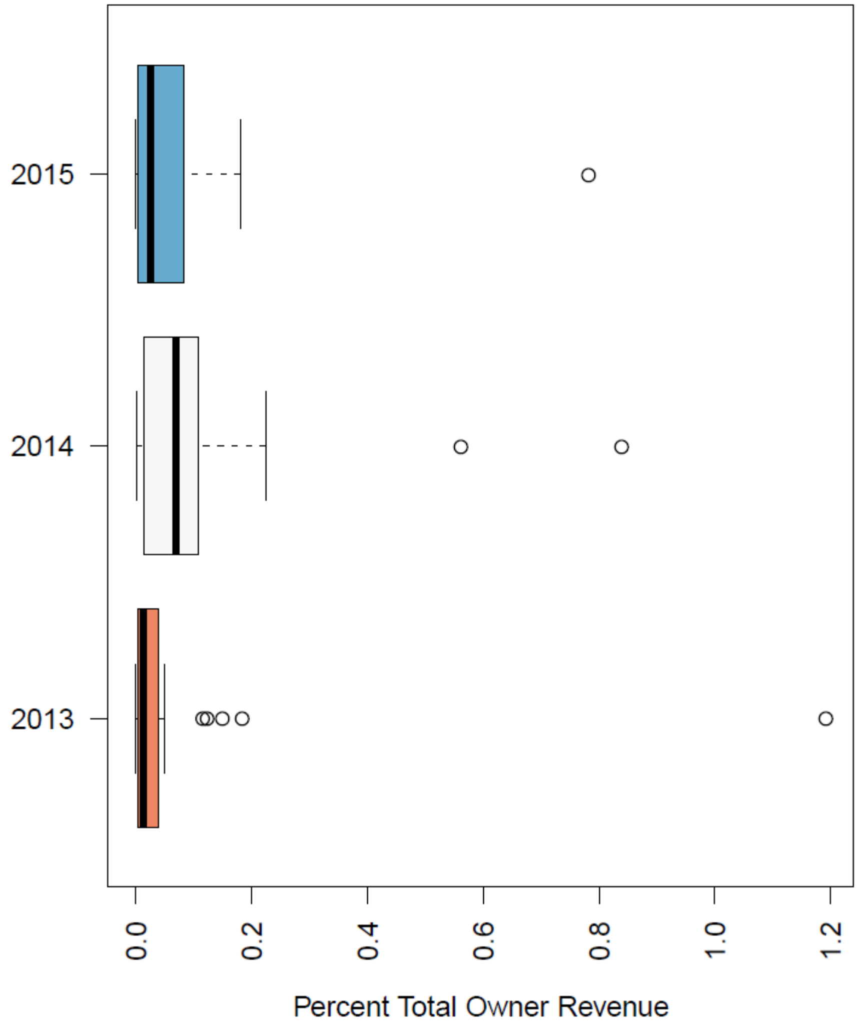


Table 78 – Percentage of VTR trips, by gear types attributed to the seamount zones that have VMS coverage, 2010-2012.

Gear	Year	Zone	Permits	VTR Trips	VMS Trips	Coverage
Bottom Trawl	2010	Offshore Seamounts	36	70	67	96%
Bottom Trawl	2011	Offshore Seamounts	41	105	91	87%
Bottom Trawl	2012	Offshore Seamounts	30	60	49	82%
Lobster Pot	2010	Offshore Seamounts	11	121	0	0%
Lobster Pot	2011	Offshore Seamounts	10	118	0	0%
Lobster Pot	2012	Offshore Seamounts	11	104	1	1%
Other Gear	2010	Offshore Seamounts	3	6	0	0%
Other Gear	2011	Offshore Seamounts	11	26	14	54%
Other Gear	2012	Offshore Seamounts	16	31	7	23%

7.2.4.3.2 Potentially affected fishing communities

General community impacts of the alternatives under consideration are described in section 7.1.3, which also describes the method, caveats, and data confidentiality standard used to develop Table 76, the revenue attributed (using the VTR analysis) to recent fishing within the seamount coral zone alternatives.

The VTR analysis attributes a small amount of fishing to the seamount coral zones, though this is likely due to imprecise VTR reporting. None the less, the VTR analysis results have been linked with fishing communities, consistent with other sections of this impacts analysis. Thus, the communities that may be impacted by the seamount coral zone alternatives are primarily located in Rhode Island and Massachusetts, with lesser activity attributed to ports in other states (Table 79).

Table 79 – Landings revenue to states, regions, and top ports attributed to fishing within the seamount coral zones, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Massachusetts	$102K	$17K	69
New Bedford	$82K	$14K	56
Gloucester	$13K	$2K	7
Other (n=4)	$7K	$1K	6
Connecticut	$3K	$1K	3
Rhode Island	$135K	$23K	27
Newport	$106K	$18K	4
Point Judith	$9K	$1K	22
Other (n=2)	$20K	$4K	4
New York	$7K	$1K	5
Montauk	$7K	$1K	5
New Jersey	$9K	$2K	5
Virginia	$1K	$0K	5
Other[b]	$24K	$4K	9
Total	**$282K**	**$50K**	**114**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
Source: VTR analysis.

The VTR analysis attributes recent landings revenue to 22 ports and 110 permits, and 48% of the associated revenue to ports in Rhode Island. Newport (4 permits), New Bedford (56 permits), and Gloucester (97 permits) are among the top ten landing ports, and 29% of the revenue is attributed to other ports, indicating that this zone may be particularly relevant for those three communities, which are some of the closer ports, distance-wise, to the seamounts. The revenue attributed to Rhode Island and Massachusetts from the seamount coral zones is about 0.03% and 0.003% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Though these are small fractions, certain individual permit holders could have as much as 1% of their revenue attributed to fishing from this area.

According to the NMFS Community Vulnerability Indicators, the commercial fishing engagement indicator is high for New Bedford and Gloucester and medium-high for Newport (Table 30). Of these three communities, New Bedford and Gloucester rank highest in terms of reliance on commercial fishing, with a medium index, while Newport ranks lowest, with a low index.

7.2.4.4 Impacts on protected resources

Because fishing is not known to occur on the seamounts at present, and considering the restrictions already associated with the overlapping monument designation, designating discrete seamount zones is not expected to have any redistributional effects on fishing effort. Therefore, no impacts on protected resources are expected to result from designation of discrete coral zones on the seamounts. This is not a preferred alternative.

7.2.5 Impacts of the Mount Desert Rock coral zones and associated fishing restrictions

This alternative would designate a coral zone just outside state waters, southwest of Mount Desert Rock (section 4.2.2.3.1), with two options for the size of the zone and options for which gear types would be prohibited from the area (Table 80). This alternative would be additive to No Action (i.e., Monkfish/MSB/Tilefish areas and the National Monument would remain in place) and could be selected in combination with other alternatives under consideration. The preferred alternative designates the smaller Option 2 boundary as a closure to mobile bottom-tending gears only.

Table 80 – Fishing restriction options relevant to the Mt. Desert Rock coral zones

Fishing restriction options	Relevance to MDR zones
Option 1: Prohibit all bottom-tending gears	Yes
Sub-option A: Exempt red crab fishery	No[1]
Sub-option B: Exempt other trap fisheries	Yes
Option 2: Prohibit mobile bottom-tending gears	Yes
[1] The red crab fishery is not prosecuted in the Gulf of Maine.	

7.2.5.1 Impacts on deep-sea corals

Deep-sea corals are known to occur within the Mt. Desert Rock zone (both Options 1 and 2) based on recent survey work (Table 46, section 6.2.3.3). Both of the zone boundary options encompass all of the recent scientific dive sites in the vicinity of Mt. Desert Rock where corals were observed. While both boundary options include a similar range of depths (Table 48), the smaller Option 2 area focuses on dive sites with steep slopes (Map 31). These steep terrain features are most likely to support coral habitats. Thus, while the larger Option 1 areawould be more likely to encompass coral habitats near Mt. Desert Rock, the two boundary options are likely to have very similar impacts on deep-sea corals.

Lobster is the dominant fishing activity in and around the Mt. Desert Rock zone (section 7.2.5.3), so the degree to which coral zone designation would have a positive impact on corals depends on the fishing restriction measures selected. If the Mt. Desert Rock coral zone was closed to all bottom-tending gears (gear restriction Option 1), without a trap fishery exemption (Sub-option B), the lobster fishery would be excluded from the zone and the likelihood of interactions between lobster gear and corals would be reduced. It is difficult to assess the rate of those interactions, and the extent to which any interactions have negative impacts on corals, given presently available information. While trap gears could crush or remove coral colonies, such effects have not been demonstrated to occur within our region, as relevant gear impacts research is not available (section 6.5.2). However, there are observed interactions between trap gear and corals in the Gulf of Maine (section 6.5.36.5). These observations cannot be used to estimate reliable coral bycatch rates in the lobster trap fishery or any regional fishery because the sampling design was not developed to answer this question. Overall, designation of this zone as a closure to all bottom tending gears would be expected to have positive impacts on deep-sea corals, but the magnitude of these impacts is difficult to determine.

If only mobile bottom-tending gear is prohibited in either of these two areas (gear restriction Option 2), the designation would have indirect, slightly positive impacts on coral habitats. Because mobile bottom-tending gear usage at Mt. Desert Rock appears to be very limited at present, any reductions in direct gear impacts on corals would be limited to the effects of lobster pots and any other fixed bottom-tending gear used in the area. Designation of the site as a coral protection zone would highlight the existence of corals in the area and might encourage additional research on them. In addition, the designation would prevent mobile bottom-tending gear use in the area in the future, should patterns of effort change. The same impacts would be expected if the Council selects a restriction on all bottom-tending gears but exempts trap fisheries (Option 1, sub-option B), because non-trap fixed gear use is not presently understood to occur within the zone.

7.2.5.2 Impacts on managed species and essential fish habitats

Designation of a coral zone at Mt. Desert Rock is likely to have indirect, positive impacts on managed species, through the conservation of habitats used for shelter, reproduction, and feeding. Similar to the discussion above on the impacts to deep-sea corals themselves, a larger zone (Option 1) with a more comprehensive gear restriction (Option 1) will have the greatest positive impact, while a smaller zone (Option 2) with less-restrictive management approaches (Option 2) will have a more reduced positive impact, but effects are expected to be similar regardless of the boundary option selected. As discussed above, the Option 1 and Option 2 boundaries are expected to perform similarly in terms of the amount of coral habitat they encompass, so the decision on which gears to restrict in the zone is a more important determinant of impacts than the decision about which zone boundary to adopt.

In terms of NEFMC-managed species and lifestages that are associated with seafloor habitats, essential fish habitat designations for various groundfish species, monkfish, and some types of skates have a moderate (25-50% by area) or high (>75% by area) degree of overlap with the Mt. Desert Rock zone. Groundfish and skate species with moderate or high overlap include Acadian redfish, American place, Atlantic wolffish, haddock, pollock, white hake, witch flounder, red hake, silver hake, smooth skate, and thorny skate. Other species that have less overlap (less than 25%), include Atlantic cod, Atlantic halibut, ocean pout, windowpane flounder, winter flounder, yellowtail flounder, little skate, winter skate, and sea scallop. In general, the species that overlap the coral zone more strongly tend to occur in deeper waters, and the species with a lower degree of overlap have shallower distributions. While the extent to which coral habitats increase production of any of these species has not been quantified, many of these species have been observed to occur within coral habitats during scientific surveys. The corals provide habitat for prey species, such as shrimp, and also provide shelter from predation and bottom currents.

7.2.5.3 Impacts on human communities

The impacts of the Mt. Desert Rock zone options on human communities are expected to be slightly negative in general, but negative for the fisheries and communities that would be constrained, to the degree that fisheries are constrained. It is difficult to determine the extent to which fishermen might be precluded from fishing altogether if a coral zone was designated at this site, or if they would be able to shift effort to other areas. The lobster fishery is particularly territorial (Acheson 1987; 2006), such that efforts to shift effort to areas remaining open may be difficult for those displaced by the closures. To the degree that a coral zone closure at Mt. Desert Rock enhances habitat function for fishery species there may be long-term benefits to fisheries and society, but these are difficult to project.

Lobster fishing is the predominant activity in the region which would be impacted by either Mount Desert Rock option. It is impossible to know the true amount of revenue generated within the Mt. Desert Rock coral zones, and thus the effort that would be displaced by closure of the areas to lobster trap gear. However, given the sizes of the two areas, the impacts to the fishing industry are expected to be more negative for zone Option 1 relative to zone Option 2. A range of potential revenue estimates were developed for the two boundary options, as described below. To summarize, data from MEDMR attribute $15M in 2015 lobster landings to all of Zone B, 3-12 nm from shore, so this is an extreme upper bound of what might have been harvested within either of the Mt. Desert Rock coral zones. On the other end, the VTR-based estimates, which averaged $14K and $36K annually for Options 2 and 1, respectively, are an extreme lower bound for displaced revenue. Intermediate to these are the percent area-based values, $1-8.5M for Option 1, and $420-845K for Option 2, using the assumption that the coral zones are between two and four times more productive than Zone B overall, and taking $15M as an upper bound.

The sociocultural impacts associated with the Mt. Desert Rock coral zones are expected to be negative for fishermen and fishing communities, and negative relative to No Action. With effort shifts, conflicts within or between fisheries would have a negative impact on the *Non-Economic Social* aspects and the *Attitudes, Beliefs, and Values* of fishery participants. Establishing the zone may change the *Social Structure and Organization* of communities as well as *Historical Dependence on and Participation* in the fishery by individuals and communities. The potential for increased interactions with large whales increases uncertainty within the lobster fishery about future fishery restrictions, a negative impact on the *Attitudes, Beliefs, and Values* held towards management. On the other hand, deep-sea corals have cultural value to society, so affording them protection has positive impacts on the *Attitudes, Beliefs, and Values* of stakeholders towards management.

7.2.5.3.1 Potentially affected fisheries

The Mt. Desert Rock zone is located between 3-12 nm from shore within Maine Lobster Management Zone B and Federal Lobster Management Area 1 (Map 46), thus, a federal permit is required to fish in the zones. Multiple approaches were used to estimate recent fishing activity and characterize the potential fishery impacts of the alternatives under consideration.

Maine DMR data

Mt. Desert Rock coral zone Option 1 is 46.8 km^2/18 mi^2, 3.1% of the area of Zone B that is 3-12 nm from shore. Based on the Maine DMR data, the total 2015 lobster harvest estimated for Zone B, 3-12 miles from shore, was 3.6M lbs. (Table 52, Map 52). This was harvested in 4,382 trips (Map 51) and valued at $15M (Map 53). Simply concluding that the revenue from the area of the Mt. Desert Rock coral zone Option 1 is 3.1% of $15M ($0.47M) is likely not appropriate, given that the spatial distribution of lobster fishing is unknown within both the management and coral zones. Lobstermen have indicated that the Mt. Desert Rock coral zone is two to four times more productive than surrounding sites and used by about 50 vessels.

Assuming that $15M is an accurate estimate of total revenue generated in Zone B between 3-12 miles from shore, and that the majority of this revenue is generated in the 96.7% of Zone B outside the coral zone, 2015 revenue from Option 1 is certainly well below $15M. If the area within Option 1 is, in fact, two to four times more productive than other parts of Zone B, this would suggest that during 2015, revenue from the coral zone was in the range of $1-2M, but accuracy of this estimate is unknown. MEDMR employed several methods to estimate recent annual lobster revenue from the zone (e.g., average value of trip, percent of area, industry surveys and interviews), and concluded that the annual lobster revenue ranged from about $1.0-$8.5M (ASMFC 2017).

Option 2 is a smaller area, encompassing 21 km^2/8 mi^2, or 1.4% of Zone B, 3-12 miles from shore. Taking 1.4% of $15M, and assuming the smaller Option 2 area is again two to four times more productive than Zone B as a whole, 2015 lobster revenues from Option B could range between $420-845K. Option 2 includes steeper habitats that are expected to be more difficult to fish with lobster pots, so it seems plausible that the multipliers within Option 2 would be on the lower end of the range, closer to twice as productive as the remainder of Zone B.

VTR analysis

Vessel Trip Report data were used to estimate recent (2010-2015) fishing activity, reported with VTR, within the two Mt. Desert Rock options (method explained in section

7.1.3). For the Area 1 lobster fishery, VTR data are very incomplete, and are most certainly an underestimate of revenue, trips, and permits associated with the Mt. Desert Rock zones. This is because many vessels do not carry other federal permits that trigger the VTR requirement. Maine DMR data indicate that VTR data account for only 9% of the lobster revenue, 7% of trips, and 6% of permits active in Zone B. An area-based expansion similar to the one discussed above is problematic, because the distribution of lobster fishing is unknown within both the management and coral zones, and there is no information to suggest that vessels submitting VTRs are randomly distributed throughout the zone in terms of home port or area fished. Thus, VTR data for these areas should be seen as a manner to assess relative exposure of fisheries in the region, as opposed to estimating impacts themselves.

Option 1 zone boundary: For 2010-2015, annual revenues from VTR-reporting vessels ranges from about $20K-40K for all bottom tending gear, averaging $36K (Figure 75). This is certain to underestimate revenue recently generated from this zone, given the caveats above. The species data (Figure 76) are consistent with the gear-based assessment in that lobster is the primary target. Thus, although an underestimate of the magnitude of impacts, the VTR data indicate that the lobster fishery, as compared to other fishing modes, would be most impacted by effort displacement associated with desgination of the Option 1 zone. The recent revenue attributed to fishing with mobile bottom-tending gear from this zone is only about $2K annually. Because no red crab fishing occurs within the Gulf of Maine, fishing gear restriction Option 1 Sub-option A is expected to have no practical management ramifications. Given the dominance of lobster pot revenue in the VTR analysis, an exemption for non-red crab pots/traps (Option 1 Sub-option B) and for mobile bottom-tending gears only (Option 2) would eliminate most, if not all, of the negative impacts to the commercial fishery active in the region.

Option 2 zone boundary: The Option 2 analysis suggests lower exposure for vessels submitting VTRs, as expected since Option 2 is a subset of Option 1. For 2010-2015, annual revenues from VTR-reporting vessels ranges from about $5K-20K for all bottom tending gear, averaging $14K (Figure 77). As for Option 1, fixed gear dominates revenue, trips, and permits, lobsters are the primary revenue generator (Figure 78). The recent revenue attributed to fishing with mobile bottom-tending gear from this zone is about $1K annually.

The low levels of VMS coverage within the inshore lobster pot fishery negates the use of VMS in assessing the potential impacts of this alternative on permit owners. Although a very small amount of VMS-estimated bottom trawl effort falls within both Mt. Desert Rock coral zone options, only a single year's data can be reported due to confidentiality issues. In 2007, three trips representing three permits have VMS polls falling within the Mt. Desert Rock coral zone Option 1, with 0.8 hours of associated fishing effort.

Impacts additive to the current ALWTRP rules

The Atlantic Large Whale Take Reduction Plan (ALWTRP) is designed to reduce fishery interactions with large whales. In Eastern Maine waters, the primary concern for potential interactions is with lobster trap gear. Regulating the amount of vertical line associated with lobster traps has been the primary tool used to minimize interactions.

A model of lobster gear vertical lines and whales has been used to support the development of the ALWTRP. The model has shown that the Mt. Desert Rock zones fall within an area of low co-occurrence. If either Mt. Desert Rock zone is selected, and lobster trap gear is probited, there could be effort displacement, potentially into nearby areas that the model identifies as having moderate to high co-occurrence. While there would be neutral short-term fishery impacts of fishing in a moderate or high co-occurrence zone, and no immediate consequences of interacting with a large whale, any increase in interactions could lead to more restrictive fishery measures in the future. The model shows that the potential for whale interaction in areas outside the Mt. Desert Rock zones is less likely than the Outer Schoodic Ridge zone (ASMFC, 2017).

Figure 75 – VTR-derived revenue by gear type within the Mt. Desert Rock coral zone Option 1, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.

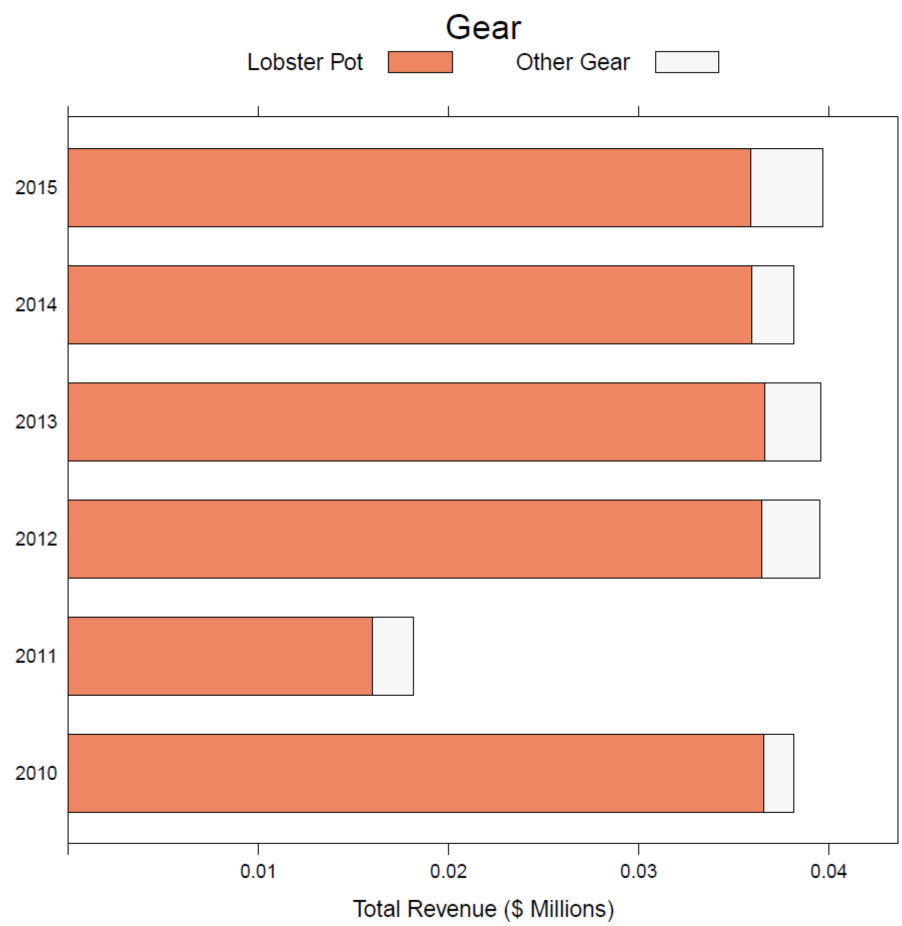


Figure 76 – VTR-derived revenue by species (top 10) within the Mt. Desert Rock coral zone Option 1, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.

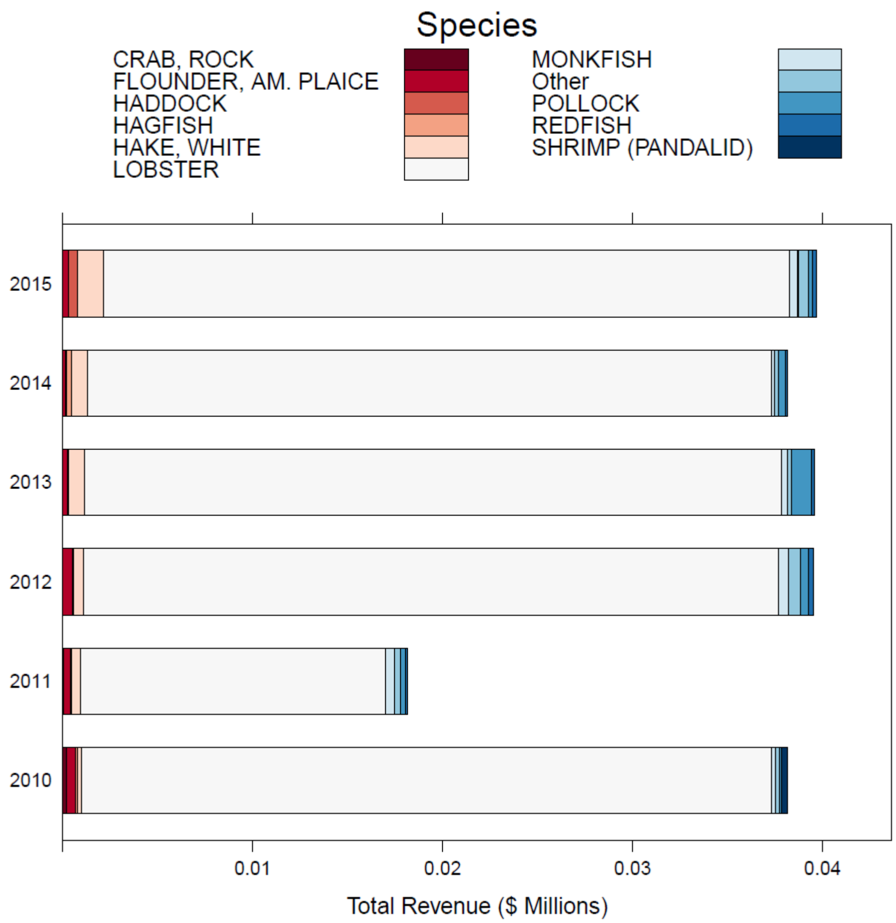


Figure 77 – VTR-derived revenue by gear type within the Mt. Desert Rock coral zone Option 2, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.

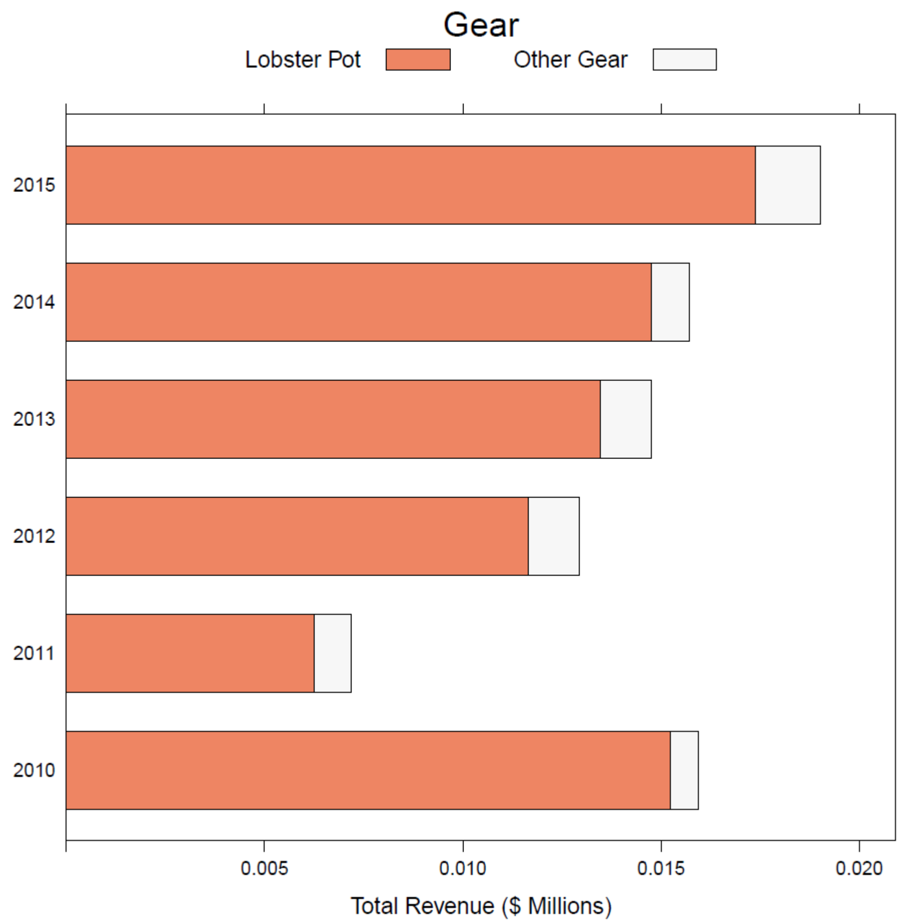
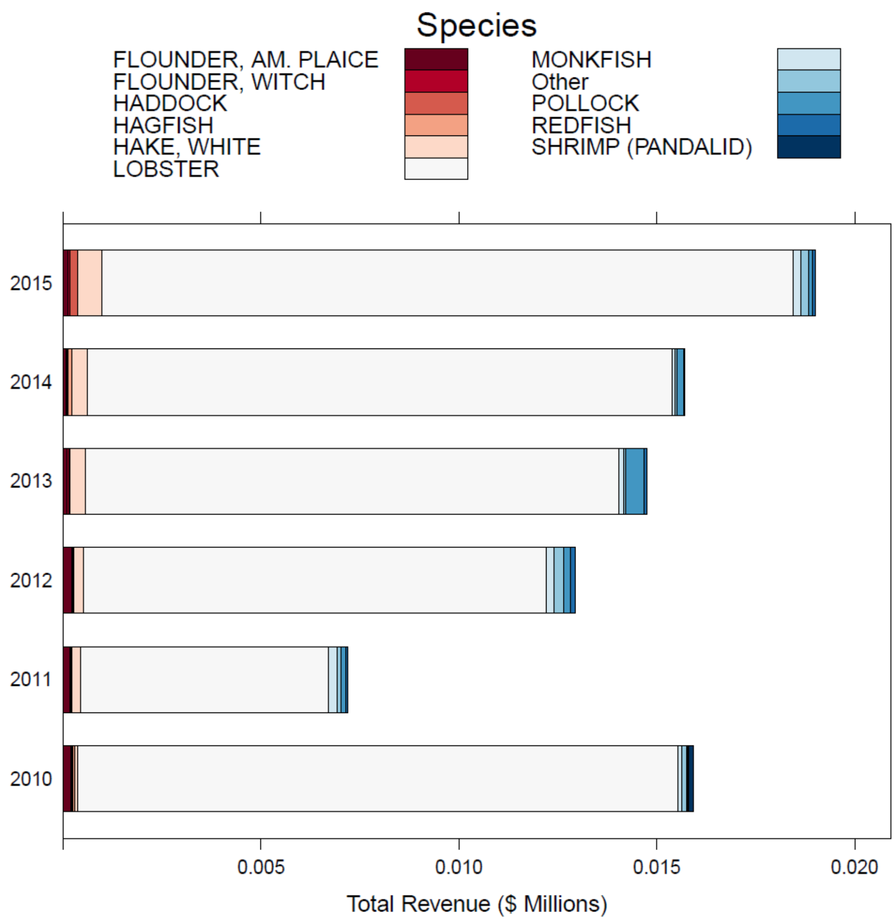


Figure 78 – VTR-derived revenue by species (top 10) attributed within the Mt. Desert Rock coral zone Option 2, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.



7.2.5.3.2 Potentially affected fishing communities

General community impacts of the alternatives under consideration are in section 7.1.3, which also describes the method, caveats, and data confidentiality standard used to develop Table 81 and Table 82, the revenue attributed (using the VTR analysis) to recent fishing within the Mt. Desert Rock coral zone options.

The VTR analysis indicates that for each of the Mt. Desert Rock zone options considered, Stonington and Winter Harbor, Maine are among the top landing ports that may be impacted. According to the NMFS Community Vulnerability Indicators, the commercial fishing engagement indicator is high for Stonington and medium for Winter Harbor (Table 30). Both communities have a high index of reliance on commercial fishing.

MEDMR interviewed commercial lobstermen who either fish in the Mt. Desert Rock coral zone or were familiar with the local fishery. The lobstermen indicated that about 30-50 vessels from Zones B and C fish the Mt. Desert Rock zone, an area that has become increasingly valuable in recent years. The area is fished year-round by a small number of fishermen and seasonally in late fall to spring by additional fishermen, as lobstermen follow the seaward migration of lobsters in winter. Most of these vessels employ a captain and two crew members. Their interviews suggested that areas around the coral zone are fished heavily, so effort displacement would likely cause gear conflicts (ASMFC 2017).

Option 1 zone boundary: Although the VTR analysis has some degree of error, it suggests that the fishing communities that may be impacted by the Mt. Desert Rock zone Option 1 are primarily located in Maine, with a small amount of activity attributed to ports in New Hampshire, Massachusetts, and Rhode Island (Table 81).

The VTR analysis attributes recent revenue from VTR-reported trips to 117 permits landing in 29 ports, and 88% of the associated revenue to ports in Maine. Stonington (9 permits) and Winter Harbor (3 permits), in eastern Maine, are among the top ten landing ports, yet 59% of the Maine revenue is attributed to other ports in that state, indicating that the fishermen and communities that may be impacted are more broadly distributed. The input of the Maine Lobstermen's Association indicates that the area near the Mt. Desert Rock coral zones are also important to lobstermen landing in ports such as Sorrento, Bar Harbor, Bass Harbor, Islesford/Cranberry Isles, Northeast Harbor, Southwest Harbor, Frenchboro, Swans Island, Oceanville, Stonington, Vinalhaven, and Owls Head (MEDMR, pers. comm., 2017). This aligns with the VTR analysis which attributes landings to 11 other ports in eastern Maine besides Stonington and Winter Harbor by 27 permits (vessels).

Based on the VTR analysis, the revenue from VTR trips is minor from the Mt. Desert Rock coral zone Option 1 relative to the total revenue for these states (ACCSP, 2017). Since the majority of Lobster Management Area 1 vessels do not hold other federal permits, the VTR dataset is known to substantially underestimate fishing activity in the Mt. Desert Rock coral zones, so this area is likely far more important to the states, ports, and individuals than what is reported here.

Table 81 – Landings revenue to states, regions, and top ports attributed to fishing with VTR within the Mt. Desert Rock coral zone Option 1, 2010-2015.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
ALL BOTTOM TENDING GEARS			
Maine	$187K	$31K	73
Eastern	$182K	$30K	36
Stonington	$59K	$10K	9
Winter Harbor	$18K	$3K	3
Other (n=11)	$105K	$17K	27
Mid-Coast	$3K	$0.5K	18
Southern	$2K	$0.4K	21
Portland	$2K	$0.4K	21
New Hampshire	$13K	$2K	10

Massachusetts	$13K	$2K	43
Gloucester New Bedford Other (n=1)	$9K $2K $2K	$1K $0.4K $0.6K	23 8 17
Rhode Island	$0.3K	$0.1K	3
Total	**$213K**	**$36K**	**117**
MBTG ONLY			
Maine	$2K	$0.4K	25
Eastern Mid-Coast Southern Portland	$0.3K $0.8K $1.1K $1.1K	$0.1K $0.8K $0.2K $0.2K	5 6 14 14
Massachusetts	$12K	$2K	40
Gloucester New Bedford Other (n-1)	$8.7K $0.7K $2.4K	$1.4K $0.1K $0.4K	22 6 17
Total	**$14K**	**$2.3K**	**56**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
"Eastern" = ports from Lubec to Verona Island
"Mid-Coast" = ports from Stockton Springs to Brunswick
"Southern" = ports from Freeport to Kittery
Source: VTR analysis.

Option 2 zone boundary: The VTR analysis suggests that the fishing communities that may be impacted by the Mt. Desert Rock zone Option 2 are primarily located in Maine, with a small amount of activity attributed to ports in Massachusetts, Rhode Island, and other states (Table 82). Specifically, the VTR analysis attributes recent revenue from VTR-reported trips to 116 permits landing in 29 ports, and 86% of the associated revenue to ports in Maine. Stonington (9 permits) and Winter Harbor (3 permits) are among the top ten landing ports, yet 65% of the Maine revenue is attributed to other ports in that state, indicating that the fishermen and communities that may be impacted are more broadly distributed. The input of the Maine Lobstermen's Association is summarized above. This aligns with the VTR analysis, which attributes landings to 11 other ports in eastern Maine besides Stonington and Winter Harbor by 27 permits (vessels).

The revenue from VTR trips is minor from the Mt. Desert Rock coral zone Option 2 relative to the total revenue for these states (ACCSP, 2017), but as noted above the VTR dataset is known to substantially underestimate fishing activity for the Area 1 lobster fishery, so this area is likely far more important to the states, ports, and individuals than what is reported here.

Table 82 – Landings revenue to states, regions, and top ports attributed to fishing with VTR within the Mt. Desert Rock coral zone Option 2, 2010-2015. All bottom-tending gears.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Maine	$74K	$12K	74
Eastern	$72K	$12K	36
Stonington	$17K	$2.8K	9
Winter Harbor	$8.9K	$1.5K	3
Other (n=11)	$48K	$7.7K	27
Mid-Coast	$1K	$0.2K	19
Southern	$1K	$0.2K	21
Massachusetts	$5.8K	$1.0K	41
Gloucester	$3.8K	$0.6K	22
New Bedford	$0.9K	$0.2K	8
Other (n=1)	$1.1K	$0.2K	17
Rhode Island	$0.1K	$0.0K	3
Other[b]	$5.3K	$0.9K	10
Total	**$86K**	**$14K**	**116**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
"Eastern" = ports from Lubec to Verona Island
"Mid-Coast" = ports from Stockton Springs to Brunswick
"Southern" = ports from Freeport to Kittery
Source: VTR analysis.

7.2.5.4 Impacts on protected resources

The protected resources potentially affected by this amendment are described in section 6.9.2, and the potential for interactions between these species and fishing gears are described in section 6.9.3. Lobster pot is the predominant gear type in and around the Mt. Desert Rock coral zone (see introductory section 7.1.4 for discussion of possible effort shifts in response to these alternatives) and is the focus on the sections below. Because any displaced lobster pot effort is expected to be redistributed within the inshore Gulf of Maine, impacts will be limited to protected species occurring locally (Table 83). Species listed in Table 39 that do not occur in the inshore Gulf of Maine are unlikely to experience any changes in interaction rates as a result of these alternatives.

Table 83 – Occurrence of protected resources in the inshore Gulf of Maine (overlapping Mt. Desert Rock and Outer Schoodic Ridge coral zones)

Species grouping	May occur in the inshore Gulf of Maine
Large whales	North Atlantic right whale, humpback whale, fin whale, minke whale
Small cetaceans	Atlantic white sided dolphin, short beaked common dolphin, harbor porpoise, pilot whales.
Pinnipeds	Harbor seal, grey seal, harp seal, hooded seal.

Species grouping	May occur in the inshore Gulf of Maine
Turtles	Green, loggerhead, Kemp's ridley, and leatherback
Fishes	Atlantic sturgeon, Atlantic salmon
Sources: http://seamap.env.duke.edu/, https://www.nefsc.noaa.gov/psb/surveys/; https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region; NMFS NEFSC FSB (2018)	

Mobile bottom-tending gear use is extremely limited within the Mt. Desert Rock coral zone boundaries (see section 7.2.5.3.17.2.5.3). For this reason, designating either zone boundary (larger Option 1 or smaller Option 2) as a closure to mobile bottom-tending gear (Option 2), or as a closure to all bottom-tending gear with an exemption for non-red crab pots (Option 1, Sub-Option B) would have very minor if any effects on the footprint of fishing effort with this gear type in and around this area. Relative to current operating conditions, the small redistribution of effort would not be expected to significantly change fishing effort in and around the zone and therefore, elevated interactions are not expected. Thus, designation of either zone boundary with gear restriction Option 1, Sub-Option B, or Option 2, is expected to have slight negative impacts on protected resources, similar to No Action, regardless of the species considered. Boundary Option 2 with gear Option 2 is the preferred alternative for this coral zone. Because lobster pots are the only bottom-tending gear type used routinely at this site, any protected resources impacts associated with designating a Mt. Desert Rock coral zone would arise from the effects of displacing lobster trap gear out of the zone and into other areas. The remainder of this section focuses on potential changes to lobster pot interaction rates.

7.2.5.4.1 Large whales

Large whales generally use nearshore areas of the Gulf of Maine for feeding, particularly in the summer months. In particular, humpback, minke, fin, and North Atlantic right whales are most likely to occur in the area. Section 7.1.4 describes potential shifts in lobster trap fishing effort. A likely outcome is that traps and vertical lines outside the coral zones would be more densely concentrated, although specific outcomes are difficult to predict. Despite mitigation measures associated with the ALWTRP (see section 6.9.3.1.1), increased vertical line density could lead to increased interaction rates between large whales and pot gears, and therefore designation of either zone as a closure to lobster pot gear could have negative impacts on large whales. The magnitude of such effects is uncertain. Based on the sizes of the two zone options, the larger Option 1 would be expected to have greater negative impacts than the smaller Option 2. Alternatively, if trap effort is reduced overall because there is no space to set additional trawls of traps, there could be a reduction in vertical lines. This could provide some benefit to large whales by reducing, to some degree, the risk of entanglement.

7.2.5.4.2 Small cetaceans and pinnipeds

Small cetacean and pinniped interactions with pots and traps are discussed in section 6.9.3.1.2. Direct observations of fishing with trap/pot gear are limited, so interaction information for small cetaceans and and pinnipeds with trap/pot gear is partly inferred from evidence of gear on stranded animals. To date, stranding data has shown no evidence of pinniped interactions with pot/trap gear; however, the stranding data does suggest that trap/pot interaction rates with small cetaceans are low. Given low estimated interaction rates, impacts to pinnipeds and small cetaceans from the designation of either Mt. Desert Rock zone is expected to be neutral to slight negative, regardless of potential shifts in fishing effort.

7.2.5.4.3 Sea turtles

Turtle interactions with pots and traps are discussed in section 6.9.3.2. Leatherback, loggerhead, green, and Kemp's ridley sea turtles are known to interact with trap/pot gear, with interactions primarily associated with entanglement in vertical lines, although sea turtles can also become entangled in groundline or surface systems. If trap gear becomes concentrated in areas outside the Mt. Desert Rock zone, this could increase vertical and ground line density. If this increased gear concentration reduced catch rates of the traps, set times could increase. Both a greater concentration of vertical/groundlines and longer set durations could increase interaction rates. Thus, designation of the Mt. Desert Rock coral zone could have slightly negative effects on sea turtles. Alternatively, if trap effort is reduced overall because there is no space to set additional trawls of traps, there could be a reduction in vertical lines, which in turn could provide some benefit to sea turtles by reducing, to some degree, the risk of entanglement.

7.2.5.4.4 Atlantic sturgeon and Atlantic salmon

Atlantic sturgeon and Atlantic salmon interactions with pots and traps are discussed in sections 6.9.3.3 and 6.9.3.4. To date, there have been no observed or documented interactions between these gears and species. Therefore, designation of a coral zone in the Mt. Desert Rock area is expected to have neutral impacts on Atlantic sturgeon and Atlantic salmon.

7.2.6 Impacts of the Outer Schoodic Ridge coral zone and associated fishing restrictions

This alternative would designate a coral zone on the Outer Schoodic Ridge, roughly 25 nm southeast of Mt. Desert Island, within NMFS Statistical Area 511 and Maine Lobster Management Zone A (section 4.2.2.3.2), with options for which gear types would be precluded from the zone (Table 80). The coral zone encompasses a portion of the Ridge that has been recently mapped with multibeam and surveyed using ROV. This alternative would be additive to No Action (i.e., Monkfish/MSB/Tilefish areas and the National Monument would remain in place) and could be selected in combination with other alternatives under consideration. Designation of the Outer Schoodic Ridge zone as a closure to mobile bottom tending gears (Option 2) is one of the Council's preferred alternatives.

Table 84 – Fishing restriction options relevant to the Outer Schoodic Ridge coral zone

Fishing restriction options	Relevance to OSR zone
Option 1: Prohibit all bottom-tending gears	Yes
Sub-option A: Exempt red crab fishery	No[1]
Sub-option B: Exempt other trap fisheries	Yes
Option 2: Prohibit mobile bottom-tending gears	Yes

[1] The red crab fishery is not prosecuted in the Gulf of Maine.

7.2.6.1 Impacts on deep-sea corals

Deep-sea corals are known to occur within the Outer Schoodic Ridge zone based on recent survey work (Table 46, section 6.2.3.3). Lobster is the dominant fishing activity at the site. Option 2 is the preferred alternative for this coral zone.

If the Outer Schoodic Ridge zone was selected as a coral zone closed to all bottom-tending gears (Option 1), without a trap fishery exemption (Sub-option B), the lobster fishery would be excluded from the zone and the likelihood of interactions between lobster gear and corals would be reduced. It is difficult to assess the rate of those interactions, and the extent to which any interactions have negative impacts on corals, given presently available information. While trap gears could crush or remove coral colonies, such effects have not been demonstrated to occur within our region, as relevant gear impacts research is not available (section 6.5.2). There are observed interactions between trap gear and corals in the Gulf of Maine (section 6.5.3), but we cannot use these observations to estimate coral bycatch rates in the lobster trap fishery or any fishery because the data were not collected with this purpose in mind. Overall, designation of this zone as a closure to all bottom tending gears would be expected to have positive impacts on deep-sea corals, but the magnitude of these impacts is difficult to determine.

If a mobile bottom-tending gear restriction (Option 2) is selected in the zone, it would have indirect, slightly positive impacts on coral habitats. While there would be limited if any reductions in direct impacts of gear on corals, designation of the site would highlight the importance of the area as coral habitat and might encourage additional research. In addition, the designation would prevent mobile bottom-tending gear use in the area in the future, should patterns of effort change. Similar impacts would be expected if the Council selects a restriction on all bottom-tending gears but exempts trap fisheries (Option 1, Sub-Option B).

7.2.6.2 Impacts on managed species and essential fish habitats

Designation of a coral zone at Outer Schoodic Ridge is likely to have indirect, positive impacts on managed species, through the conservation of habitats used for shelter, reproduction, and feeding. Similar to the discussion above on the impacts to deep-sea corals themselves, a more comprehensive gear restriction (Option 1) will have the greatest magnitude of positive impacts, while less-restrictive management approaches (Option 2) will have a smaller magnitude of positive impacts, at least at present, because at present mobile bottom-tending gear use is very limited in the vicinity.

In terms of managed species that are associated with seafloor habitats, essential fish habitat designations for various groundfish species, monkfish, and some types of skates have a moderate (25-50% by area) or high (>75% by area) degree of overlap with the Outer Schoodic Ridge zone. Groundfish and skate species with moderate or high overlap include Acadian redfish, American plaice, Atlantic wolffish, haddock, pollock, white hake, witch flounder, red hake, silver hake, monkfish, smooth skate, and thorny skate. Other species have a lesser degree of overlap (below 25% of the zones, by area), specifically Atlantic cod, Atlantic halibut, ocean pout, little skate, winter skate, and sea scallop. While the extent to which coral habitats increase production of any of these species has not been quantified, many have been observed within coral habitats during scientific surveys. In terms of the mechanism by which coral habitats improve production of managed stocks, the corals provide habitat for prey species, such as shrimp, and also provide fishes with shelter from predation and bottom currents.

