Draft Omnibus Deep-Sea Coral Amendment Including a Draft Environmental Assessment

DRAFT – December 19, 2017

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

Final Council action:
Preliminary submission:
Final submission:

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 meters (28 fathoms) 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 Section 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).

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 §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 (draft or final) are bolded and underlined for emphasis.

4.1 No Action		
Management areas	**Fishing gear restrictions**	**Notes**
• 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	• 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	• 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
4.2.1 Broad zones 4.3 Fishing gear restrictions		
Management areas	**Fishing gear restrictions**	**Notes**

• 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
• **Option 6: 600 m minimum depth zone (Draft preferred April 2017)**
• Option 7: Empirically-derived zone based on coral and fishery data
	• **Option 1: Prohibit BTG (Draft preferred April 2017)**
	  ◦ **Sub-option A: exempt red crab fishery (Draft preferred April 2017)**
	  ◦ Sub-option B: exempt other trap fisheries
	• Option 2: Prohibit MBTG
		• 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.

4.2.2.1 Discrete canyon zones 4.3 Fishing gear restrictions		
Management areas	**Fishing gear restrictions**	**Notes**

• Alvin Canyon
• Atlantis Canyon
• Nantucket Canyon
• Veatch Canyon
• Hydrographer Canyon
• Dogbody Canyon
• Clipper Canyon
• Sharpshooter Canyon
• Welker Canyon
• Heel Tapper Canyon
• Oceanographer Canyon
• Filebottom Canyon
	• Option 1: Prohibit BTG
	  ◦ Sub-option A: exempt red crab fishery
	  ◦ Sub-option B: exempt other trap fisheries
	• Option 2: Prohibit MBTG
		• 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 broad zone, if shallower boundaries or different gear restrictions are desired

• Chebacco Canyon • Gilbert Canyon • Lydonia Canyon • Powell Canyon • Munson Canyon • Nygren Canyon • Unnamed Canyon • Heezen Canyon		• 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.
4.2.2.2 Discrete seamount zones 4.3 Fishing gear restrictions		
Management areas	**Fishing gear restrictions**	**Notes**

• Bear Seamount
• Mytilus Seamount
• Physalia Seamount
• Retriever Seamount
	• Option 1: Prohibit BTG
	  • Sub-option A: exempt red crab fishery
	  • Sub-option B: exempt other trap fisheries
	• Option 2: Prohibit MBTG
		• 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.

4.2.2.3 Gulf of Maine zones 4.3 Fishing gear restrictions		
Management areas	**Fishing gear restrictions**	**Notes**

Gulf of Maine inshore:
• **Mount Desert Rock (Option 2 final preferred June 2017)**
• **Outer Schoodic Ridge (Final preferred June 2017)**
 	
Gulf of Maine offshore:
• WJB - 114 Fathom Bump
• WJB - 96 Fathom Bump
• WJB - 118 Fathom Bump
• Central Jordan Basin
• Lindenkohl Knoll
	• Option 1: Prohibit BTG
	  • Sub-option A: exempt red crab fishery
	  • Sub-option B: exempt other trap fisheries
	• **Option 2: Prohibit MBTG (Final preferred for inshore zones June 2017)**
		• 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 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: Special access program fishing • Alternative 2: Exploratory fishing • **Alternative 3: Request LOA for research activities in coral zones (Final preferred June 2017)** Notes: • Could adopt one or more alternatives, in any combination
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 (Final preferred June 2017)** • **Alternative 3: Change fishing restrictions (Final preferred June 2017)** • **Alternative 4: Allow adoption of or changes to special access or exploratory fishing programs (Final preferred June 2017)** Notes: • Could adopt one or more alternatives, in any combination. • 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 (Final preferred June 2017)** Notes: • No gear restrictions 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 7. Depending on the combination of zones and restrictions selected (Sections 4.2 and 4.3), 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):

Broad deep-sea coral zones (Section 4.2.1) and associated fishing restrictions (Section 4.3):

Discrete deep-sea coral zones (Section 4.2.2) and associated fishing restrictions (Section 4.3):

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.

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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 coral 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 Section 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 (Section 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 Section 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 Section 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 Section 303(b)(2)(C),14 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,

[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.

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 Section 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.
- Section 301(a)(9) requires Councils to include conservation and management measures that, to the extent practicable, minimize bycatch.
- Section 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 and its associated Environmental Impact Statement are currently undergoing final development and review, with implementation expected in 2017.

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 EEZ. 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 discussed by the other Council 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 approved for analysis in 2012. While final NMFS approval and rulemaking is pending, the preferred MAFMC approach is described below to facilitate continuity in management approaches. 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 meters extending to 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.

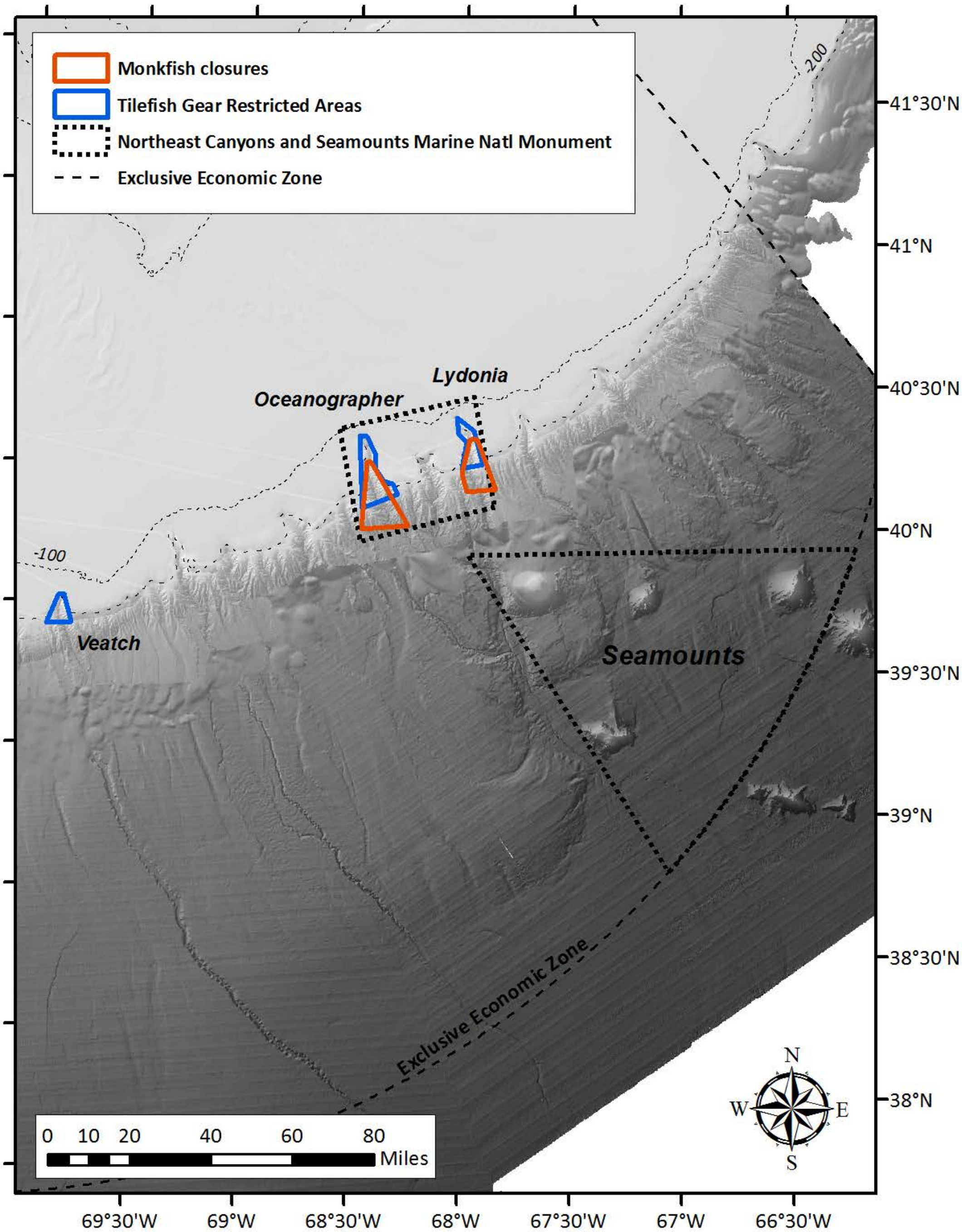
4 Management alternatives

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, which has two sub-areas. The first encompasses the shelf-slope region from Oceanographer to Lydonia Canyons between about 100 meters and 2,000 meters, 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 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.

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 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 zones have their landward/shallow boundaries along the southern flank of Georges Bank, their seaward boundary at 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 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 in Section 4.2.1.7.

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.

Details of method to define broad zone Options 1-6: 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. 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 (§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 compares the two options.

4.2.1.1 Option 1: 300 m broad zone

This option would designate a broad coral zone from the US-CAN EEZ boundary to the boundary between the New England and Mid-Atlantic Council regions, with the landward boundary based on the 300 m contour and the seaward boundary at the EEZ. The zone has a minimum depth of 250 m and an area of 67,142 km^2.

4.2.1.2 Option 2: 400 m broad zone

This option would designate a broad coral zone from the US-CAN EEZ boundary to the boundary between the New England and Mid-Atlantic Council regions, with the landward boundary at the 400 m contour and the seaward boundary at the EEZ. The zone has a minimum depth of 350 m and an area of 66,410 km^2.

4.2.1.3 Option 3: 500 m broad zone

This option would designate a broad coral zone from the US-CAN EEZ boundary to the boundary between the New England and Mid-Atlantic Council regions, with the landward boundary at the 500 m contour and the seaward boundary at the EEZ. The zone has a minimum depth of 450 m and an area of 65,838 km^2.

4.2.1.4 Option 4: 600 m broad zone

This option would designate a broad coral zone from the US-CAN EEZ boundary to the boundary between the New England and Mid-Atlantic Council regions, with the landward boundary at the 600 m contour and the seaward boundary at the EEZ. The zone has a minimum depth of 550 m and an area of 65,365 km^2.

4.2.1.5 Option 5: 900 m broad zone

This option would designate a broad coral zone from the US-CAN EEZ boundary to the boundary between the New England and Mid-Atlantic Council regions, with the landward boundary at the 900 m contour and the seaward boundary at the EEZ. The zone has a minimum depth of 850 m and an area of 64,193 km^2.

4.2.1.6 Option 6: 600 m minimum depth broad zone

This option would designate a broad coral zone from the US-CAN EEZ boundary to the boundary between the New England and Mid-Atlantic Council regions, with the landward boundary at the 600 m contour and the seaward boundary at the EEZ. The zone is similar to Option 4, but has a minimum depth of 600 m and an area of 65,147 km^2.

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 EEZ (Hague Line), and the offshore boundary at the EEZ (200 mile limit). These boundary limits are the same as for 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. The inshore boundary along the shelf break 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 where they are known or highly likely in areas where it is unlikely that fishing would be impacted.

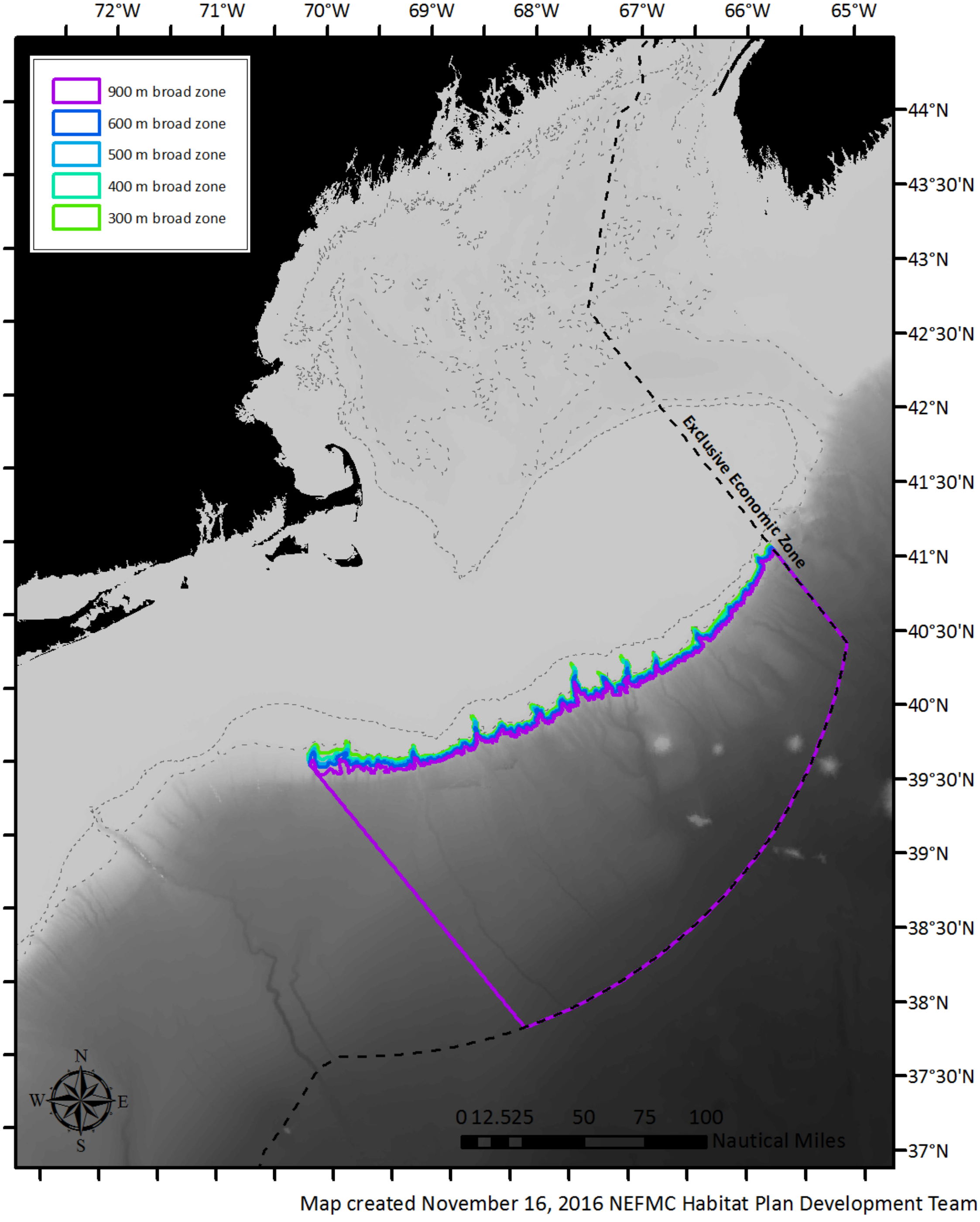
Coral habitat was assessed based on coral presence records, areas identified as highly likely to be suitable soft coral habitat in a predictive model, or presence of steep slopes (> 30°).

Fishing with mobile bottom-tending gears (MBTG) was determined based on visual inspection of VMS and VTR data via the Northeast Ocean Data Portal and Mid-Atlantic Ocean Data Portal. Map services with these data layers can be viewed within any Geographic Information System along other sources of data, including, in this case, draft coral management zones, high resolution depth contours and slope polygons, coral modeling outputs, and coral point data.

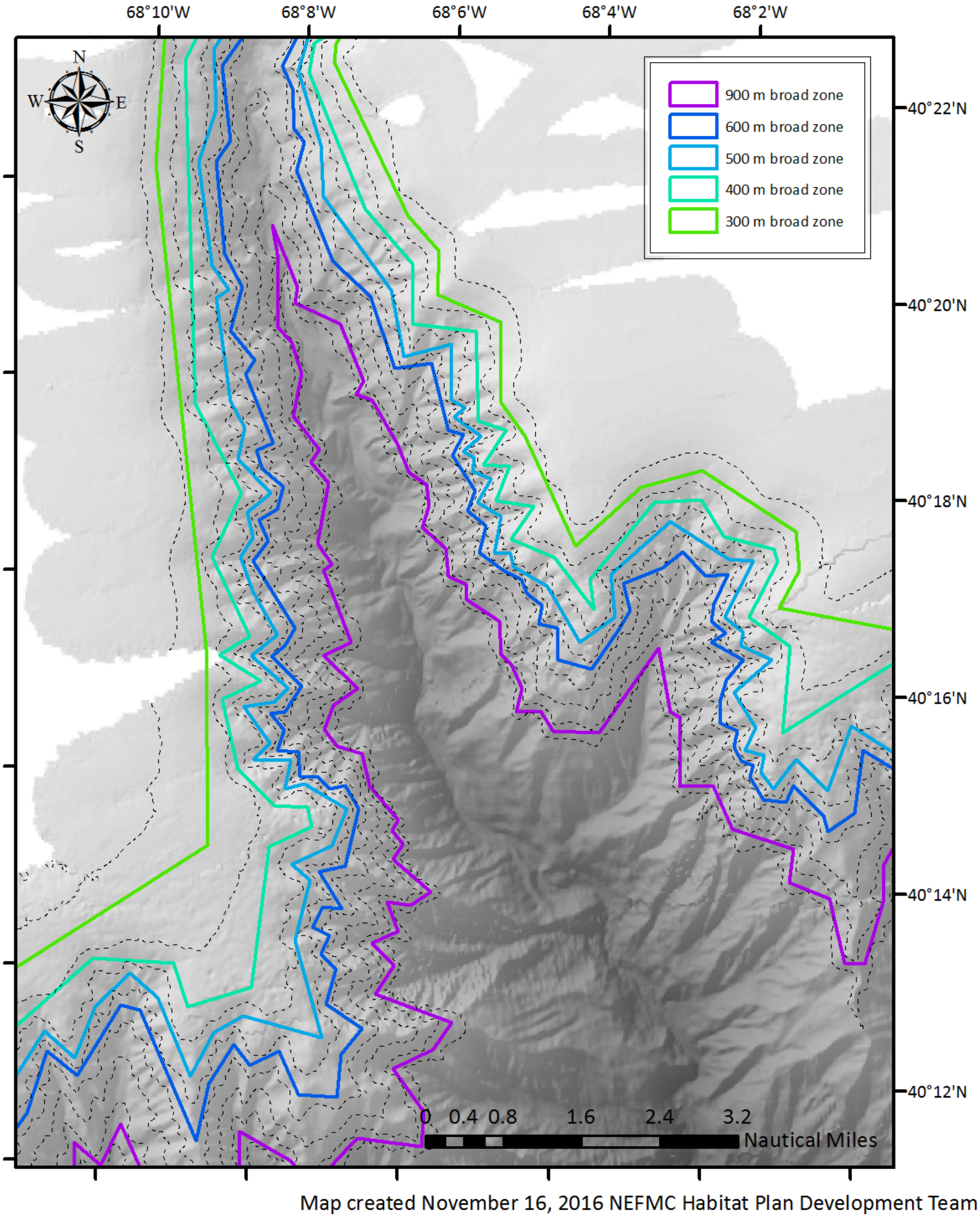
Both the Northeast and Mid-Atlantic data portals include vessel activity based on hourly VMS polls, which are point data. The data were grouped according to VMS declaration code, filtered to remove polls that indicate vessel speeds above 4 knots (5 knots for scallops), with the points (individual polls) interpolated to create a surface representing a gradient of effort in each category. VMS polls were omitted from the dataset altogether if there were fewer than 3 polls in a 1,400 m^2 grid cell. The polls were then interpolated to a 100 m^2 grid, where an individual 100 m^2 grid was turned on if there was a poll within a 1,000 m search radius. The number of polls within the search radius determined the color intensity of the 100 m2 grid cell. VMS data for monkfish (2011-2014), squid (2014), and multispecies (2011-2014) were examined during development of the alternative.

The Mid-Atlantic Ocean Data Portal also includes VTR data. VTR maps on the data portal represent the location and intensity of fishing during recent years (2011-2013). To develop the maps, individual points (trip locations) were weighted according to effort metrics such as days out, and number of crew, and then data were smoothed into a continuous surface using kernel density estimation, with a constant smoothing factor of 10 km (Jim Trimble, Rutgers University, personal communication). Data used during development of the alternative include bottom trawl < 65 ft., bottom trawl > 65 ft., and dredge, although other gears are available, and gillnet data are referenced in Pew et al.'s June 5 correspondence.

Map 2 – Location of broad coral protection zones. Options 6 and 7 are not shown.

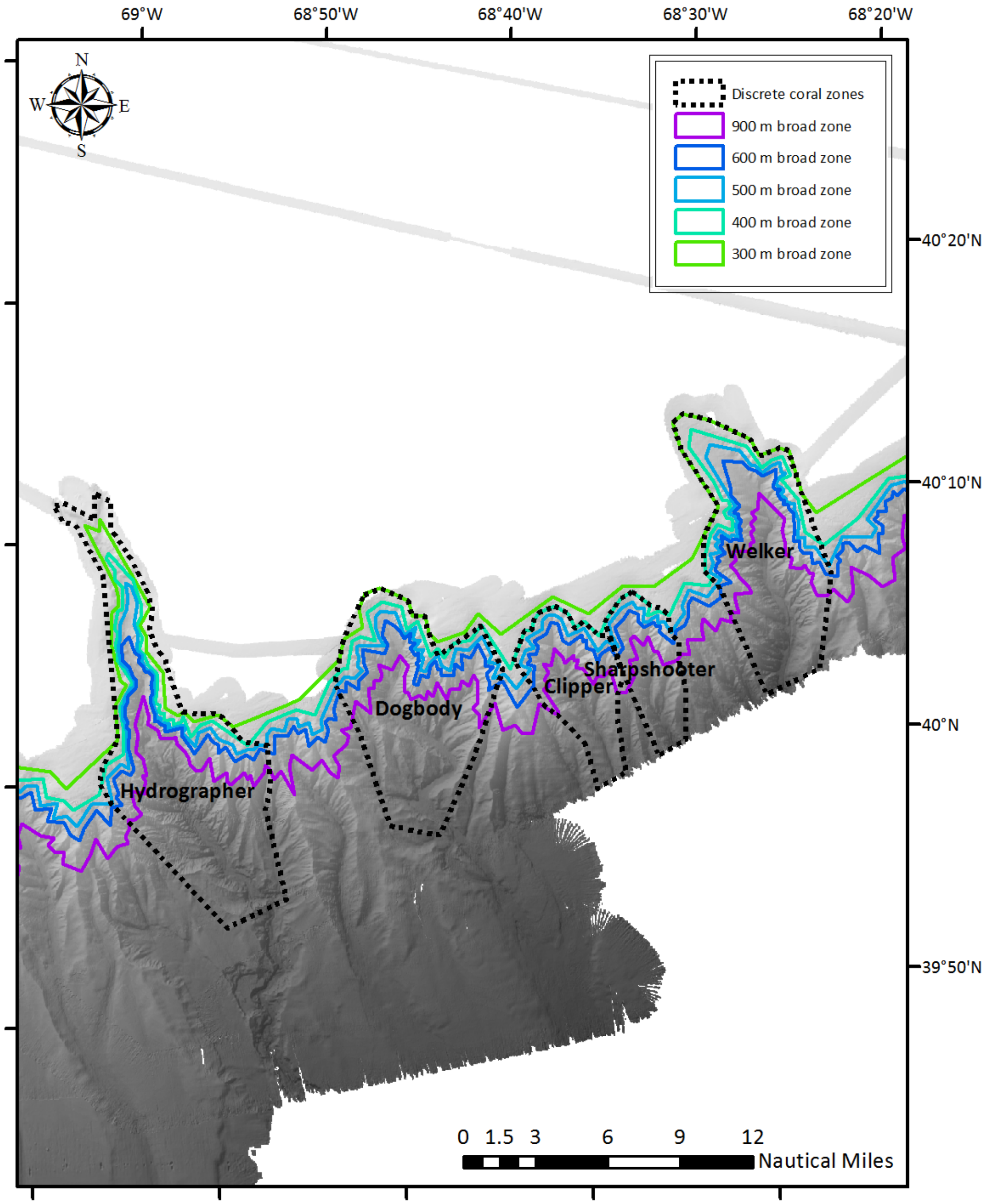


Map 3 – Broad zones Options 1-5 at the shoulder of Oceanographer Canyon showing the relationshiop between depth contours and zone boundaries. Options 6 and 7 are not shown.



Notes: Heavy straight 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.