7.2.6.3 Impacts on human communities

The impacts of the Outer Schoodic Ridge zone on human communities are expected to be low negative in general, but negative for the fisheries and communities with exposure to the coral zone. These negative impacts would be additive to the negative fishery impacts of No Action, though the No Action areas do not overlap Outer Schoodic Ridge, and the directly impacted fishermen are likely to be distinct from those fishing south of Georges Bank. It is difficult to determine if fishermen would be precluded from fishing altogether if a coral zone was designated at this site, or if they would be able to shift effort to other areas. The lobster fishery is particularly territorial (Acheson 1987; 2006), such that shifting effort to areas remaining open may be difficult for those displaced by the closures. To the degree that a coral zone closure at Outer Schoodic Ridge enhances habitat function for fishery species there may be long-term benefits to fisheries and society, but these are difficult to project.

Lobster fishing is the predominant activity in the region which would be impacted by designation of a coral zone at Outer Schoodic Ridge. It is impossible to know the true amount of revenue generated within the zone, and thus the effort that would be displaced by closure of the areas to lobster trap gear. A range of potential revenue estimates were developed for the two boundary options, as described below. To summarize, data from MEDMR attributes $9.8M in 2015 lobster landings to Zone A, 12+ nm from shore; this is likely more than the upper bound of what was harvested within the Outer Schoodic Ridge coral zone. On the other end, the VTR-based estimates, which average $37K annually, are an extreme lower bound for displaced revenue. Intermediate is the percent area-based estimate of $1-2 M, using the assumption that the coral zone is between two and four times more productive than Zone A overall.

The sociocultural impacts associated with the Outer Schoodic Ridge coral zone are expected to be negative for fishermen and fishing communities, and negative relative to No Action. With effort shifts, conflicts within or between fisheries would have a negative impact on the *Non-Economic Social* aspects and the *Attitudes, Beliefs, and Values* of fishery participants. Establishing the zone may change the *Social Structure and Organization* of communities as well as *Historical Dependence on and Participation* in the fishery by individuals and communities. The potential for increased interactions with large whales increases uncertainty within the lobster fishery about future fishery restrictions, a negative impact on the *Attitudes, Beliefs, and Values* held towards management. On the other hand, deep-sea corals have cultural value to society, so affording them protection has positive impacts on the *Attitudes, Beliefs, and Values* of stakeholders towards management.

7.2.6.3.1 Potentially affected fisheries

The Outer Schoodic Ridge zone is located between 3-12 nautical miles from shore within the Maine Lobster Management Zone A and Federal Lobster Management Area 1 (Map 46), and a federal permit is required to fish in the zone. Fishing activity in this zone is dominated by the lobster fishery. Due to data limitations, it is impossible to know the true amount of fishing activity that has occurred within the Outer Schoodic Ridge coral zone. Thus, multiple approaches are used to estimate fishing activity and characterize the potential fishery impacts of the alternatives under consideration.

Maine DMR data

The Outer Schoodic Ridge zone is 79 km^2/31 mi^2, or 4.0% of Zone A, 12+ nm from shore. Based on the MEDMR data, the total 2015 lobster harvest estimated for Zone A, 12+ miles from shore, was 2.1M lbs. (Table 52, Map 52). This was harvested in 1,902 trips (Map 51) and valued at $9.8M (Map 53). Simply concluding that the revenue from the area of the Outer Schoodic Ridge coral zone is 4.0% of $9.8M ($0.39M) is likely not appropriate, given that the distribution of lobster fishing is unknown within both the management and coral zones. Lobstermen have indicated that the Outer Schoodic Ridge coral zone is two to four times more productive than surrounding sites, used by about 50 vessels.

The total value $9.8M is likely to be an extreme upper bound of 2015 revenue from the Outer Schoodic Ridge coral zone. If the area within Option 1 is, in fact, two to four times more productive than other parts of Zone A, this would suggest that during 2015, revenue from the coral zone was in the range of $1-2M, but this is unknown. MEDMR employed several methods to estimate annual lobster revenue from the zone (e.g., average value of trip, percent of area, industry surveys and interviews), and concluded that the annual lobster revenue has ranged from about $1.0-$8.5M (ASMFC 2017).

VTR analysis

Vessel Trip Report data were used to estimate recent (2010-2015) fishing activity, reported with VTR, within the Outer Schoodic Ridge zone (method explained in section 7.1.3).

For the Area 1 lobster fishery, VTR data are very incomplete, and are most certainly an underestimate of revenue, trips, and permits associated with the Outer Schoordic Ridge zone. This is because many vessels do not carry other federal permits that trigger the requirement. The MEDMR data (above) indicate that VTR data account for only 9% of the lobster revenue, 10% of trips, and 9% of permits active in Zone A. As noted above, an area-based expansion is problematic, and VTR data for these areas should be used to assess relative exposure of fisheries in the region, as opposed to estimating impacts themselves.

For 2010-2015, annual revenue by fishing with VTR attributed to the Outer Schoodic Ridge zone ranges from $23K-53K, averaging $37K (Figure 79), likely an underestimate of true revenue recently generated from this zone. The vast majority of this revenue (91%) is from fishing with fixed gear, primarily lobster pots. Trips and permits affected are also dominated by the lobster pot fishery, and lobster landings generate the vast majority of the species revenue within the zone (Figure 80). The recent revenue attributed to fishing with mobile bottom-tending gear from this zone is only about $3K annually. Because no red crab fishing occurs within the Gulf of Maine, fishing gear restriction Option 1 Sub-option A is expected to have no practical management ramifications or impacts on the trawl fleet.

The low levels of VMS coverage within the inshore lobster pot fishery negates the use of VMS in assessing the potential impacts of this alternative on permit owners. There is some VMS-derived otter trawl effort falling within the Outer Schoodic Ridge zone, but only two years can be reported on due to confidentiality reasons. In 2006, a total of 5 permit holders on 9 trips have VMS polls falling within the Outer Schoodic Ridge zone, with a total of 16 hours of fishing effort calculated to have fallen within the bounds of this alternative. In 2007, 3 permits on 5 trips have VMS polls falling within the Outer Schoodic Ridge zone, with just over 1 hour of effort attributed to this alternative.

Impacts additive to the current ALWTRP rules

The Atlantic Large Whale Take Reduction Plan (ALWTRP) is designed to reduce fishery interactions with large whales. In Eastern Maine waters, the primary concern for potential interactions with large whales is with lobster trap gear. Regulating the amount of vertical line associated with lobster traps has been the primary tool to minimize interactions.

A model of lobster gear vertical lines and whales has been used to support the development of the ALWTRP (ASMFC 2017). The model has shown that the Outer Schoodic Ridge coral zone falls primarily within an area of high co-occurrence. Should this zone alternative be selected, and lobster trap gear is precluded, there could be effort displacement, potentially into nearby areas that the model identifies as having moderate to high co-occurrence. While there would be neutral short-term fishery impacts of fishing in a moderate or high co-occurrence zone, and no immediate consequences of interacting with a large whale, any increase in interactions would likely lead to more restrictive fishery measures in the future. The model shows that the potential for whale interaction in areas outside the Outer Schoodic Ridge zone is more likely than the Mt. Desert Rock zones, because the Outer Schoodic Ridge zone is already in the middle of a moderate to high co-occurrence area.

Figure 79 – VTR-derived revenue by gear type within the Outer Schoodic Ridge coral zone, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.

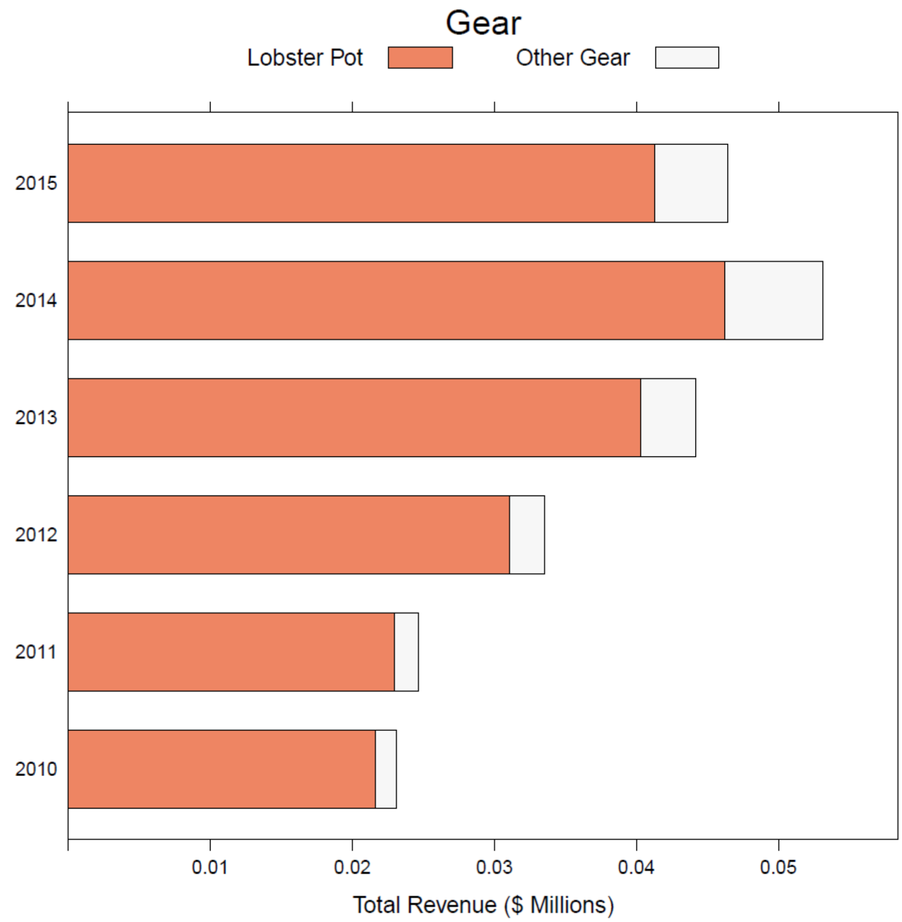
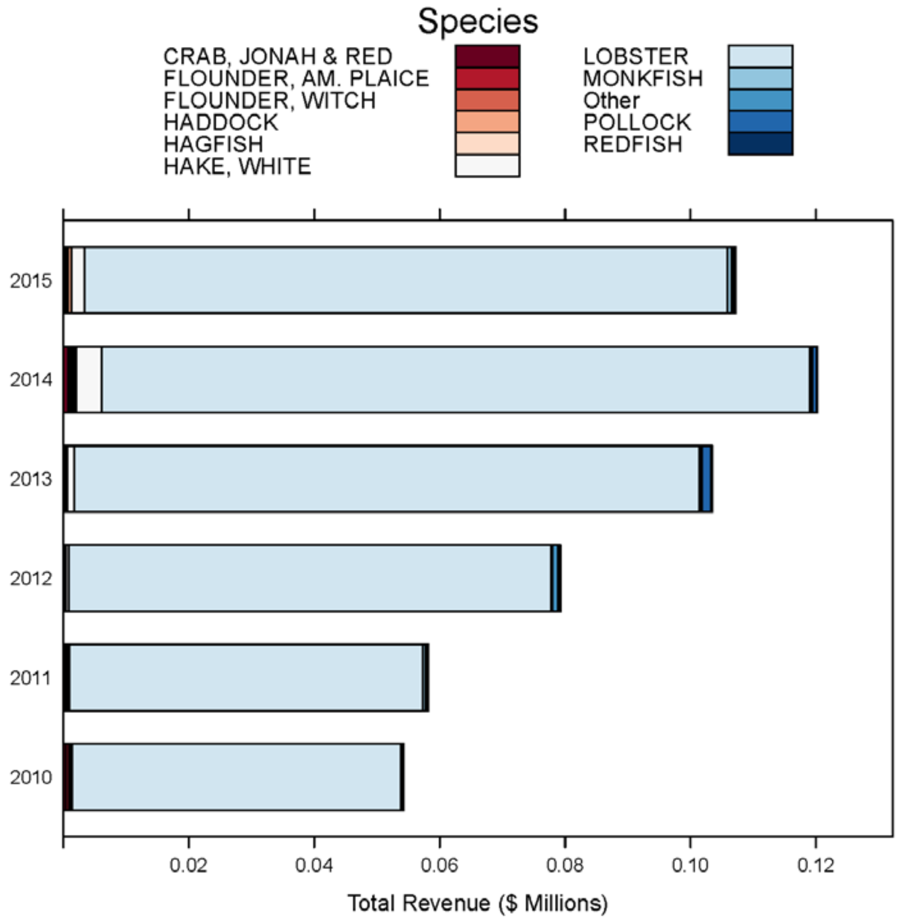


Figure 80 – VTR-derived revenue by species (top 10) within the Outer Schoodic Ridge coral zone, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.



7.2.6.3.2 Potentially affected fishing communities

General community impacts of the alternatives under consideration are described in section 7.1.3, which also describes the method, caveats, and data confidentiality standard used to develop

Table 85, the revenue attributed (using the VTR analysis) to recent fishing within the Outer Schoodic Ridge coral zone.

MEDMR interviewed commercial lobstermen who either fish in the Outer Schoodic Ridge coral zone or were familiar with the local fishery. The lobstermen indicated that over 50 vessels fish the Outer Schoodic Ridge zone, an area that has historically been important to the fishery. The area is fished year-round by a small number of fishermen and seasonally in late fall to spring by others, as lobstermen follow the seaward migration of lobsters in winter. Most of these vessels employ a captain and two crew members. Areas around the coral zone are fished heavily, so effort displacement would likely cause gear conflicts (ASMFC 2017).

Although the VTR analysis has some degree of error, it suggests that the fishing communities that may be impacted by the Outer Schoodic Ridge alternative are primarily located in Maine, with a small amount of activity attributed to ports in New Hampshire, Massachusetts, and other states (Table 85).

The VTR analysis attributes recent landings from VTR-reported trips to 112 permits landing in 27 ports, and 76% of the associated revenue to ports in eastern Maine. Steuben (4 permits), Milbridge (4 permits), Jonesport (26 permits), Beals Island (8 permits), and Addison (3 permits), in eastern Maine, are among the top ten landing ports, and just 3% of the revenue associated with VTRs is attributed to other ports in that region, indicating that the communities that may be impacted may be fairly concentrated. However, the input of the Maine Lobstermen's Association is that the area near the Outer Schoodic Ridge coral zone is also important to lobstermen landing in the ports of Harrington, Dyers Bay, Corea, Prospect Harbor, Bunkers Harbor, Winter Harbor, Bar Harbor, and Cranberry Isles. The MLA indicated that fishermen from Jonesport and Beals Island may be less likely to fish near the Outer Schoodic Ridge than the VTR analysis indicates (MEDMR, pers. comm., 2017). This aligns with the VTR analysis, which attributes landings to 10 other ports in eastern Maine (19 permits) besides those listed above.

Based on the VTR analysis, the revenue attributed to Maine and New Hampshire from the Outer Schoodic Ridge coral zone is about 0.006% and 0.02% of all revenue, respectively, for these states during 2010-2015 (ACCSP, 2017). Since the majority of Lobster Management Area 1 vessels do not hold other federal permits, the VTR dataset is known to underestimate fishing activity in the Outer Schoodic Ridge coral zone, so this area is likely more important to the states, ports, and individuals than these data would suggest.

According to the NMFS Community Vulnerability Indicators, the commercial fishing engagement indicator is high for Jonesport and medium for Milbridge and Steuben (Table 30). Of these three communities, Jonesport and Milbridge rank highest in terms of reliance on commercial fishing, with a high index, while Steuben has a medium-high reliance index.

Table 85 – Landings revenue to states, regions, and top ports attributed to fishing with VTR within the Outer Schoodic Ridge coral zone, 2010-2015

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
ALL BOTTOM TENDING GEARS			
Maine	$172K	$29K	74
Eastern	$170K	$28K	54
Stueben	$77K	$13K	4
Milbridge	$56K	$9K	4
Jonesport	$24K	$4K	26
Beals Island	$4K	$1K	8
Addison	$2K	$0.2K	3
Other (n=10)	$7K	$0.8K	19
Mid-Coast	$1K	$0.0K	7
Southern	$2K	$0.3K	15
New Hampshire	$33K	$5K	9
Massachusetts	$20K	$3K	37
Gloucester	$12K	$2K	20
New Bedford	$2K	$0.3K	7
Other[b]	$0K	$0.0K	2
Total	**$225K**	**$37K**	**112**
MBTG ONLY			
Maine	$1.3K	$0.2K	34
Eastern	$0.3K	$0.1K	12
Jonesport	$0.3K	$0.0K	9
Other (n=3)	$0.0K	$0.0K	3
Mid-Coast	$0.1K	$0.0K	4
Port Clyde	$0.1K	$0.0K	4
Southern	$1.0K	$0.2K	11
Portland	$1.0K	$0.2K	11
Massachusetts	$19K	$3K	27
Gloucester	$12K	$2K	19
New Bedford	$0.4K	$0.1K	5
Other (n=1)	$5.9K	$1.0K	14
Total	**$20K**	**$3.3K**	**53**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
"Eastern" = ports from Lubec to Verona Island
"Mid-Coast" = ports from Stockton Springs to Brunswick
"Southern" = ports from Freeport to Kittery

7.2.6.4 Impacts on protected resources

The protected resources potentially affected by this amendment are described in section 6.9.2, and the potential for interactions between these species and fishing gears are described in section 6.9.3. Lobster pot is the predominant gear type in and around the Outer Schoodic Ridge coral zone (see introductory section 7.1.4 for discussion of possible effort shifts in response to these alternatives) and is the focus on the sections below. Because any displaced lobster pot effort is expected to be redistributed within the inshore Gulf of Maine, impacts will be limited to protected species occurring locally (Table 83). Species listed in Table 39 that do not occur in the inshore Gulf of Maine are unlikely to experience any changes in interaction rates as a result of these alternatives.

Mobile bottom-tending gear use is extremely limited within the Outer Schoodic Ridge coral zone boundaries (see section 7.2.6.3.1). For this reason, the zone as a closure to mobile bottom-tending gear (Option 2), or as a closure to all bottom-tending gear with an exemption for non-red crab pots (Option 1, Sub-Option B) would have very minor if any effects on the footprint of fishing effort with this gear type in and around this area. Relative to current operating conditions, the small redistribution of effort would not be expected to significantly change fishing effort in and around the zone and therefore, elevated interactions are not expected. Thus, designation of the Outer Schoodic Ridge coral zone with gear restriction Option 1, Sub-Option B, or Option 2, is expected to have slight negative impacts on protected resources, similar to No Action, regardless of the species considered. Designation of the zone with gear Option 2 is the preferred alternative. Because lobster pots are the only bottom-tending gear type used routinely at this site, any protected resources impacts associated with designating the Outer Schoodic Ridge zone would arise from the effects of displacing lobster trap gear out of the zone and into other areas.

7.2.6.4.1 Large whales

Large whales generally use nearshore areas of the Gulf of Maine for feeding, particularly in the summer months. In particular, humpback, minke, fin, and North Atlantic right whales are most likely to occur in the area. Section 7.1.4 describes potential shifts in lobster trap fishing effort. A likely outcome is that traps and vertical lines outside the coral zones would be more densely concentrated, although specific outcomes are difficult to predict. Despite mitigation measures associated with the ALWTRP (see section 6.9.3.1.1), increased vertical line density could lead to increased interaction rates between large whales and pot gears, and therefore designation of the zone as a closure to lobster pot gear could have negative impacts on large whales. The magnitude of such effects is uncertain. Alternatively, if trap effort is reduced overall because there is no space to set additional trawls of traps, the number of vertical lines in the water could decline. This could provide some benefit to large whales by reducing, to some degree, the risk of entanglement.

7.2.6.4.2 Small cetaceans and pinnipeds

Small cetacean and pinniped interactions with pots and traps are discussed in section 6.9.3.1.2. Direct observations of fishing with trap/pot gear are limited, so interaction information for small cetaceans and pinnipeds with trap/pot gear is partly inferred from evidence of gear on stranded animals. These stranding data suggest that trap/pot interaction rates with small cetaceans are low. Given these low interaction rates, impacts on small cetaceans of designating the Outer Schoodic Ridge coral zone as a closure to lobster pot gear are expected to be neutral to slight negative, similar to No Action, regardless of potential shifts in fishing effort.

7.2.6.4.3 Sea turtles

Turtle interactions with pots and traps are discussed in section 6.9.3.2. Leatherback, loggerhead, green, and Kemp's ridley sea turtles are known to interact with trap/pot gear, with interactions primarily associated with entanglement in vertical lines, although sea turtles can also become entangled in groundline or surface systems. If trap gear becomes concentrated in areas outside the Outer Schoodic Ridge coral zone, this could increase vertical and ground line density. If this increased gear concentration reduced catch rates of the traps, set times could increase. Both a greater concentration of vertical/groundlines and longer set durations could increase interaction rates. Thus, designation of the coral zone could have negative effects on sea turtles. Alternatively, if trap effort is reduced overall because there is no space to set additional trawls of traps, there could be a reduction in vertical lines. This could provide some benefit to sea turtles but reducing, to some degree, the risk of entanglement.

7.2.6.4.4 Atlantic sturgeon and Atlantic salmon

Atlantic sturgeon and Atlantic salmon interactions with pots and traps are discussed in sections 6.9.3.3 and 6.9.3.4. To date, there have been no observed or documented interactions between these gears and species. Therefore, designation of a coral zone in the Outer Schoodic Ridge area is expected to have neutral impacts on Atlantic sturgeon and Atlantic salmon.

7.2.7 Impacts of the Jordan Basin coral zones and associated fishing restrictions

This alternative would designate four coral zones in Jordan Basin (section 4.2.2.3.3), with two options for the sizes of the zones and options for which gear types would be excluded from the zones (Table 86). Three zones are in the western part of the Basin and are named for their charted depths: 98 Fathom Bump (179 m), 114 Fathom Bump (208 m), and 118 Fathom Bump (216 m). The fourth site is in Central Jordan Basin. This alternative, which was not preferred by the Council, would have been additive to No Action and could have been selected in combination with other alternatives under consideration.

Table 86 - Fishing restriction options relevant to the Jordan Basin coral zones

Fishing restriction options	Relevance to JB zones
Option 1: Prohibit all bottom-tending gears	Yes
Sub-option A: Exempt red crab fishery	No[1]
Sub-option B: Exempt other trap fisheries	Yes
Option 2: Prohibit mobile bottom-tending gears	Yes
[1] The red crab fishery is not prosecuted in the Gulf of Maine.	

7.2.7.1 Impacts on deep-sea corals

Deep-sea corals are known to occur within the Jordan Basin coral zones based on recent survey work (Table 46, section 6.2.3.3). A small number of older soft coral records are also available for these sites (Table 45). Two different sets of boundary options are under consideration in Jordan Basin. Both the larger Option 1 areas and the smaller Option 2 areas include all sites where corals have been observed using remotely operated vehicle and towed camera systems. The Option 1 zones are more precautionary, given that the seafloor terrain in Jordan Basin, particularly at 118 Fathom Bump and 96 Fathom Bump, is not well understood. Although steep terrain features at the 114 Fathom Bump site and Central Jordan Basin site are better mapped (see Map 35), it is difficult to estimate the spatial extent of coral habitats beyond the surveyed areas.

Low resolution seafloor terrain data limit the usefulness of the coral habitat suitability model in the Gulf of Maine, so this dataset cannot be used to estimate the extent of coral habitats. (The data shown on Map 35 were not used in the development of the habitat suitability model.) While there are extensive areas of coral habitat in Jordan Basin, none of the areas are predicted to have a high or very high likelihood of coral presence in the suitability model. This is in contrast to the continental margin, where visual surveys generally correspond with model predictions.

Given these uncertainties, zones designated with either the Option 1 or the Option 2 boundaries are expected to have positive impacts on deep-sea corals, but the positive impacts are likely to be greater under Option 1.

In addition to the decision about which boundaries to adopt, the degree to which a coral zone designation at this location would have a positive impact on corals depends on the fishing restriction measures selected. Lobster trapping is an important fishing activity at the site, although trawling and gillnetting for groundfish and monkfish also occur (section 7.2.7.3). If the Jordan Basin zones are selected with closures to all bottom-tending gears (Option 1) the lobster fishery would be excluded from the zone and the likelihood of interactions between lobster gear and corals would be reduced. It is difficult to assess the extent of those interactions, and the degree to which any interactions have negative impacts on corals, given presently available information. While trap gears could crush or remove coral colonies, such effects have not been demonstrated to occur within our region, as relevant gear impacts research is not available (section 6.5.2). However, there are observed interactions between trap gear and corals in the Gulf of Maine (section 6.5.3) but overall fishery-wide bycatch rates cannot be determined from these data, which are fairly limited. Overall, designation of this zone as a closure to all bottom tending gears would be expected to have positive impacts on deep-sea corals, but the magnitude of these impacts is difficult to determine.

A mobile bottom-tending gear restriction in the Jordan Basin zones (Option 2) would also have positive impacts on coral and their habitats. The same impacts would be expected if the Council had selected a restriction on all bottom-tending gears but exempted trap fisheries (Option 1, Sub-Option B). It is difficult to determine how positive these impacts would be. Both approaches would reduce the likelihood of interactions between trawls and deep-sea corals that might damage or remove coral colonies. Option 1/Sub-Option B would eliminate the possibility of gillnet interactions as well. It is difficult to assess the rate of interactions between these gears and corals using presently available data, for reasons noted above. There is a substantial body of evidence suggesting that trawl gears negatively impact corals, but fixed gear effects are not well studied. Trawl bycatch of corals does occur in Jordan Basin, but overall fishery-wide bycatch rates cannot be determined from these limited data.

7.2.7.2 Impacts on managed species and essential fish habitats

Designation of a series of coral protection zones in Jordan Basin is likely to have indirect, positive impacts on managed species, through the conservation of habitats used for shelter, reproduction, and feeding. Similar to the discussion above on the impacts to deep-sea corals themselves, larger areas (Option 1) with more comprehensive gear restrictions (Option 1) will have greater positive impacts, while smaller areas (Option 2) with less-restrictive management approaches (Option 2) will have reduced positive impacts. As discussed above, the seafloor terrain in some parts of Jordan Basin is not well mapped, and the larger Option 1 boundaries may include additional deep-sea coral habitats. However, the smaller Option 2 boundaries do include all known coral sites. Thus, both decisions (which boundaries to adopt and which gears to restrict) are important determinant of the impacts associated with the Jordan Basin zones.

In terms of NEFMC-managed species and lifestages that are associated with seafloor habitats, essential fish habitat designations for various groundfish species, monkfish, and some types of skates have a moderate (25-50% by area) or high (>75% by area) degree of overlap with the Jordan Basin areas. Groundfish and skate species with moderate or high overlap include Acadian redfish, American place, Atlantic wolffish, pollock, white hake, witch flounder, red hake, silver hake, monkfish, smooth skate, and thorny skate. Atlantic cod and spiny dogfish have a lesser degree of overlap (below 25% of the zones, by area). While the extent to which coral habitats increase production of any of these species has not been quantified, many of these species have been observed to occur within coral habitats during scientific surveys. The corals provide habitat for prey species, and also provide shelter from predation and bottom currents.

7.2.7.3 Impacts on human communities

The impacts of the Jordan Basin zones on human communities are expected to be low negative in general, but negative for the fisheries and communities that would be constrained, to the degree that fisheries are constrained. These negative impacts would be additive to the negative fishery impacts of No Action, though the No Action areas do not overlap Jordan Basin and the directly impacted fishermen are likely distinct. As described for other coral zones, should these zones close to fishing, it is difficult to determine if fishermen would be precluded from fishing altogether or if they would be able to shift effort to other areas. The lobster fishery is particularly territorial (Acheson 1987; 2006), such that efforts to shift effort to areas remaining open may be difficult for those displaced by the closures. To the degree that these closures provide habitat for fishery species, there may be long-term benefits to fisheries and society, but these are difficult to project.

The impacts to the fishing industry are expected to be slightly negative, but more negative for Option 1 (closure to all bottom-tending gears) relative to Option 2 (closure to mobile bottom-tending gears only). The fishing effort around Jordan Basin Option 1 and 2 is more diverse than other alternatives in the Gulf of Maine, but lobster fishing is still the predominant activity based on all relevant metrics. Both the VTR and VMS analysis indicates that Option 2 (or, Option 1 with Sub-option B) mitigates a substantial portion of the impact on fishermen, when compared to Option 1. Nevertheless, the analysis suggests that even Option 1 would be expected to generate relatively low impacts.

The sociocultural impacts associated with the Jordan Basin coral zones are expected to be negative for fishermen and fishing communities, and negative relative to No Action. With effort shifts, conflicts within or between fisheries would have a negative impact on the *Non-Economic Social* aspects and the *Attitudes, Beliefs, and Values* of fishery participants. Establishing the zone may change the *Social Structure and Organization* of communities as well as *Historical Dependence on and Participation* in the fishery by individuals and communities. On the other hand, deep-sea corals have cultural value to society, so affording them protection has positive impacts on the *Attitudes, Beliefs, and Values* of stakeholders towards management.

7.2.7.3.1 Potentially affected fisheries

The Jordan Basin coral zones encompass a relatively small fraction of the basin overall, and certainly of the Gulf of Maine as a whole. VTR and VMS data are the primary sources used to characterize current effort and revenue earned from fishing at these sites. Due to data limitations, it is impossible to know the true amount of fishing activity that has occurred within the Jordan Basin zones.

VTR analysis

Vessel Trip Report data were used to estimate recent (2010-2015) fishing activity within the Jordan Basin coral zones. With the exception of lobster trap revenues, which were expanded to reflect the estimated fraction of Area 3 lobster revenues accounted for in the VTR data (method explained in section 7.1.3), these results were unscaled. Maps of revenue by gear type and species are in Appendix F.

Revenue by gear type: Between 2010 and 2015, revenue attributed to the four Option 1 Jordan Basin zones combined ranged between $100K-$180K, averaging $130K annually (Figure 81), generally increasing through the time series. The revenue attributed to fishing with mobile bottom-tending gear from this zone is about 53% of the total, or $70K annually. Fixed gear fishing revenue has been attributed primarily to lobster pot gear, with smaller amounts of revenue from sink gillnets. Because no red crab fishing occurs within the Gulf of Maine, fishing gear restriction Option 1 Sub-option A is expected to have no practical management ramifications. Lobster pots use would be allowed under fishing gear restriction Option 1B, mitigating any effects on that fleet, and potentially having a positive effect as the potential for conflicts between lobster pot use and gillnet and trawl use would be eliminated within the zones.

Over the same period, revenue attributed to the four Option 2 Jordan Basin zones combined, ranged from $40K to $70K, averaging $50K (Figure 82), substantially lower than Jordan Basin Option 1, and generally increasing through the time series. The revenue attributed to fishing with mobile bottom-tending gear from this zone is about 52% of the total (Figure 81), or $28K annually. Fixed gear fishing revenue has been attributed primarily to lobster pot gear (exempted under fishing gear restrictions Option 1B and Option 2), with smaller amounts of revenue from sink gillnets (exempted under fishing gear restriction Option 2).

Revenue by species: Unlike the Mt. Desert Rock and Outer Schoodic Ridge areas, where revenues are almost entirely associated with lobster, a substantial fraction of the revenues in the Jordan Basin zones are generated from groundfish (Figure 83). Monkfish and hagfish are also in the top ten species list. Groundfish species include cod, American plaice, witch flounder, haddock, white hake, pollock, and redfish, with plaice, white hake, pollock, and redfish contributing most of the revenue. Lobster are still in the top ten species under Option 1B and Option 2, which would exempt lobster pots from any gear restrictions, albeit at a much lower level, at an average of $4K annually.

For Option 2, the top ten species in terms of revenue generally mirror those of Option 1, with similar proportions across species (Figure 84). Lobster are still in the top ten species under Option 1B and Option 2, which would exempt lobster pots from any gear restrictions, albeit at a much lower level, at an average of $2K annually.

Vessel ownership: The number of vessel owners with revenue attributed to the Jordan Basin coral zone Option 1 averages 42 annually from 2013-2015. For these owners, the contribution of this revenue to their total annual revenue is generally under 0.5% with a few outliers approaching 2% (Figure 85). Fishing gear restriction Option 2 (MBTG only) presents a very similar distribution of exposure at the owner level (Figure 86).

The number of vessel owners with revenue attributed to the Jordan Basin coral zone Option 2 is very similar, averaging 41 annually from 2013-2015. For these owners, the contribution of this revenue to their total annual revenue is generally under 0.2%, with a few outliers approaching 1% (Figure 87). The percent of owner revenue exposed under fishing gear restriction Option 2 (MBTG only) is similar in distribution to that of for all bottom-tending gear (Figure 88).

Trips and permits: The number of trips attributed to the four Option 1 areas averages 623 per year. The number of trips using lobster traps and other types of pots is greater than for trawls. The trips attributed to the four Option 1 areas were associated with 60-70 permits annually, including roughly 30-40 trawl permits, 20 lobster and other pot permits, and 10 gillnet permits. The number of trips attributed to the Option 2 areas averages 486 per year. The number of trips using lobster traps and other types of pots is greater than for trawls. The trips attributed to the four Option 2 areas were associated with an average of 66 permits annually, including an average of 38 trawl permits, 19 lobster and other pot permits, and 8 gillnet permits. The lobster trip and permit data are not expanded like the lobster revenue data, so estimates could be low.

VTR vs. VMS comparison

As for other coral zones evaluated in this amendment, the majority of trawl gear VTR trips in this area have associated VMS data. The VMS analysis represents modeled fishing effort at a much more refined scale than VTR, and for bottom trawl, the VMS analysis is preferred to the VTR for assessing fishing effort in this region. For lobster pot and sink gillnets, the very low level of VMS coverage (0-4% for Option 1 VTR trips, 0-3% for Option 2 VTR trips) would likely result in spatial bias when extrapolating the VMS results. For these gears, VTR represents the best available estimates of fishing activity in the vicinity of Jordan Basin.

Option 1: For the four Option 1 areas, a high percentage (83-88%) of VTR trawl gear trips have VMS data from the years 2010-2012. Only 25-40% of bottom-trawl permits and 15-35% of trips identified in the VTR analysis have VMS points inside the four Jordan Basin zones. The percentage of annual permit-level revenue estimated to fall within the Jordan Basin zone (Figure 89 all BTG, Figure 90 MBTG only) indicates that most permit-holders fish within this region only sparingly, with less than 1% of VMS-derived effort falling within this region. This is consistent with the VTR-derived estimates of ownership revenue (Figure 85 all BTG, Figure 86 MBTG only). However, there are a small number of permits with up to 6% of their total effort in the area (Figure 89 all BTG, Figure 90 MBTG only), which is slightly higher than the upper bound of the percent of owner revenue from VTR data. These results likely indicate a mismatch between the spatial precision of the VTR data and the size of the areas being considered within the Jordan Basin coral zones.

Option 2: For Option 2, the percent of VTR trips with VMS data in 2010-2012 is high for trawl gear (83-89%). Only 8-20% of bottom-trawl permits and 18-43% of trips identified in the VTR analysis and covered by VMS have VMS points in the Jordan Basin zones. The percentage of annual permit-level effort estimated to fall within the Jordan Basin Option 2 zones (Figure 91) indicates that most permit-holders fish within this region only sparingly, with less than 1% of VMS-derived effort falling within this region. This is consistent with the VTR-derived estimates of ownership revenue (Figure 82 all BTG, Figure 84 MBTG only). However, there are a small number of permits with up to 6% of their total effort in the area encompassed by zone Option 2 (Figure 91 all BTG, Figure 92 MBTG only), which is slightly higher than the upper bound of the percent of owner revenue detailed in Figure 85, based on VTR data. As for Option 1, these results likely indicate a mismatch between the spatial precision of the VTR data and the size of the areas being considered within the Jordan Basin coral zones.

For both Option 1 and Option 2, these exposure levels are quite low and expected to have slightly negative to neutral impacts on individuals fishing within the region.

NEFMC workshops

The industry input from the NEFMC coral workshops was that trawl, gillnet, and lobster trap fisheries are all active within the Jordan Basin zones under consideration, which is consistent with the VTR analysis. Unlike the zones on the southern flank of Georges Bank, there is not a particular depth below which fishing does not occur; the zones are fished extensively throughout. Industry members felt that the revenues attributed to these zones from the VTR analysis seemed too low (NEFMC 2017).

Workshop participants discussed the problems associated with adjusting effort in the lobster fishery in response to a closure. Shifting effort into open areas that are already heavily fished may be difficult for displaced fishermen., Conflicts have caused fishermen to develop agreements over time about sharing fishing grounds. Because the lobster fishery is so territorial, a specific area may only be fished by one or two lobstermen (NEFMC, 2017), an observation consistent with Acheson (2006). The VTR analysis indicates that there are a small number of vessel owners that are particularly dependent on the areas under consideration (Figure 85).

In terms of gears fished and species targeted, industry attendees indicated that the trap fishery targets lobster, and trawl and gillnets are used to target groundfish. Both lobster and groundfish, as well as monkfish, are in the top ten species ranked by landed revenue that the VTR analysis attributed to the Jordan Basin zone (Figure 83, Figure 84; NEFMC, 2017).

Figure 81 – VTR-derived revenue by gear type attributed to Jordan Basin Option 1, 2010-2015.

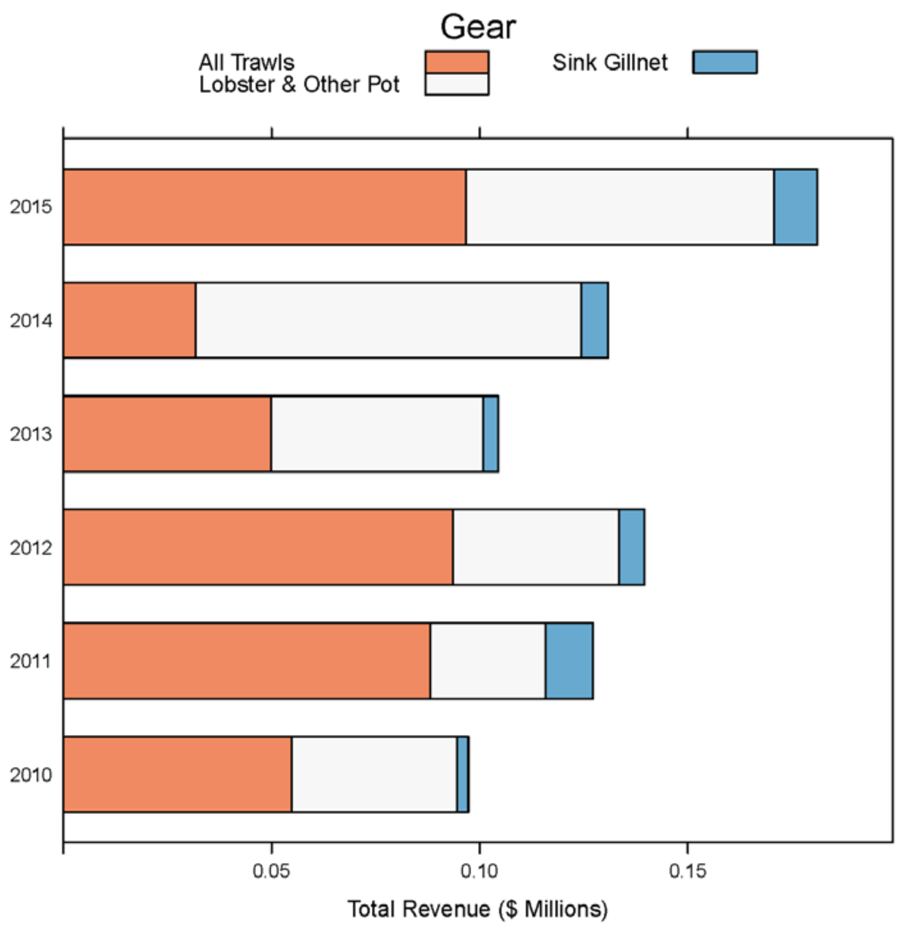


Figure 82 – VTR-derived revenue by gear type attributed to Jordan Basin Option 2, 2010-2015.

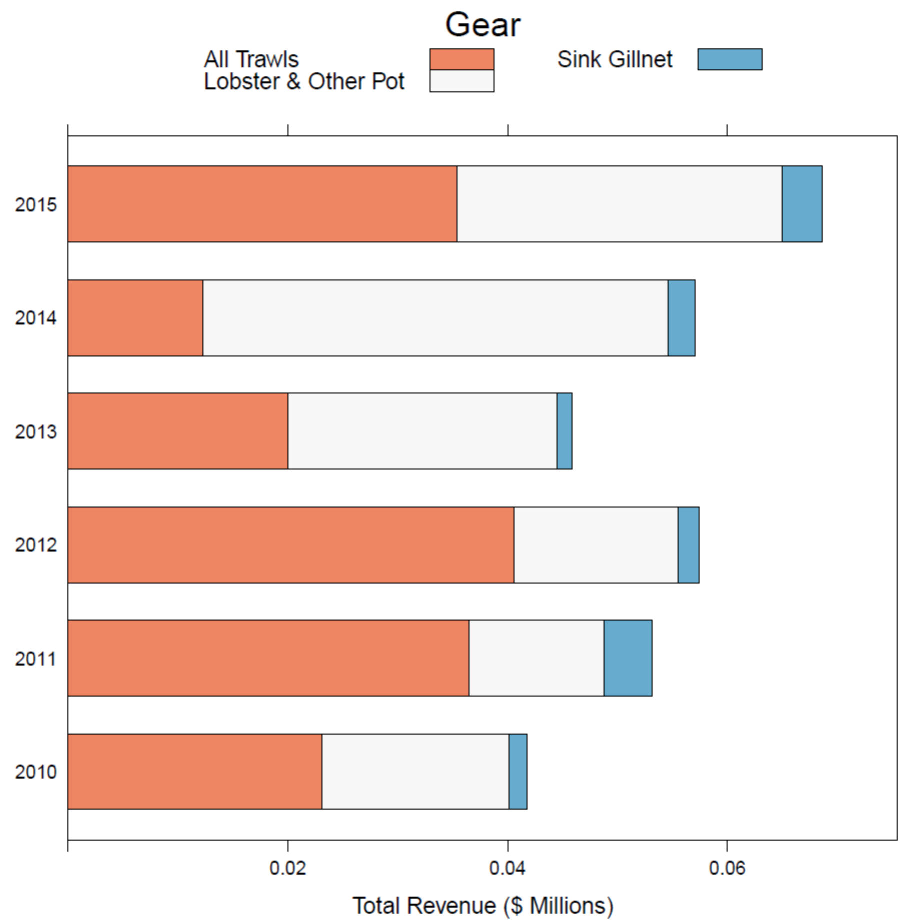


Figure 83 – VTR-derived revenue by species (top 10) attributed Jordan Basin Option 1, 2010-2015.

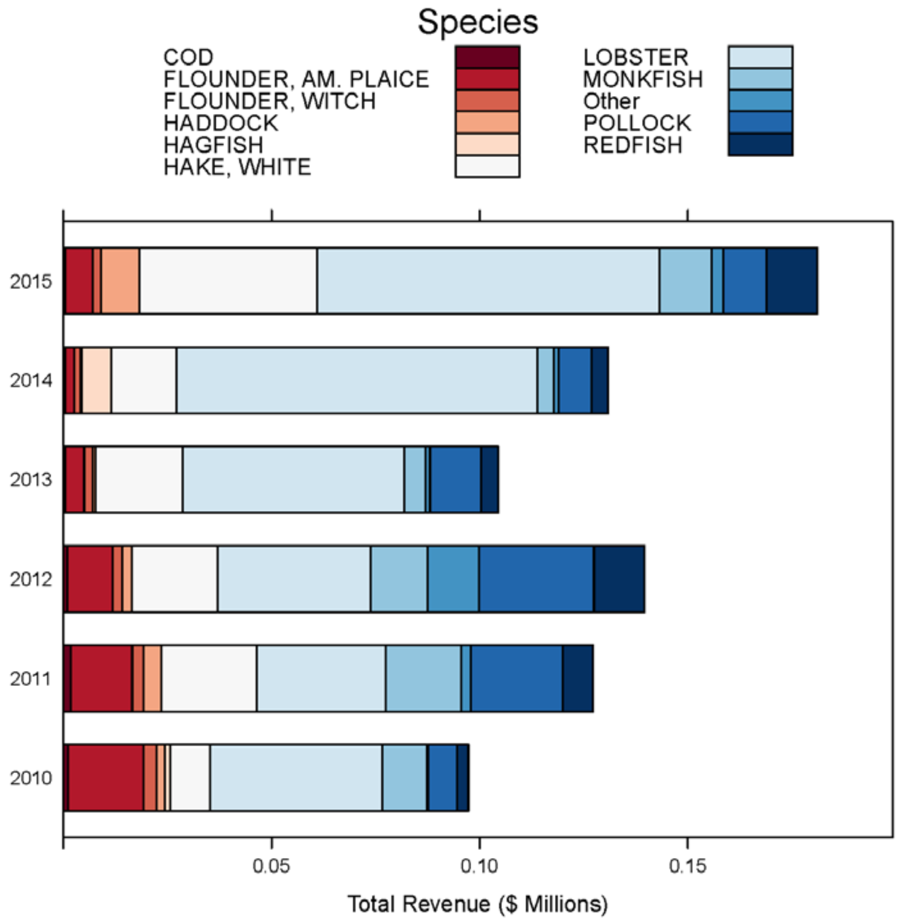


Figure 84 – Revenue by species (top 10) attributed to the four Jordan Basin coral zones Option 2, 2010-2015, as derived from VTR.

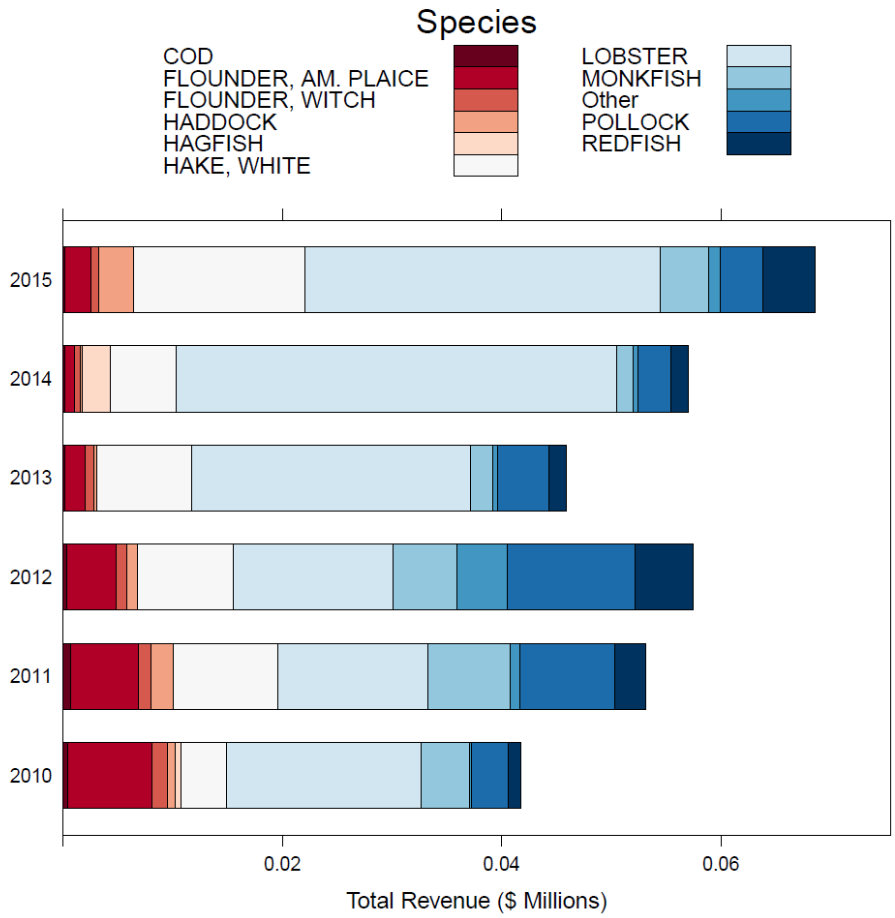


Figure 85 – Percent of vessel owner revenue attributed to the four Jordan Basin coral zones Option 1, 2013-2015, as derived from VTR.

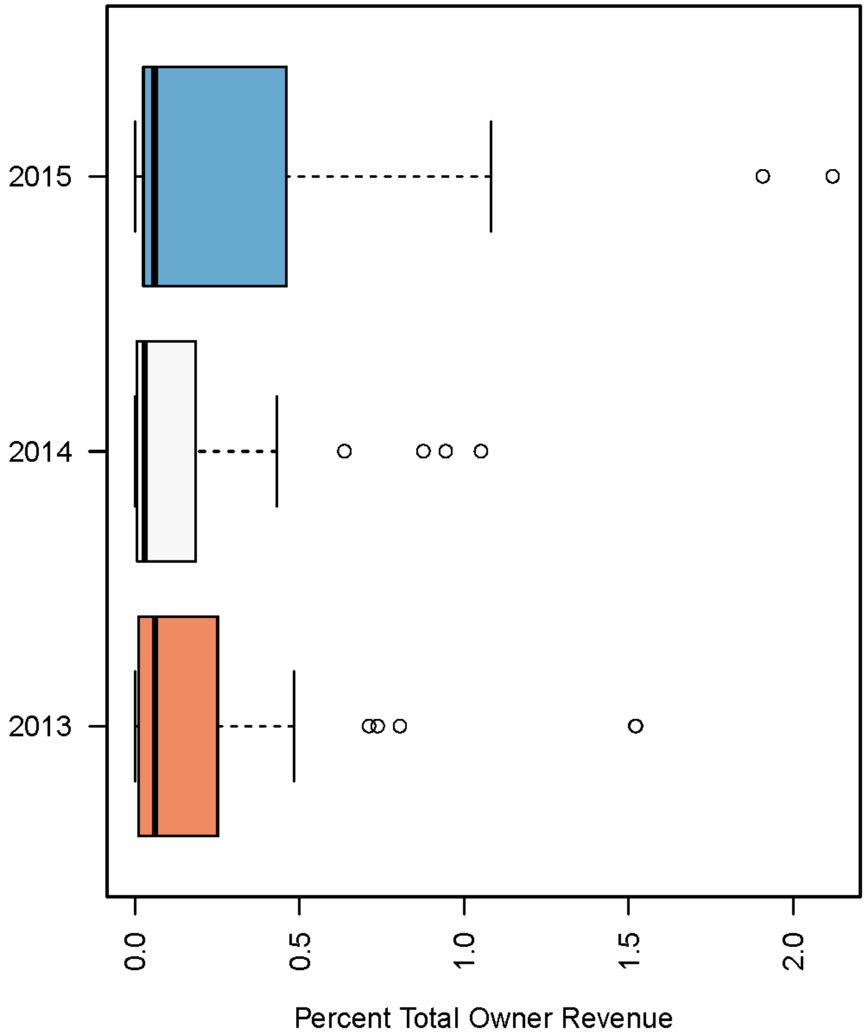


Figure 86– Percent of vessel owner revenue attributed to MBTG within the four Jordan Basin coral zones Option 1, 2013-2015, as derived from VTR.

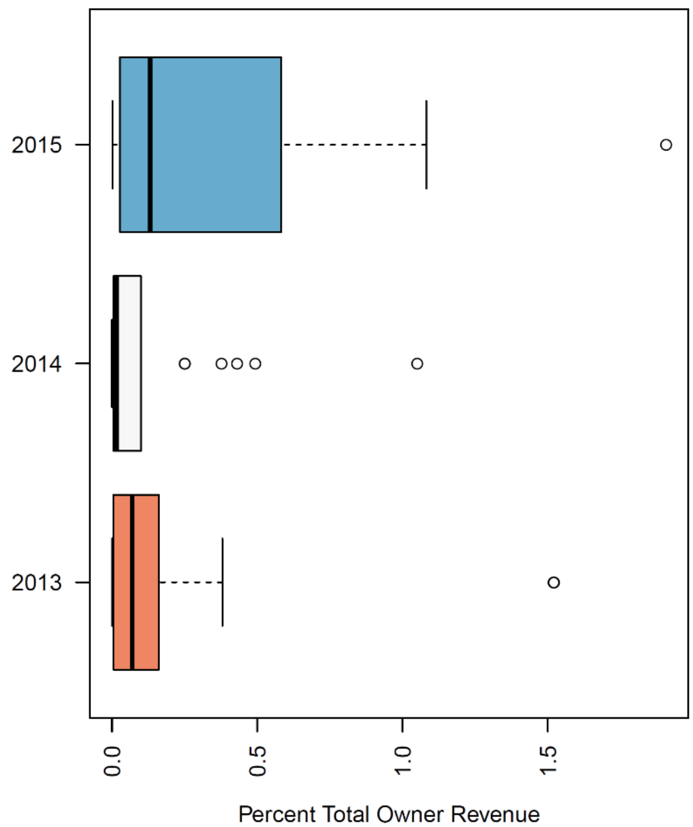


Figure 87 – Percent of vessel owner revenue attributed to the four Jordan Basin coral zones Option 2, 2013-2015, as derived from VTR.

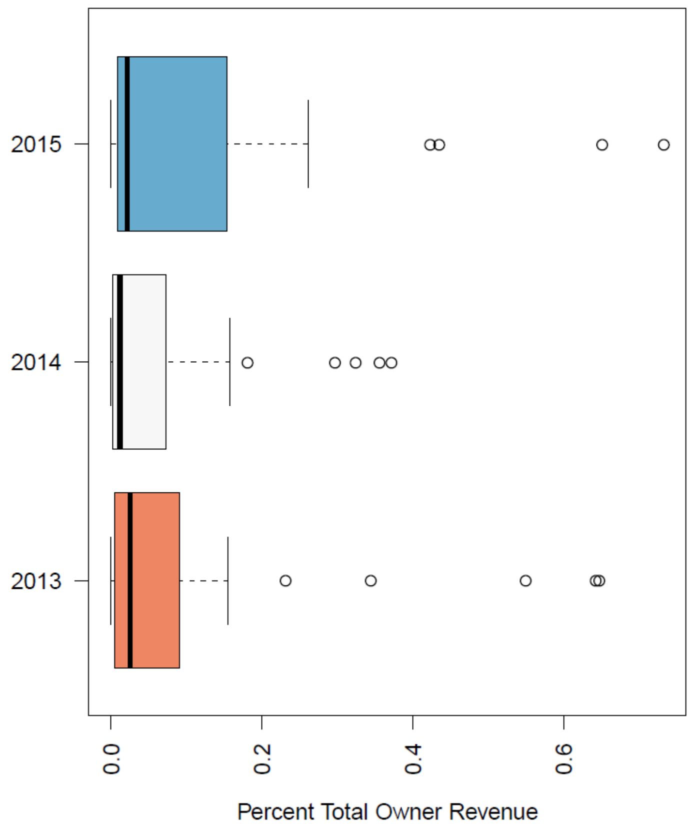


Figure 88 – Percent of vessel owner revenue attributed to MBTG within the four Jordan Basin coral zones Option 2, 2013-2015, as derived from VTR.

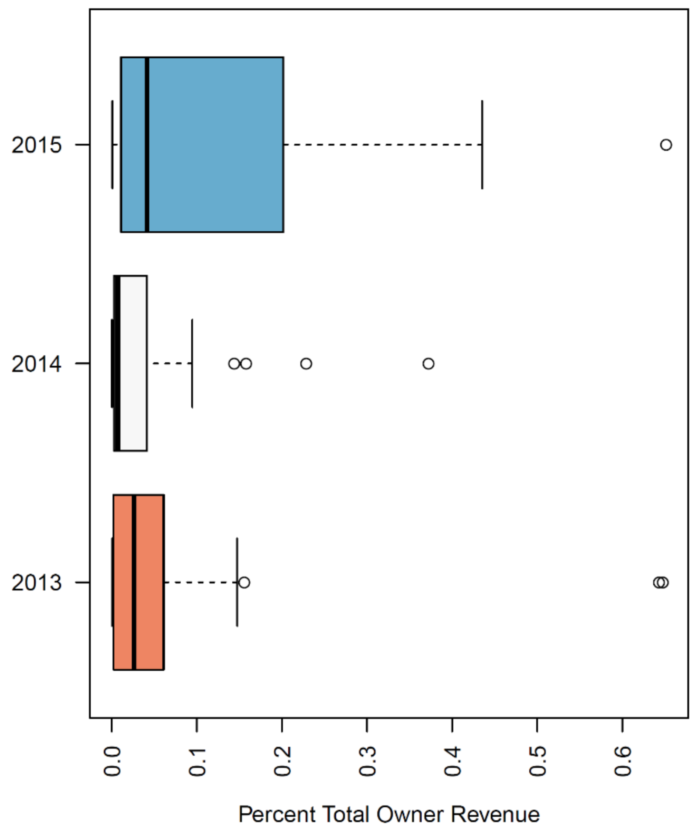


Table 87 – VMS derived estimates of effort attributed to the Jordan Basin coral zones.

Zone	Gear	Year	Hours Fished	Permits	Trips
Jordan Basin Option 1	otter	2005	113.96	16	50
	otter	2006	104.10	19	55
	otter	2007	136.23	18	65
	otter	2008	58.88	12	42
	otter	2009	114.55	17	60
	otter	2010	25.42	8	19
	otter	2011	226.51	16	59
	otter	2012	201.79	15	63
	sca-la	2005	-	1	-
	sca-la	2007	-	1	-
	trap	2005	-	1	-
	trap	2006	-	1	-
	trap	2008	-	1	-
	trap	2009	-	1	-
Jordan Basin Option 2	otter	2005	24.11	11	20
	otter	2006	35.54	10	27
	otter	2007	53.64	15	36
	otter	2008	27.13	9	17
	otter	2009	43.35	13	26
	otter	2010	9.32	5	10
	otter	2011	107.01	12	41
	otter	2012	91.04	11	39
	sca-la	2005	-	1	-
	sca-la	2007	0	0	0
	trap	2005	0	0	0
	trap	2006	0	0	0
	trap	2008	-	1	-
	trap	2009	-	1	-

Figure 89 – VMS-derived effort attributed to Jordan Basin Option 1, as a percent of all of a permit's annual effort.

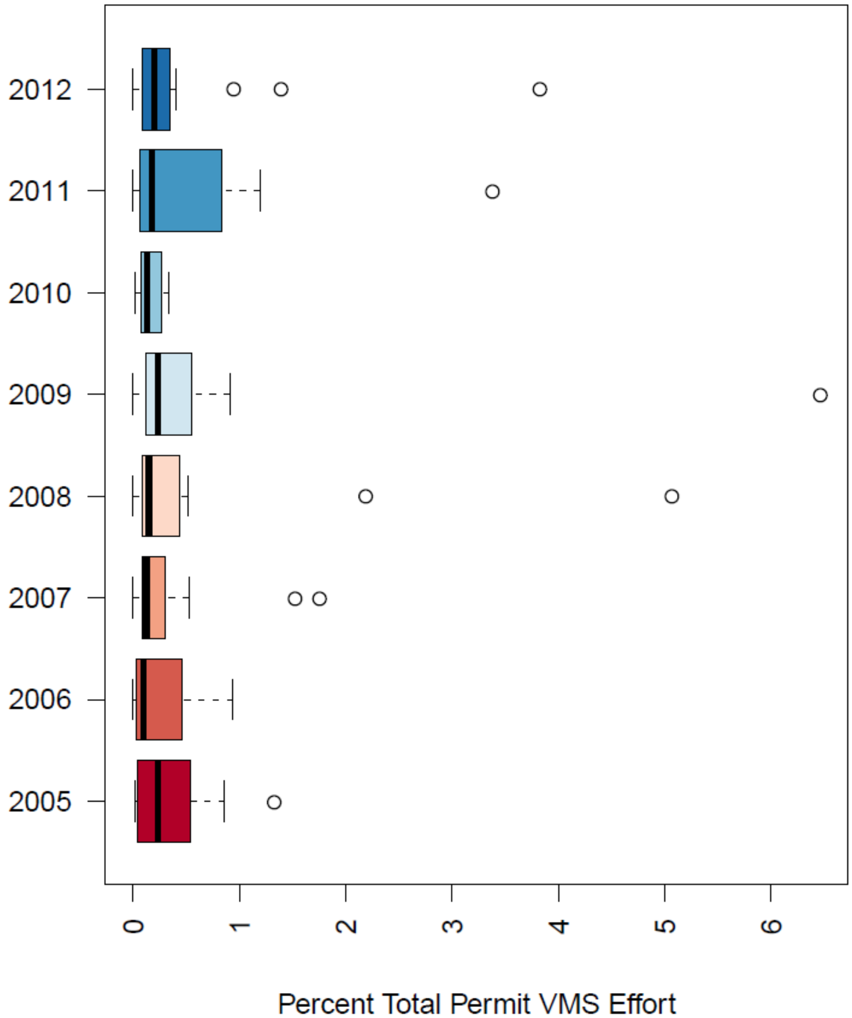


Figure 90 – VMS-derived effort attributed to MBTG within Jordan Basin Option 1, as a percent of all of a permit's annual effort.

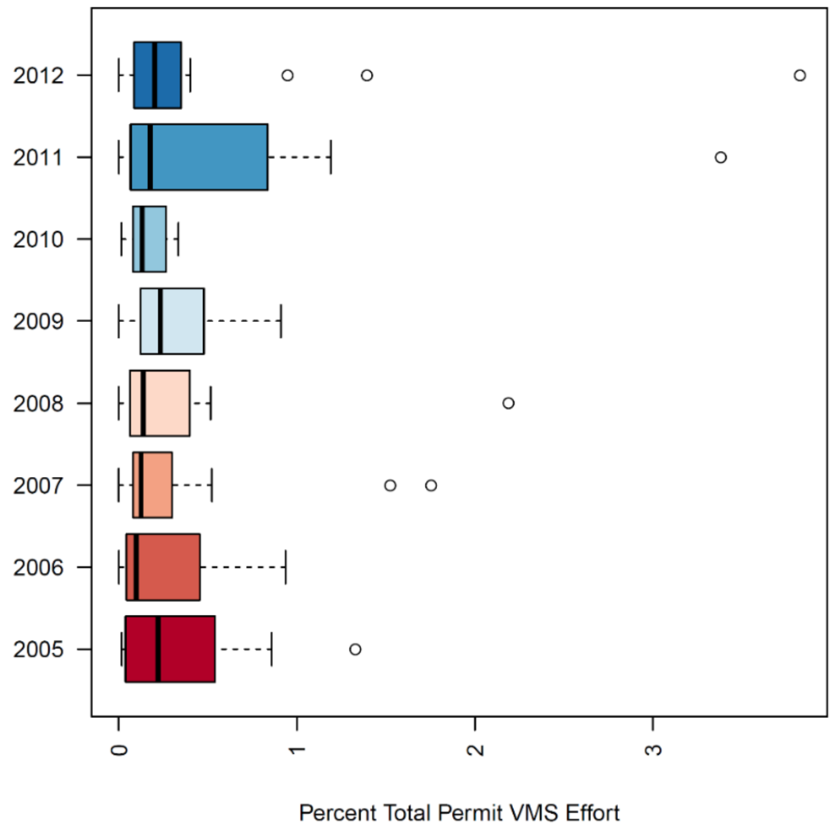


Figure 91 - VMS-derived effort attributed to Jordan Basin Option 2, as a percent of all of a permit's annual effort.

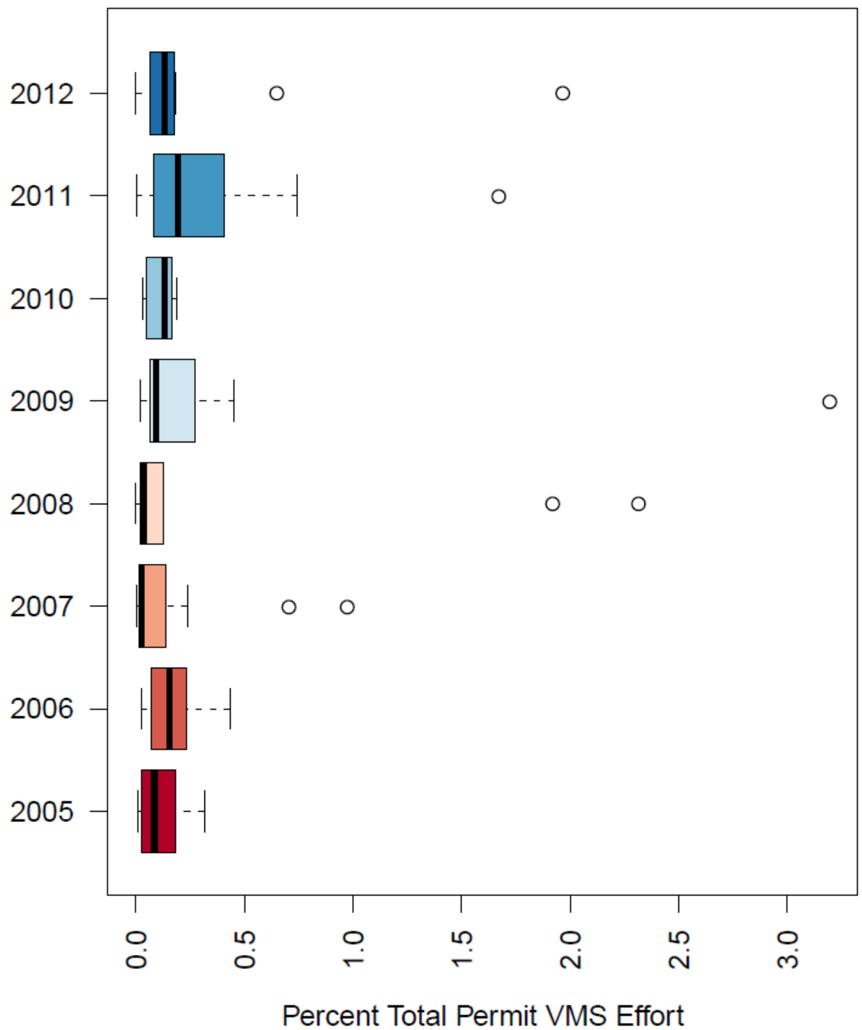
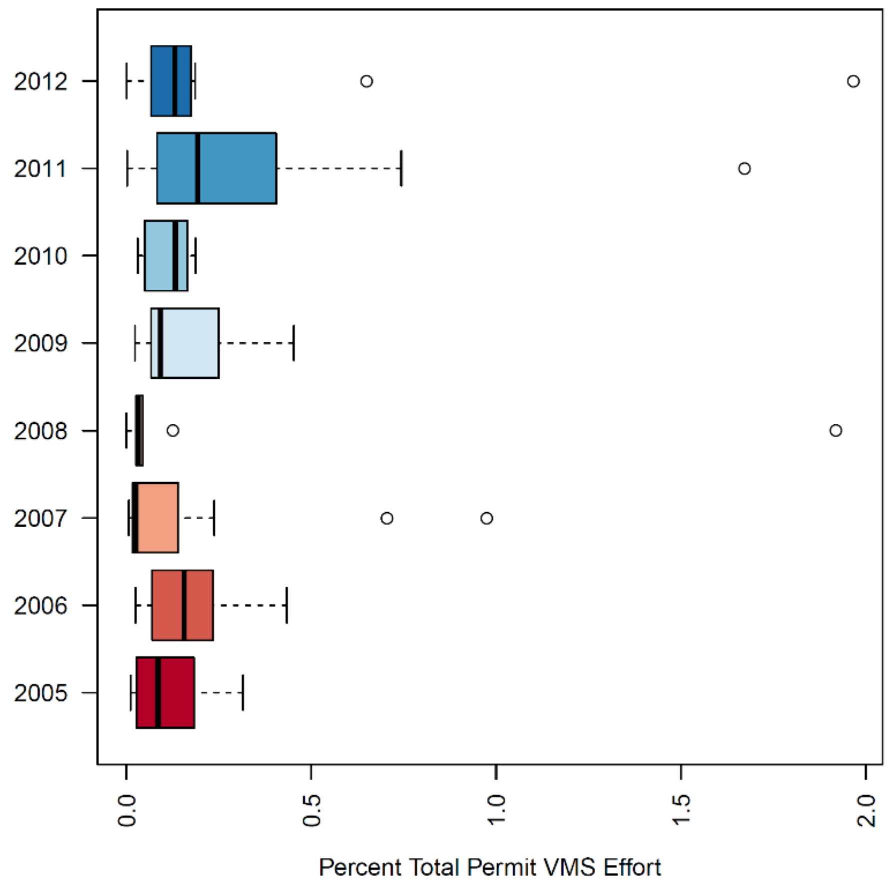


Figure 92 – VMS-derived effort attributed to MBTG within Jordan Basin Option 2, as a percent of all of a permit's annual effort.



7.2.7.3.2 Potentially affected fishing communities

General community impacts of the alternatives under consideration are described in section 7.1.3, which also describes the method, caveats, and data confidentiality standard used to develop Table 88 and Table 89, and the revenue attributed (using the VTR analysis) to recent fishing within the Jordan Basin coral zone options.

The VTR analysis indicates that for each of the Jordan Basin zone options considered, New Bedford and Gloucester, Massachusetts and Portland, Maine are among the top landing ports that may be impacted. According to the NMFS Community Vulnerability Indicators, the commercial fishing engagement indicator is high for Gloucester, Portland, and New Bedford (Table 30). Of these three communities, New Bedford and Gloucester rank highest in terms of reliance on commercial fishing, with a medium index, while Portland ranks lowest, with a low index.

Option 1 zone boundary

The VTR analysis suggests that the fishing communities that may be impacted by the Jordan Basin zone Option 1 are primarily located in Massachusetts, with lesser activity attributed to ports in New Hampshire, Maine, and Rhode Island (Table 88, Table 89). The VTR analysis attributes recent landings revenue to 27 ports and 133 permits, and 52% of this revenue to ports in Massachusetts. Gloucester (41 permits), Portland (31 permits), and New Bedford (25 permits) are among the top ten landing ports. As 49% of the revenue is attributed to other ports, this zone is also important to fishermen landing in other locations.

The revenue attributed to Massachusetts and New Hampshire from the Jordan Basin coral zone Option 1 is about 0.01% and 0.19% of all revenue, respectively, for these states during 2010-2015 (ACCSP 2017). Though these are small fractions, certain individual permit holders could have as much as 2% of their revenue attributed to fishing from this area (Figure 85, Figure 86).

Table 88 – Landings revenue to states, regions, and top ports attributed to fishing within the Jordan Basin coral zone Option 1, 2010-2015, all BTG.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
ALL BOTTOM TENDING GEARS			
Maine	$85K	$14K	58
Portland	$67K	$11K	31
Port Clyde	$9K	$1K	7
Stonington	$3K	$0.5K	3
Other (n=16)	$6K	$1.5K	22
New Hampshire	$269K	$45K	16
Portsmouth	$8K	$3K	9
Massachusetts	$408K	$68K	77
Gloucester	$304K	$51K	41
New Bedford	$31K	$5K	25
Other (n=2)	$73K	$12K	22
Rhode Island	$18K	$3K	4
Total	**$780K**	**$130K**	**133**
MBTG ONLY			
Maine	$31K	$5.2K	27
Portland	$27K	$4.6K	19
Port Clyde	$3.4K	$0.6	5
Other (n=4)	$0.6K	$0.0K	5
Massachusetts	$384K	$64K	63
Gloucester	$294K	$49K	29
New Bedford	$17K	$2.8K	22
Other (n=1)	$0.1K	$0.0K	1
Total	**$415K**	**$69K**	**78**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
"Eastern" = ports from Lubec to Verona Island
"Mid-Coast" = ports from Stockton Springs to Brunswick
"Southern" = ports from Freeport to Kittery
Source: VTR analysis.

Option 2 zone boundary

The VTR analysis suggests that the fishing communities that may be impacted by the Jordan Basin zone Option 2 are primarily located in Massachusetts, with lesser activity attributed to ports in New Hampshire, Maine, and Rhode Island (Table 89). The VTR analysis attributes recent landings revenue to 28 ports and 133 permits, and 51% of this revenue to ports in Massachusetts. Gloucester (42 permits), Portland (31 permits), and New Bedford (25 permits) are among the top ten landing ports. As 49% of the revenue is attributed to other ports, this zone is also important to fishermen landing in other locations.

The revenue attributed to Massachusetts and New Hampshire from the Jordan Basin coral zone Option 2 is minor for these states during 2010-2015 (ACCSP 2017). However, certain individual permit holders could have as much as 2% of their revenue attributed to fishing from this area (Figure 87, Figure 88).

Table 89 – Landings revenue to states, regions, and top ports attributed to fishing within the Jordan Basin coral zone Option 2, 2010-2015, all BTG.

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Maine	$32K	$5K	58
Portland	$25K	$4K	31
Port Clyde	$2K	$0.3K	7
Stonington	$3K	$0.3K	3
Other (n=16)	$2K	$0.4K	22
New Hampshire	$118K	$20K	15
Portsmouth	$3K	$0.4K	8
Massachusetts	$166K	$28K	76
Gloucester	$126	$21K	42
New Bedford	$13K	$2K	25
Other (n=2)	$27K	$5K	21
Rhode Island	$8K	$1K	4
Total	**$324K**	**$54K**	**133**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
"Eastern" = ports from Lubec to Verona Island
"Mid-Coast" = ports from Stockton Springs to Brunswick
"Southern" = ports from Freeport to Kittery
Source: VTR analysis.

7.2.7.4 Impacts on protected resources

The protected resources potentially affected by this amendment are described in section 6.9.2, and the potential for interactions between these species and fishing gears are described in section 6.9.3. Trap, bottom trawl, and to a lesser extent (<10% of revenue), gillnet, account for nearly all of the revenue attributed to the offshore Gulf of Maine coral zones, including those in Jordan Basin (Figure 81, Figure 82). Closure of either the Option 1 or the Option 2 zones to all bottom-tending gears (Option 1), just mobile bottom-tending gears (Option 2), or all bottom-tending gears with a lobster trap exemption (Option 1, Sub-Option B) is expected to have redistributional effects in terms of where fishing gears are deployed.

It is unlikely that fishing effort would increase in response to coral zone designations. Because these zones are small relative to the scale of the fishing grounds in the offshore Gulf of Maine, it also seems unlikely that designating coral zones would cause a substantial decline in effort. Thus, we assume that that effort will be maintained at similar levels, but redistributed locally, within Jordan Basin, in areas near the designated zones. Similar to the inshore Gulf of Maine zones, closures could thus have the effect of concentrating effort spatially, perhaps near the coral zone boundaries.

Because any displaced effort is expected to be redistributed within the offshore Gulf of Maine in the vicinity of the coral zones (see discussion in section 7.1.4), impacts will be limited to protected species occurring in this area (Table 90). Species listed in Table 39 that do not occur in this location are unlikely to experience differences in interaction rates relative to current conditions. Coral zone designations in Jordan Basin are not a preferred alternative.

Table 90 – Occurrence of protected resources in the offshore Gulf of Maine (overlapping Jordan Basin and Lindenkohl Knoll coral zones)

Species grouping	May occur in the inshore Gulf of Maine
Large whales	North Atlantic right whale, sei whale, humpback whale, fin whale, minke whale, sperm whale
Small cetaceans	Short-beaked common dolphin, Atlantic white sided dolphin, pilot whales, Risso's dolphin, harbor porpoise.
Pinnipeds	None; all primarily nearshore, coastal species
Turtles	Green, loggerhead, Kemp's ridley, and leatherback
Fishes	Atlantic salmon
Sources: http://seamap.env.duke.edu/, https://www.nefsc.noaa.gov/psb/surveys/; https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region; NMFS NEFSC FSB (2018)	

7.2.7.4.1 Large whales

Bottom trawl, gillnet, and trap gears are used in and around the coral zones. It is unlikely that fishing effort with any of these gears would increase in response to coral zone designations. Because these zones are small relative to the scale of the fishing grounds in the offshore Gulf of Maine, it also seems unlikely that designating coral zones would cause a substantial decline in effort. Thus, we assume that effort will be maintained at similar levels, but redistributed locally, within Jordan Basin, in areas near the designated zones. Similar to the inshore Gulf of Maine zones, closures could have the effect of concentrating effort spatially, perhaps near the coral zone boundaries. In terms of lobster trap fishing, industry members indicated that transitional areas between very complex bottom and softer bottom were the best locations to catch lobsters (see workshop report, NEFMC 2017). The coral zones include complex, rocky habitats, so it seems plausible that gear could be set along the edges of the coral zones.

Bottom trawl gear poses little to no interaction risk to any large whale species. Other than minke whales, there have been no observed or documented interactions between trawls and large whales (see section 6.9.3.1.1 for details and rationale). From 2008-2015, estimated annual mortality attributed to the northeast bottom trawl fishery went from 7.8 to zero minke whales (see section 6.9.3.1.1). Based this information, while bottom trawl effort could become somewhat concentrated in the areas around the Jordan Basin coral zones, given bottom trawl gear poses no interaction risk to North Atlantic right, humpback, fin, and sperm whales, and a low interaction risk to minke whales, these changes in effort are expected to have a neutral to slight negative effects on large whales.

Gillnet and trap/pot gears, specifically, the vertical lines associated with these gear types, pose the greatest entanglement risk to large whales (see section 6.9.3.1.1). Pot gear, and to a lesser extent, gillnet gear, is used in and around the Jordan Basin coral zones (see section 6.9.3.1.1). Therefore, the mechanism for a change in interaction rates in this region would be that vertical line density would increase, and thereby be more difficult for whales to avoid as they utilize the offshore Gulf of Maine for feeding or other activities. Because the Jordan Basin coral zones are small, changes to fishing effort distributions associated with their designation would likely have only slight negative consequences for interaction rates with large cetaceans.

Strategies developed outside the fishery management plan process serve to reduce the likelihood of gear interactions with large whales. As described in section 6.9.3.1.1, the Atlantic Large Whale Take Reduction Plan provides regulatory and non-regulatory measures to reduce the risk of serious injury and mortality caused by accidental entanglement in trap/pot and gillnet gear.

Given the discussion above about potential shifts in effort, the small size of potential coral zones, and that ALWTRP measures are already in place to reduce serious injury and mortality, the impacts of any of these alternatives on large whales are expected to be negative to slightly negative. The larger zones with more effort restrictions (i.e. zone Option 1, fishing restriction Option 1) would be expected to have a greater magnitude of impacts as compared to smaller zones with lesser restrictions (i.e. zone Option 2, fishing restriction Option 2).

7.2.7.4.2 Small cetaceans

Small cetacean interactions with pots and traps are discussed in section 6.9.3.1.2. Direct observations of fishing with trap/pot gear are limited, so interaction information for small cetaceans with trap/pot gear is partly inferred from evidence of gear on stranded animals.

These stranding data suggest that trap/pot interaction rates with small cetaceans are low. Given these low interaction rates, impacts on small cetaceans of designating the Jordan Basin coral zones (either boundary option) as a closure to lobster pot gear are expected to be slight negative, regardless of potential shifts in lobster pot fishing effort.

Small cetaceans are at risk of interacting with sink gillnet and bottom trawl gear (see section 6.9.3.1.2). In terms of bottom trawl gear and species expected to occur in the offshore Gulf of Maine, Atlantic white-sided dolphins and short-beaked common dolphins are the most frequently observed bycaught small cetacean species in the Greater Atlantic Region, followed by long-finned pilot whales, Risso's dolphins, bottlenose dolphin (offshore), and harbor porpoise (Lyssikatos 2015; Chavez-Rosales et al. 2017). In terms of gillnet gear, harbor porpoises and short beaked common dolphins are the most frequently bycaught small cetacean species in the Greater Atlantic Region (Hatch and Orphanides 2014, 2015, 2016, 2017, 2019). If these gears become more spatially concentrated along the boundaries of coral zones, it could be more difficult for these marine mammals to avoid the gear, and therefore interaction rates could increase. It is difficult to assess the likelihood of gear becoming concentrated along the edges of the coral zones since fishing effort locations are not precisely known at present, nor are the relationships between groundfish catch rates and proximity to coral habitats.

Strategies developed outside the fishery management plan process serve to reduce the likelihood of gear interactions with small cetaceans. There is a take reduction strategy for trawl gears to limit interactions with common dolphins and other cetacean species. Voluntary measures include reducing the numbers of turns made by the fishing vessel and tow times while fishing at night and increasing radio communications between vessels about the presence and/or incidental capture of a marine mammal to alert other fishermen of the potential for additional interactions in the area.

Given the discussion above about potential shifts in effort, the small size of the coral zones, and that measures outside the fishery management plan process are designed to reduce interaction, the impacts of designating coral zones in Jordan Basin are uncertain but could be negative to slightly negative. The smaller Option 2 zones are expected to have fewer impacts on small cetaceans as they would have less of an effect on fishing effort. Because gillnet effort is minor at these sites, and lobster gear is not a major concern in terms of small cetacean interactions, impacts would likely be similar, regardless of gear restriction option.

7.2.7.4.3 Sea turtles

Turtle interactions with pots and traps are discussed in section 6.9.3.2. Leatherback, loggerhead, green, and Kemp's ridley sea turtles are known to interact with trap/pot gear, with interactions primarily associated with entanglement in vertical lines, although sea turtles can also become entangled in groundline or surface systems. If trap gear becomes concentrated in areas outside the Jordan Basin coral zones, this could increase vertical and ground line density. If this increased gear concentration reduced catch rates of the traps, set times could increase. Both a greater concentration of vertical/groundlines and longer set durations could increase interaction rates. Thus, designation of the Jordan Basin coral zones could have negative effects on sea turtles.

Sea turtles are at risk for interaction with both bottom trawl and gillnet gears, as described in section 6.9.3.2. Designation of the Jordan Basin coral zones would be expected to have some effects on the distribution of fishing effort with trawl and gillnet gears, potentially concentrating bottom trawling near the edges of the coral zones. Thus, with respect to these gears, potential negative impacts to sea turtles are expected. These effects are expected to be slight, given that bottom trawl/turtle interactions are less common in New England vs. Mid-Atlantic waters, and that shifts in effort are likely to be relatively minor.

7.2.7.4.4 Atlantic salmon

Atlantic salmon interactions with pots and traps are discussed in section 6.9.3.4. To date, there have been no interactions documented. Atlantic salmon interactions with gillnet and bottom trawl have been observed since 1989; but since 2013, no additional Atlantic salmon have been observed in gillnet or bottom trawl gear (NMFS NEFSC FSB 2015, 2016, 2017, 2018). Based on the above information, specifically the very low number of observed Atlantic salmon interactions in gillnet and trawl gear reported in the Northeast Fisheries Observer Program’s database (which includes At-Sea Monitoring data), interactions with Atlantic salmon are likely rare events (Kocik et al. 2014; NMFS NEFSC FSB 2015, 2016, 2017, 2018). Considering this information, designation of coral zones in Jordan Basin is expected to have neutral to slight negative impacts on Atlantic salmon.

7.2.8 Impacts of the Lindenkohl Knoll coral zone and associated fishing restrictions

This alternative would designate a coral zone at Lindenkohl Knoll, on the western edge of Georges Basin, just north of Georges Bank (section 4.2.2.3.4), with two options for the size of the zones and two options for which gear types would be prohibited from the zone (Table 91). This alternative, which was not preferred by the Council, would have been additive to No Action and could have been selected in combination with other alternatives under consideration.

Table 91 - Fishing restriction options relevant to the Lindenkohl Knoll coral zones

Fishing restriction options	Relevance to LK zones
Option 1: Prohibit all bottom-tending gears	Yes
Sub-option A: Exempt red crab fishery	No[1]
Sub-option B: Exempt other trap fisheries	Yes
Option 2: Prohibit mobile bottom-tending gears	Yes
[1] The red crab fishery is not prosecuted in the Gulf of Maine.	

7.2.8.1 Impacts on deep-sea corals

Deep-sea corals are known to occur at Lindenkohl Knoll based on recent survey work (Table 46, section 6.2.3.3). Two different sets of boundary options are under consideration for Lindenkohl Knoll. Both the larger Option 1 area and the smaller Option 2 areas include all sites where corals have been observed using remotely operated vehicle and towed camera systems. Similar to the Jordan Basin zones, the Option 1 zones are more precautionary, given that the seafloor terrain in Georges Basin is not well understood, and therefore it is difficult to estimate the spatial extent of coral habitats beyond surveyed areas.

Low resolution seafloor terrain data limit the usefulness of the coral habitat suitability model in the Gulf of Maine in general, so the model cannot be used to estimate the extent of coral habitats at Lindenkohl Knoll. While corals are clearly documented at the site with visual surveys, none of the areas are predicted to have a high or very high likelihood of coral presence in the suitability model. This is in contrast to the continental margin, where visual surveys generally confirm the results of model predictions. Given these uncertainties, zones with either the Option 1 or the Option 2 boundaries are expected to have positive impacts on deep-sea corals, but the magnitude of positive impacts is likely greater under Option 1.

In addition to the decision about which boundaries to adopt, the degree to which a coral zone designation at this location would have a positive impact on corals depends on the fishing restriction measures selected. Trawls, lobster traps, and gillnets are all used at Lindenkohl Knoll (see below).

If the Lindenkohl Knoll zone is selected as a closure to all bottom-tending gears (Option 1) the lobster fishery would be excluded from the zone and the likelihood of interactions between lobster gear and corals would be reduced. It is difficult to assess the rate of those interactions, and the extent to which any interactions have negative impacts on corals, given presently available information. While trap gears could crush or remove coral colonies, such effects have not been demonstrated to occur within our region; however, there are observed interactions between trap gear and corals in the Gulf of Maine. Overall, designation of this zone as a closure to all bottom tending gears is expected to have positive impacts on deep-sea corals, but the magnitude of these impacts is difficult to determine.

A mobile bottom-tending gear restriction (Option 2) at Lindenkohl Knoll would have positive impacts on coral habitats. Similar impacts would be expected if the Council selects a restriction on all bottom-tending gears (Option 1) but exempts trap fisheries (Sub-option B). The magnitude of the positive impact is difficult to determine. Both approaches would reduce the likelihood of interactions between trawls and gillnets and deep-sea corals that might damage or remove coral colonies. It is difficult to assess the rate of interactions between these gears and corals using presently available data. There is a substantial body of evidence suggesting that trawl gears negatively impact corals, but fixed gear effects are not well studied. Trawl and gillnet bycatch of corals does occur in and around the site (6.5.3), but fishery-wide bycatch rates cannot be determined from these data, which are limited.

7.2.8.2 Impacts on managed species and essential fish habitats

Designation of a coral zone or series of zones at Lindenkohl Knoll is likely to have indirect, positive impacts on managed species through the conservation of habitats used for shelter, reproduction, and feeding. Similar to the discussion above on the impacts to deep-sea corals themselves, a larger area (Option 1) with more comprehensive gear restrictions (Option 1) will have the greatest magnitude of positive impacts, while smaller areas (Option 2) with less-restrictive management approaches (Option 2) will have a smaller magnitude of positive impacts. As discussed above, the seafloor terrain in the vicinity of Lindenkohl Knoll is not well mapped, and the larger Option 1 boundary may include additional deep-sea coral habitats beyond known occurrences at dive sites. However, the smaller Option 2 boundaries do include all known coral sites. Both decisions (which boundaries to adopt and which gears to restrict) are important determinant of the impacts associated with the Lindenkohl Knoll zone.

In terms of NEFMC-managed species and lifestages that are associated with seafloor habitats, essential fish habitat designations for various groundfish species, monkfish, and some types of skates have a moderate (25-50% by area) or high (>75% by area) degree of overlap with the Lindenkohl Knoll zone. Groundfish and skate species with moderate or high overlap include Acadian redfish, Atlantic wolffish, pollock, white hake, witch flounder, red hake, silver hake, monkfish smooth skate, and thorny skate. Spiny dogfish also occur in the area. While the extent to which coral habitats increase production of any of these species has not been quantified, many of these species have been observed to occur within coral habitats during scientific surveys. The corals provide habitat for prey species, and also provide shelter from predation and bottom currents.

7.2.8.3 Impacts on human communities

The impacts of the Lindenkohl Knoll zone on human communities are expected to be low negative in general, but negative for the fisheries and communities that would be constrained, to the degree that fisheries are constrained. These negative impacts would be additive to the negative fishery impacts of No Action, though the No Action areas do not overlap Lindenkohl Knoll and the directly impacted fishermen may be distinct. It is difficult to determine if fishermen would be precluded from fishing altogether or be able to shift effort to other areas. The lobster fishery is particularly territorial (Acheson 1987; 2006), such that efforts to shift effort to areas remaining open may be difficult for those displaced by the closures. To the degree that these closures provide habitat for fishery species, there may be long-term benefits to fisheries and society, but these are difficult to project.

The impacts to the fishing industry are expected to be slightly negative to negative, but more negative for zone Option 1 relative to zone Option 2. The VMS coverage is adequate to assess fishing effort by VMS for trawl gears, and both Option 1 and Option 2 have relatively substantial levels of effort by this gear within their bounds. Bottom trawl effort in zone Option 1 averages 560 hours a year, with substantial variability across years, and zone Option 2 generally presents one third as much effort in any given year. At the permit level, the effort generally represents less than 5% of total effort expended, although some small number of permit holders have up to 15% of their effort (hours fished) falling within zone Option 1 and 5% within zone Option 2. VMS coverage is insufficient to represent the other gears which VTR suggests are used in the vicinity of Linkenkohl Knoll. Although VTR suggests low exposure at the ownership level across all gear types, the VTR exposure estimates are low for bottom trawl, when compared to VMS. This suggest substantial uncertainty in the VTR-derived exposure estimates.

The sociocultural impacts associated with the Lindenkohl Knoll coral zones are expected to be negative for fishermen and fishing communities, and negative relative to No Action. With effort shifts, conflicts within or between fisheries would have a negative impact on the *Non-Economic Social* aspects and the *Attitudes, Beliefs, and Values* of fishery participants. Establishing the zone may change the *Social Structure and Organization* of communities as well as *Historical Dependence on and Participation* in the fishery by individuals and communities. On the other hand, deep-sea corals have cultural value to society, so affording them protection has positive impacts on the *Attitudes, Beliefs, and Values* of stakeholders towards management.

7.2.8.3.1 Potentially affected fisheries

The Lindenkohl Knoll coral zone encompasses a relatively small fraction of Georges Basin, and certainly of the Gulf of Maine as a whole. VTR and VMS data are the primary sources used to characterized effort and revenue at these sites. Due to data limitations, it is impossible to know the true amount of fishing activity that has occurred within the Lindenkohl Knoll zone.

VTR analysis

Vessel Trip Report data were used to estimate recent (2010-2015) fishing activity within the Lindenkohl Knoll coral zone. With the exception of lobster trap gear, revenue results were unscaled. Because a large number of vessel operators are not required to submit VTRs (their vessels do not carry other federal permits), total lobster revenue was expanded (method explained in section 7.1.3). Maps of revenue by gear type and species are provided in Appendix F.

Revenue by gear: Between 2010 and 2015, revenue attributed to the Lindenkohl Knoll coral zone Option 1 ranged between $170-370K, averaging $290K (Figure 93). The recent revenue attributed to fishing with mobile bottom-tending gear from this zone is about 42% of the total, or $118K annually. In terms of specific gears, revenue is primarily attributed to fishing with trawls and lobster pot gear, with smaller amounts of revenue from scallop gear, clam dredges, separator and Ruhle trawls, and sink gillnets. Given the water depth (200-250 m), it is unlikely that scallop gear and clam dredges gears operate in the area (section 6.7.9), but Georges Basin is located just north of Georges Bank, where both gear types are used to target sea scallops and surfclams. Spatial imprecision in the VTR data ares likely what is causing these revenues to be inferred to the Lindenkohl Knoll zone. The likelihood of fishing with separator and Ruhle trawls as well as sink gillnets can be investigated further using other data sources such as observer and VMS. Across all years included in the analysis, lobster pots are the number one source of revenue, and this gear would be exempted under fishing gear restriction Option 1B and, along with sink gillnets, under Option 2.

Over the same period, revenue attributed to the Lindenkohl Knoll coral zone Option 2 ranged between $40-90K, averaging $70K (Figure 94). The recent revenue attributed to fishing with mobile bottom-tending gear from this zone, and thus affected by fishing gear restriction Options 1 and 2, is about 39% of the total, averaging $29K annually. In terms of specific gears, as with Option 1, revenue is primarily attributed to fishing with trawls and lobster pot gear, the latter of which is exempted under fishing gear restrictions Option 1B and Option 2. Smaller amounts of revenue come from separator and Ruhle trawls and sink gillnets, the latter of which is exempted under fishing gear restriction Option 2. The likelihood of fishing with separator and Ruhle trawls as well as sink gillnets can be investigated further using other data sources such as observer and VMS. Across all years included in the analysis, lobster pots are the number one source of revenue.