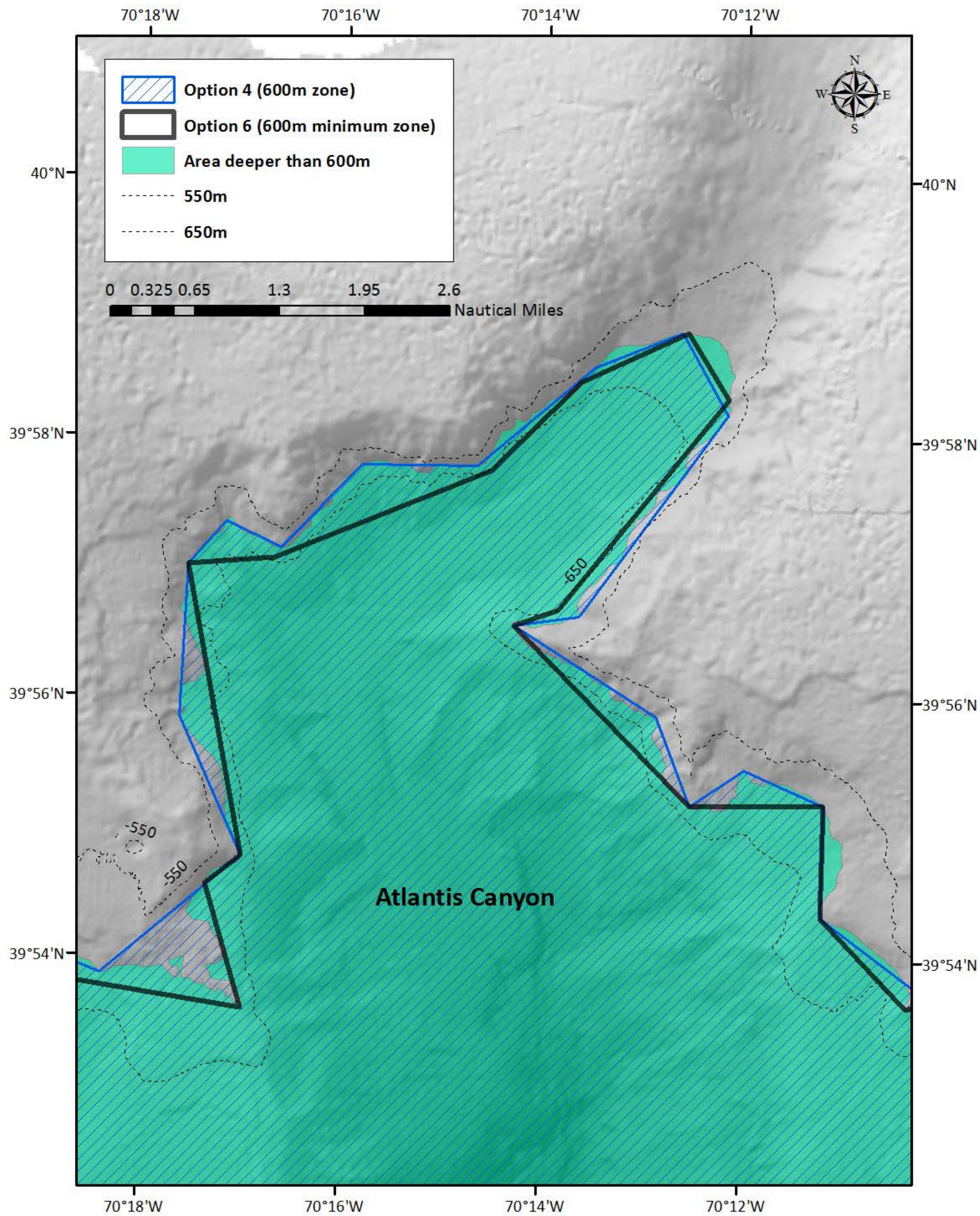
Map 4 – Broad zone boundary options and their relationship with discrete coral zones.



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 indicate 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 meter 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.

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, an unnamed canyon, 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 Marine National 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 2 – Size of each canyon coral zone.

Zone name	*Area (km^2)*	*Area (mi^2)*
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
Filebottom	56	22
Chebacco	83	32
Gilbert	167	65
Lydonia	179	69
Powell	138	53
Munson	130	50
Nygren	112	43
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.

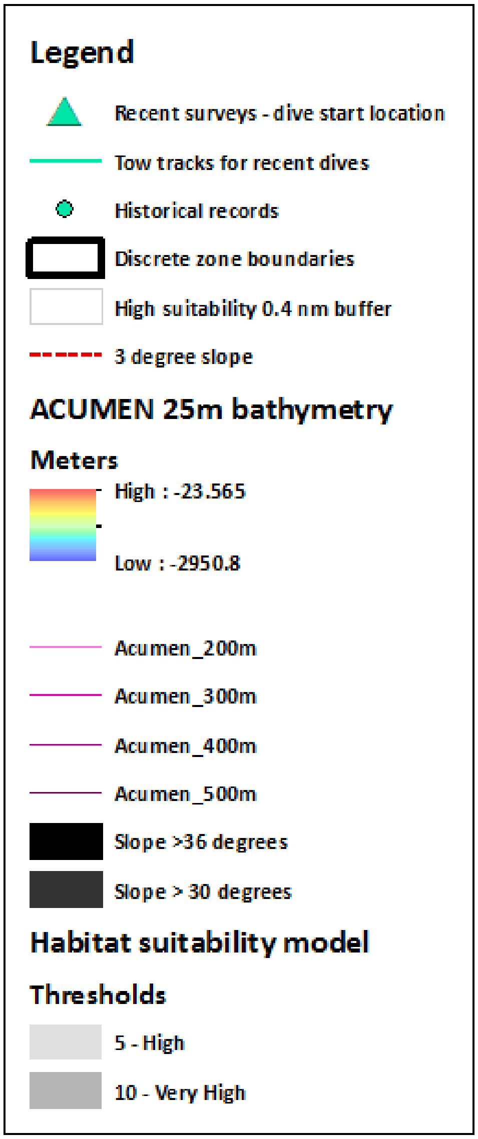
The locations of historic and recent coral observations generally fall solidly within zones developed using bathymetry, slope, and suitability model results, so while they are confirmatory of the presence of coral habitats in a canyon zone, they are not really a driving factor behind the zone boundaries.

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.

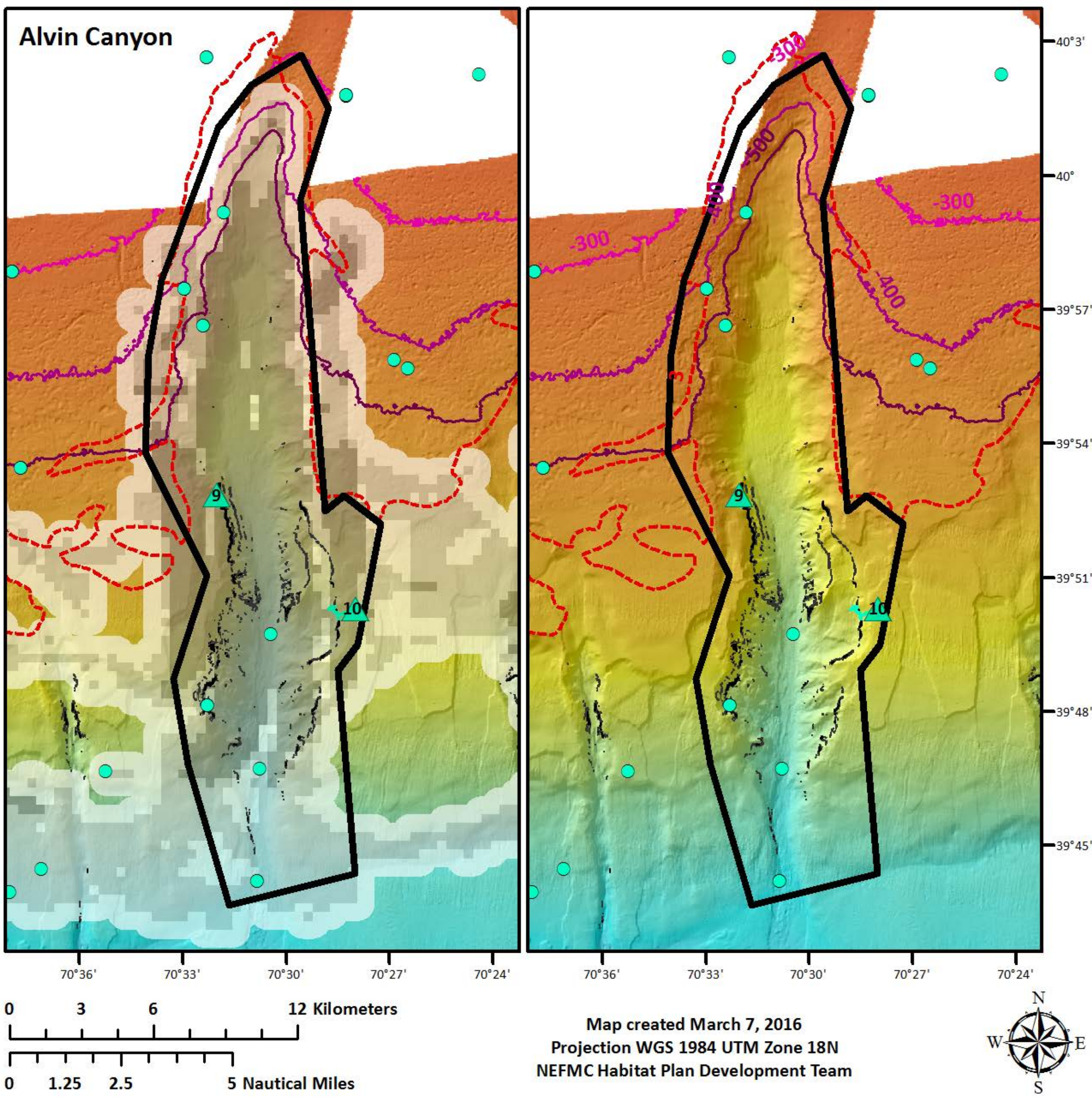
Two sets of maps were prepared for this document, one with the combined Gorgonian and Non-Gorgonian Alcyonacean habitat suitability layers, and one without, because the maps without habitat suitability more clearly show the shapes of the canyons. High and very high habitat suitability areas are shown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

Figure 1 – Legend for canyon area maps



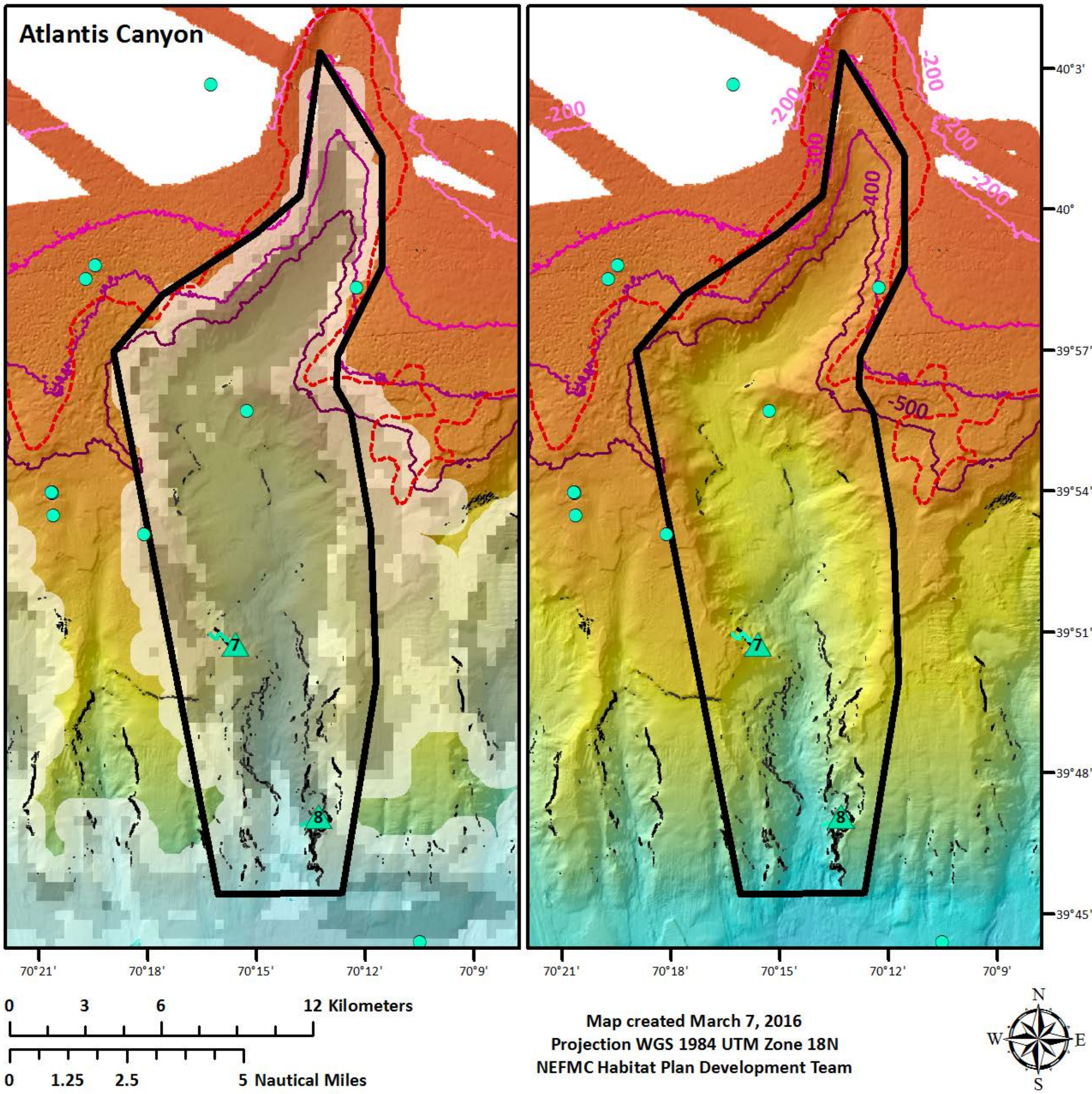
Alvin Canyon incises the continental shelf, encompassing an area of about 200 km^2. The proposed zone follows the 300 m depth contour at the head of the canyon and aligns closely with the 3° slope contour. The proposed zone encompasses areas of high and very high suitability as well as areas of high 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



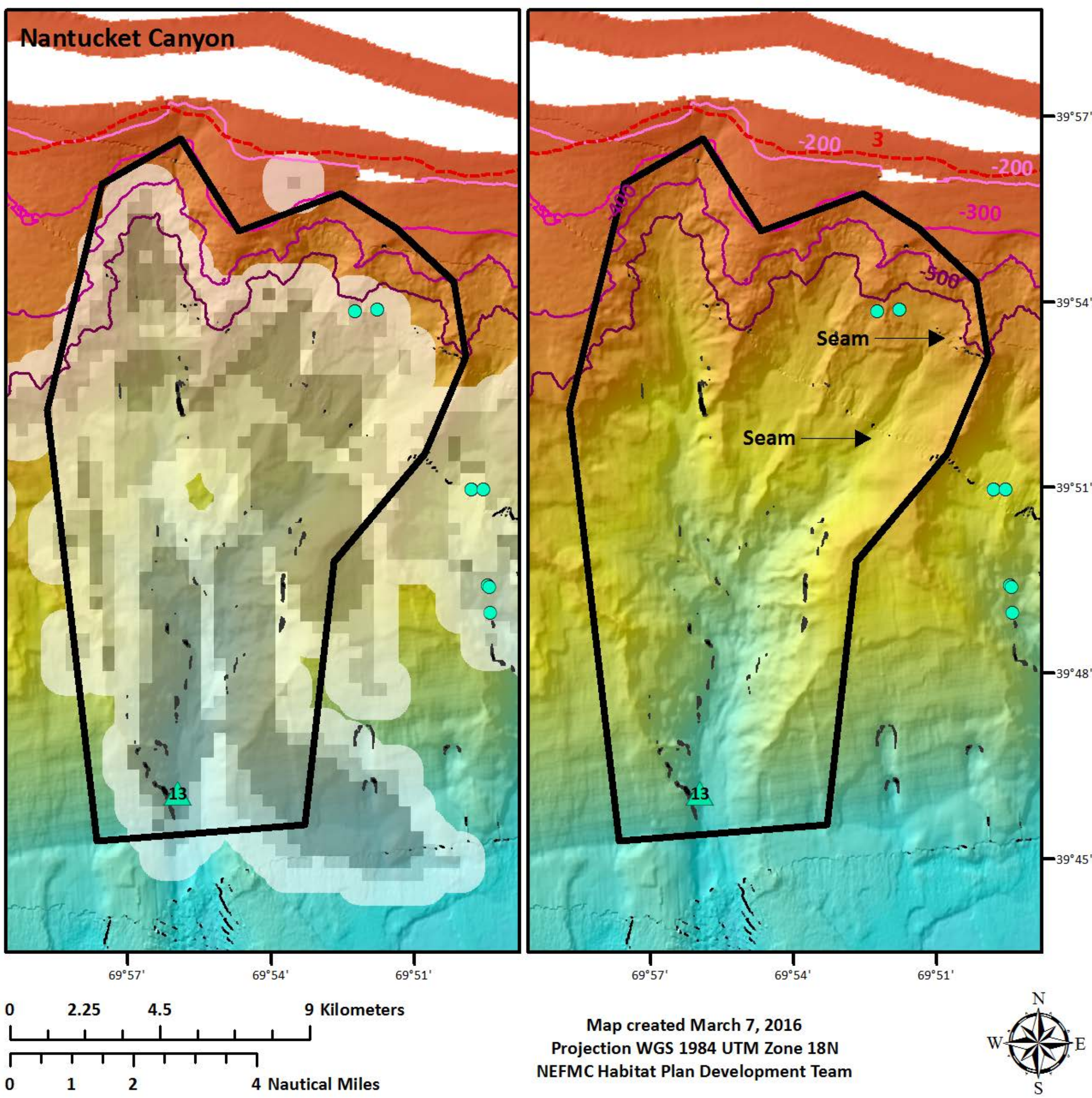
Atlantis Canyon incises the continental shelf break, encompassing an area of about 200 km^2. The proposed zone follows the 300 m depth contour at the head of the canyon and aligns closely with the 3° slope contour. The proposed zone encompasses areas of high and very high suitability as well as areas 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



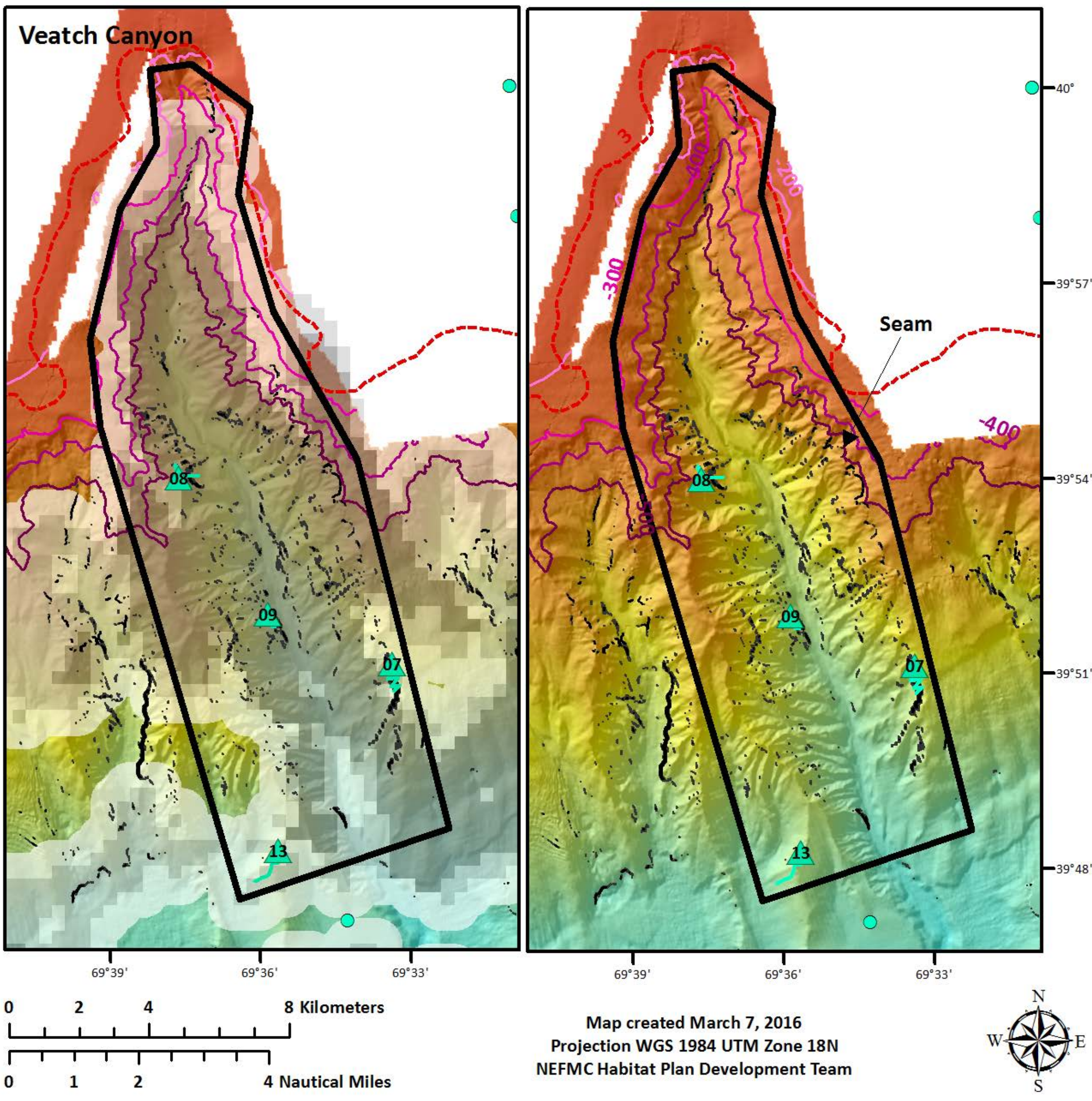
Nantucket Canyon is seaward of the 3° slope contour, with an area of about 200 km^2. It is a dendritic canyon, with three major branches. Although Harris and Whiteway (2011) classify Nantucket as shelf-incising, there is not a substantial curve in the 3° slope contour at the head of the canyon, such 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



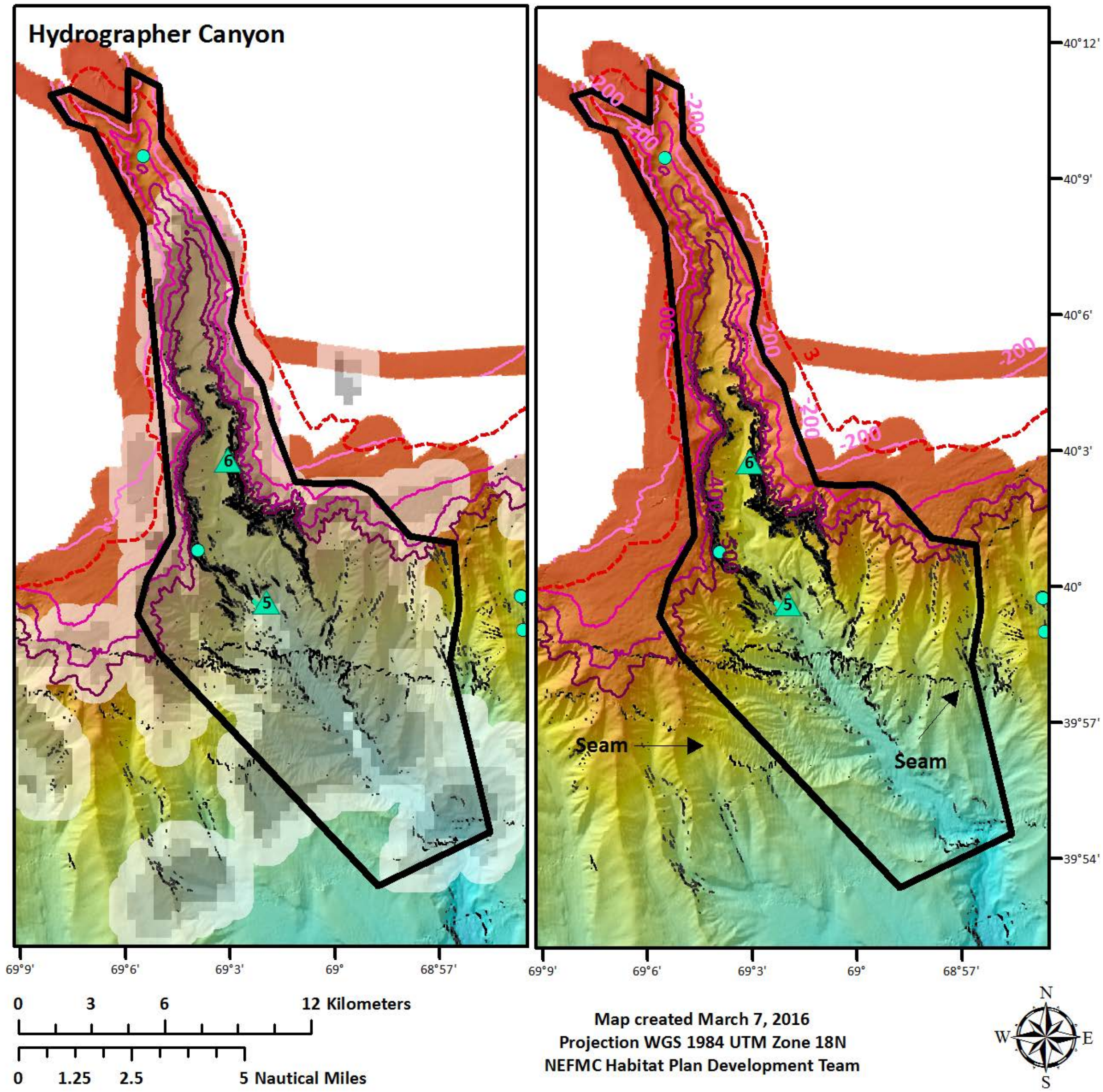
Veatch Canyon incises the continental shelf break. The recommended zone encompasses an area about 125 km^2 and is between 200 m and 300 m in the head of the canyon. The No Action Tilefish Gear Restricted Area encompasses additional areas outside the discrete coral zone. Most of the recommended zone is 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