Species landed: Similar to the Mt. Desert Rock and Outer Schoodic Ridge areas, revenues attributed to the Lindenkohl Knoll Option 1 are largely associated with lobster (about $150K annually, more in 2015, Figure 95). This is in contrast to the Jordan Basin zones, in which groundfish revenue was more prominent. Data for Option 2 suggests lobster revenues of $40K annually, more in 2015 (Figure 96). For both options, the top ten revenue generating species are similar to those identified at the Jordan Basin zones. In some years, pollock revenues are relatively sizeable (up to $100K). Other groundfish stocks, as well as monkfish and sea scallops, contribute minor amounts of revenue, though shallower water species (e.g., winter flounder, sea scallops) may not actually be landed within the zone. Given that no red crab fishing occurs within the Gulf of Maine, fishing gear restriction Option 1A has no practical impacts on management for Lindenkohl Knoll. Lobster is present in the top ten species landed with MBTG, though averaging only $8K annually, much lower than when pots are considered.

Percent revenue by owner: The number of vessel owners with revenue attributed to the Lindenkohl Knoll coral zone Option 1 averages 99 annually from 2013-2015 (Figure 97). For these owners, the contribution of this revenue to their total annual revenue is generally under 0.5%. A few outlier owners are estimated to generate a larger percentage of annual revenue, to a maximum of about 2.5%, in the zone. Figure 98 indicates that fishing gear restriction Option 2 substantially decreases what exposure exists at the owner level.

The number of vessel owners with revenue attributed to the Lindenkohl Knoll coral zone Option 2 averages 98 annually from 2013-2015 (Figure 99). For these owners, the contribution of this revenue to their total annual revenue is generally under 0.1%. A few outlier owners are estimated to generate a larger percentage of annual revenue, to a maximum of about 0.7%, in the zone. Figure 102 shows percent owner revenue based on the more spatially refined VMS data. These data suggest a slightly greater dependence, but the percentages are still small. Most of the owners have less than 2% revenue in the zones, with occasional higher values between 2-6%. Figure 100 indicates that fishing gear restriction Option 2 substantially decreases what exposure exists at the owner level.

VMS – VTR Comparison

Table 92 presents the VMS coverage for VTR trips occurring in the vicinity of Lindenkohl Knoll coral zone Options 1 and 2. Table 93 presents the VMS effort analysis (hours fished) for Lindenkohl Knoll Options 1 and 2.

For Option 1, although both bottom trawl (averaging 84%) and separator & Ruhle trawl (averaging 66%) have relatively high coverage rates, these rates are much lower than coverage for the same gear south of Georges Bank. VMS coverage rates for Option 2 are similar, with VMS coverage on an average of 84% of bottom trawl trips and 65% of separator and Ruhle trawl trips fishing in the vicinity of Option 2 (Table 92). Though VMS coverage is likely adequate to present general patterns of fishing activity for bottom trawl, separator trawl, and Ruhle trawl trips, the coverage rates suggest higher levels of uncertainty when compared to other alternatives being considered in this amendment. There is no VMS coverage for the other gears for which VTR indicates fishing activity in the vicinity of Lindenkohl Knoll coral zone, meaning that fishing gear restrictions Option 1B and Option 2 cannot be assessed using VMS data.

The analysis suggests that an average of 24% of VTR permits and 19% of VTR trips with VMS coverage in the vicinity of Lindenkohl Knoll have VMS polls falling within coral zone Option 1. The VMS analysis suggests substantial effort within the border of Lindenkohl Knoll, averaging 560 fishing hours a year, although this number fluctuates from year to year. Figure 101 shows the percent of each permit holder's total effort falling within Lindenkohl Knoll coral zone Option 1. The analysis suggests higher exposure rates than suggested by the VTR analysis presented in Figure 97. Nevertheless, the analysis suggests that most individuals present relatively low exposure in most years (< 2% of effort), with some outliers presenting much higher exposure rates (up to 15% of total effort). Of note is that both 2005 and 2008 indicate much more intensive fishing within Lindenkohl Knoll zone Option 1, when compared to other years, indicating some temporal heterogeneity in the use patterns around this zone.

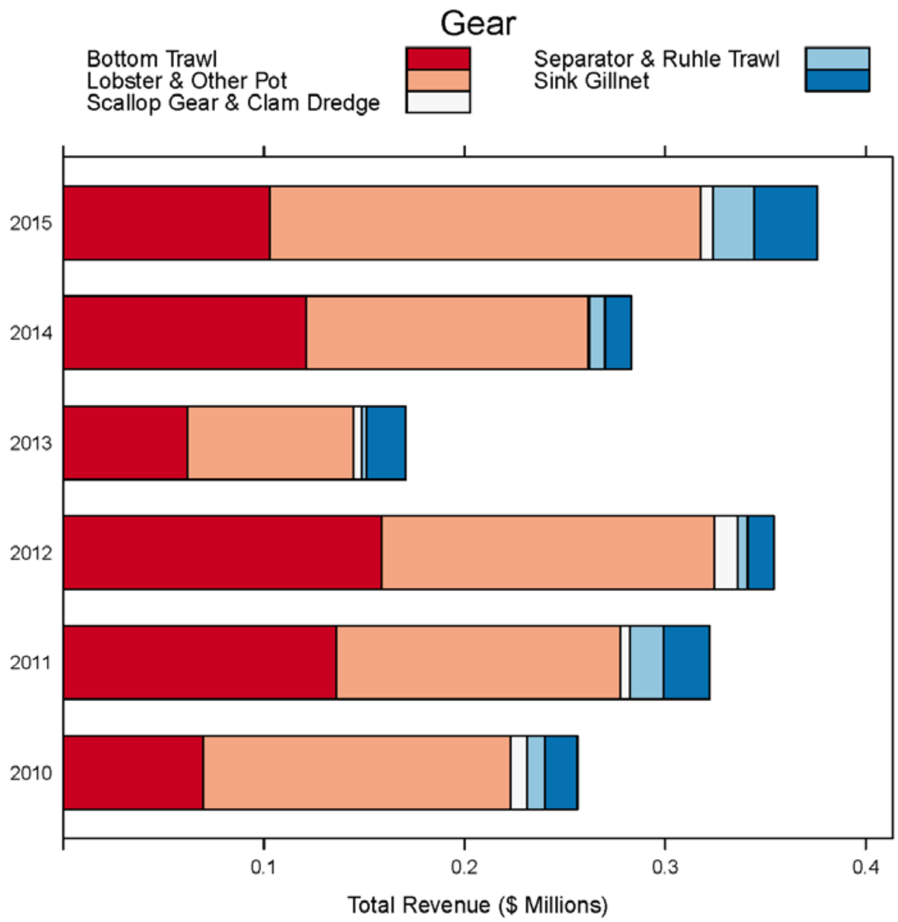
The VMS effort analysis for Lindenkohl Knoll boundary Option 2 indicates substantially lower levels of exposure, averaging 37% of the effort in zone Option 1 (Table 93). This result is also borne out in the permit level estimate of effort exposure presented inFigure 102, with even the highest exposure rates just above 5% of total permit-level effort exerted with gear within the analysis, down from 15% in zone Option 1. The VMS analysis suggests higher exposure rates than the VTR analysis presented in Figure 99. Nevertheless, most permit holders present low levels of exposure, with only a small number of outliers exerting any real effort in the region.

NEFMC workshops

The industry input from the NEFMC coral workshops was that trawl, gillnet, and lobster trap fisheries are all active within the Lindenkohl Knoll zones under consideration. As for the Jordan Basin zones, and unlike the zones on the continental margin south of Georges Bank, there is not a particular depth below which fishing does not occur; the zones are fished extensively throughout. Industry attendees indicated that the revenue attributed to these zones from the VTR analysis seems low (NEFMC 2017). Observations about the potential for redistribution are the same as those noted for the Jordan Basin zones.

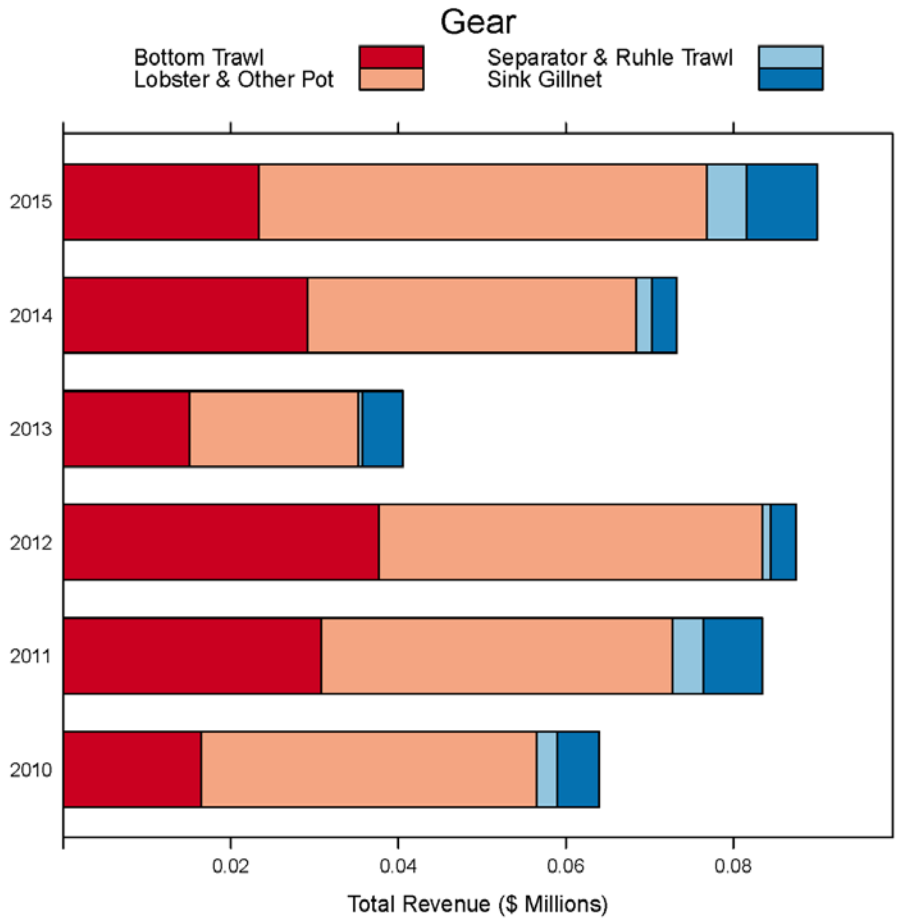
In terms of gears fished and species targeted, the industry attendees indicated that the trap fishery targets lobster, and trawl and gillnets are used to target groundfish. Both lobster and groundfish, as well as monkfish, are in the top ten species by landed revenue that the VTR analysis attributed to the Lindenkohl Knoll zone (Figure 95; NEFMC, 2017).

Figure 93 – VTR-derived revenue by gear type attributed to Lindenkohl Knoll Option 1, 2010-2015.



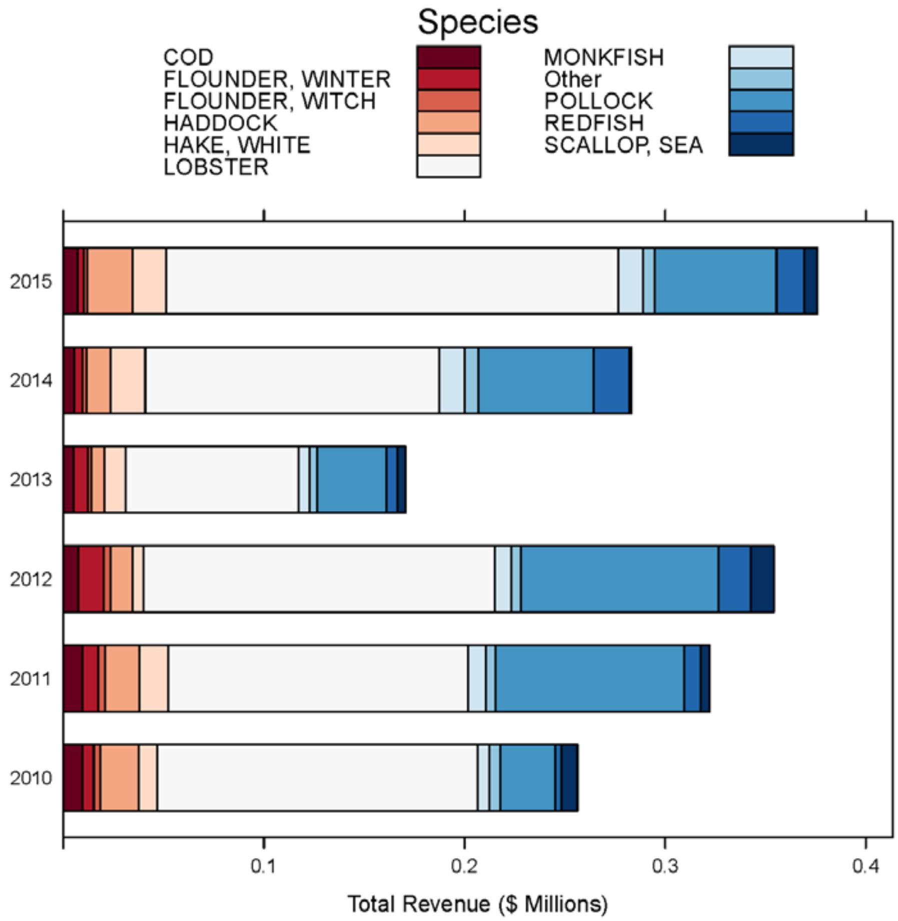
Source: **VTR analysis.**

Figure 94 – VTR-derived revenue by gear type attributed to Lindenkohl Knoll Option 2, 2010-2015.



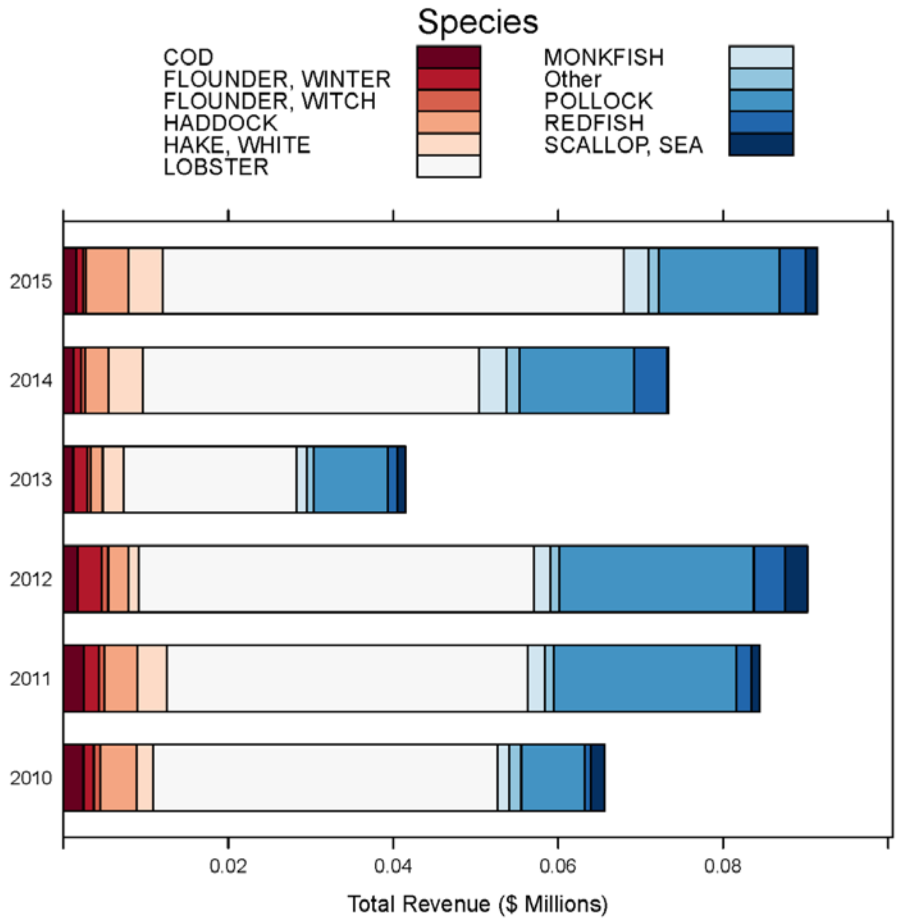
Source: **VTR analysis.**

Figure 95 – Revenue by species (top 10) attributed to the Lindenkohl Knoll coral zone Option 1, 2010-2015.



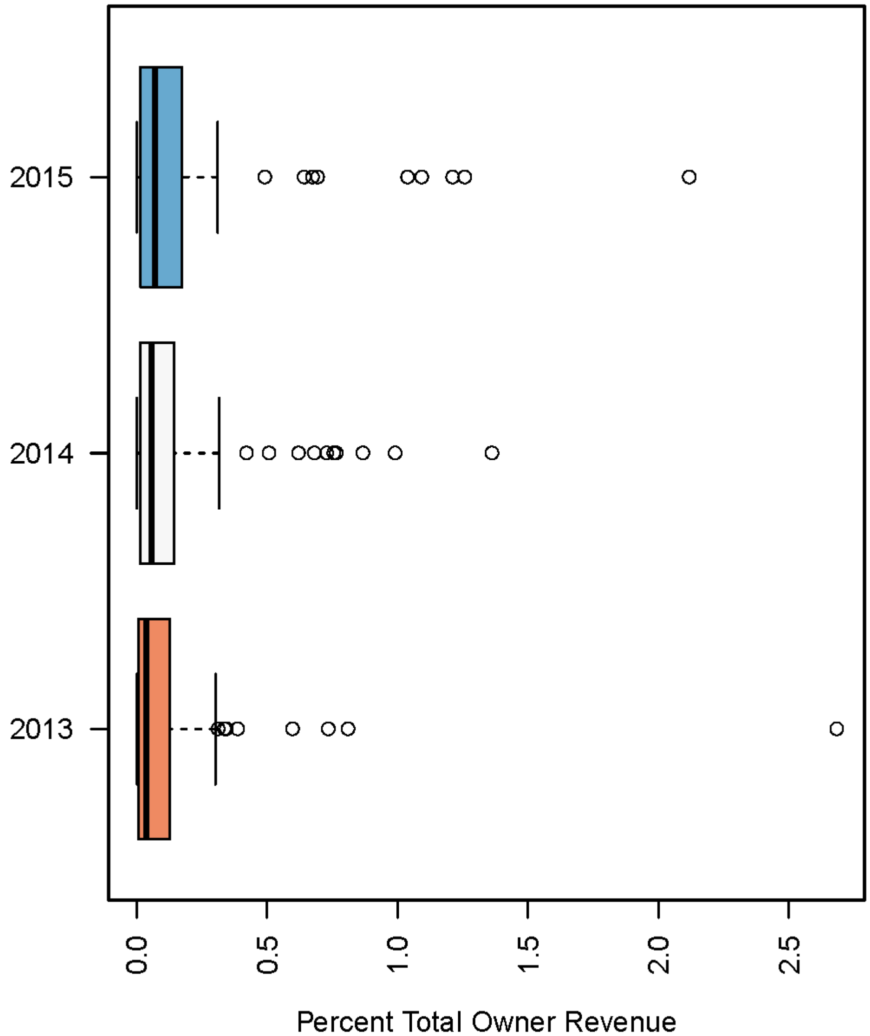
Source: **VTR analysis.**

Figure 96 – Revenue by species (top 10) attributed to the Lindenkohl Knoll coral zone Option 2, 2010-2015.



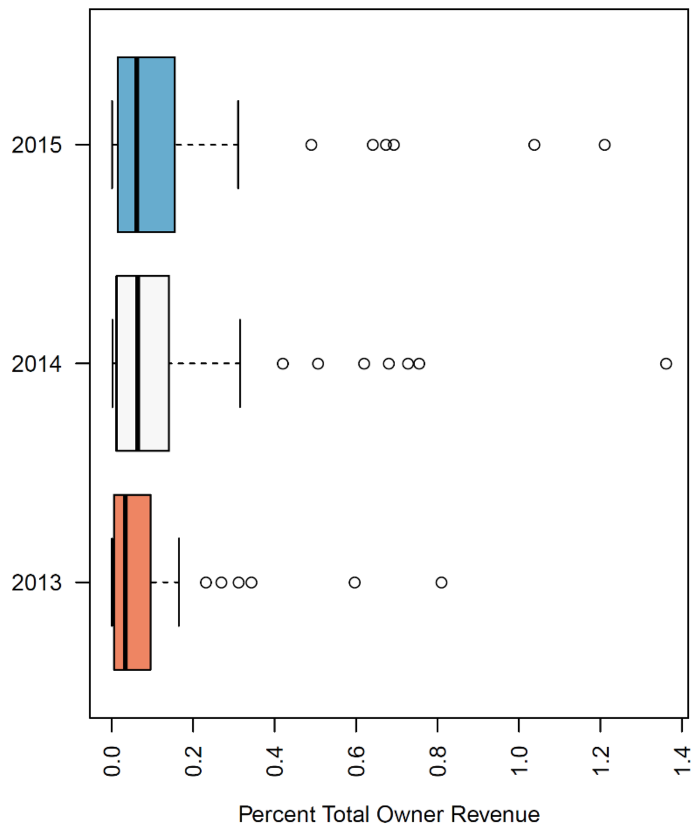
Source: **VTR analysis.**

Figure 97 – Percent of vessel owner revenue attributed to the Lindenkohl Knoll coral zone Option 1, 2013-2015.



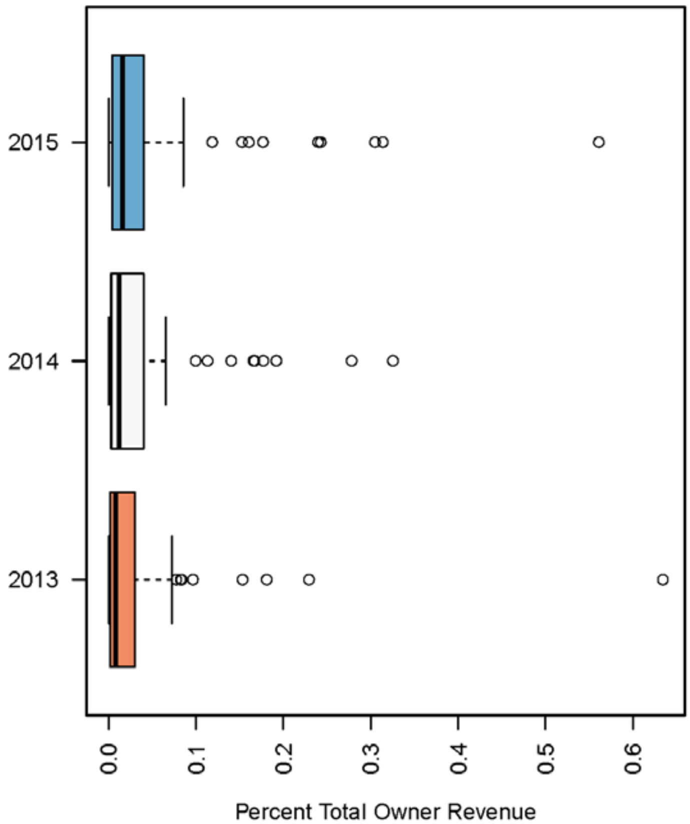
Source: VTR analysis.

Figure 98 – Percent of vessel owner revenue attributed to MBTG within the Lindenkohl Knoll coral zone Option 1, 2013-2015.



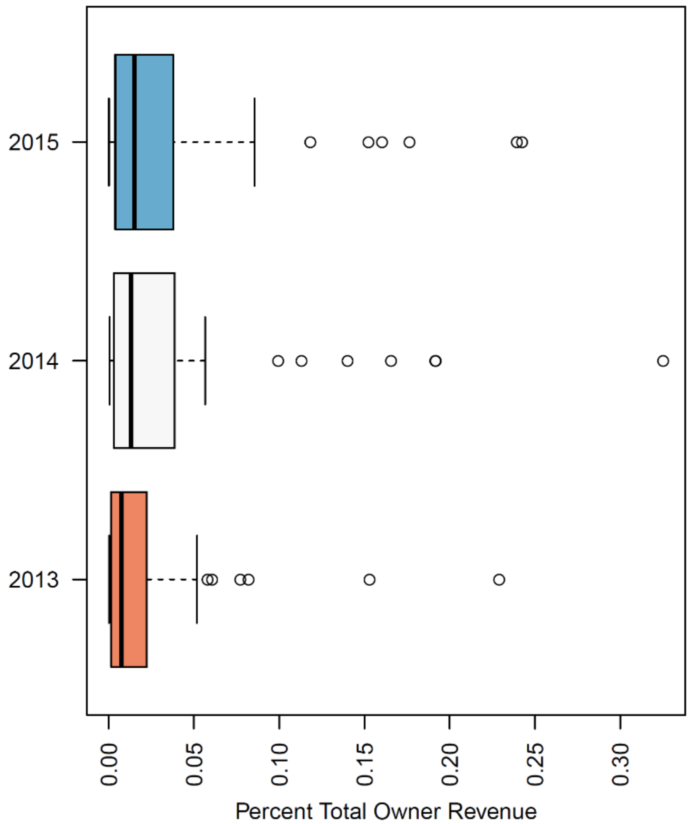
Source: VTR analysis.

Figure 99 – Percent of vessel owner revenue attributed to the Lindenkohl Knoll coral zone Option 2, 2013-2015.



Source: VTR analysis.

Figure 100 – Percent of vessel owner revenue attributed to MBTG within the Lindenkohl Knoll coral zone Option 2, 2013-2015.



Source: VTR analysis.

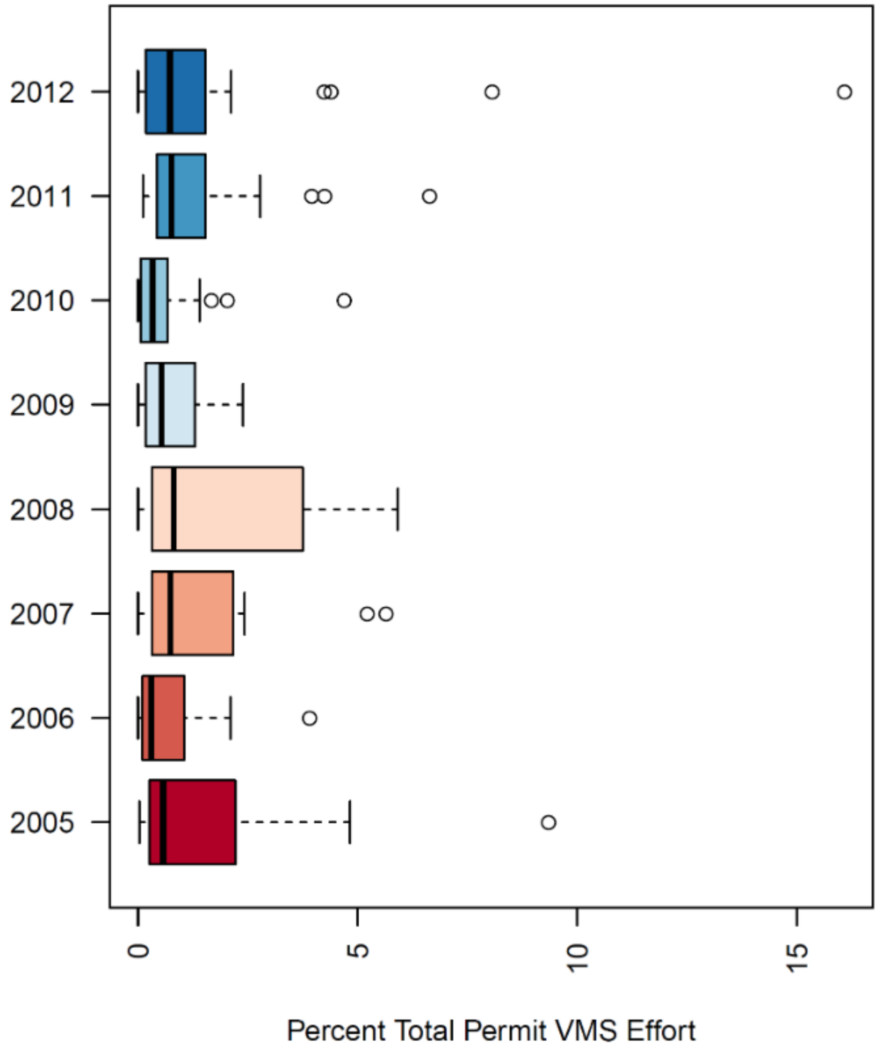
Table 92 – VMS coverage of VTR trips in the vicinity of Lindenkohl Knoll coral zone Options 1 & 2.

		Lindenkohl Knoll Option 1				Lindenkohl Knoll Option 2			
Gear	Year	Permits	VTR Trips	VMS Trips	Coverage	Permits	VTR Trips	VMS Trips	Coverage
Bottom Trawl	2010	89	424	380	90%	87	405	362	89%
Bottom Trawl	2011	73	459	366	80%	73	452	360	80%
Bottom Trawl	2012	76	607	496	82%	76	598	489	82%
Separator & Ruhle Trawl	2010	16	59	39	66%	15	58	38	66%
Separator & Ruhle Trawl	2011	24	102	72	71%	25	101	71	70%
Separator & Ruhle Trawl	2012	16	66	40	61%	15	65	39	60%
Lobster & Other Pot	2010	16	227	0	0%	16	227	0	0%
Lobster & Other Pot	2011	13	237	0	0%	13	244	0	0%
Lobster & Other Pot	2012	18	264	0	0%	18	263	0	0%
Scallop Gear & Clam Dredge	2010	13	14	0	0%	0	0	0	0%
Scallop Gear & Clam Dredge	2011	5	5	0	0%	0	0	0	0%
Scallop Gear & Clam Dredge	2012	10	10	0	0%	0	0	0	0%
Sink Gillnet	2010	9	30	0	0%	9	31	0	0%
Sink Gillnet	2011	7	24	0	0%	7	21	0	0%
Sink Gillnet	2012	6	18	0	0%	6	16	0	0%

Table 93 – VMS derived effort within the two Lindenkohl Knoll coral zone options.

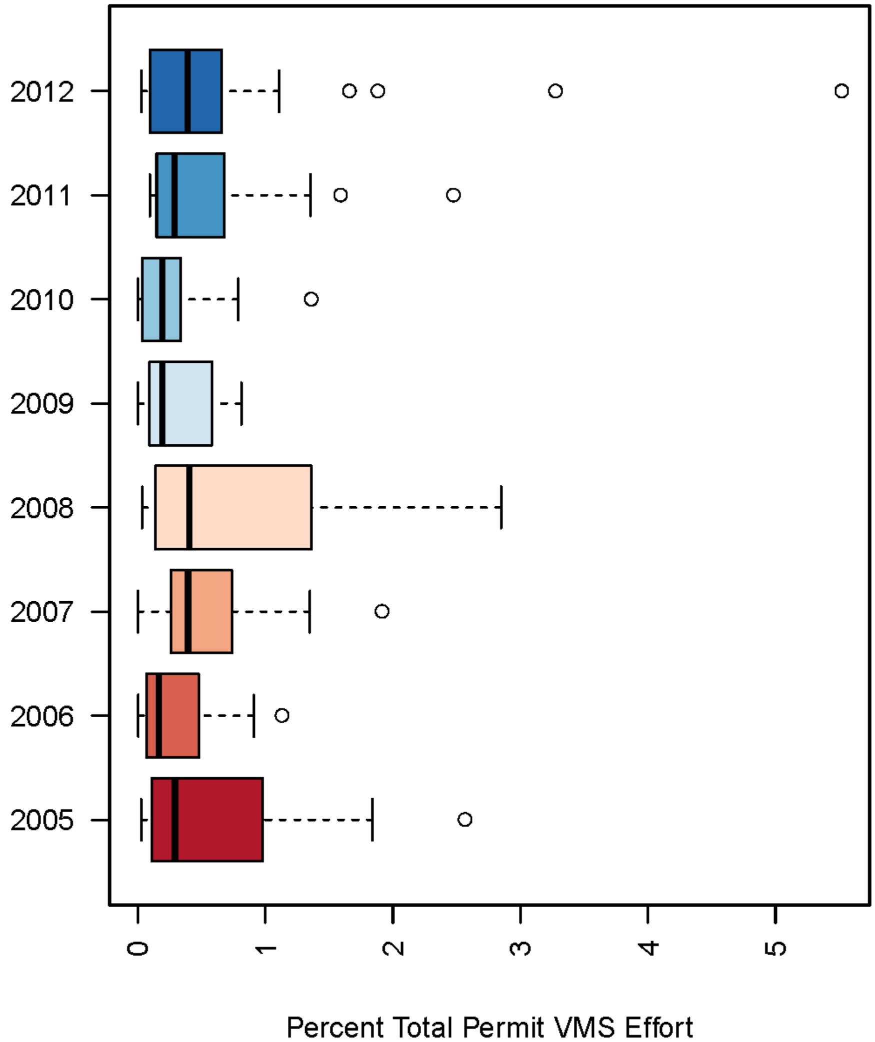
		Lindenkohl Knoll Option 1			Lindenkohl Knoll Option 2		
Gear	Year	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits
Bottom Trawl	2005	845	116	31	321	99	27
Bottom Trawl	2006	340	73	31	129	54	25
Bottom Trawl	2007	533	57	18	171	49	15
Bottom Trawl	2008	473	54	17	182	47	16
Bottom Trawl	2009	403	70	24	142	56	22
Bottom Trawl	2010	323	71	24	117	49	19
Bottom Trawl	2011	664	78	19	246	69	18
Bottom Trawl	2012	901	111	27	357	99	24

Figure 101 – Percent of permit-level effort attributed to the Lindenkohl Knoll coral zone Option 1, 2013-2015.



Source: VMS analysis.

Figure 102 – Percent of permit-level effort attributed to the Lindenkohl Knoll coral zone Option 2, 2013-2015.



Source: VMS analysis.

7.2.8.3.2 Potentially affected fishing communities

General community impacts of the alternatives under consideration are described in section 7.1.3, which also describes the method, caveats, and data confidentiality standard used to develop Table 94 and Table 95, the revenue by state, region, or port attributed (using the VTR analysis) to recent fishing within the Lindenkohl Knoll zone options.

The VTR analysis indicates that for each of the Lindenkohl Knoll zone options considered, New Bedford and Gloucester, Massachusetts and Portland, Maine are among the top landing ports that may be impacted. According to the NMFS Community Vulnerability Indicators, the commercial fishing engagement indicator is high for Gloucester, Portland, and New Bedford (Table 30). Of these three communities, New

Bedford and Gloucester rank highest in terms of reliance on commercial fishing, with a medium index, while Portland ranks lowest, with a low index.

Option 1

The VTR analysis suggests that the fishing communities that may be impacted by the Lindenkohl Knoll zone Option 1 are primarily located in New Hampshire and Massachusetts, with lesser activity attributed to ports in Maine, Rhode Island, and other states (Table 94). The VTR analysis attributes recent landings revenue to 17 ports and 195 permits, and 49% of this revenue to ports in New Hampshire. Gloucester (50 permits), New Bedford (108 permits), and Portland (24 permits) are among the top ten landing ports, and 54% of the revenue is attributed to other ports, indicating that, revenue from this zone may also be important to fishermen landing in other ports.

The revenue attributed to New Hampshire and Massachusetts from the Lindenkohl Knoll zone Option 1 is about 0.62% and 0.02% of all revenue, respectively, for these states during 2010-2015 (ACCSP 2017). Though these are small fractions, certain individual permit holders could have as much as 3% of their revenue attributed to fishing from this area (Figure 97, p. 454).

Table 94 – Landings revenue to states, regions, and top ports attributed to fishing within the Lindenkohl Knoll coral zone Option 1, 2010-2015

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
ALL BOTOM TENDING GEARS			
Maine	$132K	$22K	25
Portland	$132K	$22K	24
New Hampshire	$870K	$145K	16
Portsmouth	$31K	$5K	9
Massachusetts	$750K	$125K	160
Gloucester	$399K	$67K	50
New Bedford	$278K	$46K	108
Boston	$70K	$12K	20
Other (n=5)	$3K	$0K	17
Rhode Island	$9K	$2K	19
Newport	$8K	$1K	3
Point Judith	$2K	$0.3K	15
Other[b]	$1K	$0.2K	2
Total	**$1,762K**	**$352K**	**195**
MBTG ONLY			
Maine	$30K	$4.9K	15
Portland	$30K	$4.9K	14
Massachusetts	$713K	$119K	139
Gloucester	$370K	$62K	37
New Bedford	$273K	$45K	100
Boston	$70K	$12K	20
Other (n=3)	$0K	$0K	15

Rhode Island	$1.6K	$0.3K	17
Point Judith Other (n=2)	$1.5K $0.1K	$0.3K $0.0K	15 2
Other[b]	$1K	$0.2K	2
Total	**$746K**	**$124K**	**159**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
"Eastern" = ports from Lubec to Verona Island
"Mid-Coast" = ports from Stockton Springs to Brunswick
"Southern" = ports from Freeport to Kittery
Source: VTR analysis.

Option 2

The VTR analysis suggests that the fishing communities that may be impacted by the Lindenkohl Knoll zone Option 2 are primarily located in New Hampshire and Massachusetts, with lesser activity attributed to ports in Maine, Rhode Island, and other states (Table 95). The VTR analysis attributes recent landings revenue to 17 ports and 185 permits, and 49% of this revenue to ports in New Hampshire. Gloucester (50 permits), New Bedford (100 permits), and Portland (24 permits) are among the top ten landing ports, and 54% of the revenue is attributed to other ports, indicating that, revenue from this zone may also be important to fishermen landing in other ports.

The revenue attributed to New Hampshire and Massachusetts from the Lindenkohl Knoll zone Option 2 is about 0.62% and 0.02% of all revenue, respectively, for these states during 2010-2015 (ACCSP 2017). Though these are small fractions, certain individual permit holders could have as much as 3% of their revenue attributed to fishing from this area (Figure 97, p. 454).

Table 95 - Landings revenue to states, regions, and top ports attributed to fishing within the Lindenkohl Knoll coral zone Option 2, 2010-2015

State/Region/Port	Landings Revenue 2010-2015		Total Permits, 2010-2015[a]
	Total $	Average $	
Maine	$34K	$6K	25
Portland	$34K	$6K	24
New Hampshire	$234K	$39K	16
Portsmouth	$8K	$1K	9
Massachusetts	$176K	$29K	160
Gloucester New Bedford Boston Other (n=4)	$93K $65K $17K $1	$15K $11K $3K $0K	50 100 20 16
Rhode Island	$2K	$0.4K	19
Newport Point Judith	$2K $0.4K	$0.3K $0.1K	3 15

Other[b]	$0.3K	$0.0K	2
Total	**$447K**	**$74K**	**185**

[a] Totals may not equal the sum of the parts, because permits can land in multiple ports/states.
[b] Includes confidential state(s).
"Eastern" = ports from Lubec to Verona Island
"Mid-Coast" = ports from Stockton Springs to Brunswick
"Southern" = ports from Freeport to Kittery
Source: VTR analysis.

7.2.8.4 Impacts on protected resources

The protected resources potentially affected by this amendment are described in section 6.9.2, and the potential for interactions between these species and fishing gears are described in section 6.9.3. Trap, bottom trawl, and to a lesser extent (<10% of revenue), gillnet, account for nearly all of the revenue attributed to the offshore Gulf of Maine coral zones, including those at Lindenkohl Knoll (Figure 93, Figure 94). Closure of either the Option 1 or the Option 2 zones to all bottom-tending gears (Option 1), just mobile bottom-tending gears (Option 2), or all bottom-tending gears with a lobster trap exemption (Option 1, Sub-Option B) is expected to have redistributional effects in terms of where fishing gears are deployed.

It is unlikely that fishing effort would increase in response to coral zone designations in this location. Because these zones are small relative to the scale of the fishing grounds in the offshore Gulf of Maine, it also seems unlikely that designating coral zones would cause a substantial decline in effort. Thus, we assume that that effort will be maintained at similar levels, but redistributed locally, within Georges Basin, in areas near the designated zones. Similar to the inshore Gulf of Maine zones, closures could thus have the effect of concentrating effort spatially, perhaps near the coral zone boundaries.

Because any displaced effort is expected to be redistributed within the offshore Gulf of Maine in the vicinity of the coral zones (see discussion in section 7.1.4), impacts will be limited to protected species occurring in this area (Table 90). Species listed in Table 39 that do not occur in this location are unlikely to experience differences in interaction rates relative to current conditions. Coral zone designations at Lindenkohl Knoll are not a preferred alternative.

7.2.8.4.1 Large whales

Bottom trawl, gillnet, and trap gears are used in and around the coral zones. It is unlikely that fishing effort with any of these gears would increase in response to coral zone designations. Because these zones are small relative to the scale of the fishing grounds in the offshore Gulf of Maine, it also seems unlikely that designating coral zones would cause a substantial decline in effort. Thus, we assume that effort will be maintained at similar levels, but redistributed locally, within Georges Basin, in areas near the designated zones. Similar to the inshore Gulf of Maine zones, closures could have the effect of concentrating effort spatially, perhaps near the coral zone boundaries. In terms of lobster trap fishing, industry members indicated that transitional areas between very complex bottom and softer bottom were the best locations to catch lobsters (see workshop report, NEFMC 2017). The coral zones include complex, rocky habitats, so it seems plausible that gear could be set along the edges of the coral zones.

Bottom trawl gear poses little to no interaction risk to any large whale species. Other than minke whales, there have been no observed or documented interactions between trawls and large whales (see section 6.9.3.1.1 for details and rationale). From 2008-2015, estimated annual mortality attributed to the northeast bottom trawl fishery went from 7.8 to zero minke whales (see section 6.9.3.1.1). Based this information, while bottom trawl effort could become somewhat concentrated in the areas around the Lindenkohl Knoll coral zones, given bottom trawl gear poses no interaction risk to North Atlantic right, humpback, fin, and sperm whales, and a low interaction risk to minke whales, these changes in effort are expected to have a neutral to slight negative effects on large whales.

Gillnet and trap/pot gears, specifically, the vertical lines associated with these gear types, pose the greatest entanglement risk to large whales (see section 6.9.3.1.1). Pot gear, and to a lesser extent, gillnet gear, is used in and around the Lindenkohl Knoll coral zones (see section 6.9.3.1.1). Therefore, the mechanism for a change in interaction rates in this region would be that vertical line density would increase, and thereby be more difficult for whales to avoid as they utilize the offshore Gulf of Maine for feeding or other activities. Because the Lindenkohl Knoll coral zones are small, changes to fishing effort distributions associated with their designation would likely have only slight negative consequences for interaction rates with large cetaceans.

Strategies developed outside the fishery management plan process serve to reduce the likelihood of gear interactions with large whales. As described in section 6.9.3.1.1, the Atlantic Large Whale Take Reduction Plan provides regulatory and non-regulatory measures to reduce the risk of serious injury and mortality caused by accidental entanglement in trap/pot and gillnet gear.

Given the discussion above about potential shifts in effort, the small size of potential coral zones, and that ALWTRP measures are already in place to reduce serious injury and mortality, the impacts of any of these alternatives on large whales are expected to be negative to slightly negative. The larger zones with more effort restrictions (i.e. zone Option 1, fishing restriction Option 1) would be expected to have a greater magnitude of impacts as compared to smaller zones with lesser restrictions (i.e. zone Option 2, fishing restriction Option 2).

7.2.8.4.2 Small cetaceans

Small cetacean interactions with pots and traps are discussed in section 6.9.3.1.2. Direct observations of fishing with trap/pot gear are limited, so interaction information for small cetaceans with trap/pot gear is partly inferred from evidence of gear on stranded animals. These stranding data suggest that trap/pot interaction rates with small cetaceans are low. Given these low interaction rates, impacts on small cetaceans of designating the

Lindenkohl Knoll coral zones (either boundary option) as a closure to lobster pot gear are expected to be slight negative, regardless of potential shifts in lobster pot fishing effort.

Small cetaceans are at risk of interacting with sink gillnet and bottom trawl gear (see section 6.9.3.1.2). In terms of bottom trawl gear and species expected to occur in the offshore Gulf of Maine, Atlantic white-sided dolphins and short-beaked common dolphins are the most frequently observed bycaught small cetacean species in the Greater Atlantic Region, followed by long-finned pilot whales, Risso’s dolphins, bottlenose dolphin (offshore), and harbor porpoise (Lyssikatos 2015; Chavez-Rosales et al. 2017). In terms of gillnet gear, harbor porpoises and short beaked common dolphins are the most frequently bycaught small cetacean species in the Greater Atlantic Region (Hatch and Orphanides 2014, 2015, 2016, 2017, 2019). If these gears become more spatially concentrated along the boundaries of coral zones, it could be more difficult for these marine mammals to avoid the gear, and therefore interaction rates could increase. It is difficult to assess the likelihood of gear becoming concentrated along the edges of the coral zones since fishing effort locations are not precisely known at present, nor are the relationships between groundfish catch rates and proximity to coral habitats.

Strategies developed outside the fishery management plan process serve to reduce the likelihood of gear interactions with small cetaceans. There is a take reduction strategy for trawl gears to limit interactions with common dolphins and other cetacean species. Voluntary measures include reducing the numbers of turns made by the fishing vessel and tow times while fishing at night and increasing radio communications between vessels about the presence and/or incidental capture of a marine mammal to alert other fishermen of the potential for additional interactions in the area.

Given the discussion above about potential shifts in effort, the small size of the coral zones, and that measures outside the fishery management plan process are designed to reduce interaction, the impacts of designating coral zones at Lindenkohl Knoll are uncertain but could be negative to slightly negative. The smaller Option 2 zones are expected to have fewer impacts on small cetaceans as they would have less of an effect on fishing effort. Because gillnet effort is minor at these sites, and lobster gear is not a major concern in terms of small cetacean interactions, impacts would likely be similar, regardless of gear restriction option.

7.2.8.4.3 Sea turtles

Turtle interactions with pots and traps are discussed in section 6.9.3.2. Leatherback, loggerhead, green, and Kemp’s ridley sea turtles are known to interact with trap/pot gear, with interactions primarily associated with entanglement in vertical lines, although sea turtles can also become entangled in groundline or surface systems. If trap gear becomes concentrated in areas outside the Lindenkohl Knoll coral zones, this could increase vertical and ground line density. If this increased gear concentration reduced catch rates of the traps, set times could increase. Both a greater concentration of vertical/groundlines and longer set durations could increase interaction rates. Thus, designation of the Lindenkohl Knoll coral zones could have negative effects on sea turtles.

Sea turtles are at risk for interaction with both bottom trawl and gillnet gears, as described in section 6.9.3.2. Designation of the Lindenkohl Knoll coral zones would be expected to have some effects on the distribution of fishing effort with trawl and gillnet gears, potentially concentrating bottom trawling near the edges of the coral zones. Thus, with respect to these gears, potential negative impacts to sea turtles are expected. These effects are expected to be slight, given that bottom trawl/turtle interactions are less common in New England vs. Mid-Atlantic waters, and that shifts in effort are likely to be relatively minor.

7.2.8.4.4 Atlantic salmon

Atlantic salmon interactions with pots and traps are discussed in section 6.9.3.4. To date, there have been no interactions documented. Atlantic salmon interactions with gillnet and bottom trawl have been observed since 1989; but since 2013, no additional Atlantic salmon have been observed in gillnet or bottom trawl gear (NMFS NEFSC FSB 2015, 2016, 2017, 2018). Based on the above information, specifically the very low number of observed Atlantic salmon interactions in gillnet and trawl gear reported in the Northeast Fisheries Observer Program's database (which includes At-Sea Monitoring data), interactions with Atlantic salmon are likely rare events (Kocik et al. 2014; NMFS NEFSC FSB 2015, 2016, 2017, 2018). Considering this information, designation of coral zones at Lindenkohl Knoll is expected to have neutral to slight negative impacts on Atlantic salmon.

7.2.9 Summary of impacts associated with No Action and coral zone alternatives

This section summarizes environmental impacts across the No Action and coral zone alternatives (see also section 8.3 which summarizes the combined impacts of three scenarios: No Action, the preferred alternatives, and a maximum conservation alternative). There are various ways to combine these alternatives evaluated in the amendment. The Council's preferred approach to coral protection includes a broad coral zone with a minimum depth of 600 m (Option 6). This zone would be closed to all bottom-tending gears, with an exemption for red crab traps (Option 1, Sub-Option A). The smaller of the two proposed Mt. Desert Rock zones (Option 2) and the Outer Schoodic Ridge zone are also preferred alternatives, both as closures to mobile bottom-tending gears. No coral zones were proposed for the offshore Gulf of Maine. Under the preferred approach, the 600-m minimum zone, Mt. Desert Rock zone, and Outer Schoodic Ridge zone will be combined with the No Action areas.

Other groupings of options were available to the Council as well. Only No Action was a given as the Council identified preferred alternatives, since none of these management areas were under consideration for removal via the amendment. As presented in Table 96 below, each row could be selected in combination with one or more of the other No Action rows. The Council evaluated various boundary and gear restriction options for each alternative/row in the table. In some cases, the alternatives are nested, spatially, with other alternatives, such that impacts would not be additive. This is the case for the canyon and seamount discrete zones, which overlap the broad zones (see further discussion below). In other cases, the alternatives are non-overlapping, such that impacts would be expected to be additive to one another. This is the case for the Gulf of Maine zones, which are proposed in four separate locations, two inshore and two offshore.

Table 96 – Summary of spatial management alternatives

Alternative	Boundary options	Spatial overlaps with other alternatives?	Gear restriction options	Preferred?
No Action	n/a	Broad zones, canyon zones, seamount zones	n/a	Will continue once the amendment is implemented
Broad zones	- 300 m (Option 1) - 400 m (Option 2) - 500 m (Option 3) - 600 m (Option 4) - 900 m (Option 5) - 600 m minimum (Option 6) - Empirical zone (Option 7)	No Action, canyon zones, seamount zones	- All BTG - All BTG with red crab exemption - All BTG with other trap exemption - All BTG with all traps exempted - Only MBTG	600 m minimum, all BTG with red crab exemption
Canyon zones	Only one	No Action, broad zones	- All BTG - All BTG with red crab exemption - All BTG with other trap exemption - All BTG with all traps exempted - Only MBTG	No
Seamount zones	Only one	No Action, broad zones	- All BTG - All BTG with red crab exemption - All BTG with other trap exemption - All BTG with all traps exempted - Only MBTG	No
Mt. Desert Rock	Option 1 (larger) Option 2 (smaller)	No	- All BTG - All BTG with other trap exemption - Only MBTG	Option 2, only MBTG restricted
Outer Schoodic Ridge	Only one	No	- All BTG - All BTG with other trap exemption - Only MBTG	Option 2, only MBTG restricted
Jordan Basin	Option 1 (larger) Option 2 (smaller)	No	- All BTG - All BTG with other trap exemption - Only MBTG	No
Lindenkohl Knoll	Option 1 (larger) Option 2 (smaller)	No	- All BTG - All BTG with other trap exemption - Only MBTG	No

Table 97 summarizes the impacts of these alternatives. In terms of deep-sea corals, designation of coral zones is generally expected to have positive impacts, except in cases where no material impact on fishing activity is expected to result from the alternative, in which case the impacts are expected to be neutral (although perhaps positive in the future, by preventing the expansion of fishing into areas of coral habitat that are currently unfished). Regardless of the types of fishing gear restricted, neutral impacts are expected for the deepest broad zone (Option 5, 900 m) and for the seamount zones, because no fishing is known to occur at these depths. With the exception of the seamount zones, which are fully nested within the broad zones, combining alternatives should result in a greater magnitude of positive impacts that selecting a single area, as more coral habitat will be protected. Different coral and managed fish species occur in different parts of the region, and there is evidence for genetic diversity within species and among sites (e.g. Coykendall 2016), underscoring the value of protecting multiple areas of coral habitat.

Combining the canyon zones (not preferred) with any of the broad zones (Option 6 is preferred) would have a larger magnitude of positive impacts than designating one of the broad zones alone, because the discrete canyon zones extend further up into the heads of the canyons. This could confer particular benefits on soft corals, which tend to have shallower distributions than stony and black coral species (see section 6.2 for information on coral distributions). For the 300 m (Option 1) broad zone this change is not expected to be substantial, since the shallow extent of the canyon zones is close to this depth, but for some of the deeper broad zones more substantial areas of the canyon heads would be protected via the canyon zones, generating positive impacts. Because a mix of trap and trawl fishing (plus minor use of other gears) occurs along the edge of the shelf, greater positive impacts are associated with closing the canyon or broad zones to all bottom tending gears (Option 1), vs. just mobile bottom-tending gears (Option 2), or Option 1 with a trap exemption (red crab traps, other traps, or both). Because the red crab trap fishery only includes a few vessels, effort is limited relative to the lobster trap fishery, and the additional negative impacts to corals associated with red crab traps are expected to be minor. Impacts to managed species are indirect and mediated via habitat protections that are intended to conserve seafloor structures (including corals) that support populations of managed species. For any given alternative, the magnitude of these indirect impacts is expected to be smaller than the corresponding magnitude of impacts to deep-sea corals.

In the Gulf of Maine inshore zones (Mt. Desert Rock and Outer Schoodic Ridge), impacts are mostly related to displacement of the lobster pot fishery out of the zones. Displacement of lobster traps out of the zones would occur under gear restriction Option 1, but not under Option 2 or Option 1 with a trap exemption. This is because other types of fishing activity in these zones is negligible. Preventing the future use of other gear types, for example trawl gear, in the coral zones would have slight positive impacts but at present, these restrictions are largely precautionary. Similar to the broad zones and canyon zones, the expected impacts to managed species are indirect, and smaller in magnitude than impacts to corals.

In the Gulf of Maine offshore zones (Jordan Basin and Lindenkohl Knoll), there is both lobster pot fishing and bottom trawling, plus a small amount of gillnet fishing and use of other gear types. These alternatives are expected to have slight positive to positive impacts on corals and managed species, with a greater magnitude of impacts associated with the larger options for these zones, because additional areas of coral habitat would be protected. Similar to the inshore Gulf of Maine zones, the expected impacts to managed species are indirect.

In general, impacts to fisheries and fishing communities track with the estimated amount of effort displacement, with more negative effects associated with larger projected displacement, and neutral effects for alternatives and gear restriction approaches that are not expected to displace fishing activity. The effects of specific alternatives and options are described further below. It is important to note that fishing activities that would have taken place inside a coral zone could be conducted elsewhere, although perhaps catch rates would decline, costs might increase, or interactions with other vessels could increase. It is also important to note that while some effort displacement estimates may be relatively small at the scale of the fishery, negative effects of closures will be felt by the segment of the fleet that fishes within the area, and could be a substantial fraction of the fishing activity for certain permits and owners. Different segments of the fleet appear to fish in the canyon/slope region vs. the inshore Gulf of Maine vs. the offshore Gulf of Maine, so combinations of alternatives that affect all three locations will affect the greatest number of fishing businesses.

Impacts of the shallower broad zones (Options 1-3) are identified as slight negative overall, but negative for affected fishermen, whereas impacts for the deeper zones (Options 4-7) are identified as slight negative to neutral. The primary gear types affected are lobster pot and bottom trawl. With the exception of Option 5, the 900 m broad zone, there would be negative impacts to the red crab fishery of any of the broad zones if all types of bottom-tending gears are restricted, because this fishery operates exclusively at coral zone depths, and the broad zones cover a large extent of the fishing grounds, which extend into the Mid-Atlantic. Other fleets such as the offshore lobster fleet and squid fleet are working along the edge of the shelf, both inside and outside of the zone alternatives. Combining the discrete canyon zones with the broad zones will have slightly greater negative impacts that designating the broad zones alone, because additional areas within the heads of the canyons would be closed to fishing. Combined impacts would still be slightly negative overall, but more negative for affected fishermen who work near the heads of the canyons as compared to desginating the broad zones alone. Exemptions for red crab trap and other trap gears have a significant bearing on the overall impacts of designating coral zones in the canyon/slope region because these are important fishing locations for these two gears. Because there is no fishing activity on the seamounts at present, designation of the seamount discrete zones would have neutral impacts on fishing businesses and communities.

As noted above, impacts of designating the inshore Gulf of Maine zones would be felt almost entirely by the lobster fishery, mainly by the vessels that work inside the zones but also by other vessels in adjacent grounds where effort might be redistributed. This could affect dozens of vessels, based on information provided by Maine DMR, but these estimates are uncertain. Given the limited data on effort distribution in the inshore Gulf of Maine, the magnitude of these impacts is difficult to estimate, but would be eliminated by exempting trap fisheries from the closures or designating the areas as mobile bottom-tending gear closures only (the latter is the preferred alternative). Given the preferred alternative for both of these zones, there are likely to be neutral effects of these designations on fisheries and fishing communities, at present.

The offshore Gulf of Maine zones are fished for groundfish (with trawls and also with gillnets) as well as for lobster. Depending on the gear restriction options selected, these zone designations would have slight negative impacts, that could potentially be negative for vessel operators and fishing communities more dependent on the zones. The magnitude of effort displaced is difficult to estimate, given the spatial precision associated with effort data combined with the relatively small size of the zones.

Impacts to protected species (ESA listed and/or MMPA protected species) are expected to range from neutral to negative. Gear type and associated interaction risk to a specific protected species, the degree of overlap between coral zones and protected species, and the potential response of fisheries to the designation of the coral zones (e.g., displacement of gear) were factors considered in assessing the level of potential impacts to protected species. Large whales will primarily be affected by alternatives that influence trap/pot and/or gillnet gear distributions, while small cetaceans and turtles will be affected by alternatives that affect mobile and fixed (i.e., gillnet and pot/trap) gears. Out of all the proposed alternatives, only two may have slight negative impacts to listed species of fish (i.e., Atlantic salmon); all other alternatives are expected to have no impacts on listed fish species.

Table 97 – Summary of impacts of the No Action alternative and coral zone alternatives. 'Neutral' indicates impacts not expected to change from current conditions.

No Action (removal not possible via this amendment; applies regardless of coral zone(s) selected)				
Alternative	**Deep-sea corals**	**Managed species and EFH**	**Human communities**	**Protected resources**
Existing spatial management measures that have coral conservation implications	Positive	Positive	Slight negative	Negative to neutral for large whales; slight negative to neutral for small cetaceans; negative to slight negative for sea turtles. No overlap with endangered fish distributions.
Broad coral zones (select one zone option and a fishing restriction option, Option 6, with Option 1, Sub-Option B, preferred))				
Alternative	**Deep-sea corals**	**Managed species and EFH**	**Human communities**	**Protected resources**
Option 1 (300 m)	Positive; largest magnitude of impacts of all broad zone options. Similar impacts to options 2, 3, and 7.	Slight positive; largest magnitude of impacts of all broad zone options. Similar impacts to options 2, 3, and 7.	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative for large whales; neutral if lobster traps exempted. Slight negative for small cetaceans and turtles. No overlap with endangered fish distributions. Largest magnitude of all broad zone impacts, and similar to Options 2 and 3.

Option 2 (400 m)	Positive; similar impacts to options 1, 3, and 7.	Slight positive; similar impacts to options 1, 3, and 7.	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative for large whales; neutral if lobster traps exempted. Slight negative for small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 1 and 3.
Option 3 (500 m)	Positive; similar impacts to options 1, 2, and 7.	Slight positive similar impacts to options 1, 2, and 7.	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative for large whales; neutral if lobster traps exempted. Slight negative for small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 1 and 2.
Option 4 (600 m)	Positive; similar impacts to Option 6.	Slight positive; similar impacts to Option 6.	Neutral to slight negative; negative for red crab fishermen under Option 1 without an exemption.	Neutral for large whales, small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 5-7.
Option 5 (900 m)	Positive; smallest magnitude of impacts of all broad zone options.	Slight positive; smallest magnitude of impacts of all broad zone options.	Neutral; no fishing activity with bottom-tending gears is known to occur at these depths.	Neutral for large whales, small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 4, 6, and 7.
Option 6 (600 m minimum; preferred as a closure to all bottom tending gear with a red crab trap exemption)	Positive; similar but slightly fewer positive impacts compared to Option 4.	Slight positive; similar but slightly fewer positive impacts compared to Option 4.	Neutral to slight negative as preferred (Option 1, Sub-option A; negative for red crab fishermen under Option 1 without an exemption (not preferred).	Neutral for large whales, small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 4, 5, and 7.
Option 7 (empirical)	Positive; similar impacts to options 1, 2, and 3.	Slight positive; similar impacts to options 1, 2, and 3.	Neutral to slight negative	Neutral for large whales, small cetaceans and turtles. No overlap with endangered fish distributions. Similar to Options 4-6.
Discrete coral zones (select one or more alternatives – some have two boundary options – plus a gear restriction)				

Alternative	Deep-sea corals	Managed species and EFH	Human communities	Protected resources
Canyons	Positive; less positive than broad zone options 1 and 2; also less positive than options 3-7, but with more complex tradeoffs in terms of depths protected	Slight positive; less positive than broad zone options 1 and 2; similar impacts to options 3-7	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative to slight negative for large whales; slight negative on small cetaceans and turtles. No impacts on listed fishes.
Seamounts	Neutral to slight positive impacts as this would represent a precautionary designation that does not displace current fishing activities.	Neutral to slight positive impacts as this would represent a precautionary designation that does not displace current fishing activities.	Negligible impacts; precautionary designation that does not displace current fishing activities.	Neutral impacts; precautionary designation that does not displace current fishing activities.
Mt. Desert Rock (Option 2 preferred as a closure to all mobile bottom-tending gear)	For boundary option 1 or 2, positive with gear restriction option 1, slight positive with gear option 2	For boundary option 1 or 2, positive with gear restriction option 1, slight positive with gear option 2	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative. More negative impacts on the lobster fishery for boundary option 1 vs. option 2.	For large whales, negative to neutral impacts. Slight negative to neutral impacts on small cetaceans and sea turtles; neutral impacts on Atlantic sturgeon and Atlantic salmon.
Outer Schoodic Ridge (preferred as a closure to mobile bottom-tending gear)	Positive with gear restriction option 1, slight positive with gear option 2, or option 1 sub-option B	Positive with gear restriction option 1, slight positive with gear option 2, or option 1 sub-option B	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	For large whales, negative to neutral impacts. Slight negative to neutral impacts on small cetaceans and sea turtles; neutral impacts on Atlantic sturgeon and Atlantic salmon.
Jordan Basin	Positive regardless of boundary option or gear restriction option selected. Boundary option 1 combined with gear option 1 would have the greatest magnitude of positive impact; gear option 2 combined with boundary option 2	Positive regardless of boundary option or gear restriction option selected. Boundary option 1 combined with gear option 1 would have the greatest magnitude of positive impact; gear option 2 combined with boundary option 2	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative. More negative impacts for boundary option 1 vs. option 2.	Negative to slight negative impacts on large whales, small cetaceans, and sea turtles. Neutral impacts on Atlantic sturgeon, possible slight negative impacts on Atlantic salmon.

	would have the smallest magnitude.	would have the smallest magnitude.		
Lindenkohl Knoll	Positive regardless of boundary option or gear restriction option selected. Boundary option 1 combined with gear option 1 would have the greatest magnitude of positive impact; gear option 2 combined with boundary option 2 would have the smallest magnitude.	Positive regardless of boundary option or gear restriction option selected. Boundary option 1 combined with gear option 1 would have the greatest magnitude of positive impact; gear option 2 combined with boundary option 2 would have the smallest magnitude.	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative. More negative impacts for boundary option 1 vs. option 2.	Negative to slight negative impacts on large whales, small cetaceans, and sea turtles. Neutral impacts on Atlantic sturgeon, possible slight negative impacts on Atlantic salmon.

7.3 Impacts of special fishery programs for coral zones

The alternatives in this section would create programs to allow special access fishing, exploratory fishing, and/or research activities within coral zones. Four alternatives are under consideration, and alternatives 2, 3, and 4 could be combined. The Council's preferred approach is Alternative 4 only.

- **Alternative 1. No Action:** No special programs for access, exploratory fishing, or research tracking requirements.
- **Alternative 2. Special access program fishing:** This alternative would implement a special access program within some or all of the deep-sea coral zones.
- **Alternative 3. Exploratory fishing:** This alternative would implement an exploratory fishing program within some or all of the deep-sea coral zones.
- **Alternative 4. Research activities:** This alternative would help the council and NMFS keep track of research in coral zones by requesting that researchers ask for a letter of acknowledgement when working in coral zones.

Because the analysis of impacts for all four alternatives is qualitative, they are discussed in combination by VEC.

7.3.1 Impacts on deep-sea corals

Alternative 1/No Action is expected to have negative to neutral impacts on deep-sea corals relative to baseline environmental conditions. No programs for continued special fishery access or exploratory fishing would be developed that could have negative impacts on coral habitats, but tracking of research activities, which could have positive, indirect impacts on corals, would not be enabled either.

Alternatives 2 and 3 are expected to have slightly negative impacts on deep-sea corals relative to baseline environmental conditions. Both alternatives contemplate programs that would allow specific types of fishing in coral zones, which could negatively affect corals. However, if these alternatives are selected, it is assumed that the programs would be carefully designed so as to minimize negative impacts on coral communities to the extent possible. However, the development of such programs could facilitate the continuance of existing fisheries or the development of future deep-water fisheries, which would have negative impacts on corals as compared to not allowing such programs. Alternatives 2 and 3 are not preferred alternatives.

Alternative 4, which is preferred, is expected to have indirect, positive impacts on deep-sea corals as the Council will be able to more easily track research activities in coral zones that could be used to inform future changes to the management program.

7.3.2 Impacts on managed species and essential fish habitats

Alternative 1/No Action is expected to have no impacts on managed species and their habitats relative to baseline environmental conditions. In the absence of special access or exploratory fishing programs implemented under Alternatives 2 and 3, managed species occurring within corals zones will be harvested in other locations, such that impacts to stocks will not change from current conditions.

Alternatives 2 and 3 are expected to have slightly negative impacts on managed species and their habitats. Both alternatives contemplate programs that would allow specific types of fishing in coral zones, which could negatively affect benthic habitats. If special access programs are developed (Alternative 2), managed species will be harvested in coral zones rather than other areas, but this will not change annual catch limits or other overall limits fishing effort in the individual FMPs. Thus, any negative impacts are expected to result from the effects of fishing on habitat and resulting losses in productivity that result. Alternative 3 is also expected to have slightly negative impacts on managed species. Exploratory fishing activities are not expected to contribute large amounts of removals from any given fishery stock and would be accounted for as part of the overall management plan. However, fishing activities could affect habitats and therefore stock productivity, indirectly.

Alternative 4 is expected to have slightly positive, indirect impacts on managed species and their habitats. To the extent that this alternative helps the Council to track research in coral zones, and that research provides information about managed resources, their habitat usage, and their possible linkages to corals, Alternative 4 could improve the management of these resources.

7.3.3 Impacts on human communities

Alternative 1/No Action is expected to have slightly negative to slightly positive impacts on human communities. On the one hand, no special access or exemption programs would be developed to facilitate fishery access to designated zones, but on the other hand, these zones will be more fully off limits to fishing gear impacts if these programs are not implemented. Not implementing research tracking requirements could limit scientific and management coordination but would reduce administrative burden.

The Council's preferred alternatives for coral zones and fishing restrictions seek to freeze the footprint of fishing for affected gear types, so any fishing under either special access (Alternative 2) or exempted fishing (Alternative 3) programs in the designated zones would represent an expansion of effort into areas that have not been recently fished. Thus, based on the way the zones were designated, Alternatives 2 and 3 would not be about maintaining existing fishing access, but about developing new fisheries or expanding existing fisheries.
Alternative 2 is expected to have positive impacts on fishing communities because development of special access programs will facilitate continued access to fishing opportunities within coral zones, but in a controlled fashion. Alternative 2 could have negative impacts on those concerned with coral conservation as special access programs could dilute the conservation benefits of coral zones.

Alternative 3 is expected to have positive impacts on fishing communities because it will provide some flexibility to explore commercial fishing opportunities within coral zones in the future. Alternative 3 could have negative impacts on those concerned with coral conservation as exploratory fishing could dilute the conservation benefits of coral zones.

Alternative 4 is expected to generally have neutral impacts on human communities as it is primarily an administrative requirement. There would be some additional effort required of researchers to comply with this requirement, but to ability of the Council to track research in coral zones could provide benefits overall in terms of coral conservation and development of fishery management programs. Science-based updates to fishery management programs are expected to have indirect positive impacts on human communities overall. While some stakeholders remain skeptical of the science used in decision-making, using updated science would likely improve confidence in management, a positive impact on stakeholders.

7.3.4 Impacts on protected resources

Alternative 1/No Action would mean that no special access or exempted fishing programs would be developed (Alternatives 2 and 3), such that impacts of any given coral zone alternative on protected resources would be as described in sections 7.2.1.4 through 7.2.8.4. Not implementing Alternative 4 is unlikely to affect protected resources in a substantial way, positive or negative.

The impacts of Alternative 2 (special access programs) or Alternative 3 (exempted fishing) would depend on the programs to be developed, but the magnitude of effort under special access in particular would likely be limited in scope. In addition, catch in all fisheries would remain governed by annual catch limits, such that the programs would not create an unlimited expansion in effort and thereby the chances for negative interactions with protected resources. Thus, impacts to protected resources of either alternative would likely be neutral or slightly negative relative to No Action.

The Council's preferred alternatives for coral zones and fishing restrictions seek to freeze the footprint of fishing for affected gear types, so any fishing under either special access (Alternative 2) or exempted fishing (Alternative 3) programs in the designated zones would represent an expansion of effort into areas that have not been recently fished. Thus, based on the way the zones were designated, Alternatives 2 and 3 would not be about maintaining existing fishing access, but about developing new fisheries or expanding existing fisheries.

Alternative 4 is expected to generally have neutral impacts on protected resources as it is primarily an administrative requirement.

7.4 Impacts of framework provisions for deep-sea coral zones

Three alternatives would allow the measures adopted via this amendment to be changed via a future framework adjustment versus fishery management amendment. Under Alternative 1/No Action, no changes would be made to the coral-related framework adjustment provisions of NEFMC FMPs. Either Alternative 1/No Action, or one or more of the action alternatives could be selected.

- Alternative 1/No Action: No changes to framework adjustment provisions
- Alternative 2: Add, revise, or remove coral zones via framework adjustment
- Alternative 3: Change fishing restrictions in coral zones via framework adjustment
- Alternative 4: Allow changes to special access or exploratory fishing programs via framework adjustment

Framework adjustments facilitate expedient modifications to certain management measures. Framework actions can only modify existing measures and/or those that have been previously considered in an FMP amendment. While amendments may take several years to complete and address a variety of issues, frameworks generally can be completed more quickly and address only one or a few issues in a fishery. In general, these alternatives are administrative and intended to simplify and improve the efficiency of future actions related to deep-sea coral protections. Thus, they are not expected to result in any direct impacts to any of the VECs, though indirect impacts are possible if they allow for more efficient responses to immediate conservation concerns for deep-sea corals or associated habitats.

7.4.1 Impacts on deep-sea corals

Alternative 1/No Action would mean than an amendment would be required to adjust coral management measures in the future. This alternative could result in slightly negative indirect impacts to deep-sea corals if the alternatives considered in the future are related to the expansion of existing coral management areas, the creation of new areas, or the addition of new gear restrictions. If an immediate deep-sea coral conservation concern becomes apparent, requiring an amendment could result in indirect negative impacts to corals, as the typically lengthier process associated with an amendment would delay the implementation of protection measures. If the future alternatives considered would remove coral management areas, make them smaller in a way that reduces coral protection, remove gear restrictions, or allow special access program fishing, Alternative 1/No Action will likely have neutral to slightly positive impacts. Regardless of the management vehicle, framework or amendment, such changes to the coral management program would be fully analyzed, as required under MSA and NEPA. However, allowing such changes to occur via framework could make them more likely to be implemented than if changes required an amendment, as amendments require additional Council resources to complete and might not be as high a priority in any particular year.

Indirect slightly positive impacts are possible from Alternatives 2 and 3 if they allow for more efficient responses to immediate threats to coral communities. Specifically, because the administrative process for an amendment is longer, it is possible that any immediate conservation concerns arising in the future could be addressed more quickly through a framework action rather than an amendment. In addition, because amendments typically require more Council and NMFS time and resources, it is possible that the Council may decide not to prioritize future adjustments to the coral measures if such actions would require an amendment. Under Alternatives 2 and 3, coral areas could be added or expanded, or additional gear restrictions could be enacted in a more rapid and responsive fashion. Conversely, if framework adjustments are used to remove coral areas or reduce their size (Alternative 2), reduce gear restrictions associated with the areas (Alternative 3), or add access programs (Alternative 4), there could be slight negative indirect impacts to corals. Because analysis of the impacts of such measures is required regardless of whether an amendment or framework adjustment is developed, these slight negative indirect impacts assume that the changes would not have been enacted if an amendment were required.

Thus, in summary, the potential impacts of the framework adjustment alternatives on deep-sea corals are indirect and could range from slightly negative to slightly positive depending on the situation.

7.4.2 Impacts on managed species and essential fish habitats

In general, the framework alternatives are intended to simplify and improve the efficiency of future actions related to deep-sea coral protections. Thus, they are not expected to result in any direct impacts to any of the managed resources. The framework provision alternatives are also unlikely to have indirect impacts on managed resources, as the process and timeline for any future coral action is unlikely to impact actions that may impact the managed stocks. Any immediate need to address issues with stock status or other FMP provisions would be addressed by NMFS and/or the Councils through a separate action not related to deep sea-corals. Thus, the No Action Alternative 1 as well as the framework provision action Alternatives 2 through 4 are expected to have no impacts to managed resources relative to baseline environmental conditions.

7.4.3 Impacts on human communities

Because the framework provision alternatives are administrative, they are not expected to result in any direct impacts to the human environment, though indirect impacts are possible from some of the alternatives if they allow for more efficient responses to pressing concerns for human communities. In addition, because amendments typically require more Council time and resources, it is possible that the Council may decide not to prioritize future adjustments to the coral measures if such actions would require an amendment rather than a framework. To the extent that framework provisions may allow more efficient responses to social or economic issues resulting from coral measures, or to the priorities of the conservation community, the framework provision action Alternatives 2, 3, and 4 are expected to have indirect slight positive impacts to human communities. Alternative 1 is expected to have indirect slight negative impacts.

7.4.4 Impacts on protected resources

Because the framework provision alternatives are administrative, they are not expected to result in any direct impacts to protected resources. The framework provision alternatives are also unlikely to have indirect impacts on protected resources, as the process and timeline for any future coral action is unlikely to impact protected resources interactions. Any immediate protected resources need to would be addressed by NMFS, or through a separate Council action not related to deep-sea corals. Thus, Alternative 1/No Action as well as the framework provision action Alternatives 2 to 4 are expected to have no impacts to protected resources relative to baseline environmental conditions.

7.5 Impacts of dedicated habitat research area alternatives

Alternative 2 in this section would designate a habitat research area in Jordan Basin around the 114 Fathom Bump site; this is the preferred alternative of the Council. Under Alternative 1/No Action, no DHRA would be designated. There are no fishing restrictions associated with the DHRA. Rather, the intent of the designation is to focus the attention of the research community on particular habitat-related research topics, in locations that are well suited to addressing such questions. The specific purpose of the Jordan Basin DHRA designation is to encourage further exploration of coral habitats at the site, and to encourage research on fishing gear impacts on these habitats.

Regardless of whether or not a DHRA is designated in Jordan Basin, coral-related research is expected to continue in that part of the Gulf of Maine. The area has been relatively well studied with multiple years of surveys as described in section 6.2. The Council anticipates that designation of DHRA here, however, would highlight the utility of this specific location as a site that is well suited to exploring distribution patterns of corals in conjunction with a number of managed fishery resources as well as multiple different types of fishing gears.

7.5.1 Impacts on deep-sea corals

Alternative 1/No Action is expected to have neutral impacts on deep-sea corals. Alternative 2 is expected to have indirect positive impacts on deep-sea corals, to the extent that better information about coral habitats and fishing impacts promotes better management and conservation.

7.5.2 Impacts on managed species and essential fish habitats

Alternative 1/No Action is expected to have neutral impacts on managed species and EFH. Alternative 2 is expected to have indirect, slightly positive impacts on managed species, to the extent that better information about coral habitats and fishing impacts promotes better management and conservation of corals, which in turn serve as fish habitats and promote healthy stocks.

7.5.3 Impacts on human communities

Alternative 1/No Action is expected to have neutral impacts on human communities. Alternative 2 is expected to have indirect, slightly positive impacts on human communities, to the extent that better information about coral habitats and fishing impacts promotes more data-driven management and conservation of corals, and a better fishery management process.

7.5.4 Impacts on protected resources

Both Alternative 1/No Action and Alternative 2 are expected to have neutral impacts on protected resources. The process and outcomes around coral conservation measures may improve as a result of research that is encouraged via designation of the DHRA. However, there is no direct linkage between the development of coral conservation measures and the interaction rates between fishing gears and protected resources.

8 Cumulative effects analysis

A cumulative effects assessment (CEA) is a required part of an EIS or EA according to the Council on Environmental Quality (CEQ) (40 CFR part 1508.7) and NOAA's agency policy and procedures for NEPA, found in NOAA Administrative Order 216-6A (Companion Manual, January 13, 2017). The purpose of the CEA is to integrate into the impact analyses the combined effects of many actions over time that would be missed if each action were evaluated separately. CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action from every conceivable perspective but rather, the intent is to focus on those effects that are truly meaningful. Predictions of potential synergistic effects from multiple actions, past, present and/or future will generally be qualitative in nature.

This section serves to examine the potential direct and indirect effects of the alternatives in the Council's Deep-Sea Coral Amendment together with past, present, and reasonably foreseeable future actions that affect the human environment. Specifcally, this analysis describes past, present, and foreseeable future actions, the baseline status of all VECs, and the cumulative effects of No Action, the Council's preferred action, and for comparison, a maximum conservation alternative, building upon the baseline status and considering other foreseeable future actions. The VECs identified as relevant to this action are identified in section 6 (Affected Environment), and include:

1. Deep-sea corals;
2. Managed species and their essential fish habitats;
3. Human Communities (includes economic and social effects on the fishery and fishing communities); and
4. Protected resources including endangered and threatened species.

The geographic scope of this analysis includes the New England region, as delimited by the New England/Mid-Atlantic inter-council boundary. The region includes U.S. waters in the Gulf of Maine, on Georges Bank, and in Southern New England, together with the continental shelf and slope off Georges Bank and Southern New England to the EEZ boundary. The temporal scope of this analysis extends backwards in time to the initiation of federal fisheries management but focuses on the most recent major action in any given fishery management plan, as well as other relatively recent changes in non-fishing activities. The analysis goes forward in time ten years from the planned implementation date of 2019 (i.e. to 2029), although near-term actions are more reliably identified. Given the time it takes many species to recruit to the fishery, any benefits of coral habitat conservation are expected to be realized as productivity benefits at the stock level no earlier than around the five-year mark. Such benefits are difficult to measure. It will take longer to translate any increases in resource productivity into increased landings and economic benefits. Therefore, evaluating cumulative effects up to ten years into the future is consistent with the anticipated conservation and fishery production outcomes of the alternatives in this amendment. As described in section 6.5.1, deep-sea corals can be very long lived and therefore conservation actions taken now could have effects on coral habitats long into the future.

8.1 Past, present, and reasonably foreseeable future actions

This section describes past, present, and future foreseeable actions that have effects on the valued ecosystem components evaluated in this amendment.

8.1.1 Fishery management

Federal fishery management plans are developed to optimize yield in U.S. fisheries and to comply with the Magnuson-Stevens Act as reauthorized through 2007. The legislation promotes long-term positive impacts on the environment in the context of fisheries activities, stipulating that management plans must comply with a set of National Standards that collectively serve to optimize the conditions of the human environment. Specific goals of fishery management plans include improving or maintaining the stock structure and abundance of target species, improving economic and social outcomes, and minimizing incidental impacts, for example relative to protected resources and other non-target species. Under this regulatory regime, the cumulative impacts of past, present, and future Federal fishery management actions on the VECs should be expected to result in positive long-term outcomes, although these actions are often associated with offsetting impacts. For example, constraining fishing effort frequently results in negative short-term socio-economic impacts for fishery participants in order to bring about long-term sustainability of a given resource.

In general, the designation of deep-sea coral conservation areas is expected to have indirect, positive impacts on managed resources via habitat protection for those species that occur within coral habitats and derive shelter and feeding benefits from the structure the corals provide. Annual catch limits and accountability measures, which are a major element of fishery management plans, are also expected to have generally positive impacts of managed resources because these measures are designed to limit catches to biologically sustainable levels and to provide both proactive and reactive measures to ensure that these catch limits are not exceeded. Eliminating overfishing and reducing the number of overfished stocks is expected to generate long run benefits to the human community.

Table 98 below describes key fishery management actions by fishery management plan. In some cases, fishery management plan actions are developed in an omnibus fashion to update many plans at once. This approach was taken with this amendment, and with the Council’s recent Omnibus Habitat Amendment 2. The Mid-Atlantic Fishery Management Council’s coral amendment which implemented measures similar to those proposed in this action but for the Mid-Atlantic region, modified the Mackerel/Squid/Butterfish FMP, but fishing restriction measures were applied across gear types, regardless of the fishery or target species. A Standardized Bycatch Reporting Methodology amendment is another example of an omnibus approach to management. This action was intended to improve the information used in management of fishery resources. The Mid-Atlantic Council also recently developed an unmanaged forage species amendment that prohibits the development of new and expansion of existing directed commercial fisheries on unmanaged forage species in mid-Atlantic federal waters until the Council has had an adequate opportunity to assess the scientific information relating to any new or expanded directed fisheries and consider potential impacts to existing fisheries, fishing communities, and the marine ecosystem.

Table 98 – Past, present, and future foreseeable actions within the fishery management plans in operation in the New England region

Fishery Management Plan	Past actions	Present actions	Future foreseeable actions
Northeast Multispecies FMP	FMP completed in 1986 by NEFMC to reduce fishing mortality and promote rebuilding. Past measures included input controls such as days-at-sea, mesh size, trip, and fish size, and permit limits, and seasonal and year-round management areas. EFH was designated in 1999. Amendment 18: caps accumulation limits at an average of 15.5% across all stocks and creates a 5% permit cap.	Current management includes annual catch limits by stock and accountability measures for overages. The most recentspecifications were set via Framework 57 and Framework 58 is undergoing review. Most fishing conducted within the sector catch-share system. Limits on mesh-size, fish size, and permits are still used, along with area management. Trip limits and days-at-sea are infrequently relied upon.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information.
Monkfish FMP	FMP completed in 1999 by NEFMC and MAFMC to address concerns about small fish in landings, gear conflicts, and expanding directed fishery. Measures included permit and day-at-sea limits, trip limits, minimum fish sizes, seasonal spawning restrictions, and gear restrictions, as well as EFH designations. A subsequent action included designation of EFH management areas closed to monkfishing in Lydonia and Oceanographer canyons.	Current management includes annual catch limits by stock and accountability measures for overages. In addition to original FMP measures, current management includes various exemption areas for trawls and gillnets where vessels can use large mesh and are not required to use a Multispecies day-at-sea. Management is closely tied to Northeast Multispecies FMP. Habitat closure areas in two canyons.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information.

Fishery Management Plan	Past actions	Present actions	Future foreseeable actions
Skate Complex FMP	FMP completed in 2003 by NEFMC to protect overfished skates and collect data about the fishery to improve management. Measures included federal permits, reporting requirements, possession limits for wing fishery, and prohibitions on landings of depleted species, as well as EFH designations.	Current management includes annual catch limits and accountability measures for overages. Possession limits now include both wing and bait fisheries.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information.
Atlantic Sea Scallop FMP	FMP completed in 1982 by NEFMC to rebuild stock and reduce interannual fluctuations in abundance. Measures included limits on permits, days-at-sea, crew size, gear restrictions, and meat count restrictions. EFH was designated in 1999 and Amendment 10 (implemented 2004) designated EFH closures, which were updated via Amendment 15 (implemented 2011) updated these areas to be consistent with those in Multispecies Amendment 13	Current management includes annual catch limits and accountability measures for overages. Rotational closure/access area system combined with open area days-at-sea. Seasonal closures and groundfish sub-ACLs to limit fish bycatch, gear restrictions to limit turtle bycatch. A 4-inch ring and rotational management used to optimize yield per recruit. Habitat closure areas.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. Considering adjustments to Northern Gulf of Maine and LAGC management programs, as well as fishing year changes.
Atlantic Herring FMP	FMP completed in 1999 by NEFMC. Area-based quota/TAC system. EFH was also designated in 1999.	Current management includes annual catch limits and accountability measures for overages. Enhanced monitoring in groundfish management areas.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. Coordination with MAFMC and ASFMC on river herring/shad monitoring/bycatch. Amendment 8 which includes an ABC control rule and a localized depletion closure is under development.

Fishery Management Plan	Past actions	Present actions	Future foreseeable actions
Deep-Sea Red Crab FMP	FMP completed in 2003 by NEFMC to address overfishing and the potential for overcapitalization. Measures included permit limits, trips limits, annual TACs, days-at-sea, and limits on gear and processing at sea, as well as the EFH designations.	Current management includes annual catch limits and accountability measures for overages.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information.
Surfclam and Ocean Quahog FMP	FMP completed in 1977 by MAFMC. Initial approaches included limited entry, quarterly quotas, and fishing time restrictions. ITQ system established in 1990.	Fishery is currently managed as an ITQ system, with annual catch limits capping total catch and accountability measures for overages. Fishing is subject to food safety/PSP closures. Georges Bank fishery has expanded recently.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. A framework action to consider fishery access to Nantucket Shoals within a designated habitat management area is currently under development (NEFMC). MAMFC is developing an excessive shares amendment.
Atlantic Bluefish FMP	FMP completed in 1990 to control fishing effort.	Current management includes annual catch limits and accountability measures for overages. Quotas for recreational vs. commercial fisheries.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. MAFMC and ASMFC are developing a bluefish allocation amendment.
Atlantic Mackerel, Squid, and Butterfish FMP	Original FMPs in 1978. Consolidated into a single plan in 1983 by MAFMC.	Current management includes annual catch limits and accountability measures for overages. Deep-sea coral management areas were recently implemented in the Mid-Atlantic.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. A rebuilding plan for mackerel was approved by MAFMC in August 2018. MAFMC is developing Amendment 20 to reduce latent effort and modify management of longfin during trimester 2.

Fishery Management Plan	Past actions	Present actions	Future foreseeable actions
Spiny Dogfish FMP	Joint MAFMC-NEFMC FMP implemented in 2000.	Current management includes annual catch limits and accountability measures for overages. Catches controlled by quotas and trip limits.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information.
Summer Flounder, Scup, and Black Sea Bass FMP	Merged into the summer flounder FMP in 1996.	Current management includes annual catch limits and accountability measures for overages. Catch and landings limits are the primary management tool; allocations between recreational and commercial fisheries. Gear restricted areas to protect scup and black sea bass habitats. Commercial accountability measures updated 2018.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information. MAFMC and ASFMC are developing an amendment to review all aspects of FMP related to summer flounder. For all three stocks, MAFMC and ASMFC are considering conservation equivalency measures and recreational slot limits.
Tilefish FMP	Golden tilefish in the Mid-Atlantic are managed by MAFMC (FMP in 2001). Total allowable landings, rebuilding plan, limited entry, and tiered commercial quota system.	Current management includes annual catch limits and accountability measures for overages. Commercial fishery under ITQ management, with catch limit in incidental fishery. Gear restricted areas to protect sensitive tilefish habitats in the heads of canyons. Blueline tilefish recently added to FMP. Fishery administration and catch limits processes updated 2018.	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information.
Northern Shrimp FMP	ASMFC plan implemented 1986. Management measures included minimum mesh size, seasonal closures, possession limits, and reporting requirements.	Assessments and specifications process ongoing, although currently the fishery is closed given the status of the stock.	Ongoing specifications actions may allocate annual catch limits in response to updated assessment information that abundance has increased.

Fishery Management Plan	Past actions	Present actions	Future foreseeable actions
American Lobster FMP	ASFMC plan in state waters, federally managed in Federal waters consistent with ASMFC approach. Area-based management system with trap limits, minimum-maximum size limits, and protections for egg-bearing females.	Area-based management system with trap limits, minimum-maximum size limits, and protections for egg-bearing females. Focus on fishing mortality reduction in Southern New England. Monitoring changes via Addendum XXVI (2018).	Ongoing specifications actions will allocate annual catch limits in response to updated assessment information.

8.1.2 Protected resources management

Protected resource management (Table 99) focuses on evaluation of stock status, identification of fisheries and other activities that interact with protected resources, and development of measures to minimize interactions and the negative impacts associated with interactions that do occur. Management may also include designation of critical habitats. Protected resource conservation measures include among other measures restrictions on fishing in specific areas and during particular seasons. These restrictions are additive to fishing restrictions designed to ensure conservation of managed fish and shellfish stocks. Measures also include areas closed seasonally to specific gears, and gear requirements (e.g. pingers, turtle-compliant dredges, sinking groundlines, etc.). During 2018 there has been a specific focus on conservation on Northern Atlantic right whales as a result of new information indicating that the North Atlantic right whale abundance has been in decline since 2010 and the relatively high number of right whale deaths in recent years, specifically 2017 (Pettis et al. 2018; Pace et al. 2017). This focus on measures to protect right whales is expected to continue.

Table 99 – Past, present, and future foreseeable actions within the protected resource management plans plans in operation in the New England region

Plan	Past actions	Present actions	Future foreseeable actions
Harbor Porpoise Take Reduction Plan	Spatial and seasonal gear restrictions to minimize interaction, injuries, and mortalities between fishing gear and harbor porpoises, including requirements for pingers. Modifications to plan (effective September 30, 2013) eliminated consequence closure areas.	Continue previous actions	Continue previous actions
Atlantic Large Whale Take Reduction Plan	Spatial and seasonal gear restrictions to minimize serious injuries, and mortalities between vertical lines and large whale species. Changes to plan were published June 2014 (79 FR	Continue previous actions. Focus on conservation actions for North Atlantic Right Whale,	Continue previous actions. Expect ongoing focus on conservation actions for North

	36586), December 2014 (79 FR 73848), and May 2015 (80 FR 30367).		Atlantic Right Whale.
Ship strike reduction programs	Reporting systems and speed restrictions to minimize ship strike events; education/outreach activities	Ongoing development of temporary speed restricted areas as needed	Continued updates to measures to reduce ship strikes as technology improves
Sea turtle regulations	Annual fisheries observer coverage requirements for certain fisheries; requirements on handling and resuscitation. Biological opinions have led to gear requirements in sea scallop fishery, summer flounder fishery, NC/VA large mesh gillnet fishery, and VA pound net fishery.	Continue previous actions including coordination with stranding and disentaglement networks.	Continue previous actions
Shortnose Sturgeon Recovery Program	Fishing for, catching or keeping shortnose sturgeon illegal; federal agencies that conduct, fund or authorize activities that may adversely affect shortnose sturgeon must consult with NOAA; periodic status reviews; development and implementation of recovery plan (1998). A biological assessment was completed in 2010.	Continue previous actions	Continue previous actions
Atlantic Sturgeon Recovery Program	Fishing for, catching or keeping Atlantic sturgeon illegal; various restrictions by state. Intent to conduct 5-year review issued in 2018.	Continue previous actions	Continue previous actions.
Atlantic Salmon Recovery Program and General Conservation Plan	Species listings by distinct population segment; designation of critical habitats	General Conservation Plan to promote fish passage and dam removals; issued a revised recovery plan in 2019.	Continue previous actions
Proactive Conservation Program for Species of Concern and Candidate Species	Grants to fund research activities, monitoring of status of species of concern/candidate species.	Continue previous actions	Continue previous actions
Stranding and disentangle ment program	Network of organizations that respond to dead, sick, injured, or entangled marine mammals and sea turtles. Response often includes rescue, rehabilitatation, and release of mammal or sea turtle.	Continue previous actions	Continue previous actions

8.1.3 Other industrial uses of the marine environment

Non-fishing activities (Table 100) combine with fishery management efforts to affect the VECs considered in this action. Wherever these activities co-occur, they are likely to work additively or synergistically to decrease the quality of the physical and biological environment, and, as such, may indirectly constrain the sustainability of the managed resources, protected resources, and human communities associated with fishing. Offshore wind energy is a particularly active area at present and for the near future.