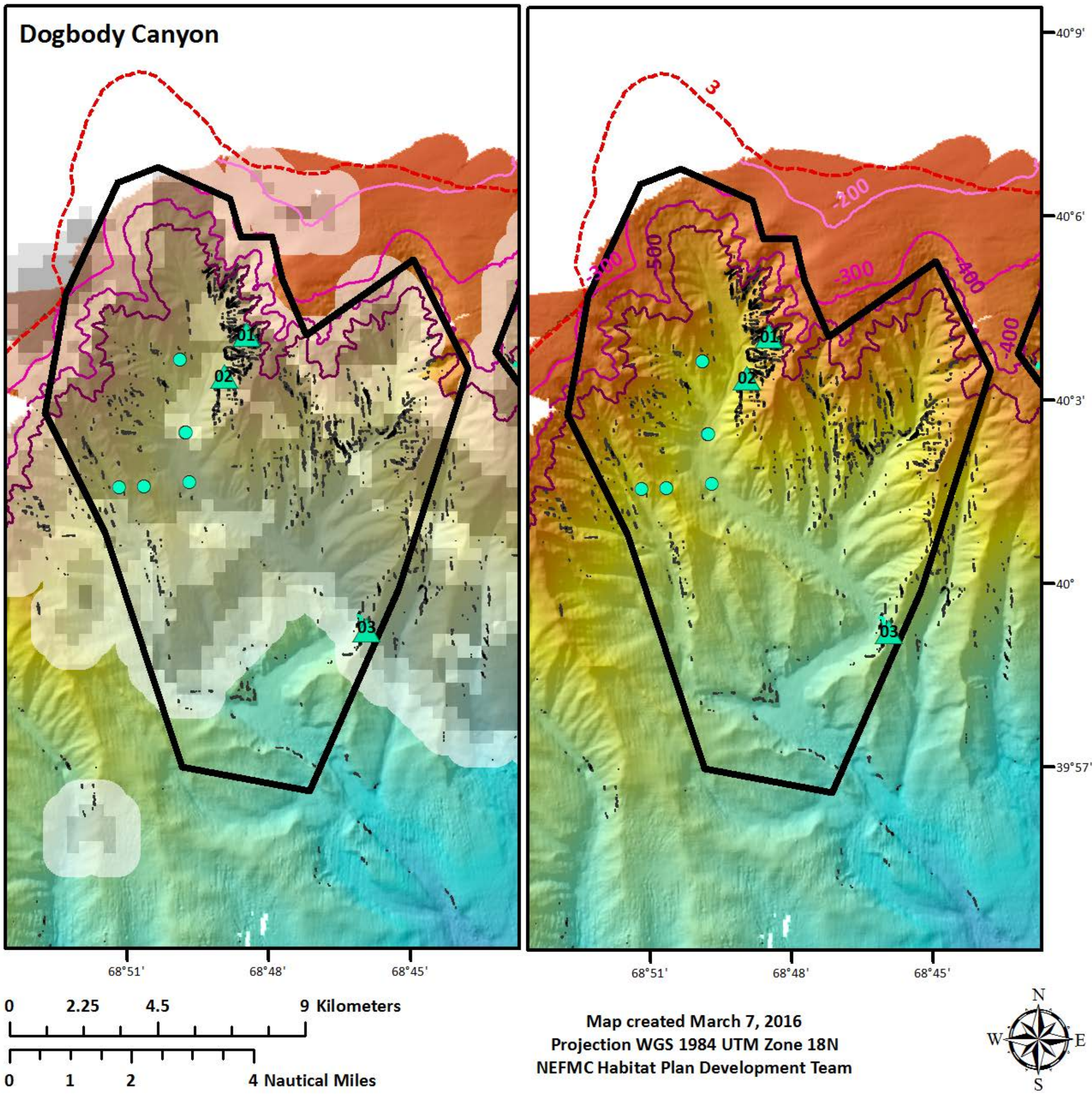
Hydrographer Canyon is a narrow canyon that incises the continental shelf break, encompassing an area about 200 km^2. The proposed zone follows the 200 m depth contour at the head of the canyon. The areas of high slope (i.e., greater than 30º) are found in the narrow portion of the proposed canyon zone, 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



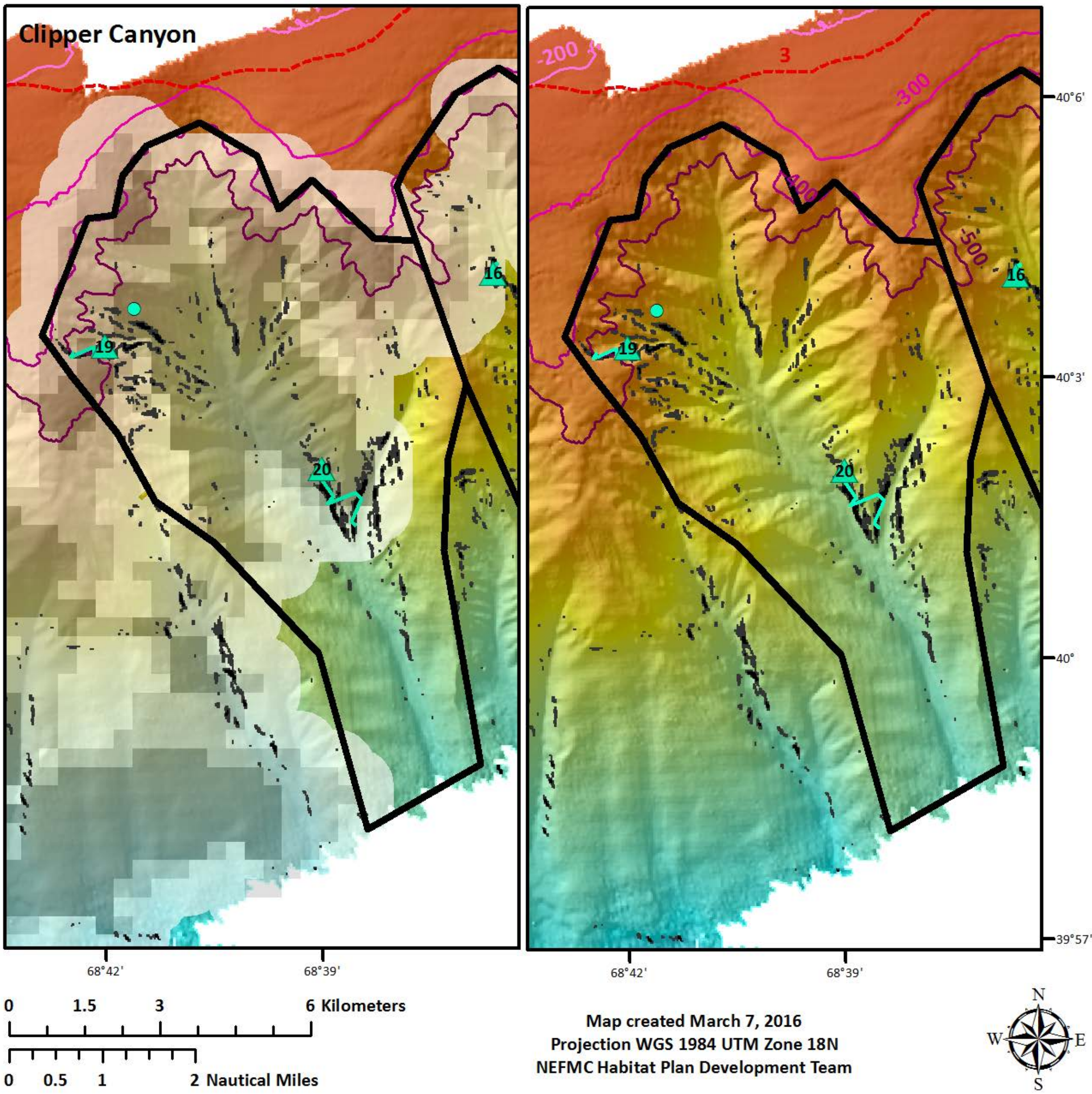
Dogbody Canyon is a dendritic canyon that incises the continental shelf break, encompassing an area about 150 km^2. The proposed zone follows the 300 m depth contour at the head of the canyon and is seaward of the 3° slope contour. The main thalweg is somewhat sinuous with a smaller branch to the east. 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



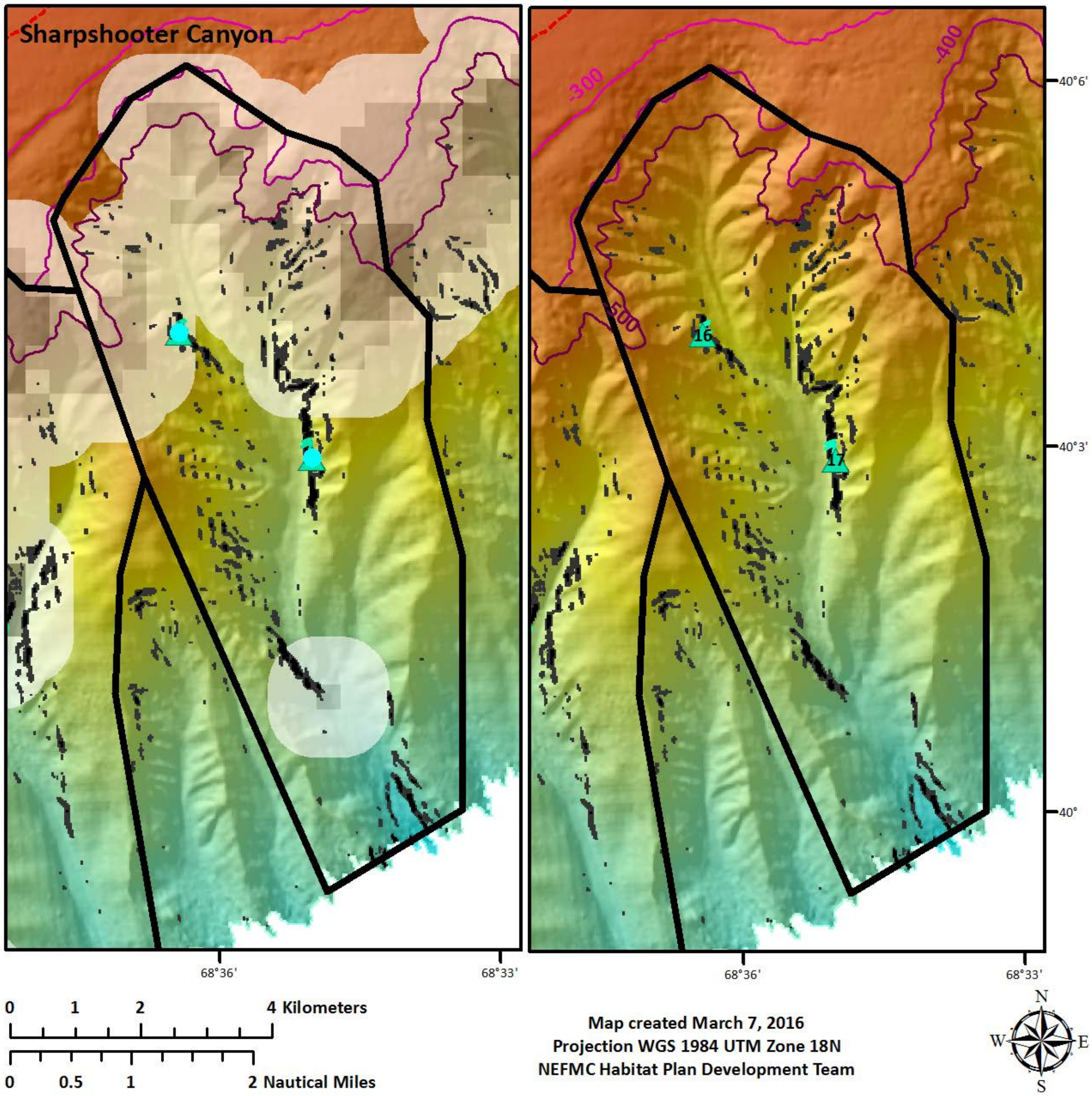
Clipper Canyon is slope-confined, encompassing an area about 50 km^2, and thus among the smaller canyons off the Northeast continental shelf. The proposed zone follows the 400 m depth contour at the head of the canyon. Clipper has one main branch and a smaller branch to the east. The habitat suitability 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



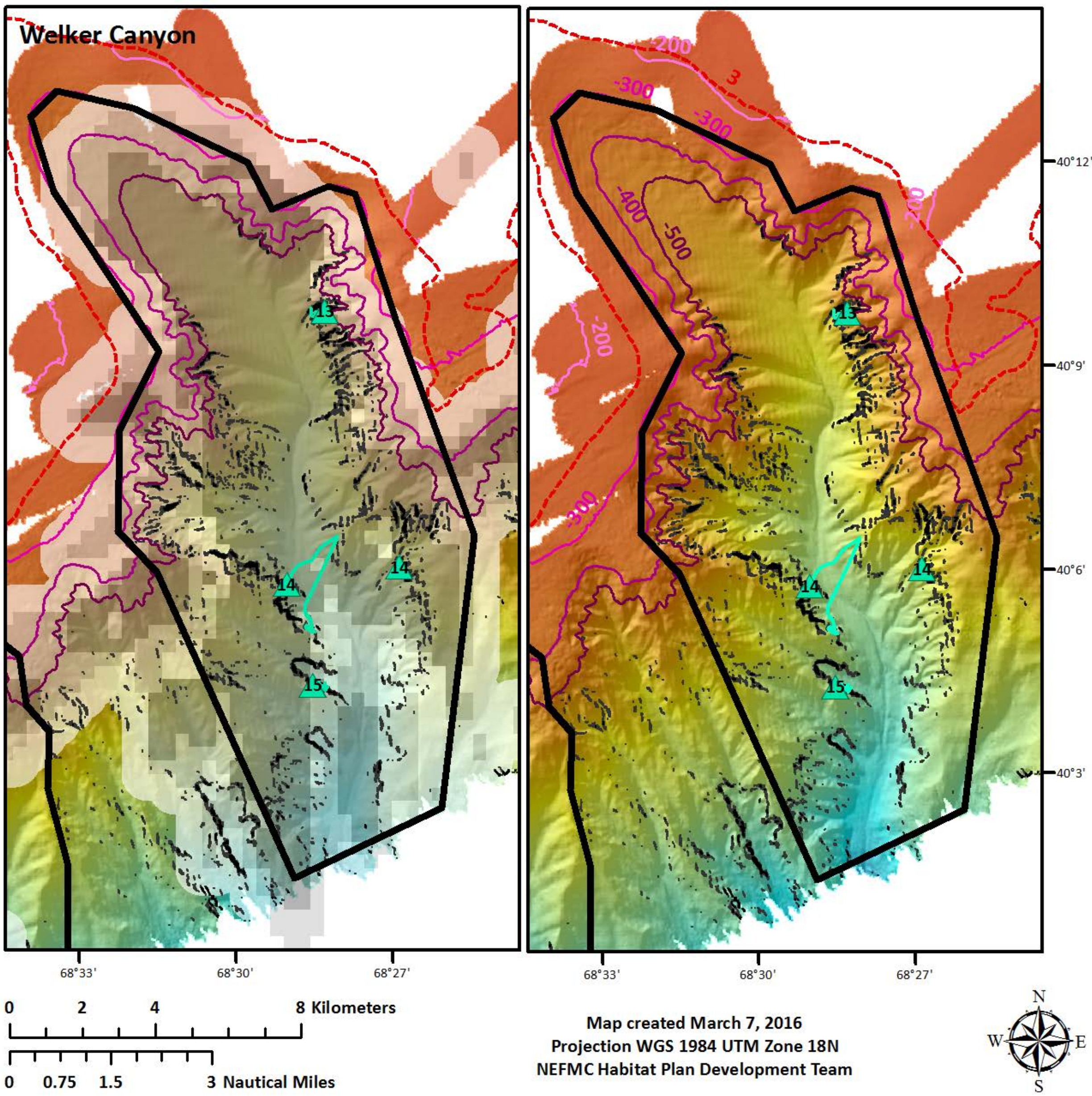
Sharpshooter Canyon is slope-confined, encompassing an area about 50 km^2, and thus among the smaller canyons off the Northeast continental shelf. The proposed zone follows the 400 m depth contour at the head of the canyon. Much of the proposed zone was not identified as high and very high habitat suitability 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



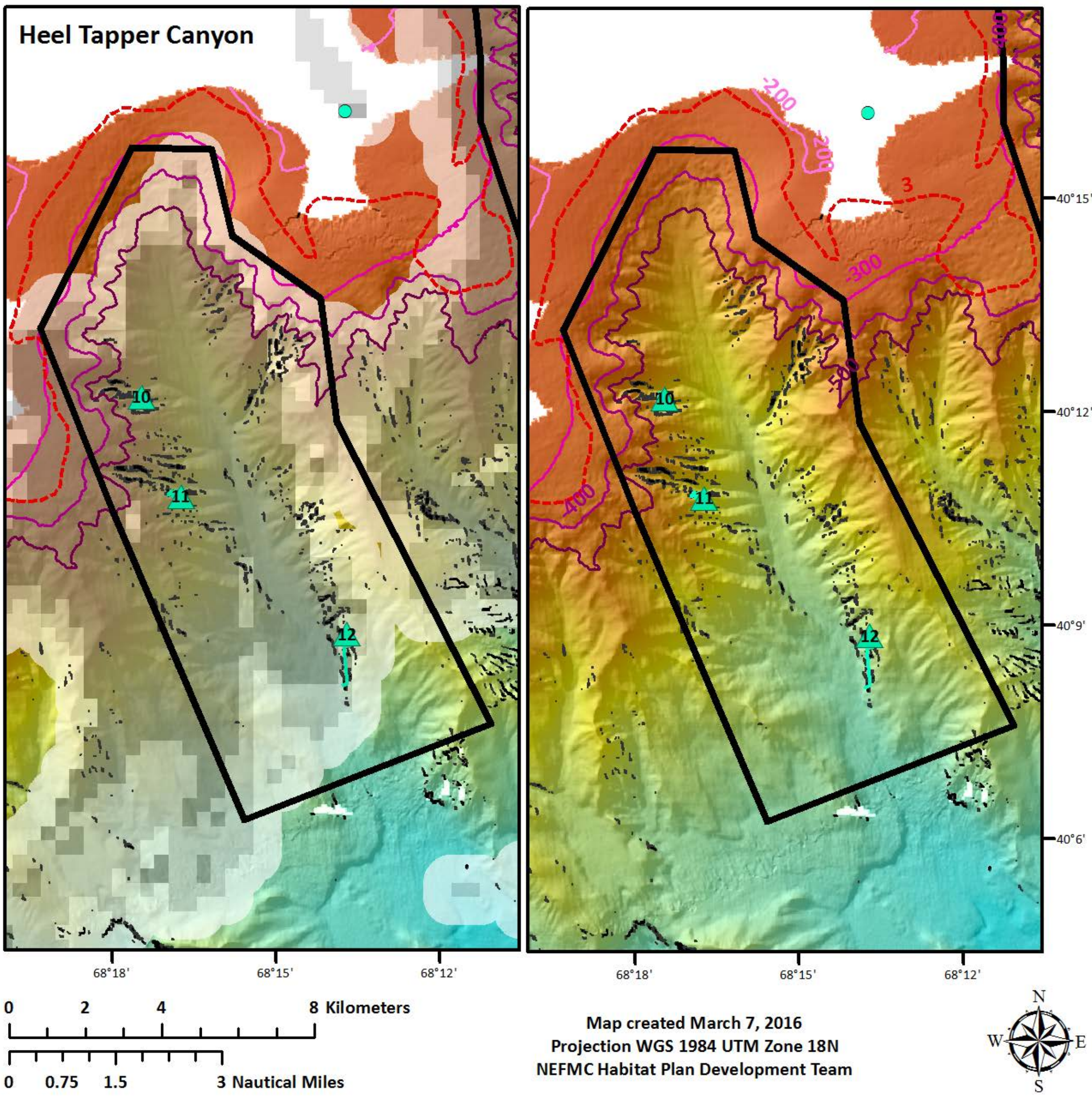
Welker Canyon incises the continental shelf break, encompassing an area about 150 km^2. The proposed zone follows the 300 m depth contour at the head of the canyon. The head of the canyon is not very steeply sloped, but there are large areas of high slope along both walls. Most of the proposed zone is 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



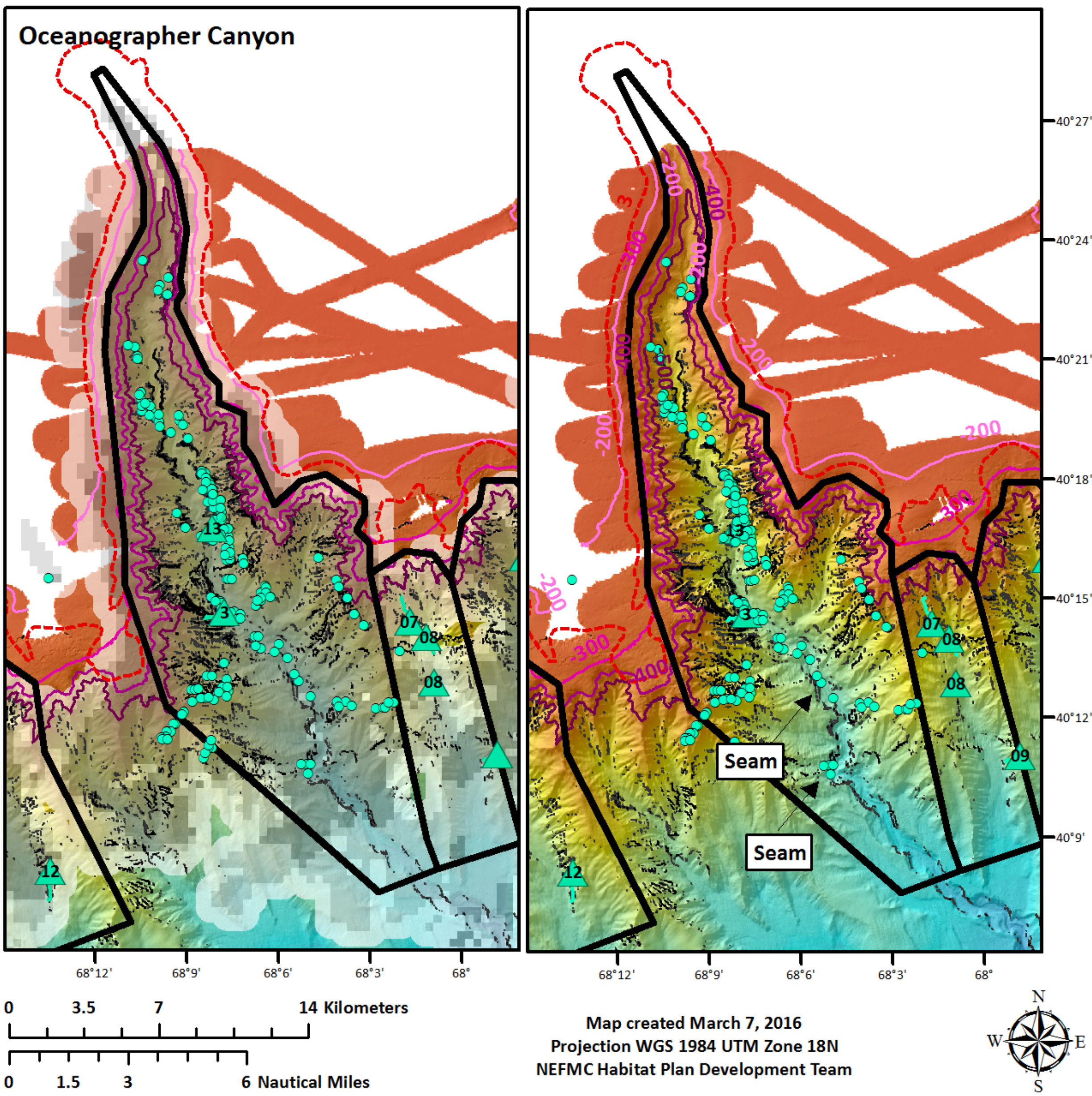
Heel Tapper Canyon incises the continental shelf break, encompassing an area about 100 km^2. The proposed zone follows the 300 m depth contour at the head of the canyon. The areas of high slope are also encompassed in the proposed zone. The area to the west of the proposed zone includes very high habitat 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