Table 100 – Past, present, and future foreseeable non-fishing activities within the New England region

Activity	Past actions	Present actions	Future foreseeable actions
Offshore renewable wind energy	Bureau of Ocean Energy Management (BOEM) oversees offshore wind leasing and development. First small-scale 5 turbine windfarm off RI operational 2016.	Leases have been sold along the entire Atlantic coast offshore MA south to NC. Other wind energy areas have been identified for future leasing. Many projects in the site assessment and construction/operations planning phase.	Constrution of new facilities expected to begin in early 2020s. Additional leasing of new areas. Site assessment, permitting, and planning will continue.
Petroleum exploration	Seismic testing, drilling sediment cores and test wells. Leases sold and test wells drilled in late 1970s and early 1980s; given findings, no additional test well activity after that (see http://www.boem.gov/OCS-Report-MMS-2000-031/) for more information.	Bureau of Ocean Energy Management (BOEM) oversees these activities; currently we are within the 2017-2022 planning period, and there are no lease sales proposed in the North Atlantic. An updated 5-year program is under development, which will revise and replace the 2017-2022 program prior to its expiration. Geological and geophysical survey permits presently being inssued in Mid-Atlantic region.	Depends on outcome of 5-year plan revisions; could potentially include additional resource assessment and possible leases in the North and Mid-Atlantic regions.
Liquefied natural gas facilities	Three New England import facilities, one land-based just north of Boston, MA, and two offshore of Cape Ann, MA. See http://www.northeastgas.org/about_lng.php.	Existing facilities are not especially active and imports of LNG have been down in New England from 2006-2010 levels, although up from 2014 lows. See https://www.northeastgas.org/pdf/lng_annual0218.pdf.	The U.S. Department of Energy regulates import and export of natural gas and would approve new import facilities or import to export facility conversions. Given excess capacity at existing New England import terminals, new terminal construction does not appear likely, at least in the short term.

Activity	Past actions	Present actions	Future foreseeable actions
Wave and tidal energy	Regulations for the Outer Continental Shelf Renewable Energy Program published in 2009; these include offshore wind energy as well as wave and current (i.e. hydrokinetic) energy projects. BOEM oversees development of these types of projects.	Information about current projects can be found here: http://en.openei.org/wiki/Marine_and_Hydrokinetic_Technology_Database. Various projects in Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut are in the siting/planning, site development, and device testing phases. There are no deployed projects in the New England region.	Future projects could be developed pursuant to the 2009 regulations.
Aquaculture	Existing facilities in New England are in currently in state waters only. There are facilities oriented towards commercial production as well as restoration aquaculture (e.g. oyster reefs, hatcheries).	Currently there are facilities in all coastal New England states, with the largest number of operations in Maine. NH, MA, RI, and CT focus mainly on shellfish, although NH has a steelhead trout facility. Maine raises a diversity of finfish and shellfish species including Atlantic salmon. Salmon is the dominant finfish aquaculture species in New England. Algae and seaweeds are also currently grown.	Expansion of aquaculture appears likely and could include offshore waters in the future. Many factors influence the rate of growth in this sector such as permitting concerns, availability of suitable sites, and regulatory stability. The National Sustainable Offshore Aquaculture Act of 2011 establishes a permitting and programmatic review system for offshore aquaculture sites, although the extensive regulatory requirements of the law could discourage entry into the system (Lapointe, 2013).
Offshore mineral mining	BOEM oversees offshore mineral extraction. First marine minerals program lease executed in 1995.	BOEM has signed agreements with various states to evaluate sand resources for coastal resilience and restoration. Sand mining projects are ongoing in the northeast region. BOEM and USGS collaborating as of December 2017 to locate critical mineral resources on OCS.	Assessment, leasing, and extraction of marine minerals resource areas expected to continue.

Activity	Past actions	Present actions	Future foreseeable actions
Offshore vessel disposal	Previous vessel disposal activity	The Environmental Protection Agency approves requests for vessel disposal offshore; a handful of vessels have been disposed of in the past few years in the western Gulf of Maine	Continued disposal of vessels at sea through EPA process (see http://www.epa.gov/region2/water/oceans/wrecks.htm)

8.1.4 Climate change

Globally, conditions in the oceans, atmosphere, and cryosphere (ice cover) are changing. These shifts will affect ecosystem components including fishery resources, their habitats, and the human communities that depend on them, as well as protected resources. Climate science is complex, and synthesis and vetting of models and their conclusions rely on an extensive body of experts working in many different scientific fields. The Intergovernmental Panel on Climate Change or IPCC published their fifth and most recent assessment report in November 2014. The sixth report is under development and due out in 2022. Although a detailed description of the underpinnings of climate science and a discussion of the results of climate projection models are beyond the scope of this document, a few conclusions from the fifth assessment synethesis report (IPCC 2014) are highlighted here.

- "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.
- In recent decades, changes in climate have caused impacts on natural and human systems on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate.
- Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is very likely that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level to rise."

The magnitude and direction of changes in sea surface and bottom temperature and salinity are predicted to vary by region. Saba et al. (2015) explore differences between lower and higher resolution climate models with regards to projections for the northwest Atlantic Ocean in particular. In the northwest Atlantic, colder, fresher waters have a generally southwesten flow via the Labrador Current, while warmer, saltier waters move northeast with the Gulf Stream. The Northeast Channel separates Georges Bank from the Scotian shelf and allows slope (Gulf Stream) and shelf (Labrador Current) waters to mix in the relatively enclosed Gulf of Maine. While acknowledging the increased implementation costs associated with high resolution models, Saba et al. note that

NOAA's Geophysical Fluid Dynamics Laboratory's high-resolution global climate model CM2.6 can resolve important features of the northeast shelf, including the Northeast Channel, that lower resolution models do not resolve. This high-resolution model predicts temperature changes of +3°C in the upper 300 meters of the ocean in response to a doubling of carbon dioxide concentration in the atmosphere, which is a faster (2-3x) rate of increase compare to CM2.6's global average, and twice as fast as a coarser resolution climate model, CM2.1. Saba et al. suggest that the Atlantic Meridional Overturning Circulation, which appears to have a robust and inverse relationship with the position of the Gulf Stream, likely has a substantial influence on temperature patterns in the northwest Atlantic via its influence on the Gulf Stream. They surmise that models that can accurately capture the likely magnitude of weakening of the AMOC should better predict oceanographic changes in the region.

The fifth IPCC assessment estimated that the oceans have absorbed approximately 28% of human-generated carbon emissions since 1750 (IPCC 2014). While this absorption helps to sequester atmospheric carbon in the oceans, it does impact ocean chemistry. Specifically, when carbon dioxide chemically reacts with seawater, carbonic acid is produced, which decreases the pH of seawater. This ocean acidification can have biological effects because lower carbonate ion concentrations lead to lower calcium carbonate saturation levels, which in turn can negatively affect the ability of certain marine organisms to build and maintain bones and shells (Fabry et al. 2008, Feely et al. 2009). Calcium carbonate is present in multiple forms, including aragonite, calcite, high magnesium calcite, and amorphous calcium carbonate (Fabry et al. 2008). These different molecules vary in their chemistry and are used differently by various marine organisms. While the impacts of changes in ocean chemistry will be challenging to predict at the population or ecosystem level, they will certainly be negative, and more impactful more quickly for some organisms than others. Deep-sea corals are known to be sensitive to changes in ocean temperature and chemistry (e.g. Dodds et al. 2007, Gómez et al. 2018, Gammon et al. 2018) such that changes in these environmental parameters could compromise coral populations.

8.2 Baseline status of Valued Ecosystem Components

This section summarizes the current status of all VECs, based on past and present actions but not including the proposed action.

8.2.1 Deep-sea corals

Coral observations in the New England region date back to the late 1800s (see section 6.2.1 for details). Anecdotal information suggests that corals may have occurred in additional locations where they are not found at present, but changes in their distribution and abundance as compared to today are not well understood. Coral habitats in the Gulf of Maine are within depths that are fished by both mobile and static bottom tending gears, such that corals in the Gulf of Maine may have been removed by fishing. Corals occurring along the shelf break south of Georges Bank in relatively shallow depths of 200-500 meters may have also been susceptible to removals, as both trawling and pot fishing are known to occur in this location and at these depths. Given the sensitivity and longevity of many corals any removals due to fishing are likely to cause a long-term impact.

Despite potential, albeit poorly understood, impacts to coral habitats in shallower waters, deeper coral habitats in New England are likely to be relatively unaffected by human-caused disturbance. Because they lie beyond the depths at which most types of fishing occurs, the canyons and slope from around 500 m to the base of the slope at around 2500 m are likely relatively undisturbed. In addition, portions of the slope and especially the canyons are extremely steep such that they are not suitable for setting fixed fishing gears or towing mobile gears. While seamounts in other parts of the world are or have been fished, fishing with bottom-tending gears is not known to occur on the New England seamounts.

Other non-fishing human impacts in the deeper waters off New England may have had some impacts on coral habitats, although these are probably limited. There was some oil and gas exploration on and south of Georges Bank in the late 1970s and early 1980s, but commercial production was not permitted. Transatlantic submarine cables occur in proximity to coral habitats and their installation could have localized negative impacts. However, considering all of these factors, coral habitats in New England are likely in good condition overall, with reductions in corals in shallower areas but not in deeper ones.

8.2.2 Managed species and essential fish habitats

The managed species VEC includes the following fishery resources. Section 6.7 describes the biology, status, and distribution of these resources, as well as the fisheries which prosecute them. Additional information is provided in Vol 1 section 4.3 of the OHA2 FEIS (NEMFC 2016) and in individual FMPs for the species. The focus here is the status (overfished/overfishing occurring) of the various species, including the status by stock if the species is not managed as a single unit.

- Northeast multispecies
- Monkfish
- Deep-sea red crab
- Atlantic mackerel, squid, butterfish
- Golden tilefish
- American lobster
- Jonah crab

In summary, the majority of stocks that overlap the coral zones proposed for the New England region are not overfished with overfishing not occurring (Table 101). In general, past fishery management actions have contributed positively to stock status, but additional action will be necessary to rebuild all stocks in the region. With the exception of Atlantic mackerel, all stocks in the overfished/overfishing category are large-mesh groundfish managed under the Northeast Multispecies Fishery Management Plan. The stock status of Jonah crab is unknown.

Table 101 – Baseline status of stocks in the FMPs listed in the text above.

	Fishing mortality below reference point	*Fishing mortality above reference point*
Stock size above reference point	Not overfished, overfishing not occurring: Acadian redfish, American plaice, Gulf of Maine haddock, Georges Bank haddock, pollock, white hake, southern windowpane flounder, GOM winter flounder, southern red hake, northern and southern silver hake, northern and southern monkfish, Atlantic mackerel, golden tilefish, GB/GOM lobster	Not overfished, overfishing occurring: None
Stock size below reference point	Overfished, overfishing not occurring: Atlantic halibut, Atlantic wolffish, ocean pout, northern windowpane flounder, witch flounder, SNE/MA winter flounder; SNE lobster (depleted)	Overfished, overfishing occurring: Gulf of Maine Atlantic cod, Georges Bank Atlantic cod, Cape Cod-Gulf of Maine yellowtail flounder, Georges Bank yellowtail flounder, Southern New England/Mid-Atlantic yellowtail flounder, red hake, Atlantic mackerel

Long term climate shifts combined with decadal oscillations and interannual variability produce the ocean conditions experienced by managed species. The effects of climate change on the physical environment, i.e. changes in temperature, salinity, pH, sea level, and currents, influence habitat suitability. Species vary in terms of their sensitivity to these climate factors. Based on species-specific biological attributes, Hare et al. (2016) estimate the likely effects of climate factors on managed and unmanaged biological resources, combining effects across factors to generate an overall assessment of vulnerability to climate change for each species. These species-level vulnerabilities are described briefly here as background, as they influence the evaluation of the cumulative effects that this amendment and other ongoing present and future forseeable actions will have on the status of managed resource.

Hare et al. summarize the results of their assessment in a matrix, where biological sensitivity and climate exposure are used in combination to categories fish and invertebrate species occupying the Northeast U.S. continental shelf. Based on climate model results, all species living in the region were likely to experience either high or very high climate exposure, with no species expected to experience low or moderate climate exposure. However, species' sensitivity varied from low to very high. The vulnerability categories of greatest concern were those where sensitivity, exposure, or both were estimated to be very high. The matrix is reproduced below for the subset of species considered to be part of the managed resources affected environment in this amendment.

Table 102 – Vulnerability of managed species to climate change, reproduced from Hare et al. 2016. Overall climate vulnerability is denoted by color: low (green), moderate (yellow), high (orange), and very high (red). Only for species included in the FMPs listed in the text above.

Biological sensitivity	Climate exposure: High	Climate exposure: Very high
Very high		Atlantic salmon
High	Atlantic halibut, Tilefish, Ocean pout, Atlantic wolffish, Witch flounder	Winter flounder
Moderate	Acadian redfish, American lobster, Atlantic cod, White hake, Pollock	
Low	Butterfish, Longfin inshore squid, Silver hake, Winter skate, Northern shortfin squid, Deep-sea red crab, Red hake, Offshore hake, Monkfish, Haddock, Windowpane, Yellowtail flounder, American plaice	

Growth rate of the population, stock status, and adult mobility had the strongest influence on vulnerability. For winter flounder, stock status was an important contributor to the overall sensitivity score, as well as two early life history sensitivity variables. Atlantic salmon are currently at low abundance and have specialized habitat requirements particularly related to their reproduction. Atlantic halibut, Atlantic wolffish, and witch flounder have low stock status and population growth rate. Wolffish also have complex reproductive habits in that they require specific habitat types and guard their eggs for relatively long periods. Tilefish are not at low abundance but do have low population growth rate.

Climate-induced changes are already evident among northeast managed species. Nye et al. (2009) examined Northeast Fisheries Science Center trawl survey data through 2007 and found evidence for poleward movement, change in area occupied, change in maximum or minimum latitude, change in mean temperature of occurrence, and/or change in mean depth of occurrence for 24 of 36 stocks examined. All of these changes are not necessarily negative, for example, the ability of a stock to undergo range expansion may be a positive adaptation under a changing climate. However, some changes indicate vulnerability to climate shifts. Specifically, southern and northern silver hake and red hake, Georges Bank cod, white hake, halibut, southern winter and yellowtail flounders, windowpane flounder, monkfish, and ocean pout showed a poleward shift in their distribution. While evidence or range expansion was present in some stocks, others stocks showed evidence of range contraction, including Georges Bank cod, southern yellowtail flounder, redfish, and wolffish. Movement into deeper waters could indicate that the fish are seeking refuge from warm summer temperatures. Gulf of Maine cod showed shifts in their centers of biomass and moved into deeper waters. Pollock and wolffish, which are all most abundant in the Gulf of Maine region, did not show shifts in their center of biomass, but were found in increasingly deeper waters over time.

8.2.3 Human communities

The various fisheries that are likely to be affected are described in section 6.7. These include fisheries for large and small mesh Northeast multispecies, monkfish, deep-sea red crab, mackerel/squid/butterfish, tilefish, lobster/Jonah crab. Recent fishery management plan actions should be consulted for detailed assessments of fishery status and communities affected. Fisheries of the United States 2017 (NMFS 2018) summarizes overall fisheries economics of the United States during 2017.

The status of these fisheries is mixed, with most fisheries relatively stable and others on the decline. In the Northeast Multispecies large-mesh fishery, ceclining fishery conditions may be linked to poor conditions for some stocks. In the monkfish fishery, landings have been on a downward trend, but monkfish catch limits do not appear to be the limiting factor. A number of other fisheries have stable landings that are below allocations.

A “fishing community” is defined in the Magnuson-Stevens Act, as amended in 1996, as “a community which is substantially dependent on or substantially engaged in the harvesting or processing of fishery resources to meet social and economic needs, and includes fishing vessel owners, operators, and crew and United States fish processors that are based in such community” (16 U.S.C. § 1802(17)). Fishing communities that are likely to be influenced by the alternatives in this amendment are listed in Table 29. The specific communities of interest were identified through the economic analysis of vessel trips most likely to be impacted by the addition of new closed areas. Depending on the status of their dominant fisheries, the associated communities may be on a positive, stable, or negative trajectory. Many other factors contribute to community status besides fishery conditions; but the community indicator tables provided in provide an indication of which communities are most engaged in and reliant on commercial and/or recreational fisheries (Table 30).

Fishery management actions and stock status are assumed to be the major contributors to fishery status and associated community impacts, with protected resources management and non-fishing uses of the marine environment contributing incidentally to fishery and community baseline status. Some protected resource conservation measures negatively impact fishing operations, restricting the use of particular gear types during specific seasons and in specific areas. In some cases, these regulations restrict use of a gear entirely, but in other instances there are gear modifications required only, such as vessel speed restrictions, pinger requirements for gillnets, or use of turtle excluder dredges in the scallop fishery.

Changes in the abundance and distribution of biological resources affect the communities that prosecute fisheries for these resources. For example, if the target species important to a particular port community declines in abundance or its distribution shifts north or south due to environmental factors, there may be negative economic impacts locally, although there could be positive impacts due to increases in abundance of other species. It is impossible to pinpoint the degree to which these types of environmental changes are influencing the baseline status of the VECs analyzed in this action, but certainly regional-scale changes in climate combine with fishing and non-fishing human activities to shape the baseline status.

Table 103 – Baseline status of fisheries

Fishery	Status and trends
Northeast multispecies large mesh fishery	Murphy et al. 2018 provides a summary of the economic performance of the Northeast multispecies fishery through the end of fishing year 2015 (April 2016). Groundfish revenue decreased to a low of $51.2 million in 2015, and non-groundfish revenues have become increasingly important to the fleet. This decline resulted from a combination of reduced landings and reduced or stable prices depending on the species. The size of the fleet and effort have also declined.
Northeast multispecies small-mesh	The small mesh/whiting specifications were recently updated through fishing year 2020. A detailed update of the fishery trends was prepared for Amendment 22 to the Northeast Multispecies FMP which considered but did not recommend a limited entry system for the fishery. Between 2002 and 2016, silver hake landings fluctuated between 5,000-8,000 mt, with landings around 6,000 mt ($10 million revenue) in 2016. About half of 2016 landings were from the northern area and half were from the southern area, which represents an increase in northern area landings. Offshore hake landings are very minor, and red hake are less commercially important.
Monkfish	Landings in both the northern and southern areas combined peaked in FY 2003 but have since declined to reach a relatively stable level between FY2011 – 2014. FY 2015 landings showed a slight increase in landings in the NFMA and a slight decrease in the SFMA, however, it is not clear yet whether this represents a new trend.
Deep-sea red crab	The 2017-2019 specifications package reviewed updated landings, LPUE and port sampling data which indicated landings have increased since 2013, and in 2015 the landings were among the highest since implementation of the Red Crab FMP in 2002. Annual landings by region indicate the fishery has been operating nearly equally in all regions (Georges Bank/southern New England, New Jersey, and Delmarva) in recent years.
Atlantic mackerel, squid, and butterfish	The Mid-Atlantic Fishery Management Council's fishery information document (2018) summarizes the current status of these fisheries. Mackerel landings have declined since the mid-2000s and have remained under 10,000 mt/$5 million in the past few years. Low Atlantic herring catch limits will likely constrain the mackerel fishery in the coming years. Illex squid landings have generally been increasing since the mid-2000s and were over 20,000 mt in 2017. Longfin squid landings have increased since 2010, with the exception of 2017. 2016 landings were particularly high, above 15,000 mt, and 2018 (preliminary) is showing an increase over 2017 catches. Butterfish landings have been increased since the early 2000s, from below 1000 mt annually to around 3500 mt in 2017, mostly landed in RI.
Golden tilefish	The Mid-Atlantic Fishery Management Council Golden Tilefish fishery information document (2018) summarizes the current status of the tilefish fishery. For the 2001 to 2017 period, golden tilefish landings have averaged 1.8 million pounds, ranging from 1.1 (2016) to 2.5 (2004) million pounds. In 2017, commercial golden tilefish landings were 1.5 million pounds. With the exception of FY 2010, commercial tilefish landings have been below the commercial quota specified each year since 2005. Commercial tilefish ex-vessel revenues have ranged between $3 and $6 million for the 2005 through 2017 period, peaking in 2013.

Fishery	Status and trends
American lobster	The lobster fishery is one of the top fisheries on the U.S. Atlantic coast (>$461M total revenue in 2013). Most landings are in Maine (over 80%), although Georges Bank and the canyons are also important grounds. The fishery has declined in Southern New England. Commercial Jonah crab landings were 2-3M lbs. throughout the 1990s, but steadily rose to over 17M lbs. in 2014. A similar increase occurred in the value of fishery, as ex-vessel values grew from about $1.5M in the 1990s to about $12.7M in 2013. Landings in 2014 predominately came from Massachusetts (70%), followed by Rhode Island (24%).

8.2.4 Protected resources

Various protected resources overlap the New England region. The distribution and status of those species potentially affected by the amendment are described in section 6.9.2. There are various large whales, sea turtles, Atlantic sturgeon and Atlantic salmon that overlap the region and are considered endangered or threatened under the Endangered Species Act. Various small cetaceans, large whales (i.e., minke and humpback), and pinniped species are also present in the affected environment of the action and are protected by the Marine Mammal Protection Act but are not listed under the ESA.

The population trends for protected resources are variable. Nest counts inform population trends for sea turtle species. In the affected environment (see section 6.9.2.4), four sea turtle species were identified as having the potential to be affected by the proposed action: Northwest Atlantic Ocean DPS of loggerhead, Kemp's ridley, North Atlantic DPS of green, and leatherback sea turtles. For the Northwest Atlantic Ocean DPS of loggerhead sea turtles, there are five unique recovery units that comprise the DPS. Nesting trends for each of these recovery units are variable; however, recent data from Florida index nesting beaches, which comprise most of the nesting in the DPS, indicate a 19% increase in nesting from 1989 to 2018 (https://myfwc.com/research/wildlife/sea-turtles/nesting/loggerhead-trends/). For Kemp's ridley sea turtles, from 1980 through 2003, the number of nests at three primary nesting beaches (Rancho Nuevo, Tepehuajes, and Playa Dos) increased 15 percent annually (Heppell et al. 2005); however, due to recent declines in nest counts, decreased survival of immature and adult sea turtles, and updated population modeling, this rate is not expected to continue and the overall trend is unclear (NMFS and USFWS 2015; Caillouett et al. 2018). The North Atlantic DPS of green sea turtle is showing a positive trend in nesting (Seminoff et al. 2015). Leatherback turtle nesting in the Northwest Atlantic is showing an overall negative trend, with the most notable decrease occurring during the most recent time frame of 2008 to 2017 (NW Atlantic Leatherback Working Group 2018).

In terms of protected species of marine mammals, large whale assessments indicate that for some species there is an increasing (i.e., humpback whales) or decreasing (i.e., North Atlantic right whales) trend in the population, while for other species, as a trend analysis has not been conducted, it is unknown what the population trajectory is (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region). For most small cetacean and pinniped populations, it is unknown what the population trajectory is as a trend analysis has not been conducted for these populations (https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region). However, in the most recent stock assessment report, poplution trends were provided for common bottlnose dolphin stocks and gray seals; the analysis indicated a declining trend in population size for all common bottlenose dolphin stocks and an increasing trend for the gray seal population (Hayes et al. 2018).

Population trends for Atlantic sturgeon are difficult to discern; however, the most recent stock assessment report concludes that Atlantic sturgeon, at both the coastwide and DPS level, are depleted relative to historical levels (ASSRT 2007; ASMFC 2017). There is no population growth rate available for Gulf of Maine DPS Atlantic salmon; however, the consensus is that the DPS exhibits a continuing declining trend (NOAA 2016; USFWS and NMFS 2018).

8.3 Combined direct impacts of proposed coral management measures and other combinations of alternatives

This section summarizes the impacts analysis from section 6.9.3 for three groupings of alternatives: the areas evaluated under No Action, the Council's preferred alternatives, and for comparison purposes, a maximum conservation alternative that includes the most extensive management areas and the most comprehensive fishing restrictions.

8.3.1 No Action management areas with coral conservation benefits

The No Action management areas evaluated in this amendment include the Lydonia and Oceanographer Canyon closures in the monkfish and mackerel/squid/butterfish FMPs, three New England tilefish gear restricted areas, and the Northeast Canyons and Seamounts Marine National Monument. The fishery management areas restrict mobile bottom tending gears, while the monument designation prohibits all commercial fishing, although the prohibition on lobster and red crab pot fishing has not yet taken effect. Cumulatively, these areas provide protection for Veatch Canyon, as well as Lydonia and Oceanographer Canyons and the minor canyons in between, including Filebottom, Chebacco, and Gilbert. The marine monument also encompasses four seamounts and their immediate surrounds to the EEZ boundary.

The No Action management areas are expected to have positive impacts on corals and managed species, slightly negative effects on human communities, negative to neutral impacts on large whales, and slightly negative to neutral impacts on small cetaceans, and negative to slightly negative impacts on turtles. The positive effects on corals and fishery resources stem from fishing gear restrictions in areas where corals and managed resources are known to occur. These restrictions are expected to reduce the impacts of gear on coral habitats in certain canyon and adjacent slope areas, and directly improving the condition of corals and indirectly improving the production of other species. In terms of fisheries and fishing communities, the effort displacement associated with these management areas has a small magnitude of impacts on a region-wide basis but may have significant effects on specific fishing businesses and will likely impact certain fisheries more than others. These impacts are described further in section 7.2.1.3. Any impacts on protected resources are the result of changing patterns in fishing effort that may concentrate fishing gear along other portions of the continental slope.

8.3.2 Preferred coral zones and fishing restrictions

The preferred alternatives designate three coral zones along the shelf break out to the EEZ boundary and in the inshore Gulf of Maine. Given the location of these zones and the specific fishing restriction measures associated with them, they are not likely to cause substantial displacement of fishing effort and therefore substantial impacts on the fishing industry, but they will prevent expansion of fishing into these areas in the future. Thus, impacts to deep-sea corals and managed resources which utilize coral habitats are expected to be positive in direction, but slight in magnitude. Impacts by alternative are summarized in Table 104. Because the alternatives are unlikely to have a material effect on the distribution of fishing effort, impacts to protected resources associated with changes in effort are unlikely to change from current conditions.

Table 104 – Summary of impacts of the preferred coral management alternatives on VECs

Alternative	Deep-sea corals	Managed species and EFH	Human communities	Protected resources
Option 6 (600 m minimum) as a closure to all bottom tending gear with a red crab trap exemption	Positive	Slightly positive, indirect	Neutral to slightly negative	Neutral
Mt. Desert Rock boundary option 1 as a closure to all mobile bottom-tending gear	Slightly positive	Slightly positive, indirect	Slightly negative	Neutral
Outer Schoodic Ridge as a closure to all mobile bottom-tending gear	Slightly positive	Slightly positive, indirect	Slightly negative	Neutral
Creates research activity notification requirement for coral zones	Slightly positive	No impacts	Neutral	No impacts
Ability to add, revise, or remove coral zones via framework action	Slightly positive	Neutral	Slightly positive, indirect	No impacts
Ability to add, revise, or remove fishing gear restrictions via framework action	Slightly positive	Neutral	Slightly positive, indirect	No impacts
Ability to develop or adjust special fishery programs via framework action	Slightly negative	Neutral	Slightly positive, indirect	No impacts
Jordan Basin DHRA designation; no fishing restrictions	Slightly positive	Slightly positive, indirect	Slightly positive, indirect	Neutral

8.3.3 Coral zones and fishing restrictions with maximum conservation benefits

For the purpose of this analysis and for the evaluation of EO 12866 significance and the regulatory flexibility analysis, a maximum conservation alternative package of coral zones and restrictions was identified. This package includes the 300 meter broad zone, all of the discrete canyons zones (Alvin, Atlantis, Nantucket, Veatch, Hydrographer, Dogbody, Clipper, Sharpshooter, Welker, Heel Tapper, Oceanographer, Filebottom, Chebacco, Gilbert Lydonia, Munson, Powell, Nygren, Kinlan, Heezen), and all of the Gulf of Maine zones with the larger boundaries for those with two boundary options (Outer Schoodic Ridge, Mount Desert Rock, the 114, 96, and 118 Fathom Bumps in Western Jordan Basin, Lindenkohl Knoll, and Central Jordan Basin). For this scenario, the areas would be designated as closures to all bottom-tending gear fishing, with no exemptions for red crab, lobster, or other types of trap gears.

These alternatives are generally similar to the preferred alternatives in that they would establish coral management areas and fishery restrictions in those areas, but the areas are generally larger in size and include additional locations, and the fishing restrictions include additional gear types and would displace more fishing effort. As a result, the impacts to corals and indirect impacts to managed species are expected to be more positive than for the preferred alternatives, but the associated negative impacts to fisheries and fishing communities are expected to be more negative (Table 105). Trap effort would be expected to shift under these alternatives, potentially becoming more concentrated in areas adjacent to the coral zones, which could have negative impacts on large whales, and slightly negative impacts on cetaceans and turtles. Effort shifts in the inshore Gulf of Maine associated with closure of those zones to all bottom-tending gears, including lobster pots, could have negative impacts on large whales and slight negative impacts on small cetaceans and turtles. The offshore Gulf of Maine zones could have negative impacts on large whales, small cetaceans, and turtles, if closed to all bottom-tending gears.

Table 105 – Summary of impacts of the maximum conservation coral management alternatives on VECs

Alternative	Deep-sea corals	Managed species and EFH	Human communities	Protected resources
Broad zone Option 1 (300 m)	Positive	Slight positive	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative on large whales, slightly negative on small cetaceans and turtles.

Alternative	Deep-sea corals	Managed species and EFH	Human communities	Protected resources
Discrete canyon zones	Positive	Slight positive	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative on large whales, slightly negative on small cetaceans and turtles.
Mt. Desert Rock (boundary option 1, gear option 1)	Positive	Positive	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative on large whales, slightly negative on small cetaceans and turtles.
Outer Schoodic Ridge (gear option 1)	Positive	Positive	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative on large whales, slightly negative on small cetaceans and turtles.
Jordan Basin (boundary option 1, gear option 1)	Positive	Positive	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative on large whales, small cetaceans, and turtles.
Lindenkohl Knoll (boundary option 1, gear option 1)	Positive	Positive	Slight negative overall; negative for affected fishing businesses and communities displaced by the alternative.	Negative on large whales, small cetaceans, and turtles.

8.4 Cumulative effects summary

For deep-sea corals, both the No Action and preferred alternatives (which will be in effect together upon implementation of this amendment) are expected to have a positive impact. The benefits of coral conservation in a fisheries context may help to buffer against any negative effects of environmental change, including ocean acidification or temperature increases. The potential impacts off offshore oil and gas development on coral habitats are of ongoing concern, although the potential for such development in the North Atlantic region over the next ten years is presently uncertain.

For managed species, both the No Action and preferred alternatives are expected to have positive impacts, albeit indirect ones, through habitat protections for these stocks that are expected to enhance production. Combined with other fishery management actions in particular, these alternatives are expected to contribute to a positive trajectory for these resources over the next ten years. Other uses of the marine environment, as well as environmental change, are expected to have countervailing effects on these resources, although these effects are difficult to estimate precisely.

For fisheries and fishing communities, both the No Action and preferred alternatives are expected to have negative impacts, which will combine with any negative effects associated with other human uses of the marine environment as well as impacts associated with environmental change. Because the impacts of the preferred alternative on human communities are not expected to be substantial in magnitude, is is unlikely that this amendment specifically will materially alter the trajectory of human community status.

For protected resources, the No Action alternatives are expected to have negative to slight negative effects on protected resources associated with displacement of fishing effort. The preferred alternative, when combined with No Action, is unlikely to have additional negative impacts on protected species beyond those assessed under No Action. Other stressors are likely to be more important determinants of protected resource status over the coming ten-year period.

9 Consistency with the Magnuson Stevens Fishery Conservation and Management Act

This section summarizes how this action complies with the Magnuson Stevens Fishery Conservation and Management Act (MSA).

9.1 National Standards

Section 301 of the MSA requires that fishery management plans contain conservation and management measures that are consistent with the ten National Standards:

(1) Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

The Council continues to meet the obligations of National Standard 1 by adopting and implementing conservation and management measures that will continue to prevent overfishing, while achieving, on a continuing basis, the optimum yield (OY) for all Council managed fisheries. To achieve OY, scientific and management uncertainty are considered when establishing catch limits. The Council adopts catch recommendations that do not exceed the recommendations of the SSC and account for scientific uncertainty. In addition, the Council considers relevant sources of management uncertainty and other social, economic, and ecological factors when setting catch limits. This action proposes to restrict the use of bottom-tending gear in some areas but will not impact the process of setting catch limits to prevent overfishing, nor is it expected to prevent the fisheries managed by this Council, or the Mid-Atlantic Fishery Management Council, from achieving their catch targets.

(2) Conservation and management measures shall be based upon the best scientific information available.

The data sources considered and evaluated during the development of this action include, but are not limited to: permit data, landings data from vessel trip reports, fishing locations from vessel monitoring system data, information from resource trawl surveys, sea sampling (observer) data, data from the dealer weighout purchase reports, peer-reviewed assessments and original literature, internally reviewed NOAA literature, databases, and models, direct communication with principal investigators from recent research projects, and descriptive information provided by fishery participants and the public. To the best of the Council's knowledge these data sources constitute the best scientific information available. All analyses based on these data have been reviewed by the National Marine Fisheries Service and the public.

Spatial alternatives for coral protections in this amendment (section 4.2) were developed based on several quality datasets for coral distribution, abundance, and habitat. The Option 1-6 broad coral zone boundaries were developed based on high-resolution bathymetry data and were intended to approximate specific depth contours. The Option 7 broad coral zone also considered trawl fishing locations based on VMS, a coral habitat suitability model developed by NOAA (Kinlan et al. 2013), areas of very high seafloor slope (> 30°), and coral occurrence records.

Canyon discrete coral zone boundaries were developed based on high resolution digital elevation model, including the derived slope data, the habitat suitability model, and coral occurrence records. Seamount discrete coral zone boundaries were based on bathymetric data. Gulf of Maine dicrete zone boundaries were based on a combination of digital elevation models and coral occurrence data, with the elevation data used to delineate the spatial extent of seafloor features similar to those from which corals were positively identified.

Very high seafloor slope has been shown to be highly correlated with coral presence. The habitat suitability model has performed well in groudtruthing and represents the best relevant scientific information available to the Council at this time since it incorporates established factors supporting coral presence. The model has been internally reviewed by NCCOS and NEFSC to meet technical standards for data quality, and detailed metadata have been produced and made publicly available as part of the full data package. The model output package was subsequently provided to the NOAA Coastal Services Center/Bureau of Ocean Energy Management’s Multipurpose Marine Cadastre, where it underwent another review process with internal and external reviewers.

Coral occurrence data included coral presence records from a database provided by NEFSC. In addition, the Council considered data and findings from several recent deep-sea research cruises, funded by NOAA’s Deep-Sea Coral Research and Technology Program and NOAA’s Office of Ocean Exploration and Research (OER). The Council coordinated with lead scientists on these expeditions to ensure proposed management measures and analysis incorporated the most accurate and up to date information regarding coral presence and distribution in the New England Council region.

(3) To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

All NEFMC and MAFMC fishery management plans manage unit stocks.

(4) Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

The proposed management measures are not expected to discriminate between residents of different States. This action does not allocate or assign fishing privileges among various fishermen.

(5) Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

The Council considered the practicability of measures, including efficient utilization of fishery resources, when identifying preferred alternatives for this amendment, i.e., balancing the needs of the fisheries in addition to the benefits of deep sea coral protections. Impacts to the human community including economic information were provided to the Council in a draft environmental assessment/amendment document prior to final action. Voting members considered oral and written input from the Council's committees and advisory panels, as well as input from fishing industry members and representatives of conservation non-governmental organzations attending its meetings. While the proposed measures are expected to result in small changes to fishing patterns (mainly the spatial distribution of effort), the measures are not expected to substantially impact the overall efficiency of utilization of fishery resources. In addition, the proposed measures include provisions for allowing transit through closed areas to avoid inefficient transit around closed areas in the heads of canyons. No measures are proposed regarding economic allocation.

(6) Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

In order to provide the greatest flexibility possible for future management decisions, this amendment includes framework adjustment provisions allow the Council to adjust coral management approaches as conditions in the fishery change.

(7) Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

The Council considered the costs and benefits associated with the management measures proposed when developing this action. The measures in this amendment are generally complementary to but dissimilar from other habitat protection measures in the Council's family of FMPs.

(8) Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities.

The human community impacts of the action are described in section 6.9.3 and are predicted to range from negative to positive. Positive impacts on human communities are associated with protection of the non-use value of corals, while any negative impacts are associated with fishing effort displacement. These negative impacts are mitigated by the fishing restriction measures selected and the location of the zones relative to fishing footprints. While the 600 m minimum depth broad zone makes up a very large area, fishing effort in this zone is very limited due to waters that are too deep and/or seafloor terrain that is too steep or rugged. While the area is fished with deep-sea red crab pots, this gear was exempted by the Council from any restrictions. In the Gulf of Maine, mobile bottom-tending gear fishing is very limited in and around the Mt. Desert Rock nor the Outer Schoodic Ridge coral zones. Thus, the actual area of fishing grounds expected to be impacted is small relative to the total footprint of effort for the affected fisheries. While some redistribution of fishing effort is expected, it is anticipated that effort will shift to areas just outside the coral zone boundaries, and the impacts on overall harvest in the affected fisheries will be minimal. Therefore, the Council's preferred measures are not expected to be highly controversial.

(9) Conservation and management measures shall, to the extent practicable, (A) minimize bycatch and (B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.

The MSA defines "bycatch" as fish that are harvested in a fishery, but are not retained (sold, transferred, or kept for personal use), including economic discards and regulatory discards. Deep sea corals fall under the statutory definition of "fish,"[10] thus, the MSA bycatch provisions are applicable to corals. The measures proposed under this action are designed to reduce interactions between commercial fishing gear and deep-sea corals, and consistent with the intent of National Standard 9 to minimize bycatch to the extent practicable. The proposed measures are not expected to substantially alter the catch composition or increase the bycatch rates of other species.

(10) Conservation and management measures shall, to the extent practicable, promote the safety of human life at sea.

Fishing is a dangerous occupation; participants must constantly balance the risks imposed by weather against the economic benefits. According to the National Standard guidelines, the safety of the fishing vessel and the protection from injury of persons aboard the vessel are considered the same as "safety of human life at sea." The safety of a vessel and the people aboard are ultimately the responsibility of the master of that vessel. Each master makes many decisions about vessel maintenance and loading and about the capabilities of the vessel and crew to operate safely in a variety of weather and sea conditions. This national standard does not replace the judgment or relieve the responsibility of the vessel master related to vessel safety. The proposed alternatives contain options to allow for transit over closed areas, which may allow vessels more flexibility to prevent dangerous activity meant to avoid going into a closed area. Given these provisions, the Council determined that safety at sea had been considered to the extent practicable and should not be materially affected by the proposed measures.

9.2 Other required provisions

Section 303 of the MSA contains 15 additional required provisions for FMPs, which are listed and discussed below. Nothing in this action is expected to contravene any of these required provisions.

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[10] *See* 16 U.S.C. § 1802(12) (defining "fish" as "finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals and birds").

(1) contain the conservation and management measures, applicable to foreign fishing and fishing by vessels of the United States, which are-- (A) necessary and appropriate for the conservation and management of the fishery to prevent overfishing and rebuild overfished stocks, and to protect, restore, and promote the long-term health and stability of the fishery; (B) described in this subsection or subsection (b), or both; and (C) consistent with the National Standards, the other provisions of this Act, regulations implementing recommendations by international organizations in which the United States participates (including but not limited to closed areas, quotas, and size limits), and any other applicable law

This action proposes gear restricted areas for deep sea coral protections and modifications to the framework provisions of the Council's FMPs. These habitat conservation measures, combined with other measures in the Council's FMPs, should continue to promote the long-term health and stability of the fisheries consistent with the MSA.

(2) contain a description of the fishery, including, but not limited to, the number of vessels involved, the type and quantity of fishing gear used, the species of fish involved and their location, the cost likely to be incurred in management, actual and potential revenues from the fishery, any recreational interest in the fishery, and the nature and extent of foreign fishing and Indian treaty fishing rights, if any

Amendments to the Council's individual FMPs provide this information. This document summarizes this information as appropriate in section 6.7.

(3) assess and specify the present and probable future condition of, and the maximum sustainable yield and optimum yield from, the fishery, and include a summary of the information utilized in making such specification

This provision is addressed via assessments that are conducted through a peer-reviewed process at the NMFS Northeast Fisheries Science Center. The available information is summarized in every FMP amendment, framework, or specifications document. Full assessment reports are available at: http://www.nefsc.noaa.gov/saw/.

(4) assess and specify-- (A) the capacity and the extent to which fishing vessels of the United States, on an annual basis, will harvest the optimum yield specified under paragraph (3); (B) the portion of such optimum yield which, on an annual basis, will not be harvested by fishing vessels of the United States and can be made available for foreign fishing; and (C) the capacity and extent to which United States fish processors, on an annual basis, will process that portion of such optimum yield that will be harvested by fishing vessels of the United States

Individual FMP amendment, framework, or specifications documents summarize this information. This amendment does not set catch limits or change capacity in any of the Council's fisheries.

(5) specify the pertinent data which shall be submitted to the Secretary with respect to commercial, recreational, and charter fishing in the fishery, including, but not limited to, information regarding the type and quantity of fishing gear used, catch by species in

numbers of fish or weight thereof, areas in which fishing was engaged in, time of fishing, number of hauls, and the estimated processing capacity of, and the actual processing capacity utilized by, United States fish processors

Individual FMP amendment, framework, or specifications document summarize this information. This amendment does not change reporting requirements in any way, except that research vessels working in coral zones are asked to request a letter of acknowledgement.

(6) consider and provide for temporary adjustments, after consultation with the Coast Guard and persons utilizing the fishery, regarding access to the fishery for vessels otherwise prevented from harvesting because of weather or other ocean conditions affecting the safe conduct of the fishery; except that the adjustment shall not adversely affect conservation efforts in other fisheries or discriminate among participants in the affected fishery

There are no such requests pending, but the plan contains provisions for framework actions to make modifications regarding access/permitting if necessary.

(7) describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under §*305(b)(1)(A), minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat*

The Council's recent Omnibus Essential Fish Habitat Amendment 2 described and identified EFH for all FMPs and included meaures to minimize adverse effects on these habitats. The coral zones and associated fishing restrictions proposed in this action spatially overlap with designated EFH and habitat areas of particular concern and protect sensitive seabed features including corals from damage.

(8) in the case of a fishery management plan that, after January 1, 1991, is submitted to the Secretary for review under §304(a) (including any plan for which an amendment is submitted to the Secretary for such review) or is prepared by the Secretary, assess and specify the nature and extent of scientific data which is needed for effective implementation of the plan

The preparation of this action included a review of the scientific data available to assess the impacts of all alternatives considered. No additional data was deemed needed for effective implementation of the plan.

(9) include a fishery impact statement for the plan or amendment (in the case of a plan or amendment thereto submitted to or prepared by the Secretary after October 1, 1990) which shall assess, specify, and describe the likely effects, if any, of the conservation and management measures on-- (A) participants in the fisheries and fishing communities affected by the plan or amendment; and (B) participants in the fisheries conducted in adjacent areas under the authority of another Council, after consultation with such Council and representatives of those participants;

This document provides an assessment of the likely effects on fishery participants and communities from the considered actions (see section 6.9.3).

(10) specify objective and measurable criteria for identifying when the fishery to which the plan applies is overfished (with an analysis of how the criteria were determined and the relationship of the criteria to the reproductive potential of stocks of fish in that fishery) and, in the case of a fishery which the Council or the Secretary has determined is approaching an overfished condition or is overfished, contain conservation and management measures to prevent overfishing or end overfishing and rebuild the fishery

Individual FMP amendment, framework, or specifications document summarize this information. If a fishery is declared overfished or if overfishing is occurring, another action would be undertaken to implement effective corrective measures.

(11) establish a standardized reporting methodology to assess the amount and type of bycatch occurring in the fishery, and include conservation and management measures that, to the extent practicable and in the following priority-- (A) minimize bycatch; and (B) minimize the mortality of bycatch which cannot be avoided

In June 2015, NMFS published a final rule implementing measures contained within an Omnibus Standardized Bycatch Reporting Methodology (SBRM) Amendment (80 FR 37182, June 30, 2015), which revised an older SBRM system that was invalidated by court order. This final rule established an SBRM for all FMPs administered by the Greater Atlantic Regional Fisheries Office. Additional details, including the final rule and supporting Environmental Assessment, are available at: https://www.greateratlantic.fisheries.noaa.gov/regs/2015/June/15SBRMOmnibusAmend.html.

(12) assess the type and amount of fish caught and released alive during recreational fishing under catch and release fishery management programs and the mortality of such fish, and include conservation and management measures that, to the extent practicable, minimize mortality and ensure the extended survival of such fish

The fisheries overlapping and managed by the proposed coral zones are primarily commercial, such that these questions do not apply to this action.

(13) include a description of the commercial, recreational, and charter fishing sectors which participate in the fishery and, to the extent practicable, quantify trends in landings of the managed fishery resource by the commercial, recreational, and charter fishing sectors

Amendments to the Council's individual FMPs provide this information. This document summarizes this information as appropriate in section 6.7.

(14) to the extent that rebuilding plans or other conservation and management measures which reduce the overall harvest in a fishery are necessary, allocate any harvest restrictions or recovery benefits fairly and equitably among the commercial, recreational, and charter fishing sectors in the fishery.

Amendments to the Council's individual FMPs provide this information.

(15) establish a mechanism for specifying annual catch limits in the plan (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, including measures to ensure accountability.

Amendments to the Council's individual FMPs provide this information.

9.3 Discretionary provisions

The alternatives for coral zones and corresponding management measures described in this document were developed under the discretionary authority for deep sea coral protections described in §303(b)(2)(B) of the MSA. §303(b)(2) provides that any fishery management plan (FMP) which is prepared by any Council or the Secretary, with respect to any fishery, may:

(A) Designate zones where, and periods when, fishing shall be limited, or shall not be permitted, or shall be permitted only by specified types of fishing vessels or with specified types and quantities of fishing gear;

(B) Designate such zones in areas where deep sea corals are identified under §408 [the Deep-Sea Coral Research and Technology Program], to protect deep sea corals from physical damage from fishing gear or to prevent loss or damage to such fishing gear from interactions with deep sea corals, after considering long-term sustainable uses of fishery resources in such areas. 16 U.S.C. § 1853(b)(2)(A)-(B).

The most recent guidance on these provisions was distributed by NMFS in June 2014. Below, compliance with the deep-sea coral discretionary provisions is described based on this guidance.

For the purposes of the implementation of the MSA, NOAA has defined the term "deep-sea corals" as azooxanthellate corals (i.e., corals that do not depend upon symbiotic algae and light for energy) generally occurring at depths below 50 m. The coral ecosystems described in this document are consistent with this definition. NOAA's Strategic Plan for Deep Sea Corals and Sponges (NOAA 2010) notes that of particular ecological importance and conservation concern are "structure-forming deep-sea corals," those colonial deep-sea coral species that provide vertical structure above the seafloor that can be utilized by other species and are most likely to be damaged by interactions with fishing gear. Structure-forming deep-sea corals include both branching stony corals that form a structural framework (e.g., *Lophelia pertusa*) as well as individual colonies of corals, such as gorgonians and other octocorals, black corals, gold corals, and lace corals. The measures proposed in this amendment focus on protection of these structure-forming corals, many of which require hard substrate to attach, which is relatively rare in the deep-water areas of the New England region. Although other types of corals would also receive protection from the proposed measures, protections for structure-forming corals were prioritized in the design of the deep-sea coral zones and measures.

Consistent with the discretionary provision guidance, the proposed deep-sea coral zones were designed with the following parameters and considerations:

- This amendment document clearly states the purpose, need and rationale for the action, and the citation of the regulatory authority (section 3), and is supported by the factual record, including environmental, economic and social impact analyses (section 6.9.3).
- The discretionary authority is applied only to deep-sea coral areas identified by the DSCRTP or using DSCRTP products.
- Deep-sea coral zones are proposed only within the U.S. EEZ and within the geographical range of the fisheries managed under the Council's FMPs. Consistent with the guidance, the protective measures proposed in this action apply to general categories of fishing gear, not just the species managed under the NEFMC's FMPs. Thus, measures would apply to fishing activities managed under different federal FMPs.
- The NEFMC coordinated with MAFMC and ASMFC in order to acquire sufficient information to support the need for the action and to analyze impacts of the action on other fisheries.
- Long-term sustainable uses of fishery resources in the deep-sea coral areas were considered throughout the process of amendment development, by attempting to achieve conservation goals while minimizing economic impacts to potentially affected fisheries. These impacts were considered through multiple methods of socioeconomic impacts analysis and consulting with potentially affected stakeholders throughout the amendment process. This consideration informs but does not limit the scope of protective measures that a Council may adopt.
- Portions of deep-sea coral zones are proposed in areas where there are no vessels currently fishing in or near the areas or there is no indication that current fishing activities are causing physical damage to deep-sea corals.
- To ensure the effectiveness of protective measures, proposed deep-sea coral zones include additional areas beyond the exact locations of the deep-sea corals.
- Areas considered as priorities for protective measures were identified after consideration of the best available information on several factors identified in the NOAA guidance, including: 1) available abundance and density information for deep sea corals,[11] 2) the occurrence of rare species (including corals requiring hard substrate and specific rare mid-Atlantic species, such as *Lophelia pertusa*), 3) the ecological function provided by the deep-sea corals as habitat (see section 6.4), the extent to which the area is sensitive to human-induced environmental degradation (see the description of coral vulnerability and recovery in section 6.5and the impacts analysis in section 6.9.3); and 4) the likelihood of occurrence of deep-sea corals in un-surveyed areas based on the results of a NOAA-developed and reviewed coral habitat suitability model (see section 6.3).

Within the designated deep-sea coral zones, there are various options available for protecting the corals from physical damage from fishing gear. Consistent with the guidance on applying these discretionary provisions, measures proposed include:

[11] Note: Density and abundance information for deep sea corals is often lacking but was considered where available. Otherwise, presence information or modeled habitat suitability was evaluated.

- Restrictions on the location where fishing may occur. There are no coral zones proposed to be closed to all fishing. Therefore, compliance with requirements at MSA §303(b)(2)(C)[12] is not necessary. The Council instead concluded that targeted gear restrictions for certain gear types, as opposed to a full fishing closure, would provide sufficient protection.
- Restrictions on fishing by specified types of vessels or vessels with specified types and quantities of gear. These include limits on the use of bottom-tending fishing gear.
- Proactive protection by freezing the footprint of current fishing activities of specified types of vessels or vessels with specified types and quantities of gear to protect known or expected locations of deep-sea corals. The proposed broad zone was intended to be designated beginning at depths beyond which there is very limited fishing effort, consistent with the freeze the footprint approach, in order to prevent expansion of current fishing effort into deeper waters. The Council-preferred exemption for deep sea red crab in the broad and discrete zones is also consistent with this freeze the footprint approach, since all red crab effort takes place within the proposed zones.

This action does not propose limits on the harvest or bycatch of species of deep sea coral. Unlike EFH requirements, the discretionary authority does not require demonstration that corals are habitat for federally-managed fish or that current fishing activities are causing physical damage. The discretionary authority has no required consultation process for non-fishing activities that may affect deep sea corals. However, there may be avenues for providing non-binding recommendations to conserve or protect corals through other processes under the MSA (see, e.g., §305(b)(3)(A)), National Environmental Policy Act, Fish and Wildlife Coordination Act, and other authorities.

[12] With respect to any closure of an area to all fishing, an FMP/amendment must ensure the closure: "(i) is based on the best scientific information available; (ii) includes criteria to assess the conservation benefit of the closed area; (iii) establishes a timetable for review of the closed area's performance that is consistent with the purposes of the closed area; and (iv) is based on an assessment of the benefits and impacts of the closure, including its size, in relation to other management measures (either alone or in combination with such measures), including the benefits and impacts of limiting access to: users of the area, overall fishing activity, fishery science, and fishery and marine conservation." 16 U.S.C. § 1853(b)(2)(C).

10 Relationship to other applicable laws

10.1 National Environmental Policy Act

10.1.1 Environmental Assessment

The required elements of an Environmental Assessment (EA) are specified in 40 CFR 1508.9(b) and NAO 216-6A §5.04b.1. They are included in this document as follows:

- The need for this action is described in section 3.2
- The alternatives that were considered are described in section 4
- The environmental impacts of alternatives are described in section 7
- The agencies and persons consulted on this action are listed in section 10.1.4

This document includes the following additional sections that are based on requirements for an Environmental Impact Statement (EIS).

- An Executive Summary and a summary of the document can be found in section 1
- A Table of Contents can be found in section 2
- Background and purpose are described in section 3
- A brief description of the affected environment is in section 6
- Cumulative impacts of the Preferred Alternatives are described in section 8
- A determination of significance is in section 10.1.2
- A list of preparers is in section 10.1.3

10.1.2 Finding of No Significant Impact (FONSI)

The Council on Environmental Quality (CEQ) Regulations state that the determination of significance using an analysis of effects requires examination of both context and intensity and lists ten criteria for intensity (40 CFR 1508.27). In addition, the Companion Manual for National Oceanic and Atmospheric Administration Administrative Order 216-6A provides sixteen criteria, the same ten as the CEQ Regulations and six additional, for determining whether the impacts of a proposed action are significant. Each criterion is discussed below with respect to the proposed action and considered individually as well as in combination with the others.

1) Can the proposed action reasonably be expected to cause both beneficial and adverse impacts that overall may result in a significant effect, even if the effect will be beneficial?

The purpose of NEPA is to protect the environment by requiring Federal agencies to consider the impacts of their proposed actions on the human environment, defined as “the natural and physical environment and the relationship of the people with that environment.” A complete discussion of the potential impacts of the proposed management measures is provided in section 7.0 of this document. Some fishermen, shore-side businesses, and others may experience slight negative impacts to their livelihood resulting from gear restrictions associated with coral zones. Coral habitats and associated managed species are likely to experience slight positive impacts associated with the proposed measures, and the measures prevent future expansion of fishing activity into new deep-water fishing grounds. Impacts on protected species are potentially negative, but very small in magnitude since only limited changes in fishing gear distributions are expected, and therefore interaction risks associated with the proposed action are not expected to change much relative to current conditions. Overall, a significant effect is not expected to result from the proposed alternatives.

2) Can the proposed action be reasonably expected to significantly affect public health or safety?

None of the proposed measures are expected to substantially alter the manner in which the industry conducts fishing activities for the target species. The measures are expected to slightly alter the physical footprint of fishing but are not expected to shift fishing effort into areas where it does not already occur. Therefore, no changes in fishing behavior that would affect safety are anticipated. The overall effect of the proposed actions on these fisheries, including the communities in which they operate, will not significantly affect public health or safety.

3) Can the proposed action reasonably be expected to result in significant impacts to unique characteristics of the geographic area, such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?

A variety of types of commercial fishing already occur in the management areas proposed, and although it is possible that historic or cultural resources such as shipwrecks could be present in the affected environment, it is unlikely given the depths at which the gear-restricted areas are proposed. If they did occur in the affected environment, vessels try to avoid fishing too close to wrecks due to the possible loss or entanglement of fishing gear. Therefore, it is not likely that the preferred alternative would result in substantial impacts to unique areas. In fact, this action is intended to protect deep-sea coral habitats, which are an ecologically important and sensitive seabed type.

4) Are the proposed actions effects on the quality of the human environment likely to be highly controversial?

This action proposes to restrict the use of bottom-tending fishing gear in proposed “coral zones,” with associated transit, framework provision, and monitoring alternatives. In developing and analyzing the impacts of these proposed measures, the Council used the best scientific information available to characterize the direction and magnitude of the impacts, including the impacts of fishing gear on corals, the impacts of proposed restrictions on the fisheries, and other impacts discussed in this document. The impacts of the proposed measures on the human environment are described in section 7.0 of the EA. Some fishermen, shore-side businesses, and others may experience slight negative impacts to their livelihood resulting from gear restrictions associated with coral zones. Although some of the relied upon information is associated with uncertainties (for example, the predictive habitat suitability model for deep sea corals or the VTR revenue mapping model to analyze fishery effort and revenues), these tools represent the current best available information to complete this analysis. We do not consider this action to be controversial because no information exists that conflicts with the information provided by these models. The Council worked directly with potentially affected members of the fishing industry during development of the amendment through both the typical Committee/Advisory Panel/Council meeting process, and during dedicated workshops. Throughout the amendment development process, industry observations and information were used to ground truth other sources of data evaluated.

5) Are the proposed actions' effects on the human environment likely to be highly uncertain or involve unique or unknown risks?

While there is always a degree of variability in the year to year performance of the relevant fisheries, the proposed actions are not expected to substantially increase overall effort or to substantially alter fishing methods and activities. As a result, the effects on the human environment of the proposed measures are not highly uncertain nor do they involve unique or uncertain risks (section 7.0 of this document).

6) Can the proposed action reasonably be expected to establish a precedent for future actions with significant effects or represent a decision in principle about a future consideration?

This action will establish gear-restricted areas for bottom-tending gear types in offshore waters, allow for transit through gear-restricted areas, and modify the framework provisions of the Council's FMPs. None of the proposed measures are expected to change the total amount of current fishing effort or substantially alter the spatial and/or temporal distribution of current fishing effort. All of these types of measures have been implemented in other federal marine fisheries; they are not novel or unique except in the direct focus of protection (deep sea corals, as opposed to habitat more broadly). When new information about deep sea coral distribution or the affected fisheries becomes available in the future, these measures may be adjusted consistent with the FMPs and MSA. None of these measures is expected to result in significant effects, nor do they represent a decision in principle about a future consideration. The impact of any future changes will be analyzed as to their significance in the process of developing and implementing them.

7) Is the proposed action related to other actions that when considered together will have individually insignificant but cumulatively significant impacts?

As discussed in section 8, the proposed action is not expected to have individually insignificant, but cumulatively significant impacts. The proposed actions, together with past, present, and reasonably foreseeable future actions, are not expected to result in significant cumulative impacts on the biological, physical, and human components of the environment.

8) Can the proposed action reasonably be expected to adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources?

The impacts of the proposed measures on the human environment are described in section 7.0 of the EA. Although there may be shipwrecks present in the affected area where fishing occurs, including some registered on the National Register of Historic Places, vessels typically avoid fishing too close to wrecks due to the possible loss or entanglement of fishing gear. Therefore, it is not likely that the proposed action would adversely affect the historic resources listed above.

9) Can the proposed action reasonably be expected to have a significant impact on endangered or threatened species, or their critical habitat as defined under the Endangered Species Act of 1973?

This action falls within the range of impacts considered in the Batched Fisheries Biological Opinion (December 16, 2013)[13], Red Crab Opinion (February 6, 2002), and Lobster Opinion (July 13, 2014). However, in a memorandum dated October 17, 2017, GARFO's Protected Resources Division reinitiated consultation on these Opinions. As part of the reinitiation, it was determined that allowing these fisheries to continue during the reinitiation period will not violate ESA sections 7(a)(2) and 7(d) because it will not increase the likelihood of interactions with protected species above the amount that was previously considered in these Opinions. Therefore, conducting the proposed action during the reinitiation period will not affect endangered and threatened species in any manner beyond what has been considered in prior consultations on these fisheries.

For other fisheries (i.e., Atlantic herring, tilefish, Atlantic sea scallop) not covered under the above noted Biological Opinions, but are still covered by their own ESA section 7 informal or formal consultation, none of the proposed measures are expected to increase the magnitude of fishing effort or substantially alter fishing methods and activities. While several of the proposed measures are likely to affect the spatial distribution of fishing effort, effort is likely to be redistributed in a manner which is not expected to result in adverse effects on endangered or threatened species. Therefore, this action is not expected to affect ESA-listed species in any manner not considered in previous consultations on the fisheries.

As described in section 6.9.1.1, the proposed action is also not likely to adversely affect any designated critical habitat. The proposed action will not affect the essential physical and biological features of North Atlantic right whales critical habitat and therefore, will not result in the destruction or adverse modification of this species critical habitat (NMFS 2015b,c).

[13] Fisheries covered under the Batched Fisheries Opinion include: Northeast multispecies, monkfish, spiny dogfish, Northeast skate complex, Atlantic mackerel/squid/butterfish, Atlantic bluefish, and summer flounder/scup/black sea bass.

10) Can the proposed action reasonably be expected to threaten a violation of Federal, state, or local law or requirements imposed for environmental protection?

None of the proposed measures are expected to alter fishing methods or activities such that they threaten a violation of federal, state, or local law or requirements imposed for the protection of the environment. The proposed measures have been found to be consistent with other applicable laws as described in this section.

11) Can the proposed action reasonably be expected to adversely affect stocks of marine mammals as defined in the Marine Mammal Protection Act?

None of the proposed measures presented in this document are expected to jeopardize the sustainability of any MMPA protected species. The proposed measures are not expected to alter fishing methods or activities in a manner that would substantially affect interactions with MMPA protected species.

12) Can the proposed action reasonably be expected to adversely affect managed fish species?

The proposed measures described in this document are not expected to jeopardize the sustainability of any target species affected by the action. The proposed measures are likely to slightly shift the physical footprint of fishing effort but are not expected to impact levels of harvest for any target stocks.

13) Can the proposed action reasonably be expected to adversely affect essential fish habitat as defined under the Magnuson-Stevens Fishery Conservation and Management Act?

The proposed action is not expected to cause damage to the ocean, coastal habitats, and/or EFH as defined under the Magnuson-Stevens Act and identified in the FMP. In general, the mobile bottom-tending gear types (primarily otter trawls) used to prosecute the fisheries that may be impacted by the proposed measures have the potential to adversely affect EFH for the benthic life stages of a number of species in the Greater Atlantic region that are managed by other FMPs. However, because none of the management measures proposed in this action should cause any increase in overall fishing effort relative to the *status quo*, nor cause substantial shifts in the physical footprint of fishing, they are not expected to have any substantial negative impact on EFH or on coastal and ocean habitats.

14) Can the proposed action reasonably be expected to adversely affect vulnerable coastal and marine ecosystems, including but not limited to deep coral ecosystems?

The proposed action is not expected to cause adverse effects on vulnerable marine ecosystems, and is in fact intended to enhance conservation of deep coral ecosystems through restrictions on the use of fishing gears that could harm those habitat types.

15) Can the proposed action reasonably be expected to adversely affect biodiversity or ecosystem functioning (e.g., benthic productivity, predator-prey relationships, etc.)?

The fisheries operating in and around proposed coral zones are prosecuted mainly using bottom otter trawls and traps which have the potential to impact bottom habitats. In addition, a number of non-target species are taken incidentally to the prosecution of these fisheries. However, fishing effort is not expected to increase in magnitude under the proposed measures. In addition, none of the proposed measures are expected to substantially alter fishing methods or activities. Therefore, this action is not expected to result in increased negative effects on ecosystem functions. The proposed measures may have a slight positive impact on biodiversity of deep-sea corals and their surrounding ecosystems, however, the measures proposed in this amendment are primarily precautionary and the effect is not expected to be substantial.

16) Can the proposed action reasonably be expected to result in the introduction or spread of a nonindigenous species?

There is no evidence or indication that these fisheries have ever resulted or would ever result in the introduction or spread of nonindigenous species.

DETERMINATION

In view of the information presented in this document and the analysis contained in the supporting EA prepared for the Deep-Sea Coral Amendment, it is hereby determined that the proposed measures will not significantly impact the quality of the human environment as described above and in the EA. In addition, all beneficial and adverse impacts of the proposed action have been addressed to reach the conclusion of no significant impacts. Accordingly, preparation of an EIS for this action is not necessary.

____________________________________ __________________

Michael Pentony Date
Regional Administrator for GARFO, NMFS, NOAA

10.1.3 List of preparers, points of contact

This environmental assessment was prepared by the New England Fishery Management Council in consultation with the National Marine Fisheries Service. Questions concerning this document may be addressed to:

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This document was prepared by members of the Council's Habitat Plan Development Team, including:

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- Kiley Dancy (MAFMC)
- Dr. Geret DePiper (NMFS Northeast Fisheries Science Center)
- Dr. Rachel Feeney (NEFMC)
- Marianne Ferguson (NMFS Greater Atlantic Regional Fisheries Office)
- Dr. Kathryn Ford (Massachusetts Division of Marine Fisheries)
- Travis Ford (NMFS Greater Atlantic Regional Fisheries Office)
- David Packer (NMFS Northeast Fisheries Science Center)
- Dr. David Stevenson (NMFS Greater Atlantic Regional Fisheries Office)
- Dr. Page Valentine (U.S. Geological Survey)
- Carl Wilson (Maine Department of Marine Resources)

In addition to Habitat PDT members, Dr. Martha Nizinski (NOAA/NMFS/Office of Science & Technology, National Systematics Lab) provided data from deep-sea coral surveys conducted between 2012 and 2017 and consulted on the coral-related sections of the affected environment. The late Dr. Brian Kinlan and his colleague Matthew Poti (NOAA National Ocean Service, National Centers for Coastal Ocean Science) provided bathymetric data and habitat suitability modeling results and aided in their interpretation. Danielle Palmer (NMFS Greater Atlantic Regional Fisheries Office) assisted with protected resources background information an impacts analysis. Megan Ware (Maine Department of Marine Resources, formerly with ASMFC) coordinated the lobster fishing effort survey (Appendix E1) and provided analyses prepared by the ASMFC's American Lobster Technical Committee to the Council (Appendix E2).

10.1.4 Agencies consulted

The following agencies were consulted in the preparation of this document:

- Mid-Atlantic Fishery Management Council
- New England Fishery Management Council, which includes representatives from the following additional organizations:
    - Connecticut Department of Environmental Protection
    - Rhode Island Department of Environmental Management
    - Massachusetts Division of Marine Fisheries
    - New Hampshire Fish and Game
    - Maine Department of Marine Resources
- Atlantic States Marine Fisheries Commission
- National Marine Fisheries Service, NOAA, Department of Commerce
- United States Coast Guard, Department of Homeland Security

10.2 Marine Mammal Protection Act (MMPA)

The various species which inhabit the management unit of this FMP that are afforded protection under the Marine Mammal Protection Act of 1972 (MMPA) are described in section 6.5. None of the measures are expected to significantly alter fishing methods or activities or result in substantially increased effort. The Council has reviewed the impacts of the proposed measures on marine mammals and concluded that the management actions proposed are consistent with the provisions of the MMPA and would not alter existing measures to protect the species likely to inhabit the management units of the subject fisheries. For further information on the potential impacts of the fishery and the proposed management action, see section 6.9.3.

10.3 Endangered Species Act (ESA)

ESA section 7 consultations (informal or formal/Biological Opinion) on FMPs considered in this action were reviewed. The Batched Fisheries Biological Opinion (Opinion), Red Crab Opinion, and Lobster Opinion were issued by NMFS on December 16, 2013, February 6, 2002, and July 13, 2014, respectively. The Opinions concluded that the fisheries may adversely affect but were not likely to jeopardize the continued existence of any ESA listed species. However, in a 7(a)(2)/7(d) memorandum dated October 17, 2017, NMFS reinitiated consultation on these Opinions due to updated information on the decline of Atlantic right whale abundance.

Section 7(d) of the ESA prohibits federal agencies from making any irreversible or irretrievable commitment of resources with respect to the agency action that would have the effect of foreclosing the formulation or implementation of any reasonable and prudent alternatives during the consultation period. This prohibition is in force until the requirements of section 7(a)(2) have been satisfied. Section 7(d) does not prohibit all aspects of an agency action from proceeding during consultation; non-jeopardizing activities may proceed as long as their implementation would not violate section 7(d). Per the October 17, 2017, memo, it was concluded that allowing those fisheries specified in the batched, red crab, and lobster Opiniona to continue during the reinitiation period will not increase the likelihood of interactions with ESA listed species above the amount that would otherwise occur if consultation had not been reinitiated. Based on this, the memo concluded that the continuation of these fisheries during the reinitiation period would not be likely to jeopardize the continued existence of any ESA listed species. Taking this, as well as our analysis of the proposed action into consideration, we do not expect the proposed action, in conjunction with other activities, to result in jeopardy to any ESA listed species.

This action does not represent any irreversible or irretrievable commitment of resources with respect to the FMPs that would affect the development or implementation of reasonable and prudent measures during the consultation period. NMFS has discretion to amend its MSA and ESA regulations and may do so at any time subject to the Administrative Procedure Act and other applicable laws. As a result, the Council has preliminarily determined that fishing activities conducted pursuant to this action will not affect endangered and threatened species or critical habitat in any manner beyond what has been considered in prior consultations on this fishery.

Other fisheries (i.e., Atlantic herring, tilefish, Atlantic sea scallop) not covered under the above noted FMP Biological Opinions but are still covered by their own ESA section 7 informal or formal consultation were also reviewed to obtain information on fishery impacts to listed species.

10.4 Coastal Zone Management Act (CZMA)

The Coastal Zone Management Act (CZMA) of 1972, as amended, provides measures for ensuring stability of productive fishery habitat while striving to balance development pressures with social, economic, cultural, and other impacts on the coastal zone. It is recognized that responsible management of both coastal zones and fish stocks must involve mutually supportive goals. The Council has developed this document and will submit it to NMFS; NMFS must determine whether this action is consistent to the maximum extent practicable with the CZM programs for each state (Maine through North Carolina).

10.5 Administrative Procedures Act (APA)

Sections 553 of the Administrative Procedure Act establishes procedural requirements applicable to informal rulemaking by Federal agencies. The purpose of these requirements is to ensure public access to the Federal rulemaking process, and to give the public adequate notice and opportunity for comment. The Council is not requesting any abridgement of the rulemaking process for this action.

10.6 Data Quality Act (§515)

Pursuant to NOAA guidelines implementing §515 of Public Law 106-554 (the Data Quality Act), all information products released to the public must first undergo a Pre-Dissemination Review to ensure and maximize the quality, objectivity, utility, and integrity of the information (including statistical information) disseminated by or for Federal agencies. The following section addresses these requirements.

Utility

The information presented in this document should be helpful to the intended users (the affected public) by presenting a clear description of the purpose and need of the proposed action, the measures proposed, and the impacts of those measures. A discussion of the reasons for selecting the proposed action is included so that intended users may have a full understanding of the proposed action and its implications, as well as the Council's rationale.

Until a proposed rule is prepared and published, this document is the principal means by which the information contained herein is available to the public. The information provided in this document is based on the most recent available information from the relevant data sources. The development of this document and the decisions made by the Council to propose this action are the result of a multi-stage public process. Thus, the information pertaining to management measures contained in this document has been improved based on comments from the public, the fishing industry, members of the Council, and NMFS.

This document is available in several formats, including printed publication and online through the Council's web page. The Federal Register notice that announces the proposed rule and the final rule and implementing regulations will be made available in printed publication, on the website for the Greater Atlantic Regional Office, and through the Regulations.gov website. The Federal Register documents will provide metric conversions for all measurements.

Integrity

Prior to dissemination, information associated with this action, independent of the specific intended distribution mechanism, is safeguarded from improper access, modification, or destruction, to a degree commensurate with the risk and magnitude of harm that could result from the loss, misuse, or unauthorized access to or modification of such information. All electronic information disseminated by NMFS adheres to the standards set out in Appendix III, "Security of Automated Information Resources," of OMB Circular A-130; the Computer Security Act; and the Government Information Security Act. All confidential information (e.g., dealer purchase reports) is safeguarded pursuant to the Privacy Act; Titles 13, 15, and 22 of the U.S. Code (confidentiality of census, business, and financial information); the Confidentiality of Statistics provisions of the Magnuson-Stevens Act; and NOAA Administrative Order 216-100, Protection of Confidential Fisheries Statistics.

Objectivity

For purposes of the Pre-Dissemination Review, this document is considered to be a Natural Resource Plan. Accordingly, the document adheres to the published standards of the Magnuson-Stevens Act; the Operational Guidelines, FMP Process; the EFH Guidelines; the National Standard Guidelines; and NOAA Administrative Order 216-6, Environmental Review Procedures for Implementing the National Environmental Policy Act.

This information product uses information of known quality from sources acceptable to the relevant scientific and technical communities. Stock status (including estimates of biomass and fishing mortality) reported in this product are based on either assessments subject to peer-review through the Stock Assessment Review Committee or on updates of those assessments prepared by scientists of the Northeast Fisheries Science Center. Landing and revenue information is based on information collected through the Vessel Trip Report and Commercial Dealer databases. Information on catch composition, by tow, is based on reports collected by the NOAA Fisheries Service observer program and incorporated into the sea sampling or observer database systems. These reports are developed using an approved, scientifically valid sampling process. In addition to these sources, additional information is presented that has been accepted and published in peer-reviewed journals or by scientific organizations. Original analyses in this document were prepared using data from accepted sources, and the analyses have been reviewed by members of the Habitat Plan Development Team.

Despite current data limitations, the conservation and management measures proposed for this action were selected based upon the best scientific information available. The analyses conducted in support of the proposed action were conducted using information from the most recent complete calendar years, generally through 2014 except as noted. The data used in the analyses provide the best available information on the number of seafood dealers operating in the northeast, the number, amount, and value of fish purchases made by these dealers, catch information by area, and deep-sea coral distribution and abundance in the Greater Atlantic region. Specialists who worked with these data are familiar with the most current analytical techniques and with the available data and information relevant to the affected fisheries.
The policy choices are clearly articulated in section 3 of this document as are the management alternatives considered in this action (section 4). The supporting science and analyses, upon which the policy choices are based, are described in section 6 and section 6.9.3. All supporting materials, information, data, and analyses within this document have been, to the maximum extent practicable, properly referenced according to commonly accepted standards for scientific literature to ensure transparency.

The review process used in preparation of this document involves the responsible Council, the Northeast Fisheries Science Center (Center), the Greater Atlantic Regional Office, and NOAA Fisheries Service Headquarters. The Center's technical review is conducted by senior level scientists with specialties in population dynamics, stock assessment methods, demersal resources, population biology, and the social sciences. The Council review process involves public meetings at which affected stakeholders have opportunity to provide comments on the document. Review by staff at the Regional Office is conducted by those with expertise in fisheries management and policy, habitat conservation, protected species, and compliance with the applicable law. Final approval of the action proposed in this document and clearance of any rules prepared to implement resulting regulations is conducted by staff at NOAA Fisheries Service Headquarters, the Department of Commerce, and the U.S. Office of Management and Budget.

10.7 Paperwork Reduction Act

The purpose of the Paperwork Reduction Act is to control and, to the extent possible, minimize the paperwork burden for individuals, small businesses, nonprofit institutions, and other persons resulting from the collection of information by or for the Federal Government. The authority to manage information and recordkeeping requirements is vested with the Director of the Office of Management and Budget (OMB). This authority encompasses establishment of guidelines and policies, approval of information collection requests, and reduction of paperwork burdens and duplications. This action requests that research vessels operating in coral zones seek a letter of acknowledgement from NMFS GARFO. If appropriate, a Paperwork Reduction Act package prepared in support of this action and the information collection required by the proposed action, including forms and supporting statements, will be submitted when implementation action is taken.

10.8 Impacts relative to federalism (E.O. 13132)

This E.O. established nine fundamental federalism principles for Federal agencies to follow when developing and implementing actions with federalism implications. The

E.O. also lists a series of policy making criteria to which Federal agencies must adhere when formulating and implementing policies that have federalism implications. However, no federalism issues or implications have been identified relative to the measures proposed measures. This action does not contain policies with federalism implications sufficient to warrant preparation of an assessment under E.O. 13132. The affected states have been closely involved in the development of the proposed management measures through their representation on the Council (all affected states are represented as voting members of at least one Regional Fishery Management Council). No comments were received from any state officials relative to any federalism implications that may be associated with this action.

11 Regulatory Impact Review/Initial Regulatory Flexibility Analysis

11.1 Introduction

This section provides the analysis and conclusions to address the requirements of Executive Order 12866 and the Regulatory Flexibility Act (RFA). Since many of the requirements of these mandates duplicate those required under the Magnuson-Stevens Act and NEPA, this section contains references to other sections of this document.

NMFS requires the preparation of a Regulatory Impact Review (RIR) for all regulatory actions that either implement or significantly amend an FMP. The RIR in section 11.2 provides a comprehensive review of the changes in net economic benefits to society associated with proposed regulatory actions. This analysis reviews the problems and policy objectives prompting the regulatory proposals and evaluates the alternatives presented as a solution. This analysis ensures that the regulatory agency systematically and comprehensively considers all available alternatives so public welfare can be enhanced in the most efficient and cost-effective way. This RIR addresses multiple items in the regulatory philosophy and principles of Executive Order (EO) 12866. An Initial Regulatory Flexibility Analysis (IRFA; section 11.3) was prepared to further evaluate the economic impacts of the various alternatives presented in this document on small business entities. This analysis is undertaken in support of a more thorough analysis for the potential impacts of various deep-sea coral zone designations and management measures within those coral zone designations.

11.2 Evaluation of EO 12866 Significance

The purpose of Executive Order 12866 (E.O. 12866, 58 FR 51735, October 4, 1993) is to enhance planning and coordination with respect to new and existing regulations. This E.O. requires the Office of Management and Budget (OMB) to review regulatory programs that are considered to be "significant." E.O. 12866 requires a review of proposed regulations to determine whether or not the expected effects would be significant, where a significant action is any regulatory action that may:

- Have an annual effect on the economy of $100 million or more, or adversely affect in a material way the economy, a sector of the economy, productivity, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;
- Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
- Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or
- Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set for the Executive Order.

In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider.

11.2.1 Statement of the problem/goals and objectives

The statement of the problem(s) that this document addresses can be found in the Need and Purpose for Action as described in section 3.2, which should be referenced for additional information.

11.2.2 Management alternatives and rationale

A general description, including the rationale, for development of the proposed action can be found in section 4. Considered but rejected alternatives are described in section 5.

11.2.3 Description of the fishery

Information about fishery-related businesses and communities potentially affected by the Deep-Sea Coral Amendment can respectively be found in section 6.7 and 6.8.

11.2.4 Summary of impacts

A description of and caveats associated with the impact analyses undertaken in support of this action can be found in section 7.1. The discussion in section 7.1 includes issues associated with quantifying the full range of costs and benefits associated with the Deep-Sea Coral Amendment. The expected effects of each alternative relative to the status quo for the fishery-related businesses and communities are discussed in sections 7.2-7.4. Section 11.3 quantifies the number of businesses potentially affected by the Deep-Sea Coral Amendment, as well as the potentially displaced revenue associated with the preferred alternatives. In this section we focus on assessing the combined areas of the Preferred Alternative. All monetary values discussed in this section are presented in 2014 constant dollars.

A preliminary analysis of 2012 – 2014 recreational VTR charter and party boat data indicates a total of 12 out of 86,054 trips reported VTR data points within any of the alternatives during those years, corresponding to 0.01% of trips. Seven of these 12 trips fall within a single discrete offshore canyon, and none of the 12 fall within the Preferred Alternatives. Additionally, six of these twelve trips reported landing only pelagic species, which would not be precluded from fishing within any of the alternatives as defined. The remaining six trips were reported by 3 permits, representing an average of 2/3 a trip per permit per year. Because of this extremely low level of fishing activity, further analysis of recreational fishing is not conducted.

11.2.4.1 Estimated Impacts associated with the Preferred Alternatives

Figure 103 presents the total revenue estimated to have been generated within the areas associated with the preferred alternatives, accounting only for the gears regulated within each preferred alternative. As sections 7.2-7.4 indicate, this revenue estimate is likely high, given the imprecision of the underlying dataset and small distances separating alternatives considered, and as compared to alternate datasets such as Vessel Monitoring effort estimates and survey results where available. Section 11.3 indicates that some businesses are estimated to use the areas within the Preferred Alternative relatively intensively. Figure 104 presents the revenue potentially displaced by the Preferred Alternative, by gear, which aligns with the dominant gears used in the plans presented in Figure 103. The scallop fishery is conducted primarily using scallop dredges, and exposure in this fishery originates from the 600 m minimum broad zone alternative. Section 7.2.2.3.1 indicates that VMS coverage is high for those permits identified in the VTR as fishing within this alternative. VMS effort estimates within the Preferred Alternative areas are very low for the scallop fishery, indicating that the revenue estimates from the VTR likely stem from imprecision in the data as opposed to actual fishing effort within the boundaries of the Preferred Alternative.

Figure 105 presents the percentage of VTR-reported landings exposed by the Preferred Alternative and indicates that fishermen within the small-mesh multispecies fishery face the highest levels of exposure, primarily from the 600 m minimum broad zone alternative. The squid fishery also faces relatively high exposure primarily to the 600 m minimum broad zone. Section 7.2.2.3.1 highlights that, although VMS coverage for trips identified to occur in the vicinity of the broad zone alternatives by VTR is generally high, the most highly exposed individuals are under-represented in the VMS dataset, and these individuals fish for species within the small-mesh multispecies complex and squid fishery known to occur along the shelf break (particularly silver hake and inshore longfin squid). However, VMS coverage generally increases over time for the trawl fishery, and the amount of effort estimated to occur within the 600 m minimum broad zone does not concurrently increase. Additionally, the stakeholder workshops discussed in section 7.2.2.3 indicate the trawl fishery for both small-mesh multispecies and squid is active primarily at depths of less than 500 m. This suggests that the VTR is likely to represent an overestimate even for the most highly exposed individuals. Nevertheless, this lack of VMS coverage and the fact that workshops were conducted with a subsample of active fishermen induces additional uncertainty with respect to the assessment of impacts from the alternative.

The lobster fishery represents the second most highly exposed fishery in the VTR, again primarily from the 600 m minimum broad zone. Both the ASMFC survey of offshore lobstermen and stakeholder workshops discussed in section 7.2.2.3 suggest that the lobster fishery is active primarily in depths shallower than the 600 m minimum broad zone. Uncertainty in this assessment for the lobster fishery is derived from the fact that both the survey and workshops were held with subsamples of active offshore lobstermen which might not be representative of the population of interest, and the lack of VMS coverage for this fishery by and large. Other fisheries identified to be exposed to the Preferred Alternative have relatively low exposure levels overall.

Figure 103 – Revenue potentially displaced from within the preferred alternatives, by Federal management plan. Note: All revenue from plans consisting of less than 5% of preferred alternative revenue or 5% of total plan revenue are represented in the "Other Plan" category.

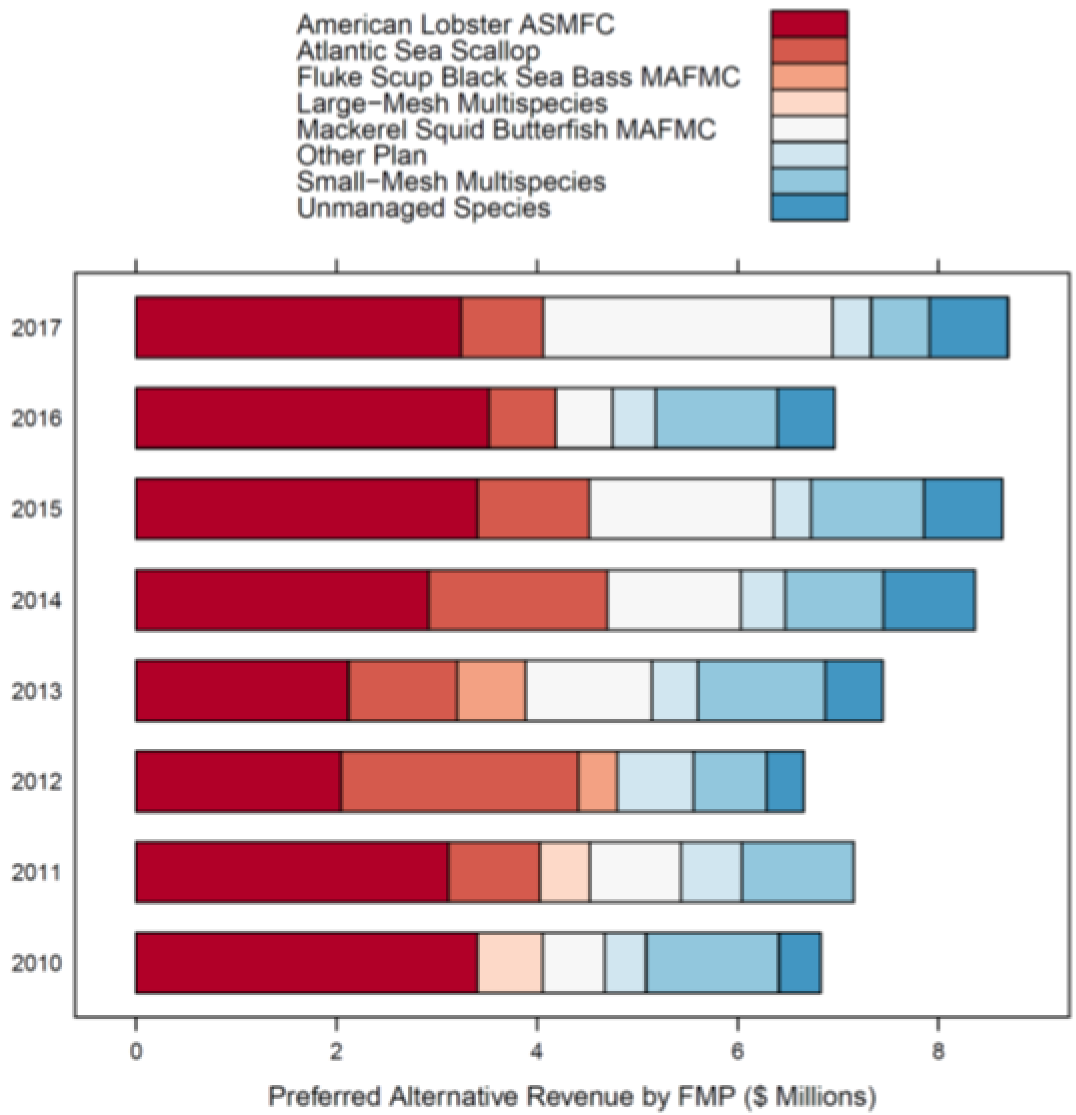


Figure 104 – Revenue potentially displaced from within the preferred alternatives, by gear. Note: All revenue from gears consisting of less than 5% of preferred alternative revenue or 5% of total gear revenue are represented in the "Other Gear" category.

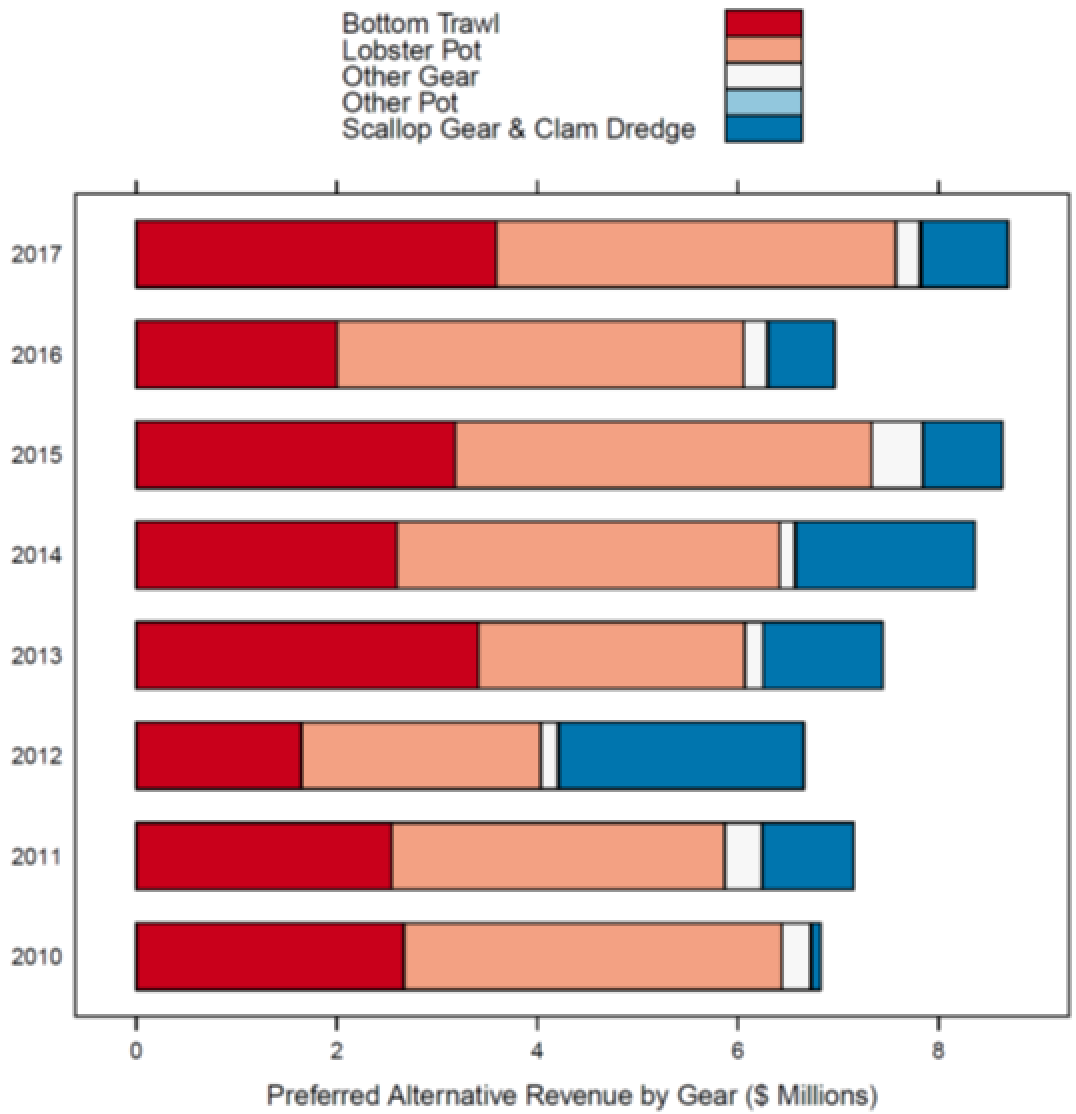
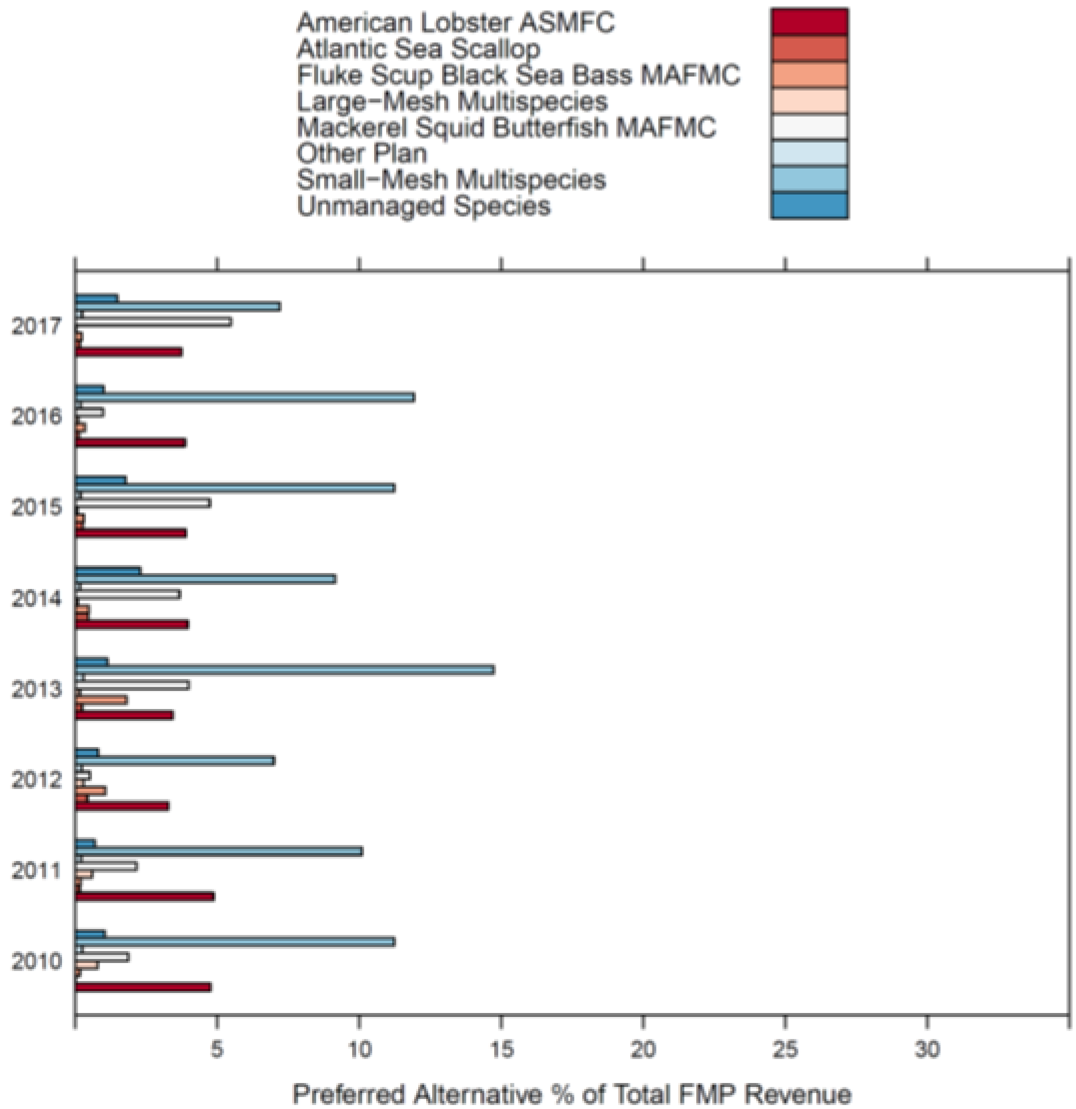


Figure 105 – Percent of total Federal management plan revenue estimated to be generated from areas defined within the Preferred Alternative, by Plan. Note: All revenue from plans consisting of less than 5% of preferred alternative revenue and 5% of total plan revenue are represented in the "Other Plan" category.