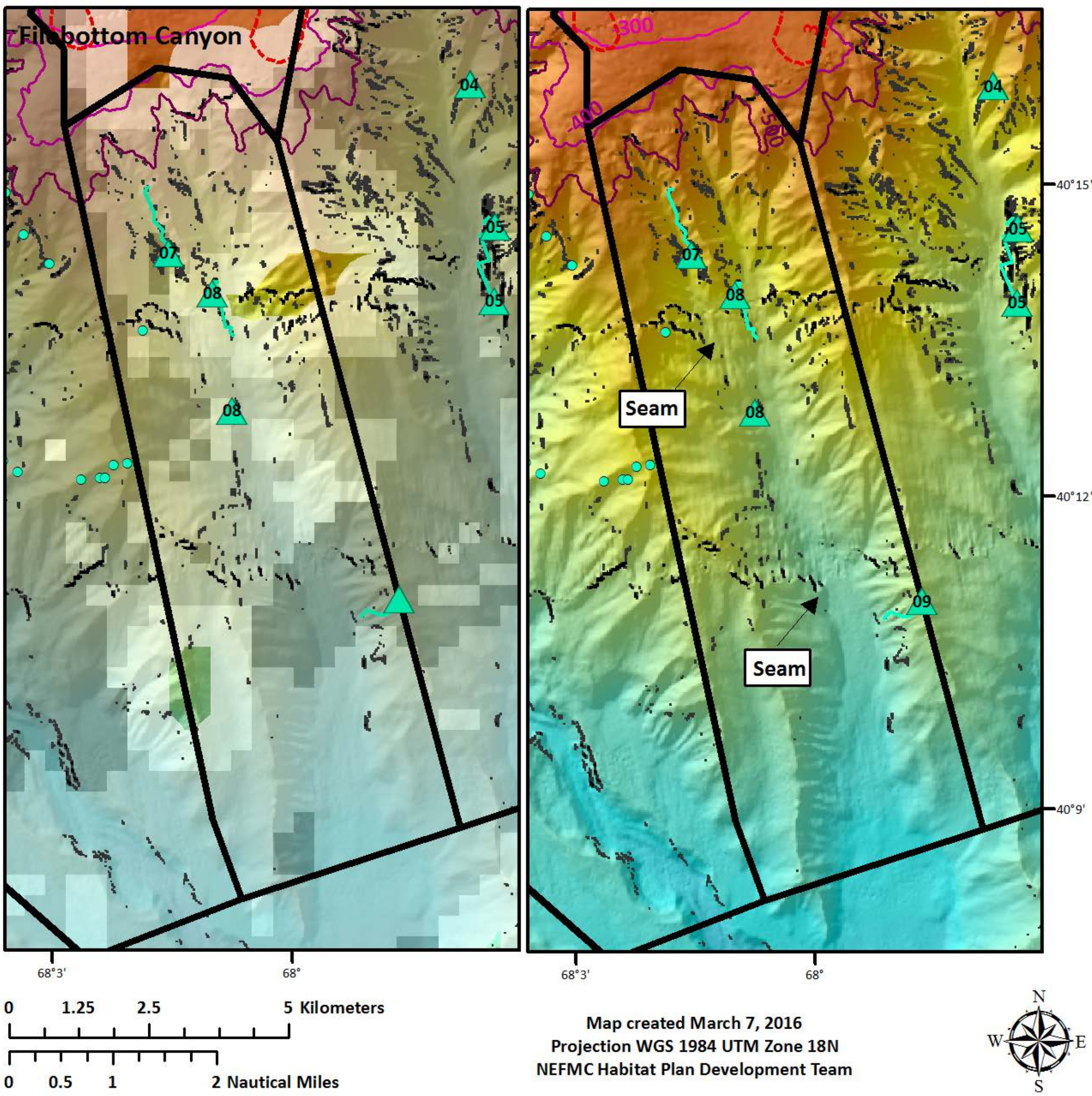
Oceanographer Canyon incises the continental shelf break, encompassing an area of over 200 km^2. It is the largest of the proposed canyon zones. The proposed zone follows the 300 m depth contour at the head of the canyon and the boundary is largely within the 3° slope contour. Oceanographer has a clear 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



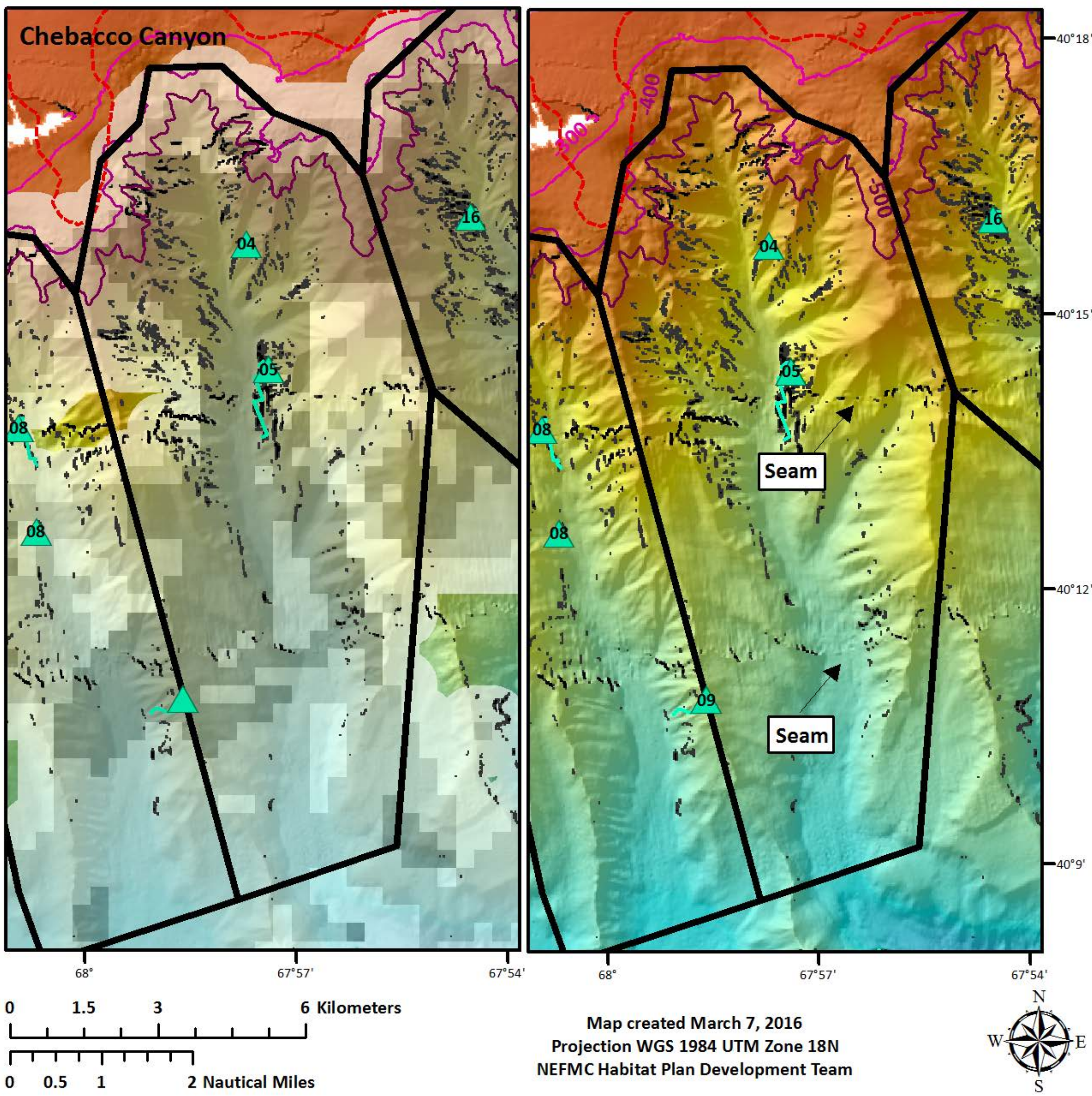
Filebottom Canyon is slope-confined, encompassing an area about 50 km^2. It is immediately adjacent to Oceanographer Canyon to the west and Chebacco Canyon to the east. The proposed zone follows the 300 m depth contour at the head of the canyon. There are fewer areas of high slope compared with some 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



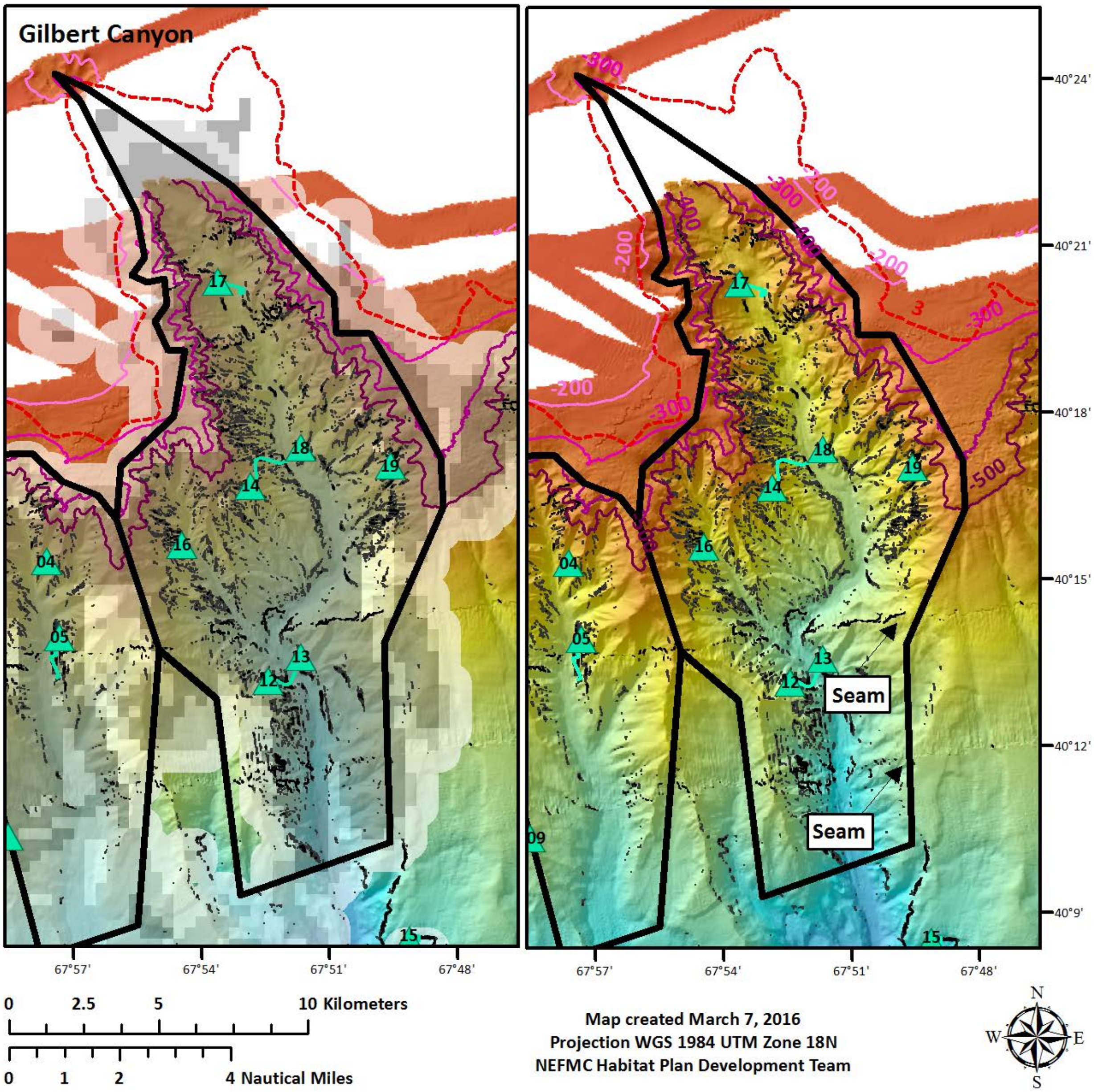
Chebacco Canyon is slope-confined, encompassing an area about 100 km^2. It is larger and steeper than nearby Filebottom. The proposed zone follows the 400 m depth contour at the head of the canyon. Some of the high slope areas shown on Map 18 are artifacts resulting from seams in the data. Much of the 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



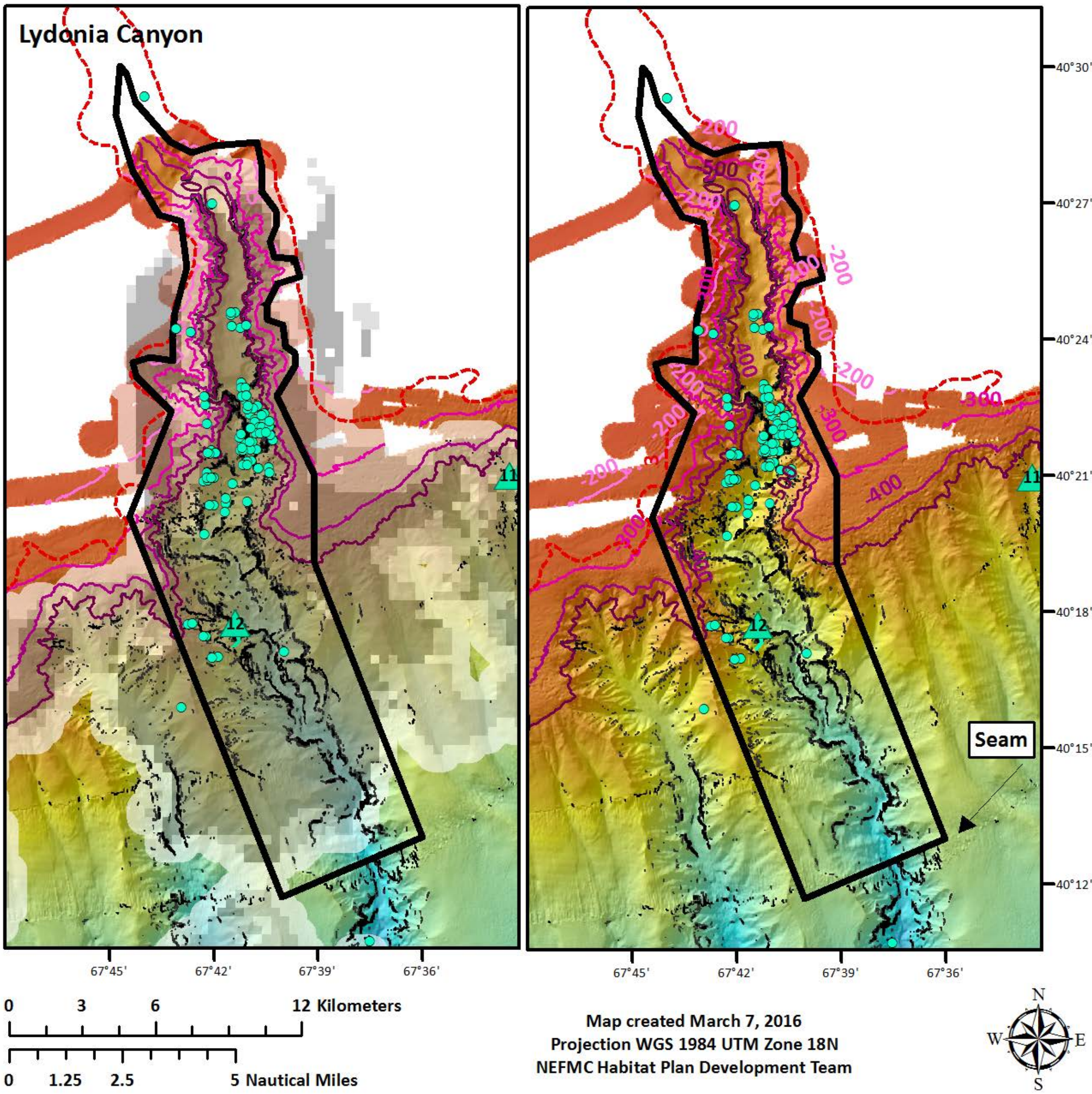
Gilbert Canyon incises the continental shelf break, and has two major branches. The main thalweg is located to the east, and there is another limb to the west. The recommended zone encompasses an area about 175 km^2, following the 300 m depth contour at the mouth of the canyon. The recommended zone is 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



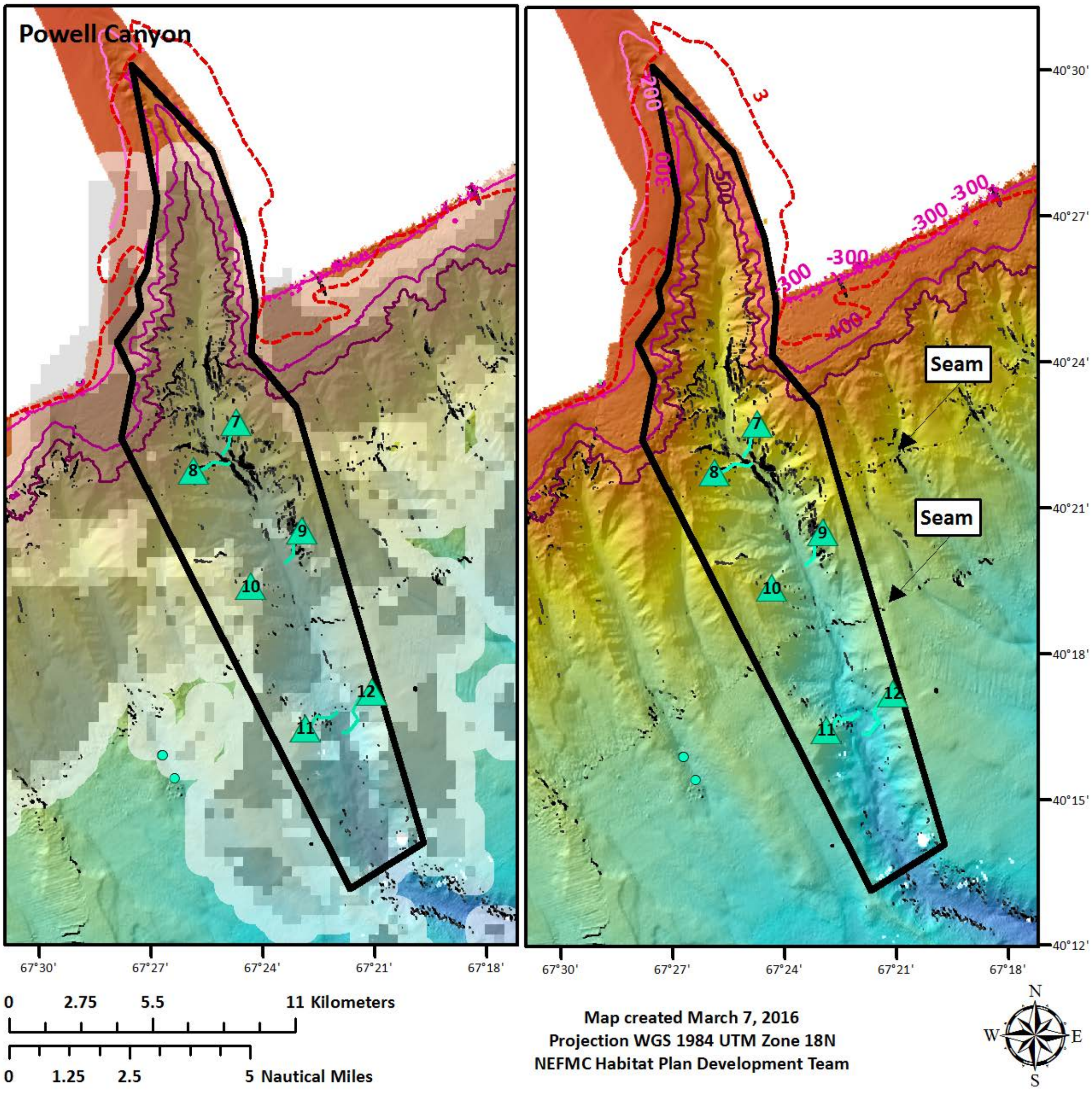
Lydonia Canyon incises the continental shelf break, encompassing an area of over 200 km^2, second in size only to Oceanographer Canyon. The proposed zone follows the 200 m depth contour at the head of the canyon. Based on the ACUMEN bathymetric data, the proposed zone has a depth range of 142 to 2,249 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



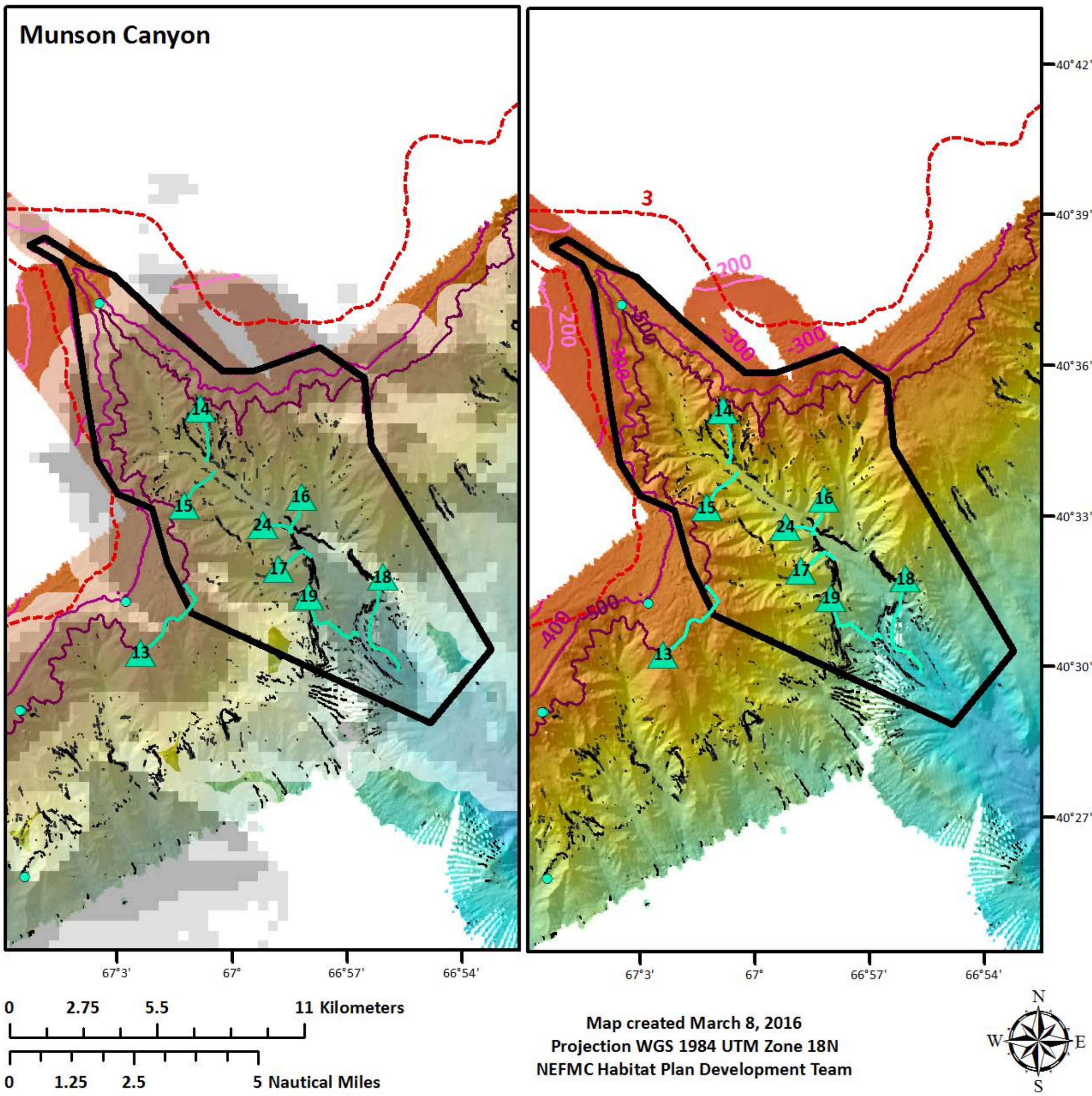
Powell Canyon incises the continental shelf break, encompassing an area about 200 km^2. The proposed boundary follows the 300 m depth contour along the head of the canyon. The areas predicted to have a high likelihood of coral presence based on the habitat suitability model are also encompassed in the 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



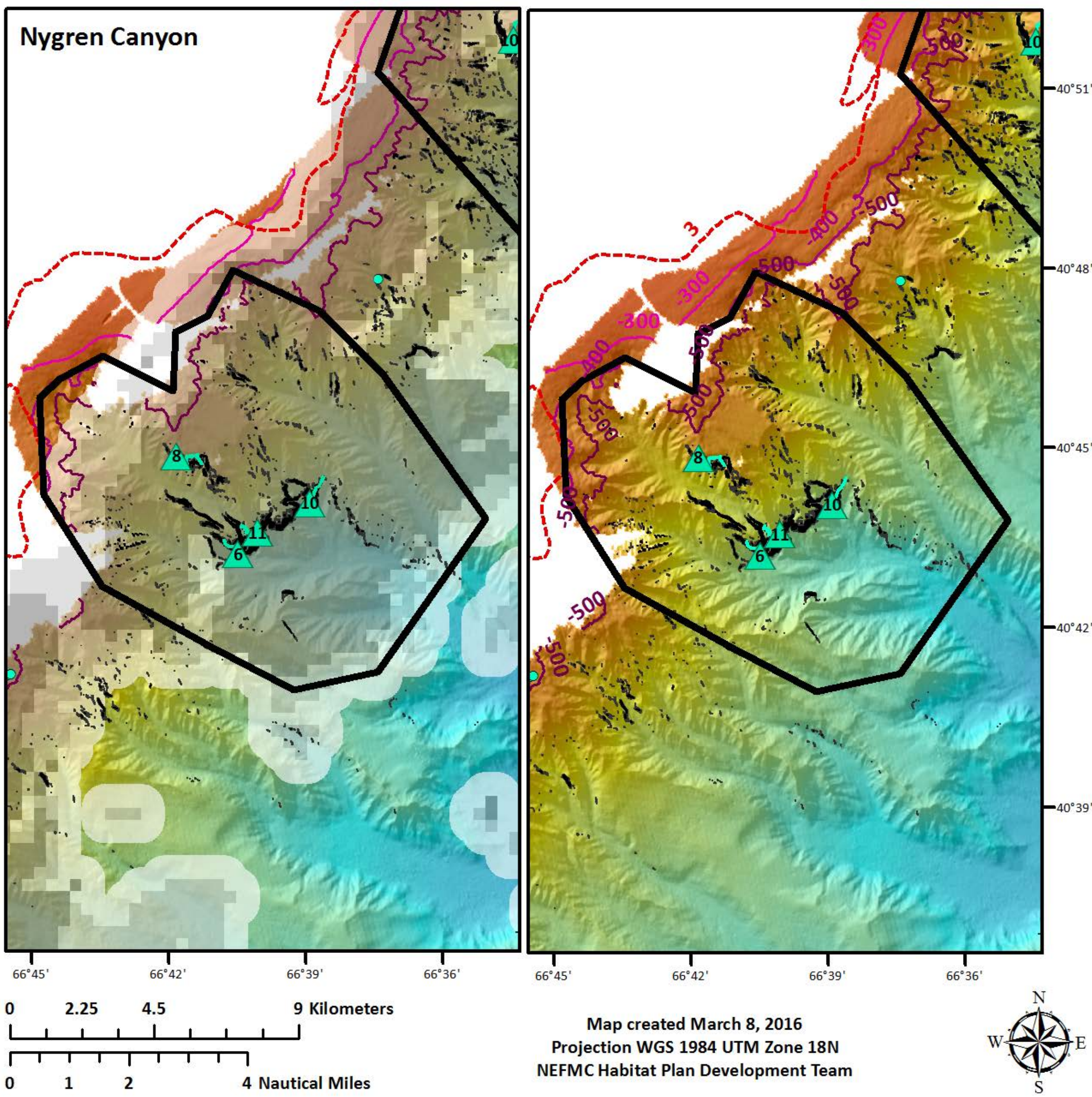
Munson Canyon incises the continental shelf break, encompassing an area about 100 km^2. The proposed boundary follows the 300 m depth contour along the head of the canyon. Munson has one main branch and a smaller branch to the east. Most of the canyon is identified as having high and very high likelihood 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



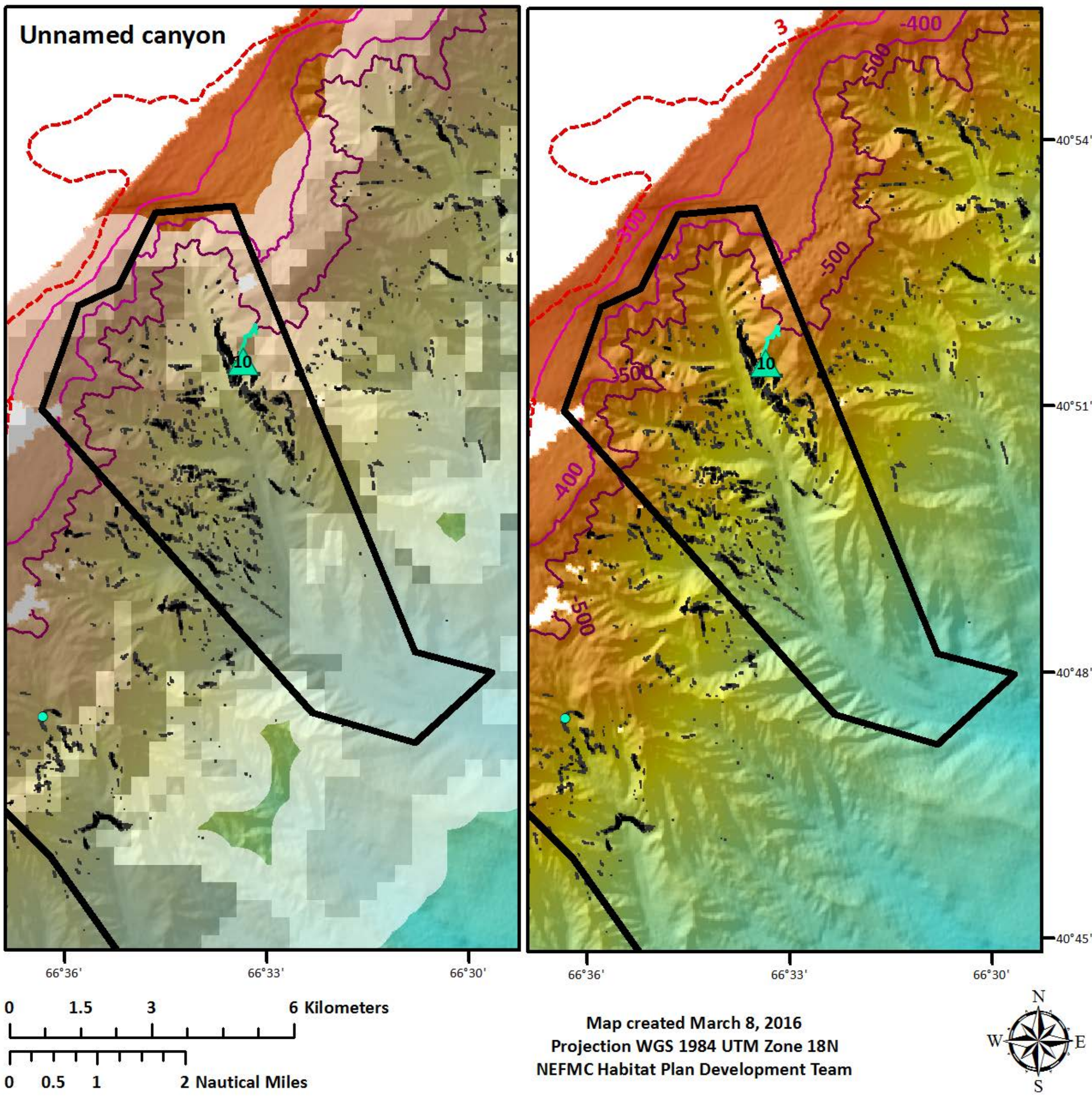
Nygren Canyon is a dendritic, slope-confined canyon that encompasses an area about 100 km^2. The recommended zone follows the 400 m depth contour along the head of the canyon. Most of the canyon is identified as having high and very high likelihood of coral presence based on the habitat suitability model. 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



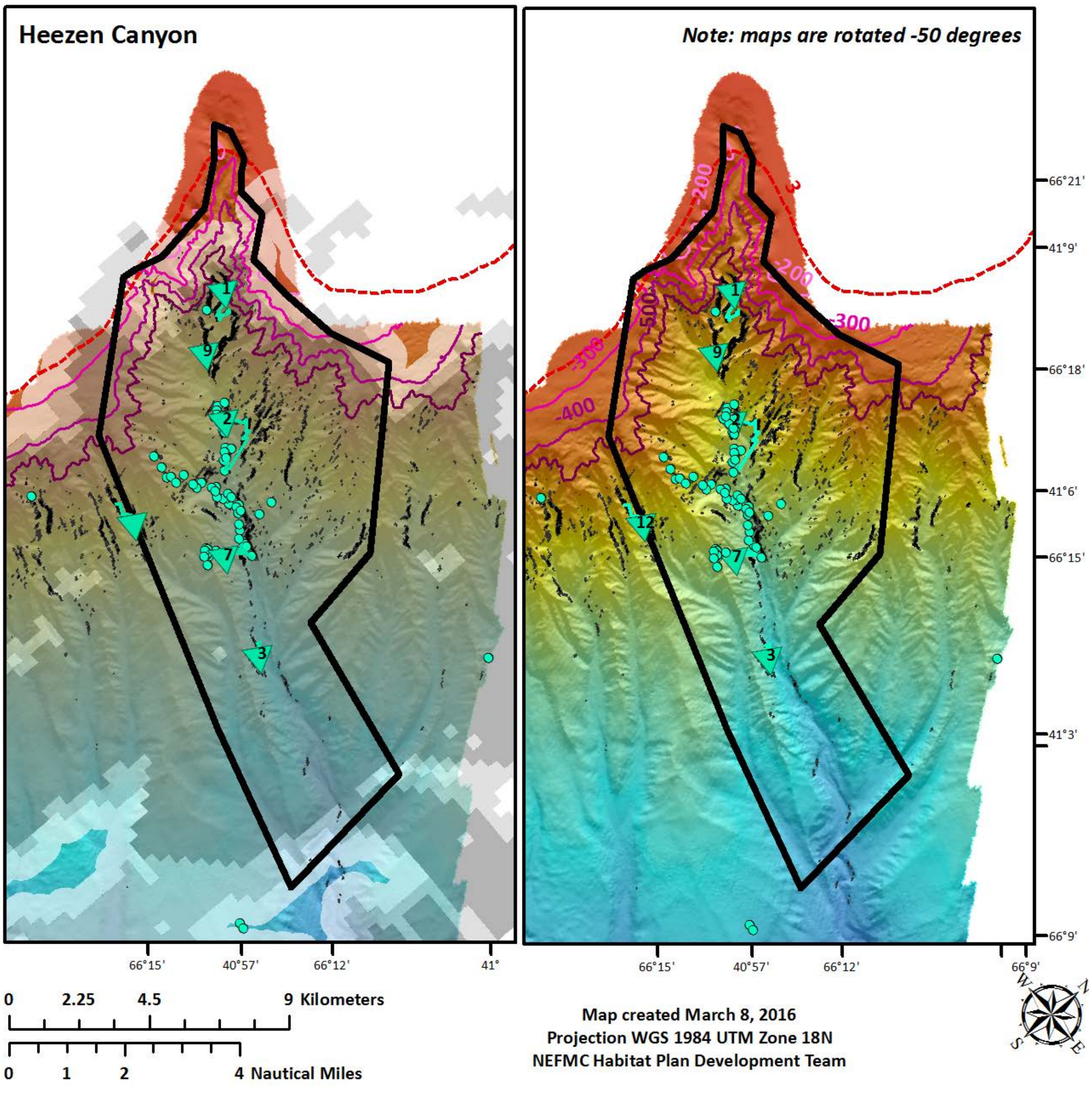
This **unnamed, slope-confined canyon** is relatively small, encompassing an area about 50 km^2. The recommended zone follows the 400 m contour along the head of the canyon. Most of the canyon is identified as having high or very high likelihood of coral presence based on the habitat suitability model. 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 unnamed canyon located between Heezen and Nygren Canyons



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. Given the monument, the bottom-tending gear restrictions imposed by the Council would have no additional conservation benefit. The only difference is that under the monument designation, restrictions on red crab and lobster pots do not take effect until 2023, and Council regulations prohibiting these gears from fishing on the seamounts could take effect sooner, potentially during 2018. 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.

Table 3 – 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'	317

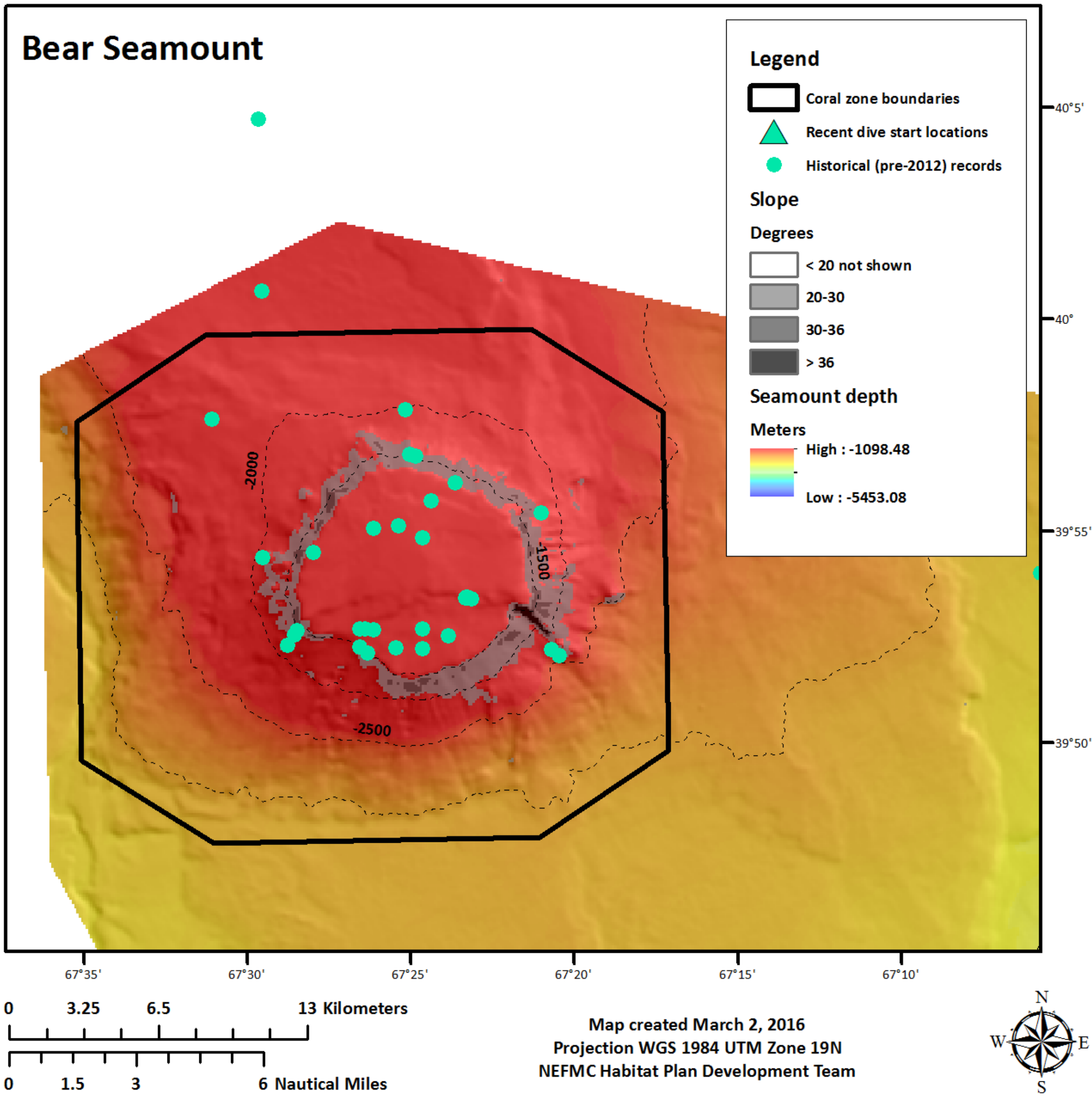
	-66°18', 39°44' -66°22', 39°46' -66°22', 39°51'	

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 in 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.

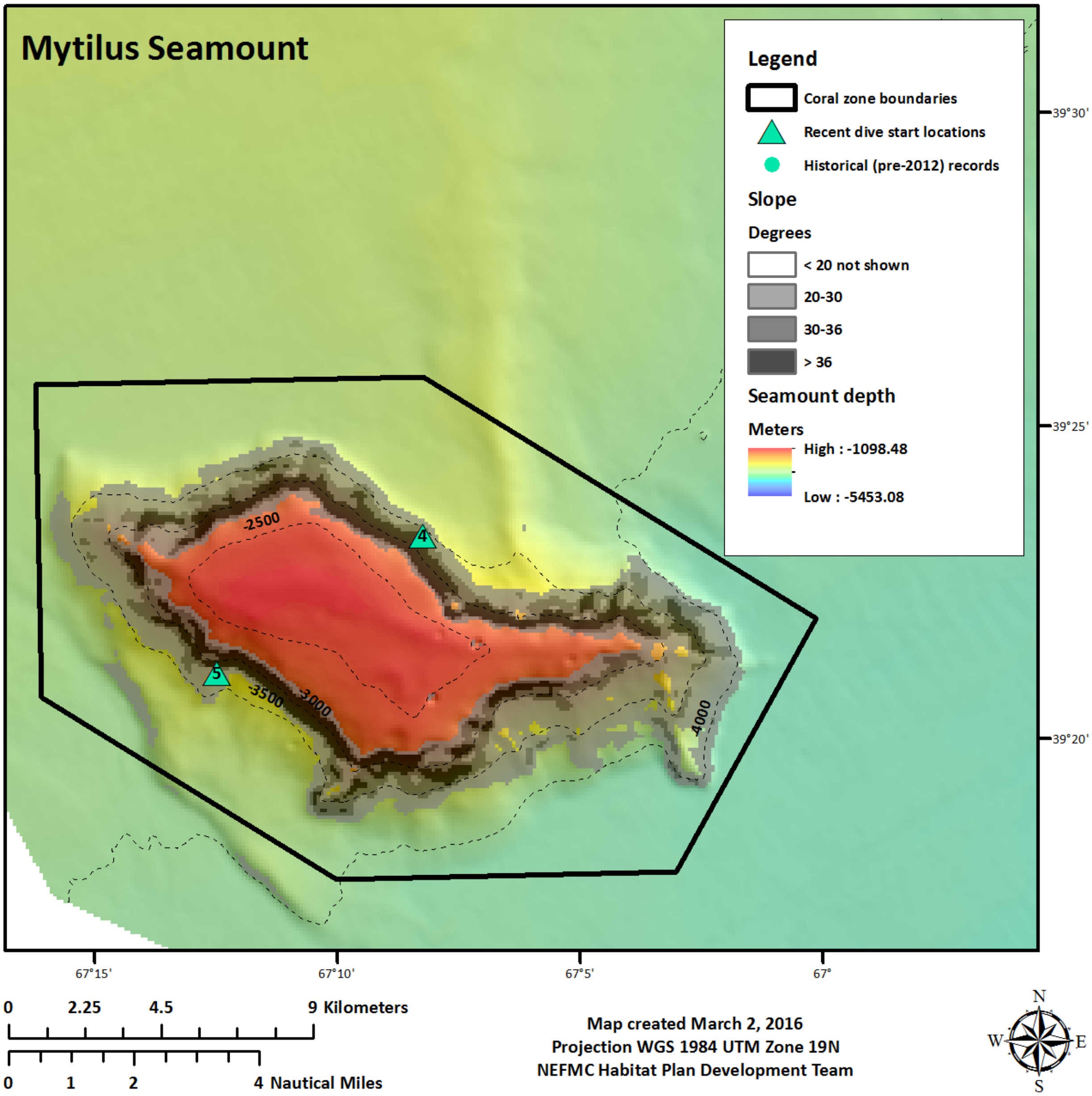
Bear is the largest of the New England seamounts. The summit is about 1,100 m below sea level, and the base of the seamount is at over 3,000 m. While it was not visited during recent (2012-2015) cruises, all four groups of corals (soft, stony, sea pens, and black corals) had been previously documented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

Map 26 – Bear Seamount coral zone boundary



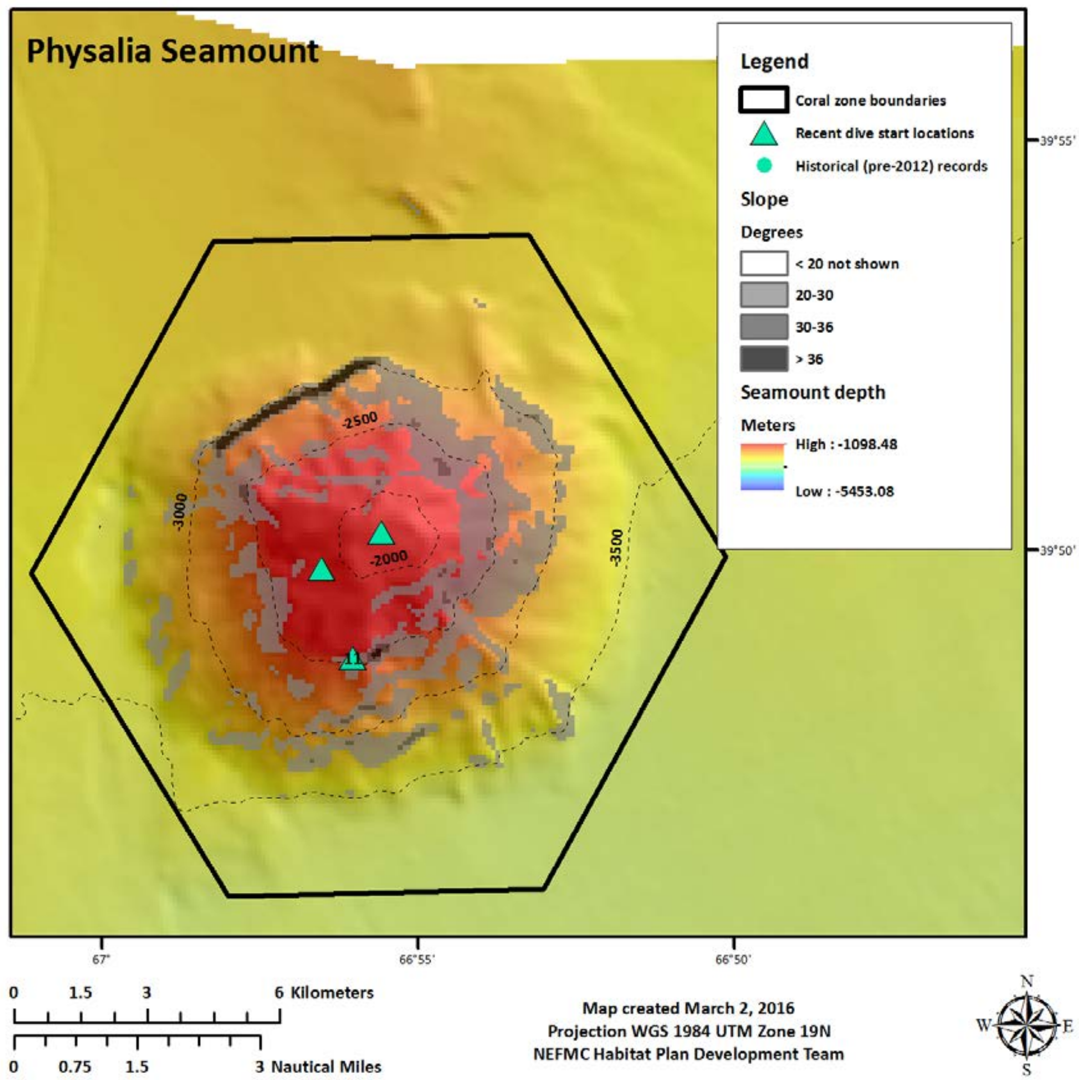
Mytilus is the deepest of the four seamounts, with a minimum depth of 2,396 m and a maximum depth within the proposed coral zone boundary of 4,183 m. Corals have been documented in recent data only (Section 6.2.3.1).