11.2.4.2 Comparison of proposed action with alternate areas

To generate a sense of the scope of alternatives investigated within this action, this section compares the Preferred Alternative with the maximum conservation alternatives as defined in terms of both area under proposed management and gear restrictions assessed. The exact definition of this maximum conservation alternative can be found in section 11.3, along with an assessment of potential impacts estimated at the business level. Figure 106 presents the total revenue potentially displaced by this alternate maximum conservation alternative, by Federal management plan, and Figure 107 presents the same data by gear. A comparison with the Preferred alternative indicates that revenue estimates are roughly 25% higher for the maximum conservation alternative. A substantial driver of this differential is the Red Crab fishery (corresponding to the "Other Pot" gear category), which is exempted from the Preferred Alternative and makes up a sizeable proportion of the revenue in the maximum conservation alternative, particularly in 2014. The remainder of the FMPs have relatively fixed ratios between the two alternatives. However, whereas alternate sources of data indicate VTRs greatly overestimate fishing revenue for the preferred alternative, those same sources align more clearly with the VTR estimates for the maximum conservation alternative.

Figure 108 presents the percentage of total Federal management plan revenue potentially displaced by the maximum conservation alternative. The major deviation in comparison to the Preferred Alternative is again the Red Crab fishery, with all other management plants seeing a slight uptick in exposure. These likely overestimates highlight the fact that even the maximum conservation alternative would have only a slight impact on managed fisheries overall. VMS effort estimates presented in sections 7.2.2.3.1 and 7.2.3.3.1 indicate substantial bottom trawl and pot/trap effort within the offshore canyons and 300 m broad zone alternatives (note that area overlap means the effort estimates cannot be summed across the broad zone and discrete canyon alternatives). Additionally, the ASMFC lobster survey and stakeholder workshops indicate that both lobster pot and bottom trawl fishing occurs at depths encompassed within the maximum conservation areas offshore.

The major caveat to this analysis is again the lack of information for the inshore lobster fishery, and the complete lack of value estimates for the value of deep-sea coral conservation. The entirety of the analysis suggests, however, that the overall impact of both the Preferred Alternative and Maximum Conservation Alternative falls far short of the $100 million threshold for a significant action. Additionally, although some individuals are estimated by VTR to be highly exposed to the Preferred Alternatives, the additional data sources available indicate that potentially displaced revenue are substantially overestimated, which in turn suggests that the action is not likely to adversely affect in a material way the economy, a sector of the economy, productivity, jobs, the environment, public health or safety, or State, local, or tribal governments or communities. In addition, the action does not interfere with actions taken by other agencies, and does not affect entitlements, grants, user fees, or loan programs nor raise novel legal concerns. The suite of preferred alternatives identified mitigate a substantial proportion of the negative impacts to the commercial fisheries. However, this comes at a trade-off with conservation benefits associated with deep sea coral protection, the value of which are highly uncertain to begin with.

Figure 106 – Revenue potentially displaced from within the maximum conservation area alternatives, by Federal management plan. Note: All revenue from Plans consisting of less than 5% of the maximum conservation alternative revenue and 5% of total plan revenue are represented in the "Other Plan" category.

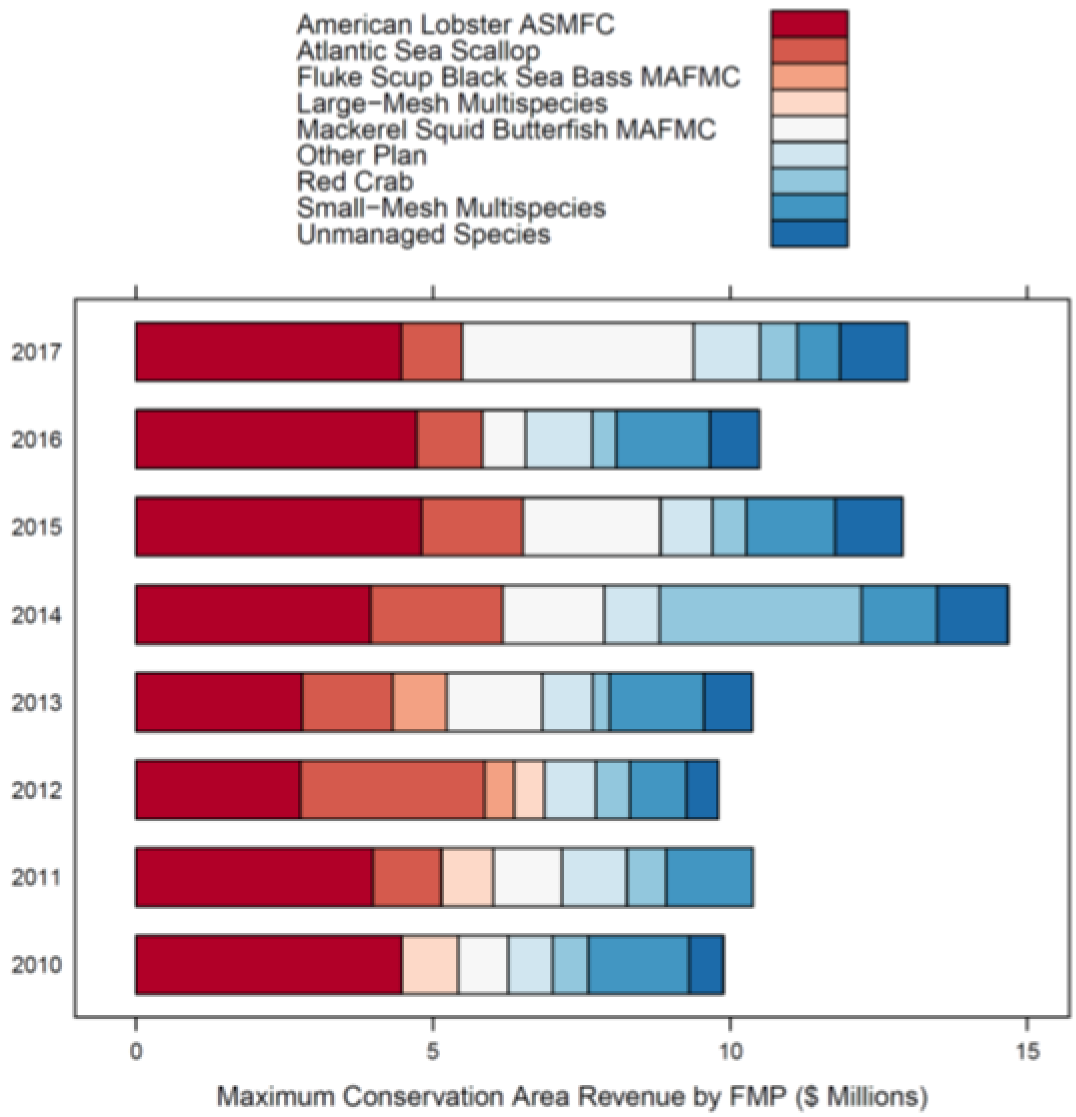


Figure 107. Revenue potentially displaced from within the maximum conservation alternative, by gear. Note: All revenue from gears consisting of less than 5% of preferred alternative revenue or 5% of total gear revenue are represented in the "Other Gear" category.

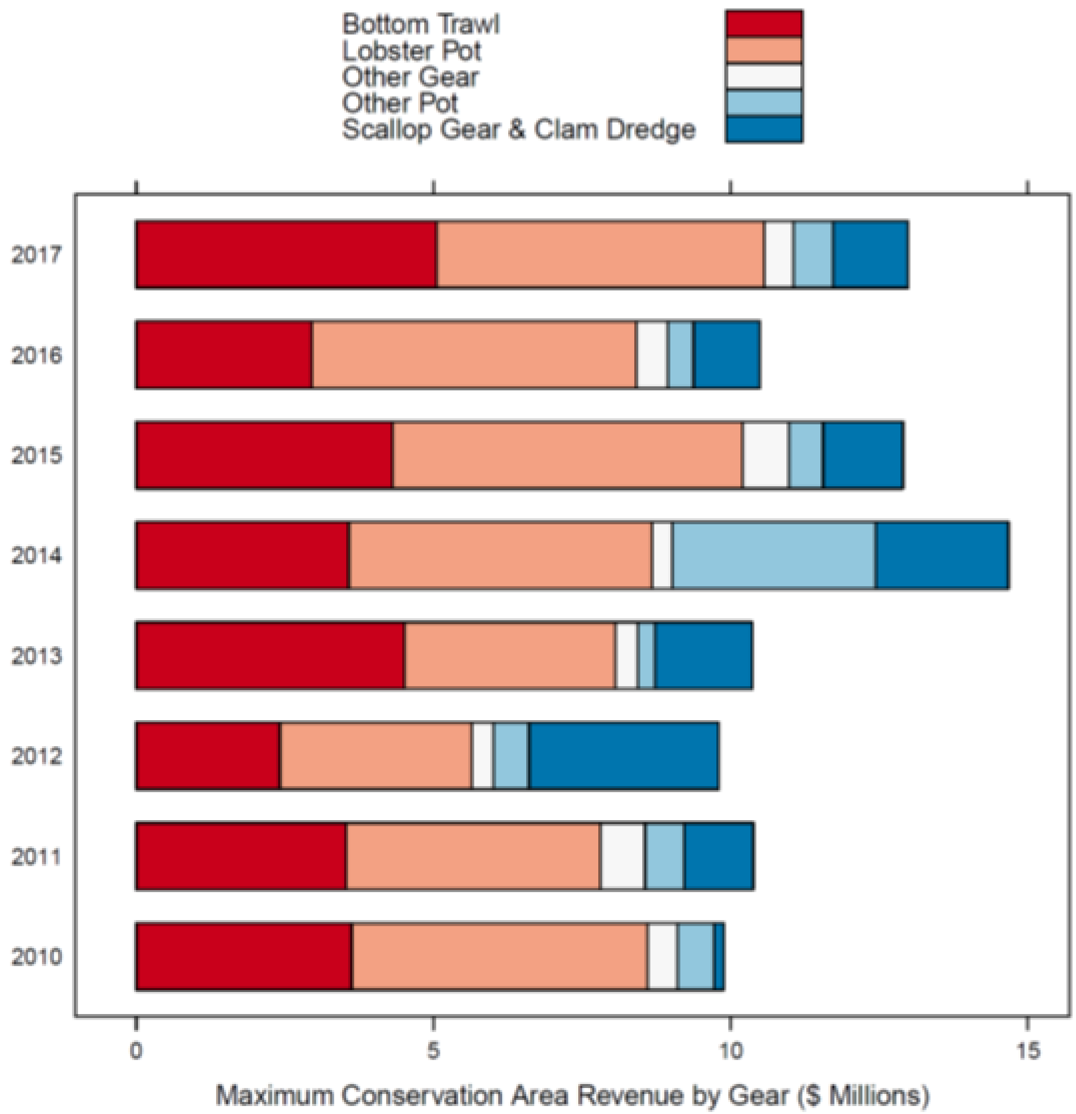
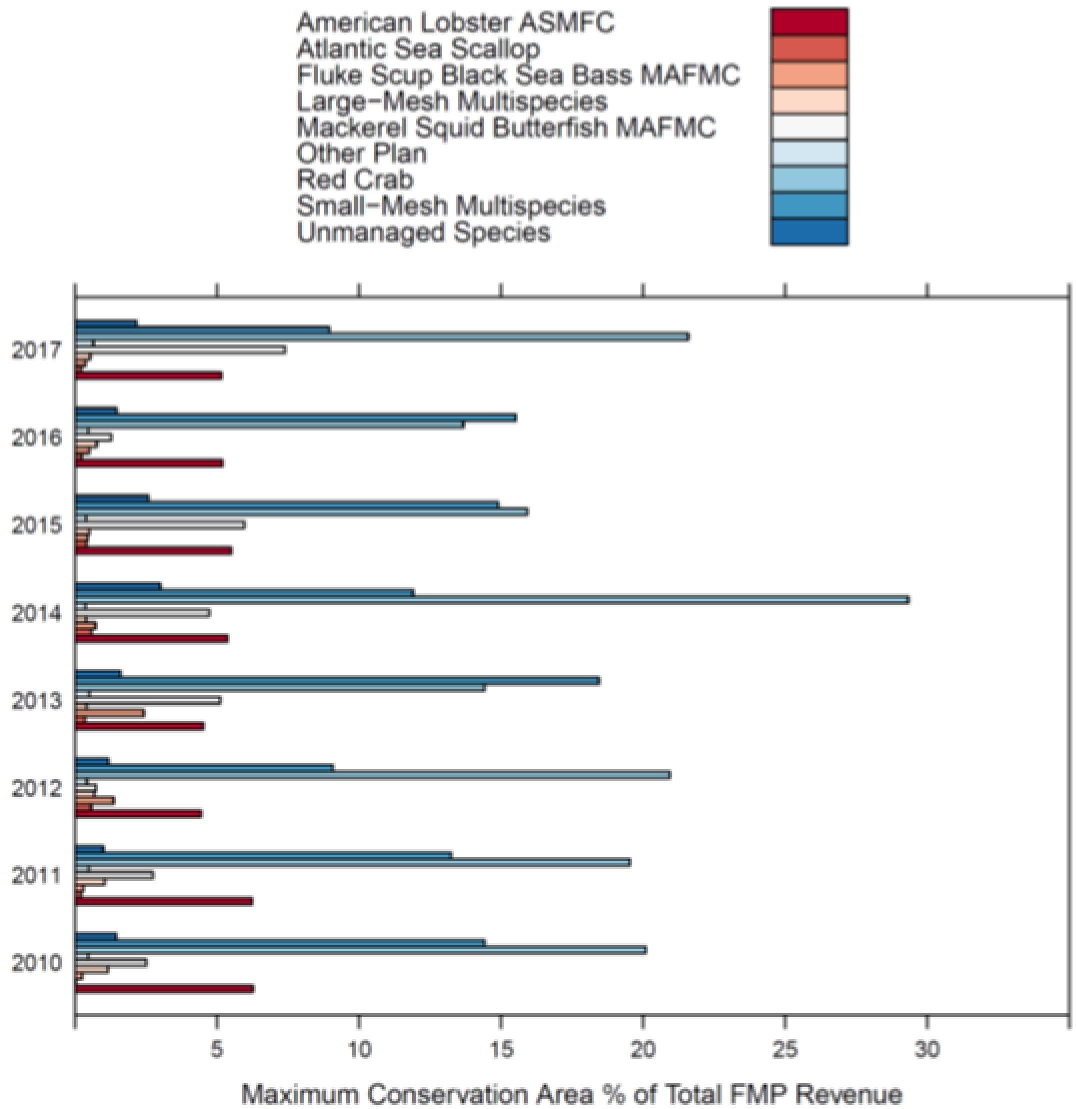


Figure 108. Percent of total Federal management plan revenue estimated to be generated from areas defined within the maximum conservation alternatives, by Plan. Note: All revenue from plans consisting of less than 5% of preferred alternative revenue and 5% of total plan revenue are represented in the "Other Plan" category.



11.3 Regulatory Flexibility Analysis

The purpose of the Regulatory Flexibility Act (RFA) is to reduce the impacts of burdensome regulations and recordkeeping requirements on small businesses. To achieve this goal, the RFA requires federal agencies to describe and analyze the effects of proposed regulations, and possible alternatives, on small entities. Ultimately, the goal of the RFA analysis is to understand to what extent the action induces significant economic impacts on small entities. To this end, this document contains an Initial Regulatory

Flexibility Analysis (IRFA), found below, which includes an assessment of the effects that the proposed action and other alternatives are expected to have on small entities.

Under §603(b) of the RFA, an IRFA must describe the impact of the proposed rule on small entities and contain the following information:

1. A description of the reasons why the action by the agency is being considered.
2. A succinct statement of the objectives of, and legal basis for, the proposed rule.
3. A description—and, where feasible, an estimate of the number—of small entities to which the proposed rule will apply.
4. A description of the projected reporting, recordkeeping, and other compliance requirements of the proposed rule, including an estimate of the classes of small entities that will be subject to the requirement and the types of professional skills necessary for preparation of the report or record.
5. An identification, to the extent practicable, of all relevant federal rules that may duplicate, overlap, or conflict with the proposed rule.

11.3.1 Reasons for Considering the Action

The statement of the problem(s) that this document addresses, along with the goals and objectives of the Deep-Sea Coral Amendment, can be found in the Need and Purpose for the Action, section 3.2, which should be referenced for additional information.

11.3.2 Objectives and Legal Basis for the Action

The Council's objective in this action is to utilize its discretionary authority under §303(b) of the Magnuson-Stevens Fishery Conservation and Management Act, Public Law 94-265, as amended by the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (P.L. 109-479) to identify and implement measures that reduce, to the extent practicable, impacts of fishing gear on deep-sea corals in New England.

11.3.3 Description and Number of Small Entities to Which the Rule Applies

The RFA recognizes three kinds of small entities: small businesses, small organizations, and small governmental jurisdictions. Small organizations and small governmental jurisdictions are not directly regulated by this action. For RFA purposes only, NMFS has established a small business size standard for businesses, including their affiliates, whose primary industry is commercial fishing (see 50 CFR § 200.2). A business primarily engaged in commercial fishing (NAICS code 11411) is classified as a small business if it is independently owned and operated, is not dominant in its field of operation (including its affiliates) and has combined annual receipts not in excess of $11 million for all its affiliated operations worldwide. Throughout this section, revenue is presented in 2015 dollars, for consistency with the remainder of the document, although classification was made using 2017 dollars, consistent with SBA guidelines. Further, SBA rules of affiliation are used to define a business entity. Thus, the following analysis is conducted upon unique business interests, which can represent multiple vessel-level permits.

The Deep-Sea Coral Amendment regulates all fishermen with federal permits allowing the holder to fish in the federal waters off Southern New England, Georges Bank, and the Gulf of Maine. In 2017, this represents 10 large commercial fishing businesses, 3,832 small commercial fishing businesses and 351 recreational for-hire businesses. Total revenue from estimates used in entity classification can be found in Table 106.

Table 106 – Totals for revenue estimates used for entity classification, in $2017 per SBA Guidelines

Year	Size	Entity Type	Total Revenue	Commercial Revenue	For-Hire Revenue
2015	Large Business	Commercial Fishing	184,535,645	184,535,645	0
2016	Large Business	Commercial Fishing	199,019,785	199,015,738	4,047
2017	Large Business	Commercial Fishing	212,662,637	212,662,637	0
2015	Small Business	Commercial Fishing	981,648,495	980,596,368	1,052,127
2016	Small Business	Commercial Fishing	1,091,837,474	1,090,867,777	969,697
2017	Small Business	Commercial Fishing	1,044,835,419	1,044,011,489	823,930
2015	Small Business	Recreational For-hire	101,492,169	50,926,669	50,565,500
2016	Small Business	Recreational For-hire	107,997,539	54,249,071	53,748,468
2017	Small Business	Recreational For-hire	103,882,395	52,184,155	51,698,240

11.3.3.1 Assessment of impacts associated with the Proposed Alternatives

The preferred alternative for the special fishery programs for coral zones outlined in section 4.4 is expected to provide de minimis impacts on scientists conducting research in the deep-sea coral management areas due to the additional administrative requirement of alerting NMFS to their activities. Those de minimis impacts are expected to be slightly outweighed by the small positive benefit associated with allowing NMFS to track research endeavors within the coral zones, which could help inform management. The framework provision outlined in section 4.5 is an administrative provision which does not directly regulate any entities external to NOAA Fisheries and the New England Fishery Management Council.

The remainder of the rules within this amendment primarily affect fishermen using either bottom-tending or mobile bottom-tending gear. Bottom-tending gear is defined in section 4.3 as bottom-tending otter trawls, bottom-tending beam trawls, hydraulic dredges, non-hydraulic dredges, bottom-tending seines, bottom-tending longlines, sink or anchored gillnets, and pots and traps. Mobile bottom-tending gear are defined in the same section as bottom-tending otter trawls, bottom-tending beam trawls, hydraulic dredges, non-hydraulic dredges, and bottom-tending seines. Sub-options provide exemptions for the red crap trap, and non-red crab traps. Section 7.1 presents rationale for the exclusion of recreational fishing from the formal analysis presented here. As such, Figure 109 presents the firm-level percentage of revenue generated by each gear type differentially managed by this action, with the exception of red crab traps, which has been combined with the general trap category due to confidentiality issues. The distribution of revenue indicates that, for both small and large businesses, individuals fishing with mobile bottom-tending gear tend to generate the majority of their revenue from that gear type. Although 50% of small businesses fishing traps generate 100% of their revenue from traps, large businesses fishing traps generate a much smaller portion of their overall revenue stream from traps with a median of roughly 20%. Similarly, non-bottom tending gear is less prevalent in small, as opposed to large, businesses, and no static bottom-tending gear is used by large businesses.

Given the spatial nature of the management alternatives, self-reported VTR data, modeled as outlined in DePiper (2014), Benjamin et al. (In Press), and section 7.1.3.1 of this action, were used to assess impacts in the Deep-Sea Coral Amendment. Historical fishing revenue generated within coral conservation alternatives are reviewed in section 7.2.1.3 - 7.4.3, for each alternative and option where relevant, and presented by gear type, top 10 species fished, percentage of permit revenue, and percentage of owner revenue. This RFA analysis complements the above analysis by providing an estimate of the number and types of businesses potentially affected by the proposed action due to historical fishing patterns overlapping area alternatives.

Figure 110 identifies the number of entities fishing in the vicinity of the Preferred Alternatives, by business size, which indicates that a substantial number of businesses are potentially exposed to the Deep-Sea Coral action. Figure 111 presents the distribution of the percentage of total business revenue in areas currently open to fishing that would be potentially displaced by the Preferred Alternatives, by business type. Note that this only includes revenue generated by gears that would be excluded from fishing areas defined within the Preferred Alternatives, as identified in the preferred alternatives themselves. The distribution indicates that large and small businesses are not facing substantially different impact levels overall, although the most highly exposed small businesses generate a larger fraction of their overall revenue from areas within the preferred alternative when compared to large businesses. The majority of these impacts are estimated from the 600 m minimum broad zone alternative, as illustrated in the analyses presented in section 7.2.2.3.1- 7.4.3 of this document. The gross revenue estimate is an upper bound on impact estimates, due to the fact that it does not consider behavioral responses to the proposed regulations. Additionally, as discussed in section 7.2.2.3.1, 7.2.5.3, and 7.2.6.3.1, Vessel Monitoring System data, when available, suggests that the VTR analysis overestimates exposure to the alternatives under consideration in this action. This result is driven primarily by the spatial imprecision of the VTR data, and the relatively small distance between alternative boundaries. Nevertheless, Figure 111 indicates that although a small number of businesses are estimated to be highly exposed, the vast majority of businesses fishing in the vicinity of the preferred alternatives have a relatively low exposure to the action.

Figure 109 – Percent of total owner revenue generated by each relevant gear type in calendar year 2017

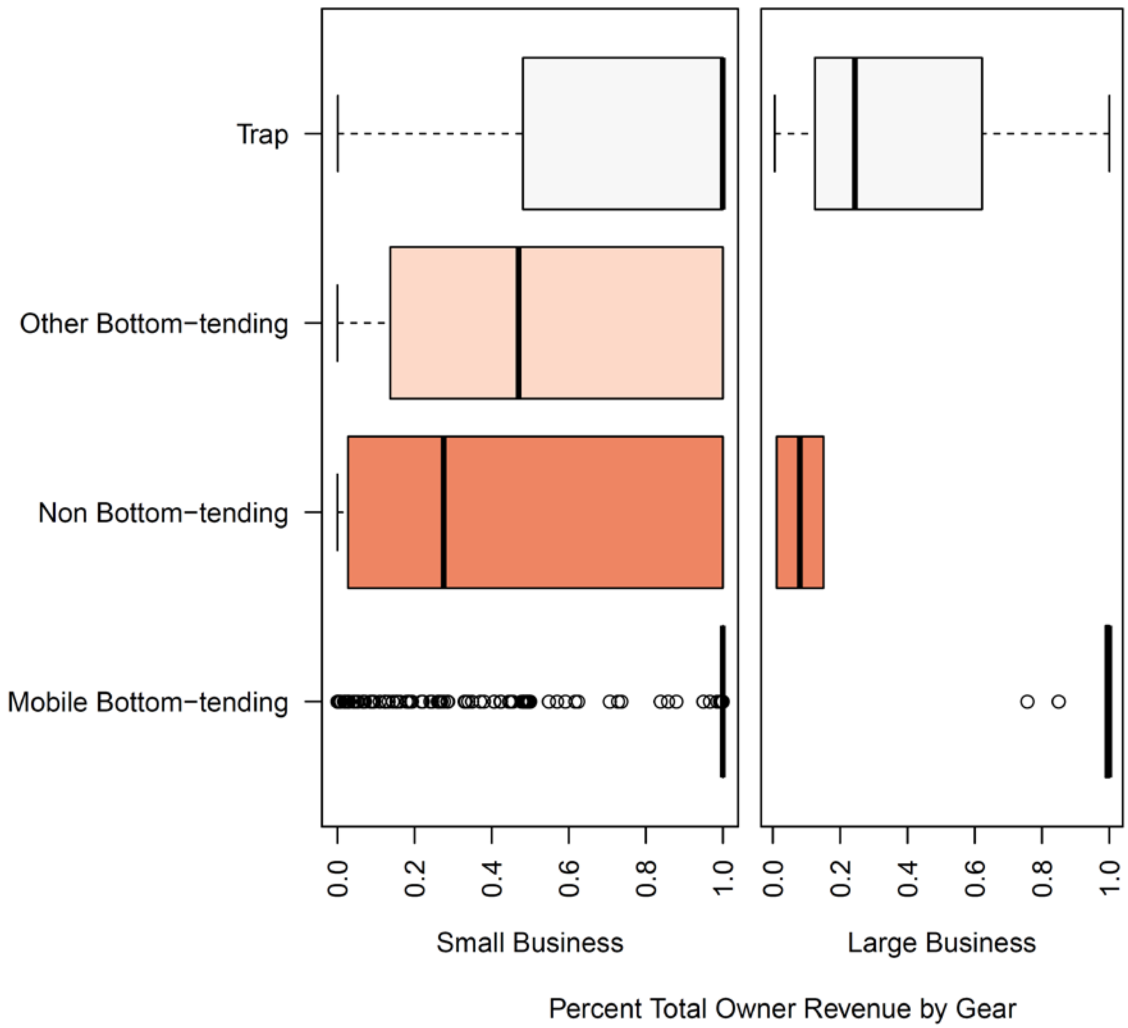


Figure 110 – Number of businesses historically fishing in areas of the Preferred Alternatives currently open to fishing.

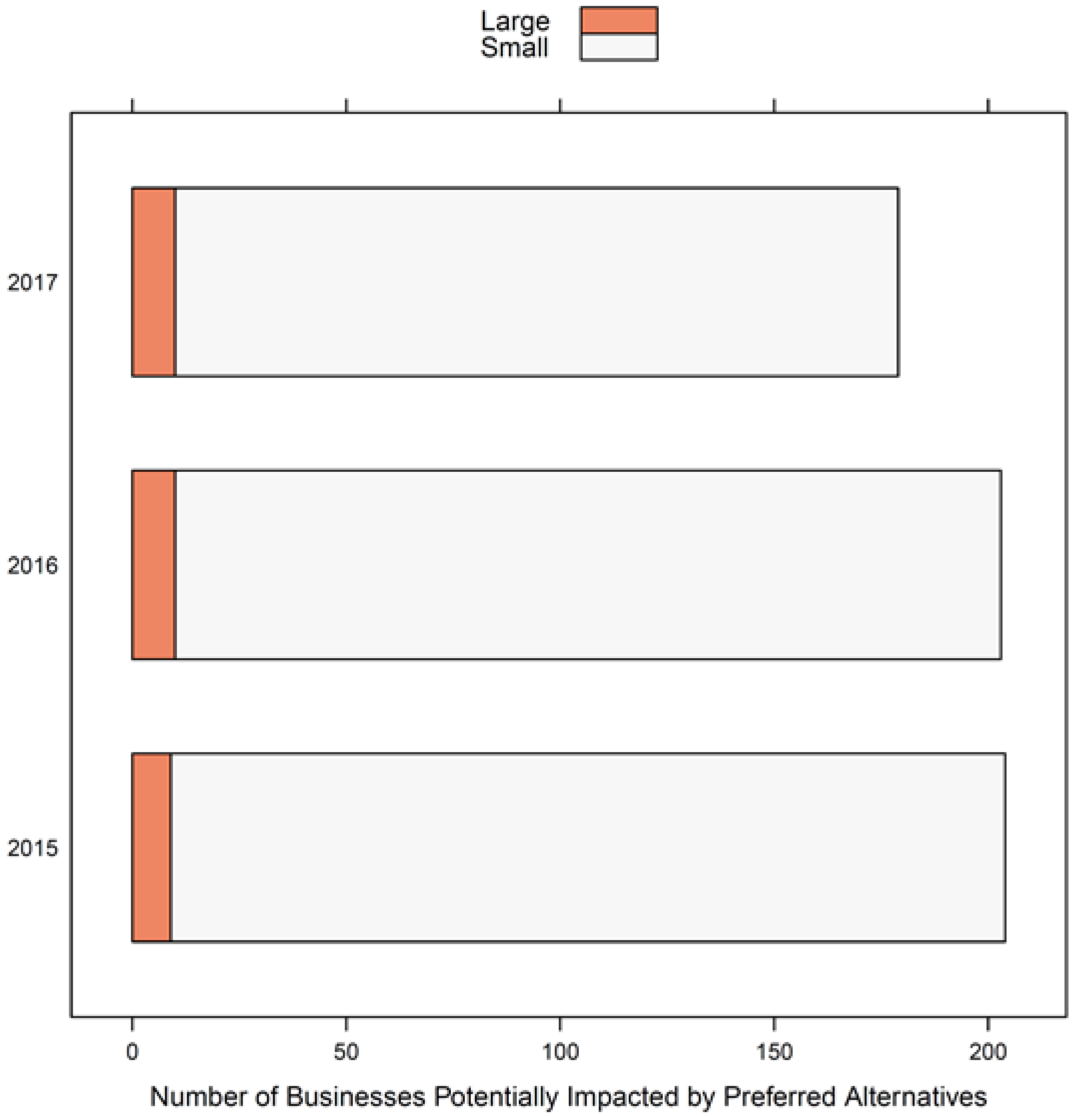
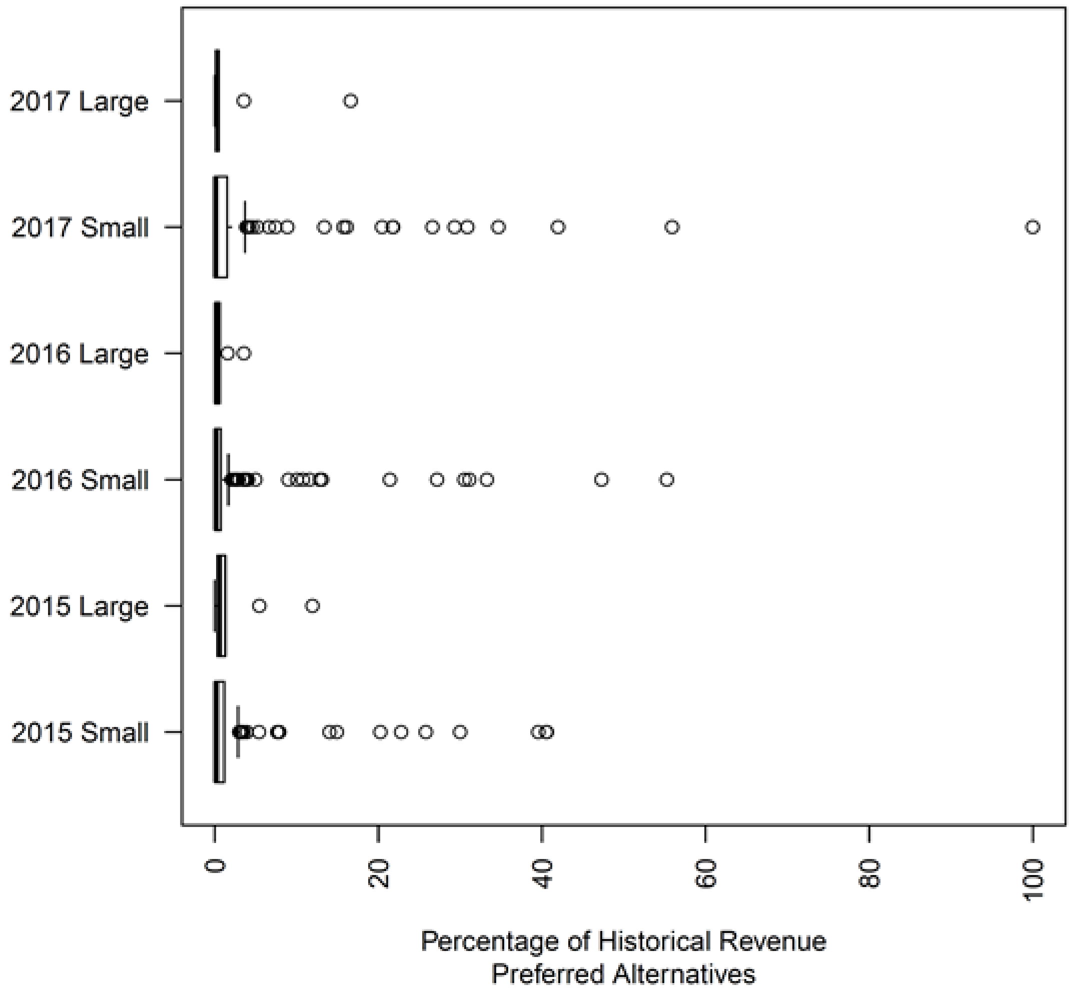


Figure 111 – Percentage of business revenue, by business size, estimated to fall within currently open areas and potentially displaced by the preferred alternatives.



11.3.3.2 Comparison of Proposed Action with Alternate Areas

This section compares the suite of Preferred Alternatives to the most expansive suite of alternatives considered, in order to assess the relative impact of the Preferred Alternatives with the breadth of alternatives considered under this action. The purpose of this comparison is to provide a sense of the extent to which impacts to fisheries were mitigated while attempting to achieve the goals of the Deep-Sea Coral Amendment. The list of alternatives assessed in this additional "Maximum Conservation" analysis includes the 300 meter broad zone, all of the discrete canyons zones (Alvin, Atlantis, Nantucket, Veatch, Hydrographer, Dogbody, Clipper, Sharpshooter, Welker, Heel Tapper, Oceanographer, Filebottom, Chebacco, Gilbert Lydonia, Munson, Powell, Nygren, Kinlan, Heezen), and all of the Gulf of Maine zones with the larger boundaries for those with two boundary options (Outer Schoodic Ridge, Mount Desert Rock, the 114, 96, and 118 Fathom Bumps in Western Jordan Basin, Lindenkohl Knoll, and Central Jordan Basin). For this analysis, the areas would be designated as closures to all bottom-tending gear fishing, with no exemptions for red crab, lobster, or other types of trap gears. An important caveat in what follows is the lack of spatial data on the inshore lobster fishery, as detailed in section 7.2.5.3 and 7.2.6.3. This translates into an inability to identify the number of businesses (or vessels) historically fishing within the inshore alternatives. A similar issue exists with respect to the percentage of historical business revenue being generated from inshore areas. This is problematic given that even with low VTR coverage of the fishery (less than 10% of trips), what data we have indicates that the lobster fishery represents the dominant fishery engaged in the inshore areas.

Figure 112 presents the number of businesses estimated to be fishing in the vicinity of currently open areas of the Maximum Conservation Alternatives, which indicates roughly 25% more businesses are exposed to the Maximum Conservation Alternatives when compared to the Preferred Alternatives. Figure 113 presents the distribution of the percentage of total business revenue in areas currently open to fishing that would be potentially displaced by the Maximum Conservation Alternatives, by business type. For small businesses, exposure to the Maximum Conservation Alternatives average 26% higher than the Preferred Alternatives, while large businesses face an average 47% higher exposure to the Maximum Conservation Alternatives. A small number of individuals are highly exposed to the Maximum Conservation Alternatives. Nevertheless, the majority of individuals face relatively low exposure even to the Maximum Conservation Alternatives.

The biggest caveat to this analysis is again the lack of spatial fishing location information from the inshore lobster pot fishery, at the level of resolution necessary to assess impacts. This has particularly strong ramifications for the inshore Gulf of Maine alternatives of Outer Schoodic Ridge and Mount Desert Rock, in which the lobster pot fishery comprises the overwhelming majority of identified fishing activity. Sections 7.2.5.3 and 7.2.6.3 discuss the uncertainty associated with estimates of revenue being generated within these alternatives. Of greater certainty is that the vast majority of lobster pot businesses impacted by the Maximum Conservation Alternatives but not represented in the federal VTR data would be classified as small businesses. Additionally, the territoriality of both the lobster fishery (e.g. Acheson 1987) and the lobster fishery management system likely makes a redistribution of effort from inside the Deep-Sea Coral alternatives to outside of those alternatives difficult for affected fishermen.

The alternative for the special fishery programs for coral zones outlined in section 4.4 would be expected to have neutral to slightly positive marginal impacts on fishermen, as they could allow for some regulatory relief when combined with the deep-sea coral area management alternatives. Given these are voluntary programs, fishermen would not engage in the programs unless they expected to benefit from them. The framework provision outlined in section 4.5 is an administrative provision which does not directly regulate any entities external to NOAA Fisheries and the New England Fishery Management Council.

Figure 112 – Number of businesses historically fishing in areas of the Maximum Conservation Alternatives currently open to fishing.

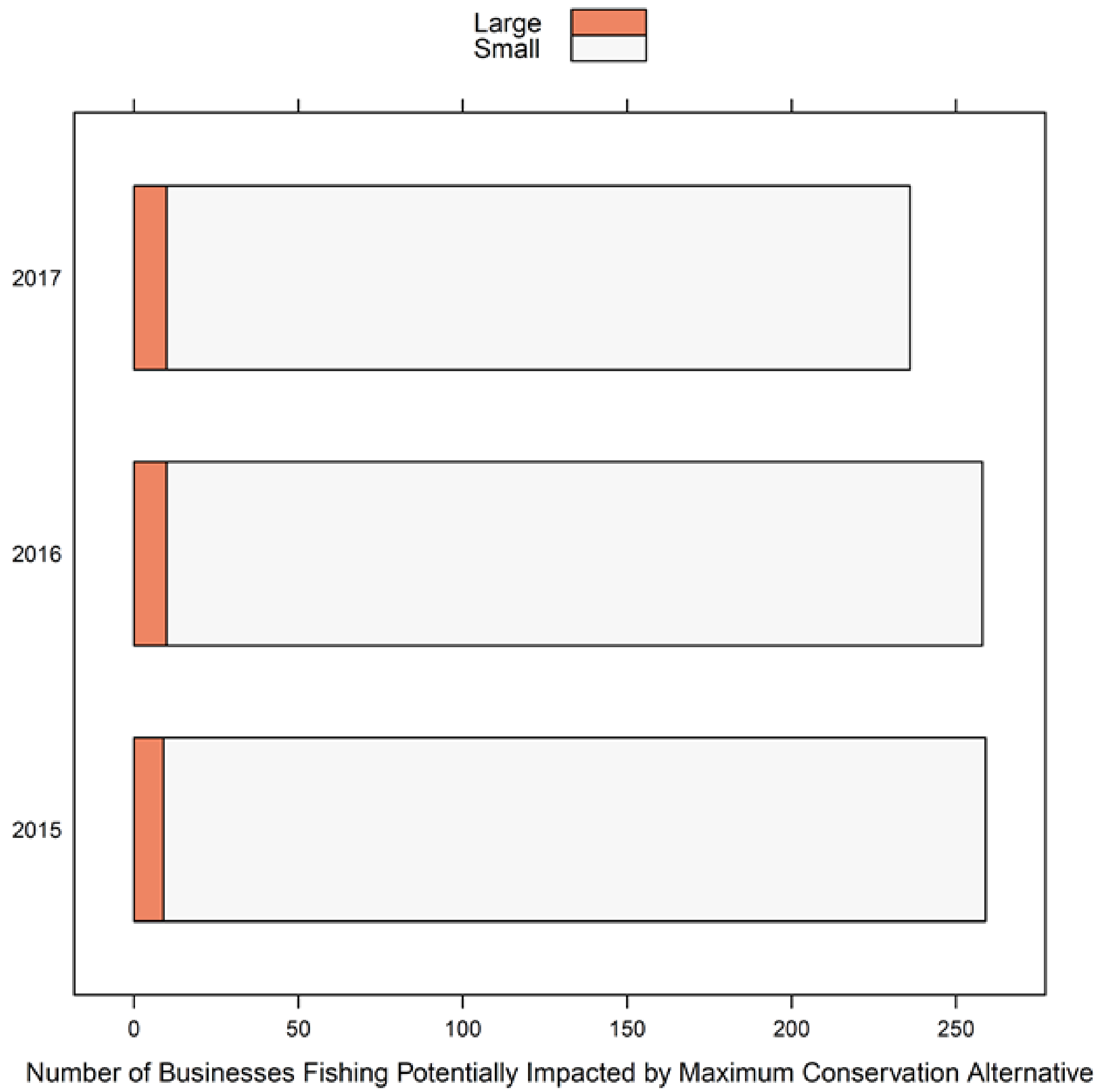
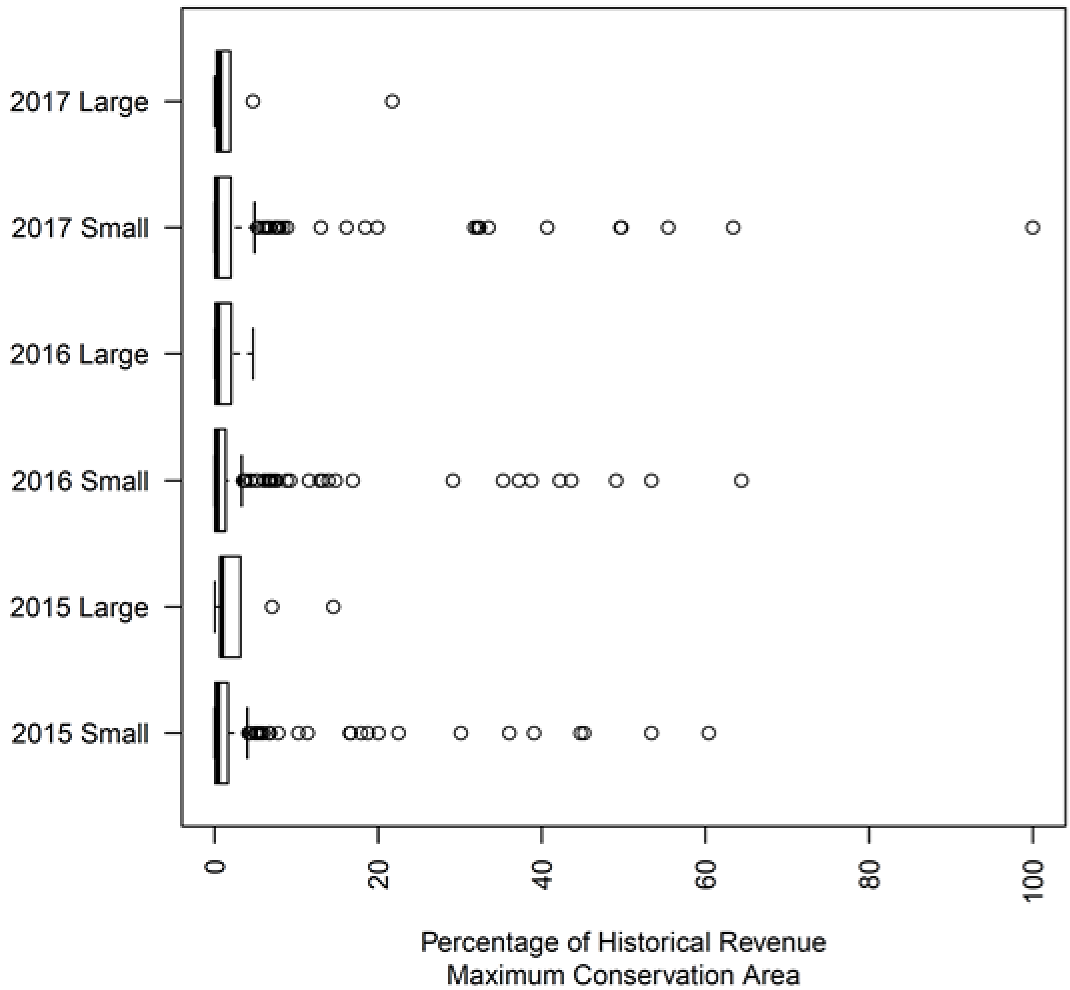


Figure 113 – Percentage of business revenue, by business size, estimated to fall within currently open areas and potentially displaced by the Maximum Conservation Alternatives.



11.3.4 Record Keeping and Reporting Requirements

The deep-sea coral amendment does not necessitate any additional reporting, recordkeeping, or other compliance requirements.

11.3.5 Duplication, Overlap, or Conflict with Other Federal Rules

Parts of the proposed action overlap spatially with the Northeast Canyons and Seamounts Marine National Monument, defined by Presidential Proclamation 9496 of September 15, 2016 (81 FR 65159). However, the proposed action does not duplicate, overlap, or conflict with any other Federal rules.

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