Map 27 – Mytilus Seamount coral zone boundary



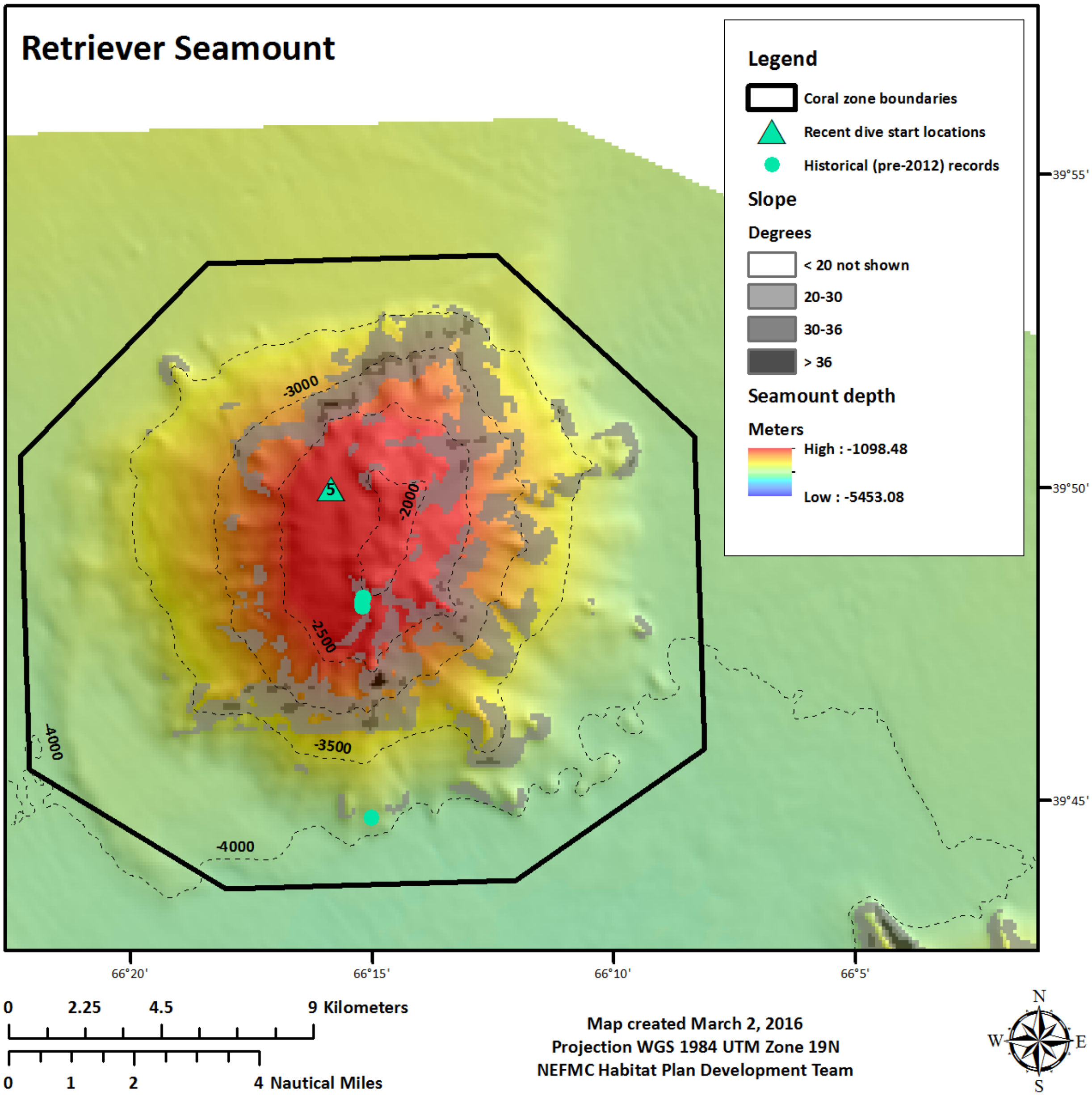
Physalia and Retriever seamounts have similar minimum and maximum depths. The summit of Physalia is at about 1,900 m, and the deepest part of the proposed zone is at over 3,700 m. Physalia was surveyed for the first time in 2012 using AUV technology (Kilgour et al. 2014), and was also observed during 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 not possible 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.

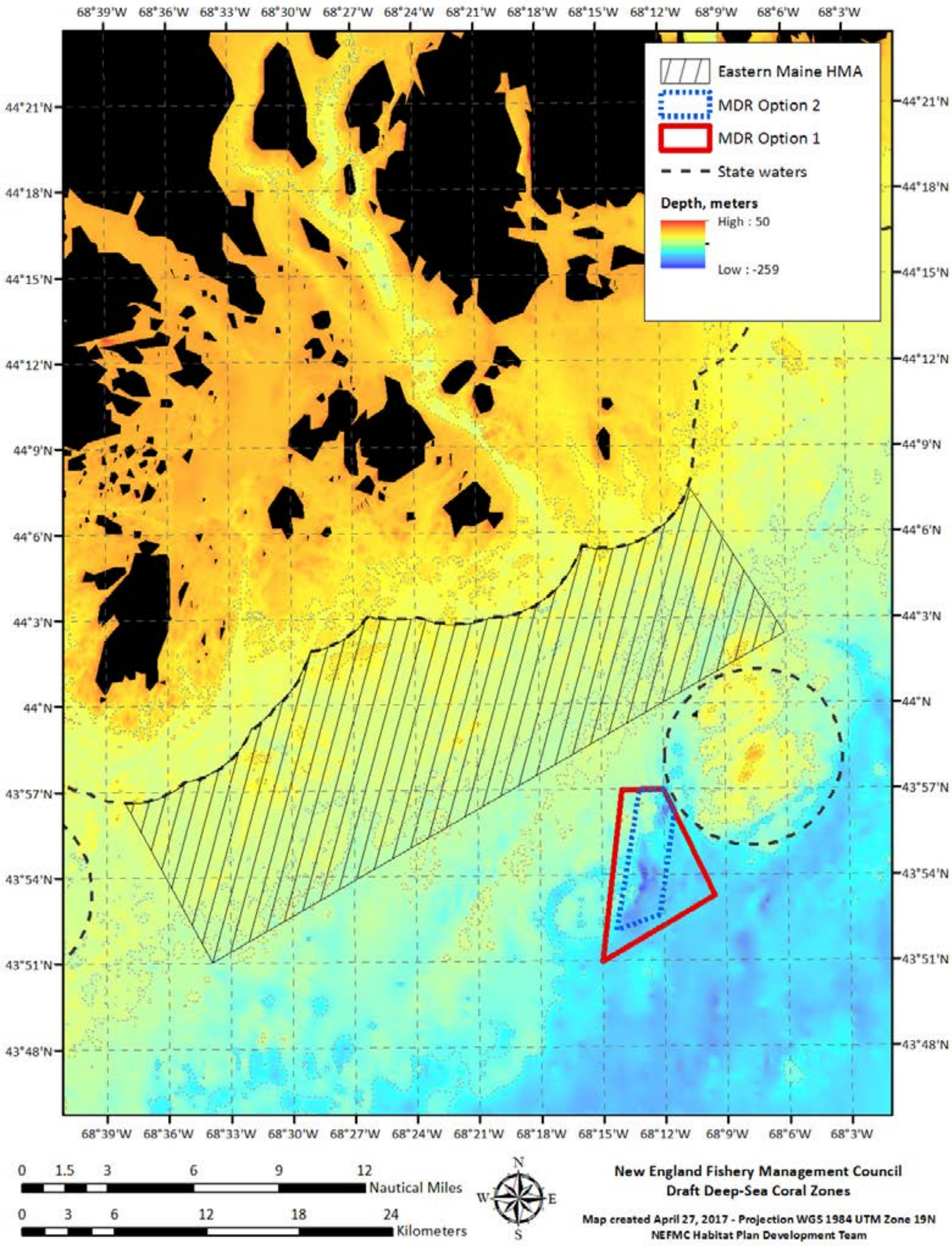
There are two boundary options for the Mt. Desert Rock zone (Table 4, Map 31). **Option 1** is the larger of the two, and encompasses an area of about 47 km^2/18 mi^2. **Option 2** lies within Option 1, a smaller area about 21 km^2/8 mi^2. Both options encompass depths of 100-200 m. Boundary Option 2 is the preferred alternative, designated as a closure to mobile bottom-tending gears (gear restriction option 2).

Table 4 – Summary of 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”

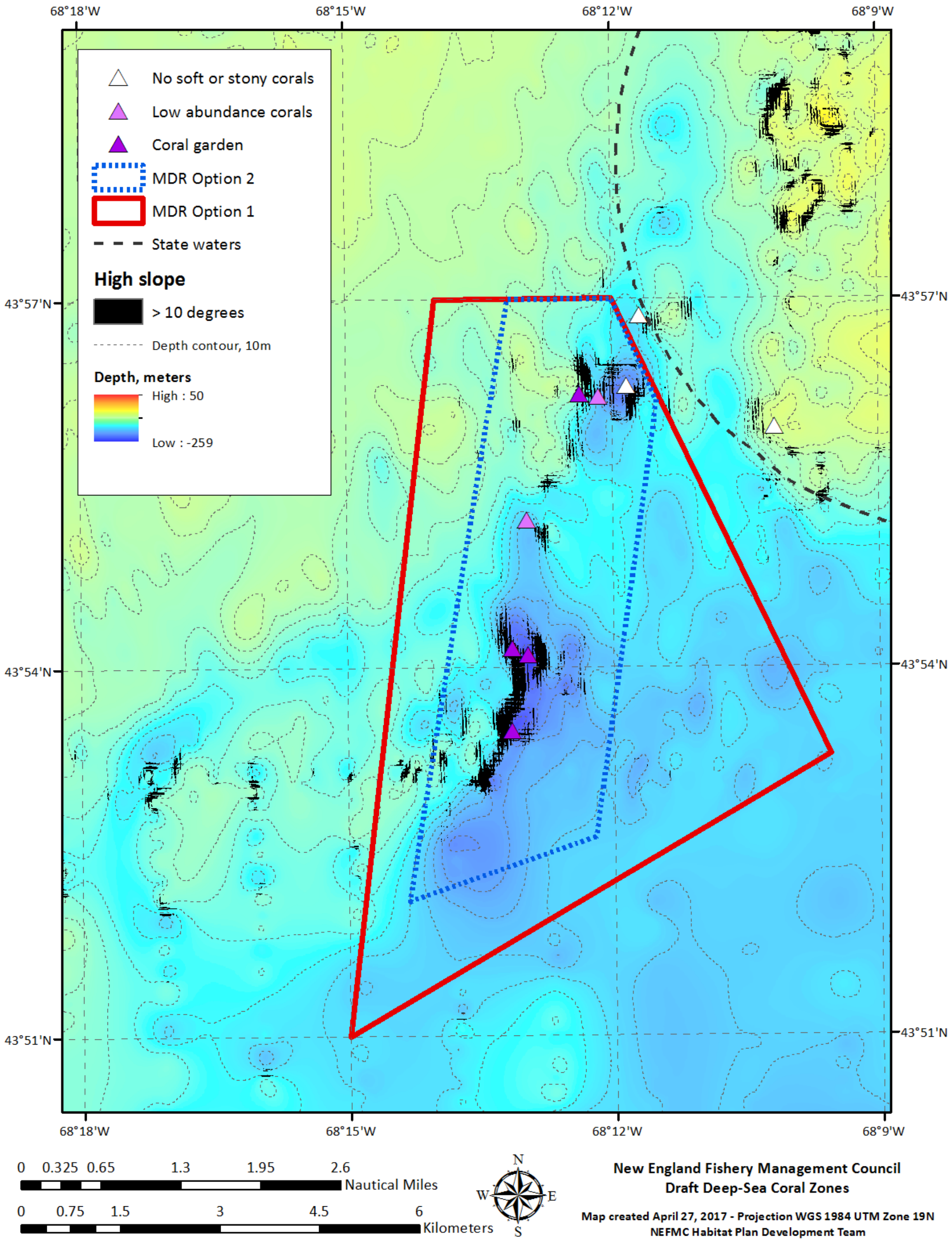
Rationale: This alternative would protect corals in the Mt. Desert Rock region from fishing impacts. Corals have been documented in both the historical and recent data (Section 6.2.3.3).

Map 30 – Regional siting of Mount Desert Rock Coral Zone



Notes: **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



Notes: **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)

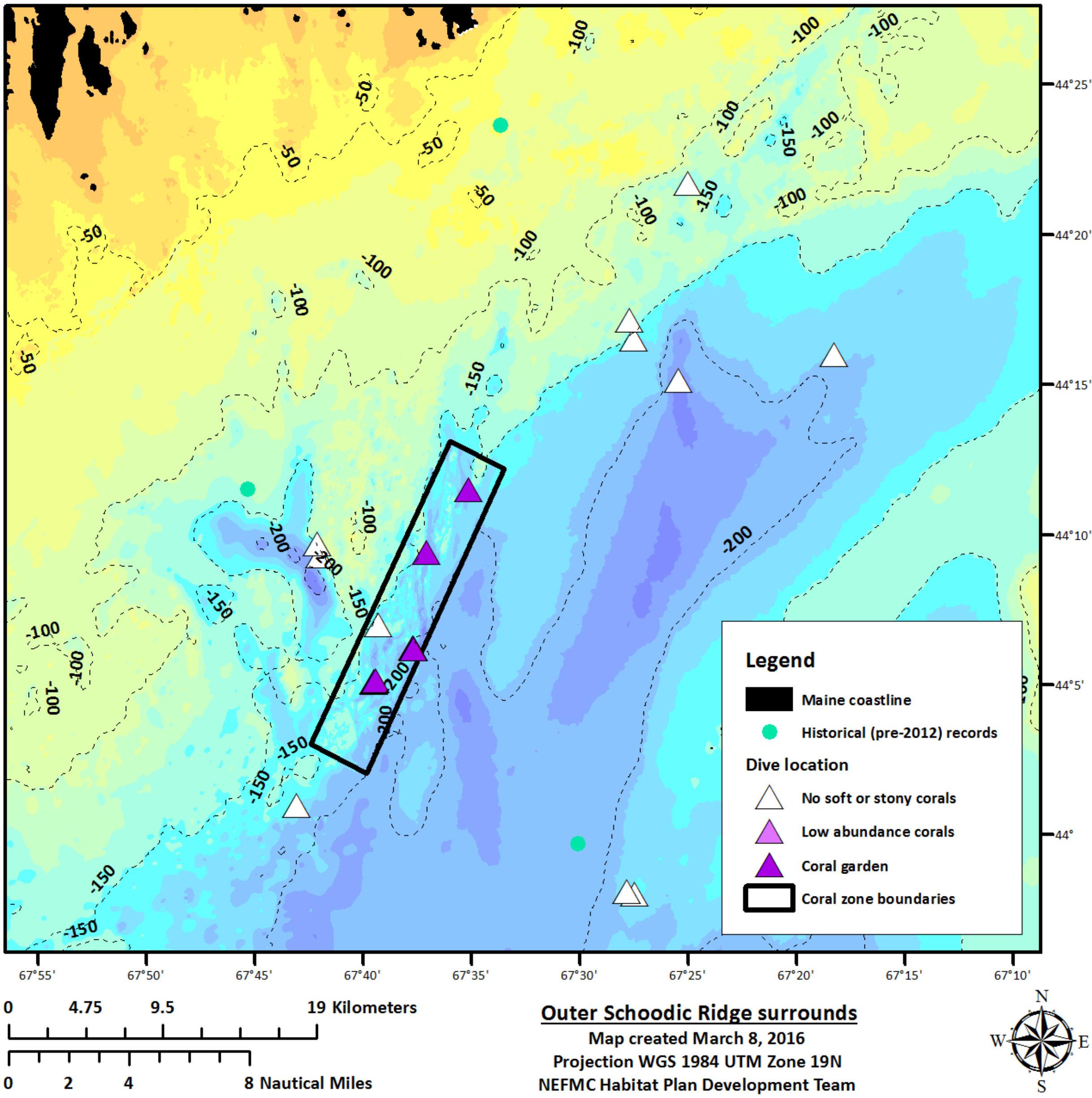
This alternative would designate a coral zone on the Outer Schoodic Ridge, roughly 25nm southeast of Mt. Desert Island (Table 5, Map 32), within Statistical Area 511 and Maine Lobster Management Zone A. The coral zone encompasses a portion of the ridge that has been recently mapped with multibeam and 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 5 – 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"

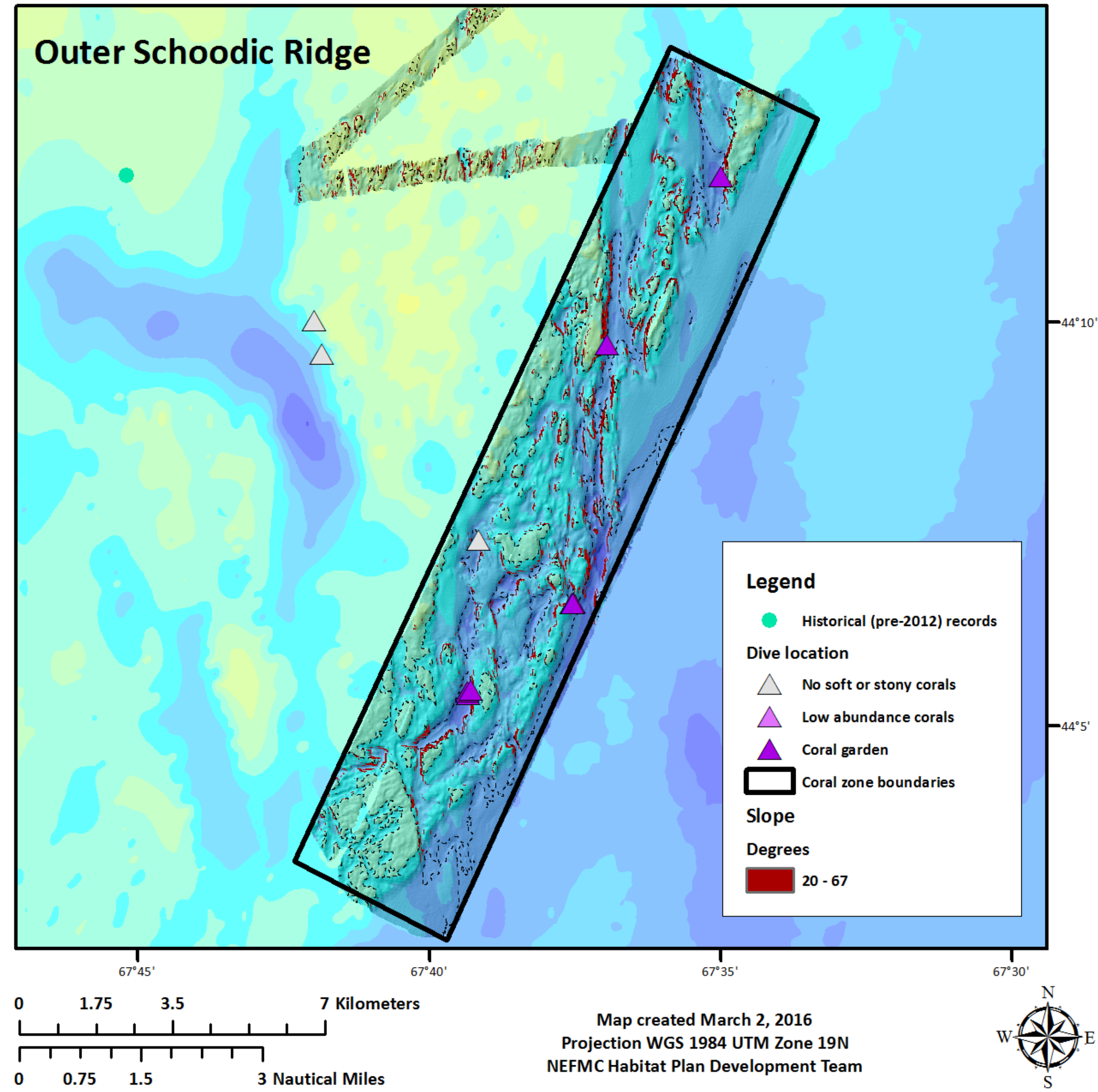
Rationale: This alternative would protect corals in the Outer Schoodic Ridge region from fishing impacts. Corals have been documented in both the historical and recent data (Section 6.2.3.3). Corals at this location were studied during eight ROV dives and two camera tows during 2013, 2014, and 2015. 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



Notes: **Contours are at 50 meter intervals. Relative coral densities during recent dives are shown in purple shading.**

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



Notes: **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 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 6). Options for fishing restrictions in these zones are described in Section 4.3.

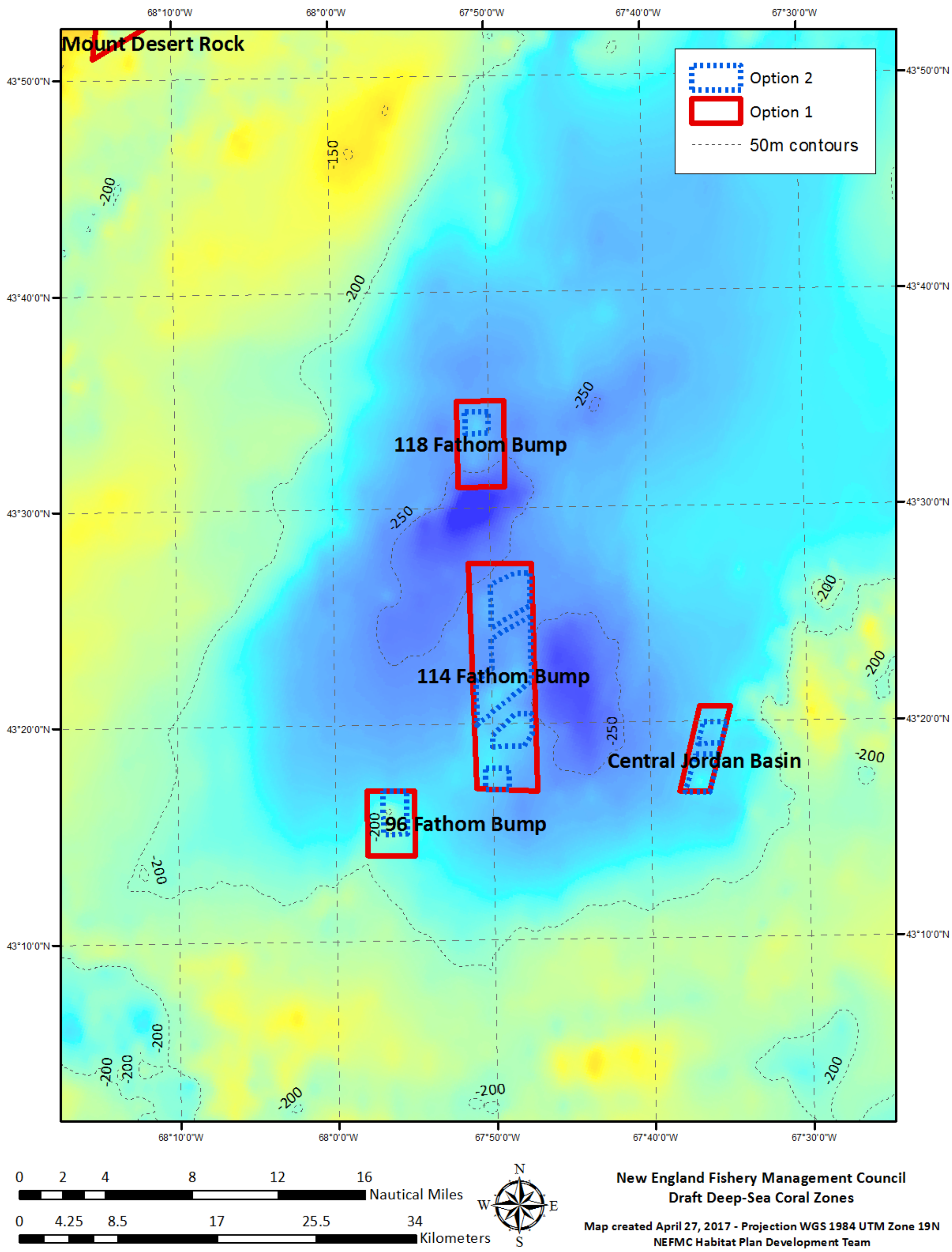
Coral zone designation is Jordan Basin is not a preferred alternative.

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

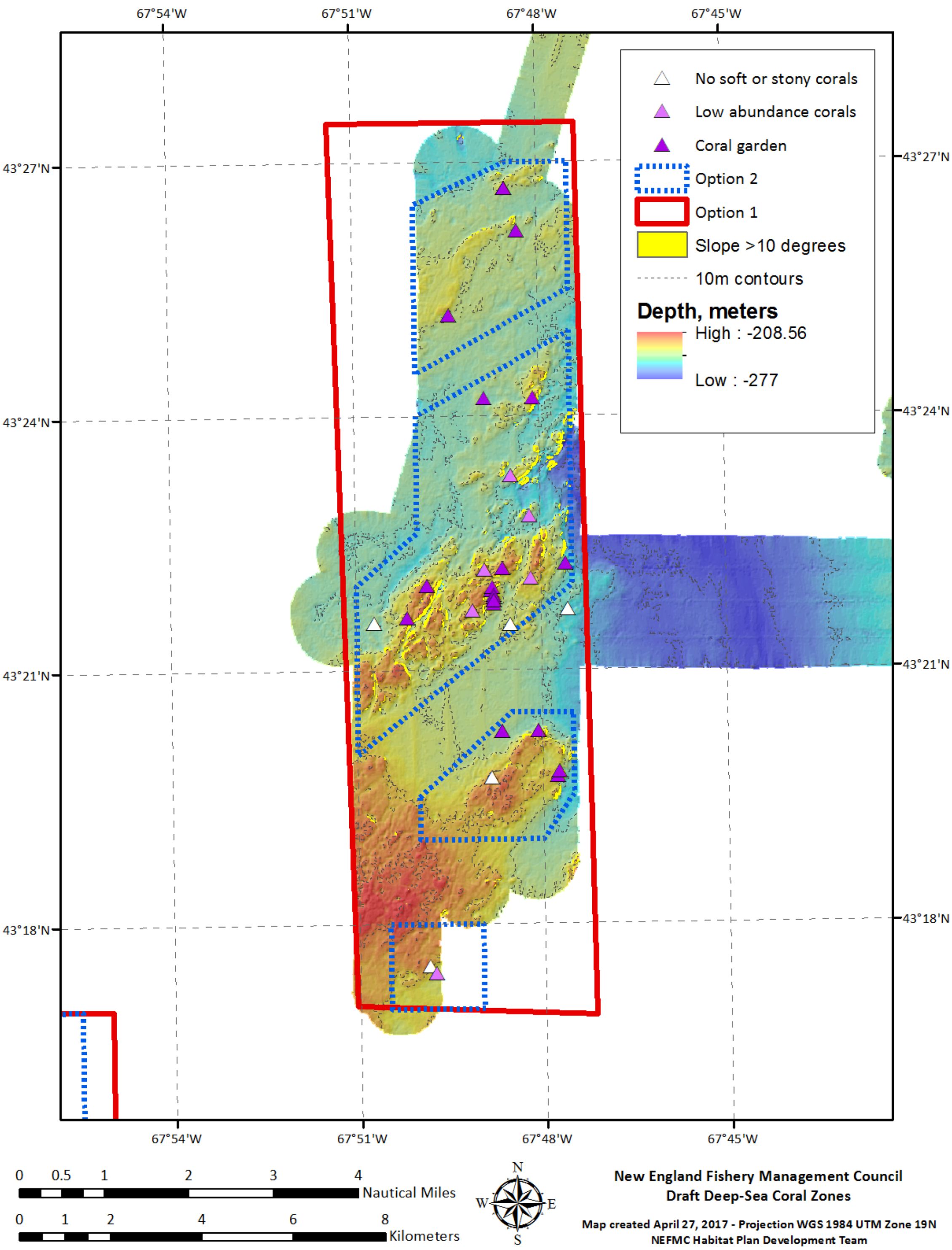
Table 6 – Summary of coordinates and sizes for the Jordan Basin coral zone options

		Option 1		Option 2	
		Coordinates	**Size (km²)**	**Coordinates**	**Size (km²)**
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



Notes: **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 7).

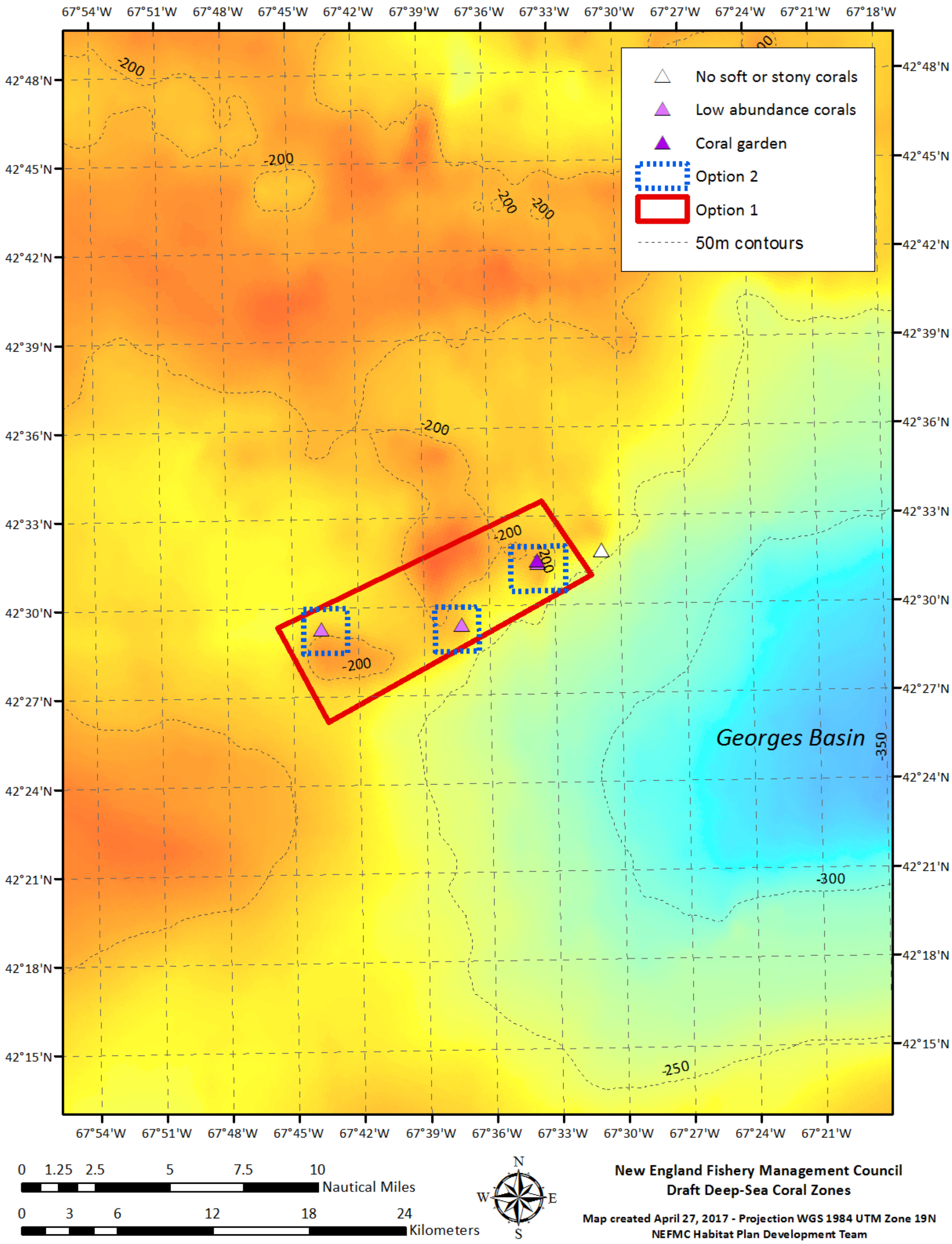
Coral zone designation at Lindenkohl Knoll is not a preferred alternative.

Table 7 – 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 precaution 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

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 active in the coral zones currently. 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.

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 Mid-Atlantic Fishery Management Council 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

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 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 certain 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 active in the coral zones currently. 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.

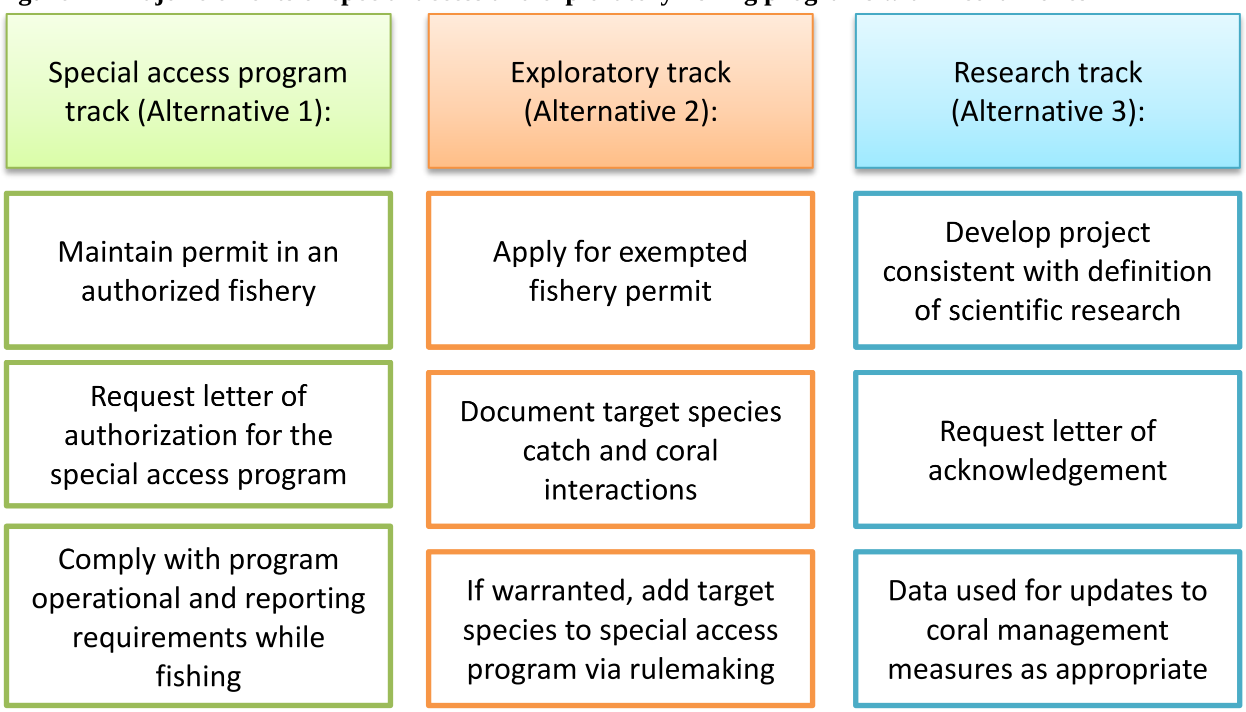
Vessels may transit the coral zones provided bottom-tending trawl nets are out of the water and stowed on the reel and any other fishing gear that is prohibited in these areas is onboard, out of the water, and not deployed. Fishing gear would not be required to meet the definition of “not available for 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



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 the 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. 2010). 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 8 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

This alternative would request 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 8). This alternative would not change requirements for exempted fishing permits, temporary possession permits, or exempted educational activity authorizations.

Table 8 – 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 via framework adjustment versus fishery management 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

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

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

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). Publication of the final EIS and proposed rule is pending as of July 2017. 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. 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?

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.

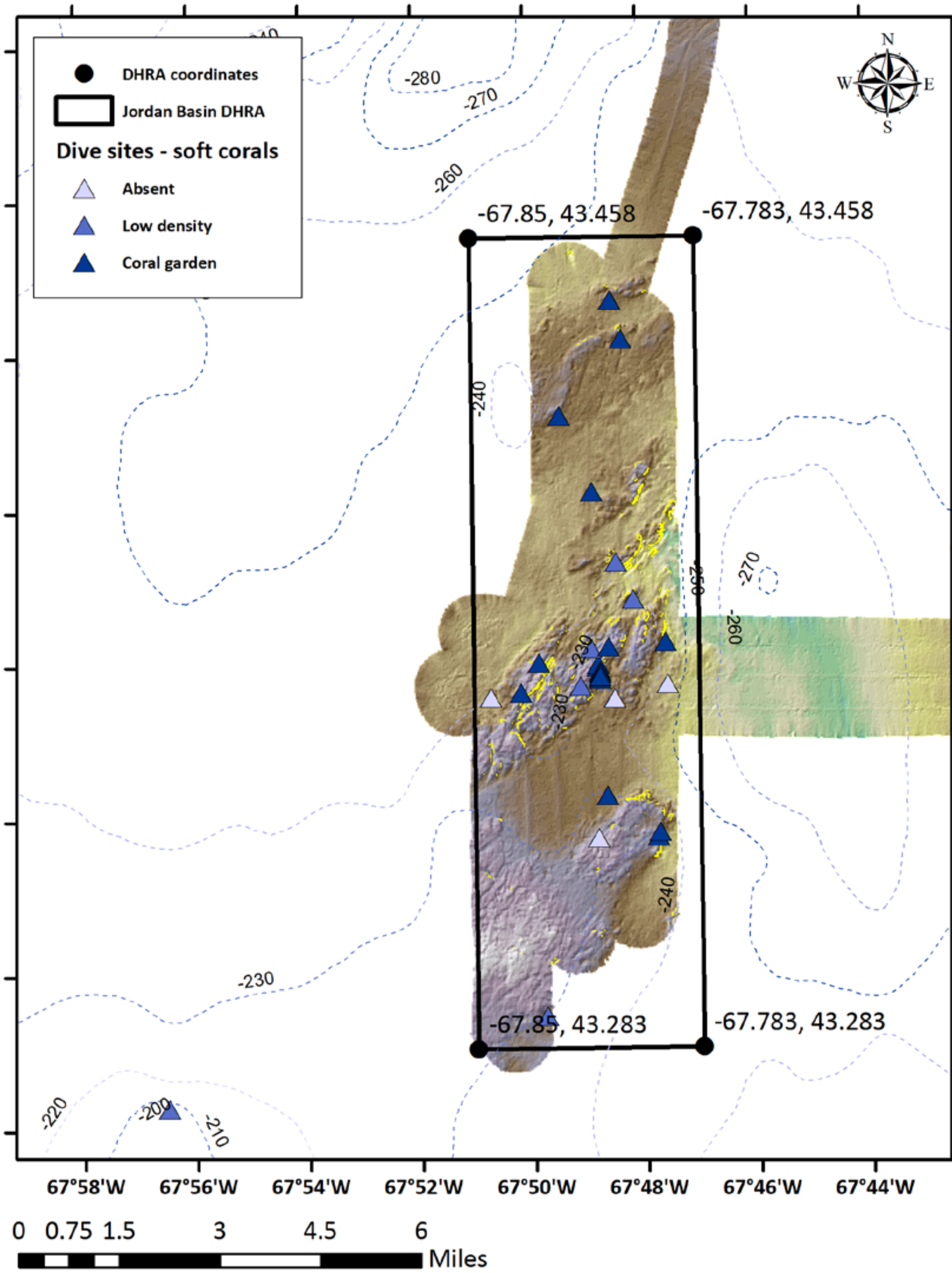
4.6.1 Alternative 1/No Action: No new DHRA designtions

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

Alternative 2 would designate a new DHRA in Jordan Basin, based on the Option 1 coral zone boundaries around 114 Fathom Bump (see 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



Notes: 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 Considered and rejected alternatives

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.

Larger discrete coral zones in the Gulf of Maine were not recommended for further analysis at the April 6, 2012 Committee meeting:

- 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. The Committee concurred with the PDT's assessment and did not ask for further analysis of these options at their February 23, 2012 meeting. Note that some of these canyons are in the mid-Atlantic region, and were later evaluated by the MAFMC and their coral FMAT. Some were later reconsidered by the PDT given additional coral exploratory survey data.

- 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 Description of the 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.

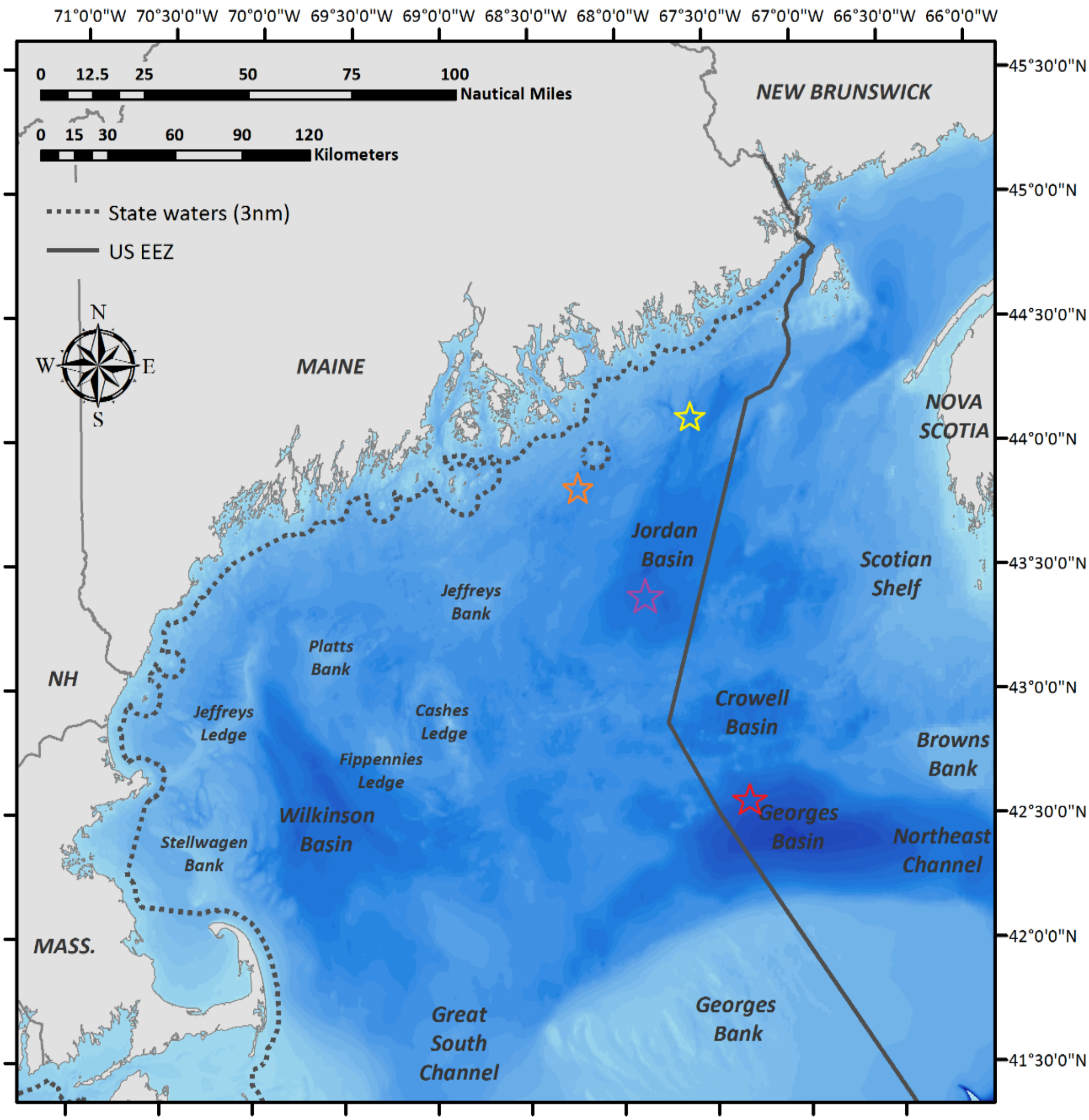
6.1.1 Gulf of Maine

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). Lindenkohl Knoll is west of the EEZ boundary.

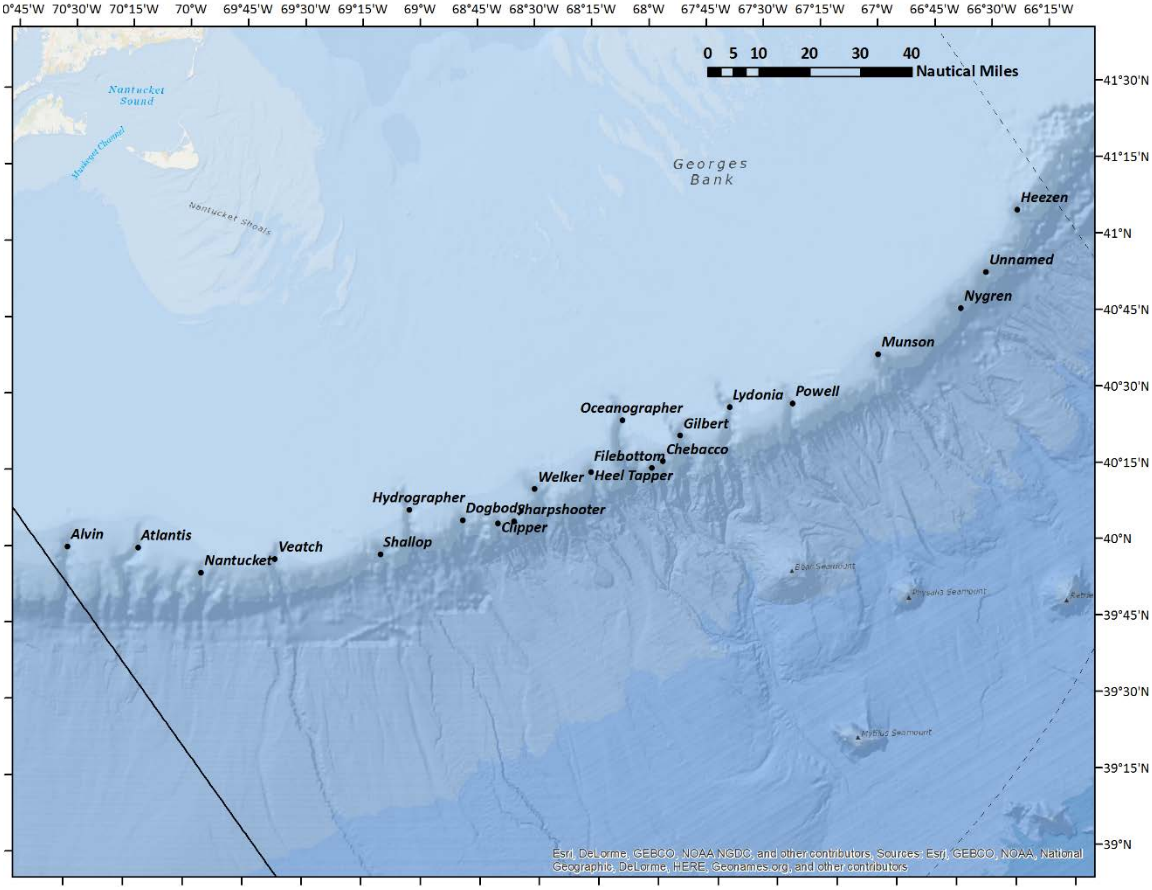
6.1.2 Continental slope, canyons, and seamounts

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.



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.

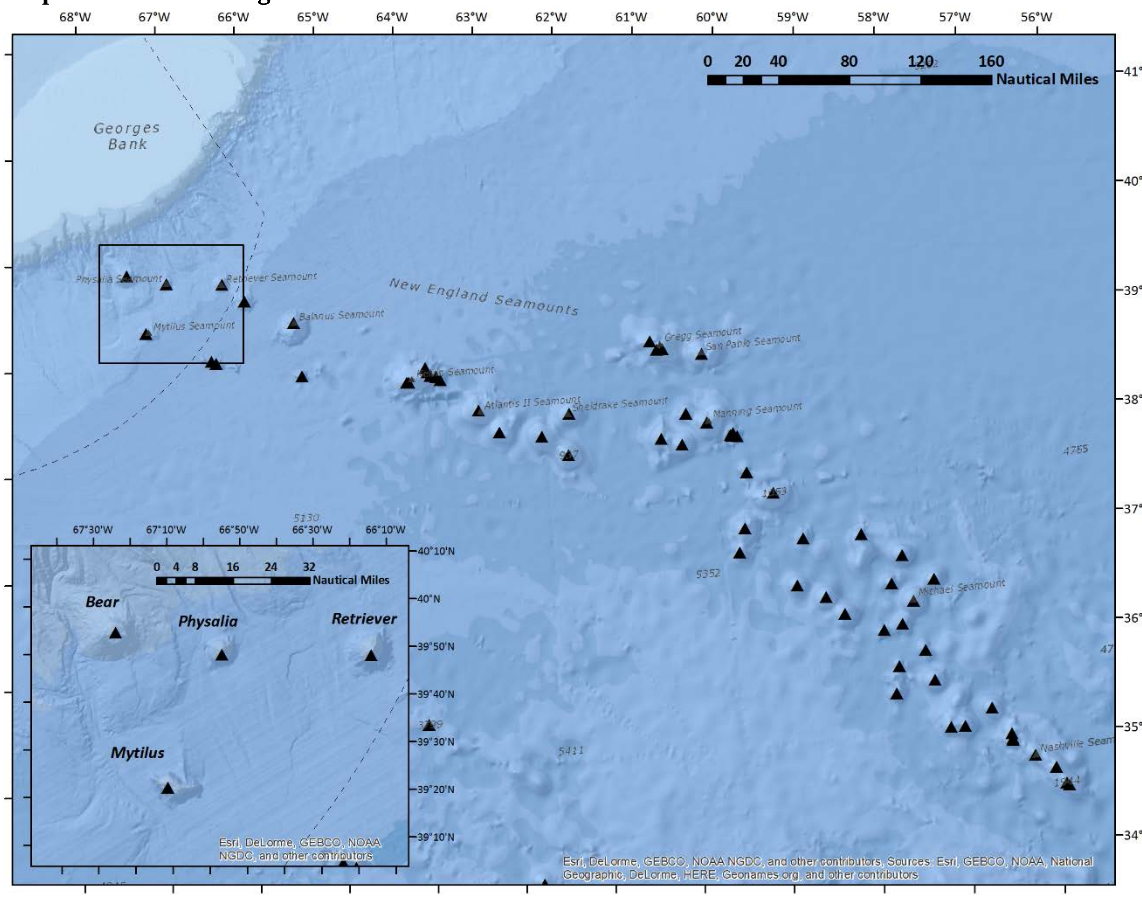
Two currents found on the slope, the Gulf Stream and Western Boundary Undercurrent, together represent one of the strongest low frequency horizontal flow systems in the world. Both currents have an important influence on slope waters. Warm and cold core rings that spin off the Gulf Stream are a persistent 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 (see 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 9.

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 10). 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 2012) 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 9 – 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
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 10 – 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)
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

Year	Cruise Dates	Cruise Number	Vessel	Gear	Tows (#)[a]	Locations
						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 10 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 un-named 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 11 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 11 – 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
	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 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	*Corallium ?bathyrubrum* Simpson and Watling 2010	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

Family	***Species***	***References***
	Keratoisis sp. 2	Quattrini et al. 2015
	Keratoisis sp. 3	Quattrini et al. 2015
	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
	Capnella glomerata (Verrill, 1869)	Hecker et al. 1980; Opresko 1980; Watling and Auster 2005
	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 n. sp.	Watling and Auster 2005
	Paramuricea spp.	Quattrini et al. 2015
	Paramuricea/Placogorgia sp. 1	Quattrini et al. 2015

Family	***Species***	***References***
	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
	Narella laxa Deichmann, 1936	Watling and Auster 2005
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
	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). Eight additional families are represented in New England: Anthoptilidae, Funiculinidae, Halipteridae, Kophobelemnidae, Ombellulidae, Protoptilidae, Renillidae, and Scleroptilidae.

Table 12 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 12 – 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
Ombellulidae (or Umbellulidae)	*Ombellula guntheri* Kölliker, 1880	US NMNH collection
	Ombellula lindahlii Kölliker, 1880	US NMNH collection, OBIS
	Umbellula (= Ombellula) Gray, 1870	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 aberrans	US NMNH collection
	Protoptilum carpenteri	US NMNH collection, OBIS
Scleroptilidae	*Scleroptilum gracile*	US NMNH collection
Scleroptilidae	*Scleroptilum grandiflorum*	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 13 lists stony corals found in the New England region. Families with representatives in New England include the Caryophillidae, Dendrophylliidae, 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 13 – 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
	Caryophyllia ambrosia caribbeana Cairns, 1979	Cairns and Chapman 2001
	Dasmosmilia lymani (Pourtales, 1871)	Hecker 1980; Hecker et al. 1983; Maciolek et al. 1987a; Hecker 1990; Cairns and Chapman 2001
	Deltocyathus italicus (Michelotti, 1838)	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
	Solenosmilia variabilis Duncan, 1873	Hecker 1980; Hecker et al. 1983; Cairns and Chapman 2001; Moore et al. 2004; Quattrini et al. 2015
	Vaughanella margaritata (Jourdan, 1895)	Cairns and Chapman 2001; Moore et al. 2003
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

Family	*Species*	*References*
	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 14 – 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) *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.

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

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 were 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 **unamed 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 (Martin 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 15). 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 15 – 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 16). 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.

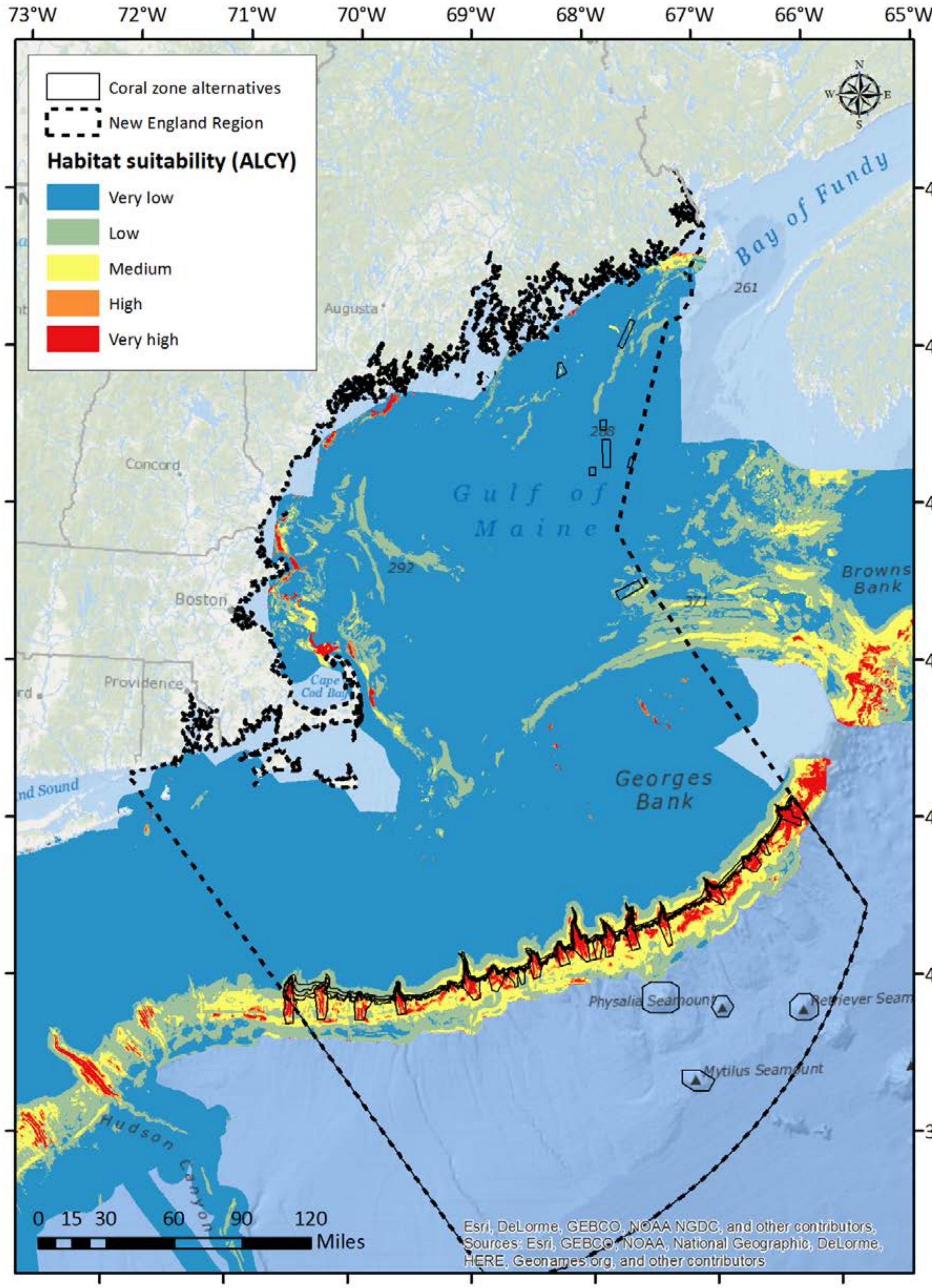
When using the results, it is important to consider the underlying data quality and resolution. As noted above, the model grid resolution was selected to accommodate the positional uncertainty associated with the underlying coral data, but the canyon areas in particular have complex terrain at this spatial 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 (Section 7.1.1.2).

Table 16 – 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

Predictor Variable	Code	Category
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. 2015; 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 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 (Brook 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 study sites are varied, the impacts of commercial fishing on the local corals and 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 via various methods, 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 reviewed, there was frequently a lack of adequate descriptions of the gear used, 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 area 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). Despite these gears having a smaller footprint than a trawl, in certain conditions, these gear types 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.

Heifetz et al.'s 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 (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 20º. 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.

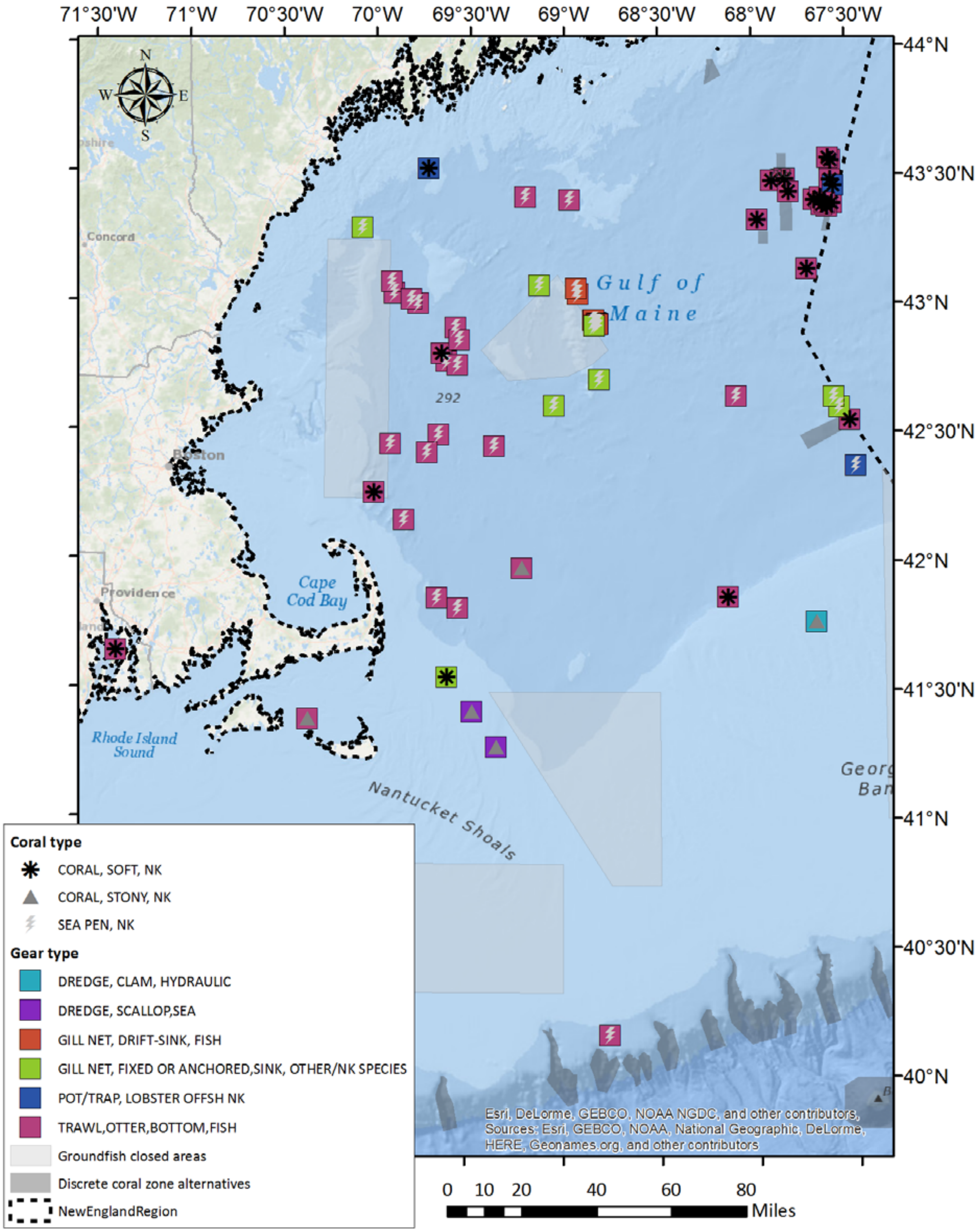
The spatial patterns of coral bycatch by species are consistent with known distributions of corals in the Gulf of Maine. There are relatively large number of observed catches of sea pens in Wilkson Basin and surrounding Cashes Ledge. The catches in Wilkinson Basin (N=15) were taken with bottom trawls 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 not possible 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

EFH designations (updated in Omnibus Habitat Amendment 2) include both a map representation (spatial coverage) and qualitative text description of preferred habitat attributes. The designations reflect the distribution of essential habitats occupied by a particular species and lifestage, and can be used to indicate which coral zones may provide conservation benefits for particular managed species.

The analysis in this section uses the same approach as the EFH overlap analysis completed for OHA2 (see Volume 2 of the FEIS for updated designations, and Volume 4, Section 3 for more detailed methods). Most of the juvenile and adult EFH map representations were developed by conditioning relative abundance survey data binned into ten minute squares 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.

Some of the juvenile and adult designations do not follow this method and cannot really be compared with designations that do use the abundance/habitat considerations approach. Atlantic wolffish EFH includes all waters north of 41° N in the Gulf of Maine and on Georges Bank, as limited by the habitat types outlined in the text description. EFH for wolffish is based on very broadly defined geographic range information so spatial overlap with the proposed management areas or alternatives is not especially meaningful. Similarly, sea scallop EFH uses a species range (100% presence in all surveys) approach in the map representation, so areas where positive survey catches are relatively uncommon are still mapped as EFH. However, scallop EFH is limited to depths shallower than 110 meters, which removes many areas with positive but infrequent catches.

The coral zone management measures focus on bottom-tending gear restrictions, so this analysis is restricted to species and lifestages that are benthic versus pelagic (Table 17). Benthic lifestages that are in close association with the seabed are most likely to benefit from measures that protect seabed habitats. In general, egg and larval lifestages are typically pelagic, and juvenile and adult lifestages are benthic, but there are a few species with benthic eggs and larvae. 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 analysis. Some Council-managed species are not listed on the overlap tables. Specifically, clearnose skate occur south of the proposed management areas, and Atlantic salmon EFH is designated in specific rivers and associated coastal waters to a distance of 3 nm, and therefore has no overlap with any coral zones, which are in federal waters only.

Certain species managed by the Council occur in deeper waters of the continental slope. 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 18.

Table 17 – Benthic vs. pelagic habitat use by species and lifestage

Benthic eggs:	Benthic larvae:	Benthic juveniles:	Benthic adults:
Atlantic salmon, Atlantic wolffish, ocean pout, red crab (attached to adults), sea scallop, winter flounder, Atlantic herring. 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.	Atlantic salmon, Atlantic wolffish, sea scallop after settlement (spat)	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 after settlement, windowpane flounder, winter flounder, winter skate, witch flounder, yellowtail flounder, deep-sea red crab	Acadian redfish, American plaice, Atlantic cod, Atlantic halibut, spawning Atlantic herring, spawning 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, windowpane flounder, winter flounder, winter skate, witch flounder, yellowtail flounder, deep-sea red crab
Pelagic/surface eggs:	**Pelagic/surface larvae:**	**Pelagic juveniles:**	**Pelagic adults:**
American plaice, Atlantic cod, Atlantic halibut, monkfish, haddock, offshore hake, pollock, red hake, silver hake, white hake, windowpane flounder, witch flounder, yellowtail flounder	Acadian redfish, American plaice, Atlantic cod, Atlantic halibut, Atlantic herring, Atlantic wolffish, monkfish, haddock, offshore hake, pollock, red crab, red hake, sea scallop prior to settlement, silver hake, white hake, windowpane flounder, winter flounder, witch flounder, yellowtail flounder, deep-sea red crab	Atlantic herring, white hake prior to settlement, offshore hake	Atlantic herring, Atlantic salmon, offshore hake

Table 18 – NEFMC-managed species with deep-water distribution

Species	Depth (m)	Location	References	Max. depth determined by 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)
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)
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)

Species	Depth (m)	Location	References	Max. depth determined by PDT
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)

Table 19 and Table 20 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 both the number of designations and the degree of overlap for those designations. This "total score" metric ranges from 2 to 68, out of a possible score of 141 (equivalent to a score of 3 for all 47 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. The tables include 26 species (clearnose skate and Atlantic salmon excluded). The "designation count" metric is the number of individual benthic designations overlapping an area.

Table 19 – Degree of overlap between designated EFH and coral zones, Gulf of Maine

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	3	3
American plaice juvenile	1	2	0	0
American plaice adult	3	3	3	0
Atlantic cod juvenile	0	1	1	1
Atlantic cod adult	1	1	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	0	1
Pollock adult	2	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

Species and life stage	Outer Schoodic Ridge	Mt. Desert Rock	Jordan Basin	Lindenkohl Knoll
Winter flounder larvae and adult	1	0	0	0
Winter flounder juvenile	1	0	0	0
Witch flounder juvenile	3	3	3	3
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
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 larvae & juvenile	0	0	0	0
Deep-sea red crab adult	0	0	0	0
Total score (out of 141)	**68**	**66**	**51**	**49**
Count of species (out of 26)	**21**	**15**	**12**	**11**
Count of designations (out of 47)	**35**	**26**	**19**	**19**

Table 20 – Degree of overlap between designated EFH and coral zones overlapping the canyons, continental slope, and seamounts

Species and life stage	Slope depth range, m	Canyon (MNM)	Canyon (not MNM)	Sea-mount	300 m	400 m	500 m	600 m	900 m
Acadian redfish juv	400-600	1	1	0	1	1	1	0	0
Acadian redfish adult	400-600	1	1	0	1	1	1	0	0
American plaice juv	None	0	0	0	0	0	0	0	0
American plaice adult	None	0	0	0	0	0	0	0	0
Atlantic cod juvenile	None	0	0	0	0	0	0	0	0
Atlantic cod adult	None	0	0	0	0	0	0	0	0
Atlantic halibut - all	400-700	1	1	0	1	1	1	1	0
Atlantic wolffish - all	None	0	0	0	0	0	0	0	0
Haddock juvenile	None	0	0	0	0	0	0	0	0
Haddock adult	None	0	0	0	0	0	0	0	0

Ocean pout egg	None	0	0	0	0	0	0	0	0
Ocean pout juvenile	None	0	0	0	0	0	0	0	0
Ocean pout adult	None	0	0	0	0	0	0	0	0
Pollock juvenile	None	0	0	0	0	0	0	0	0
Pollock adult	None	0	0	0	0	0	0	0	0
White hake juvenile	None	1	1	0	0	0	0	0	0
White hake adult	400-900	2	2	0	1	1	1	1	0
Windowpane juvenile	None	0	0	0	0	0	0	0	0
Windowpane adult	None	0	0	0	0	0	0	0	0
Winter flounder egg	None	0	0	0	0	0	0	0	0
Winter fl larvae/adult	None	0	0	0	0	0	0	0	0
Winter flounder juv	None	0	0	0	0	0	0	0	0
Witch fl juvenile	400-1500	3	3	0	1	1	1	1	1
Witch flounder adult	400-1500	3	3	0	1	1	1	1	1
Yellowtail fl juvenile	None	0	0	0	0	0	0	0	0
Yellowtail fl adult	None	0	0	0	0	0	0	0	0
Red hake e/l/j	None	0	0	0	0	0	0	0	0
Red hake adult	400-750	2	2	0	1	1	1	1	0
Silver hake juvenile	None	0	0	0	0	0	0	0	0
Silver hake adult	None	1	1	0	1	0	0	0	0
Offshore hake juvenile and adult	400-750	2	2	0	1	1	1	1	0
Monkfish juvenile	400-1000	2	2	0	1	1	1	1	1
Monkfish adult	400-1000	2	2	0	1	1	1	1	1
Smooth skate juv	400-900	2	2	0	1	1	1	1	0
Smooth skate adult	400-900	2	2	0	1	1	1	1	0
Thorny skate juvenile	400-900	2	2	0	1	1	1	1	0
Thorny skate adult	400-900	2	2	0	1	1	1	1	0
Barndoor skate j/a	400-750	2	2	0	1	1	1	1	0
Little skate juvenile	None	0	0	0	0	0	0	0	0
Little skate adult	None	0	0	0	0	0	0	0	0
Winter skate juvenile	None	0	0	0	0	0	0	0	0
Winter skate adult	None	0	0	0	0	0	0	0	0
Rosette skate j/a	None	0	1	0	1	0	0	0	0
Sea scallop all	None	0	0	0	0	0	0	0	0
Atlantic herring egg	None	0	0	0	0	0	0	0	0
Red crab lar/juv	400-1300	3	3	1	1	1	1	1	1
Red crab adult	400-900	2	2	1[a]	1	1	1	1	1
Total score (out of 141)		**36**	**37**	**2**	**19**	**17**	**17**	**15**	**6**
Species count (out of 26)		**12**	**13**	**1**	**13**	**11**	**11**	**10**	**3**
Designation count (out of 47)		**19**	**20**	**2**	**19**	**17**	**17**	**15**	**6**

[a] Adult red crab EFH is designated to 2,000 m on the seamounts.

Overall, EFH designations for the largest number of species overlap the inshore Gulf of Maine zones, with moderate numbers of designations overlapping the offshore Gulf of Maine zones, and lower EFH overlap in the canyon and 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 (e.g., pollock, white hake, witch flounder, monkfish, some skates; deep-sea red crab in the canyon, seamount, and broad zones).

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 7.1.3.2). 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 21).

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.

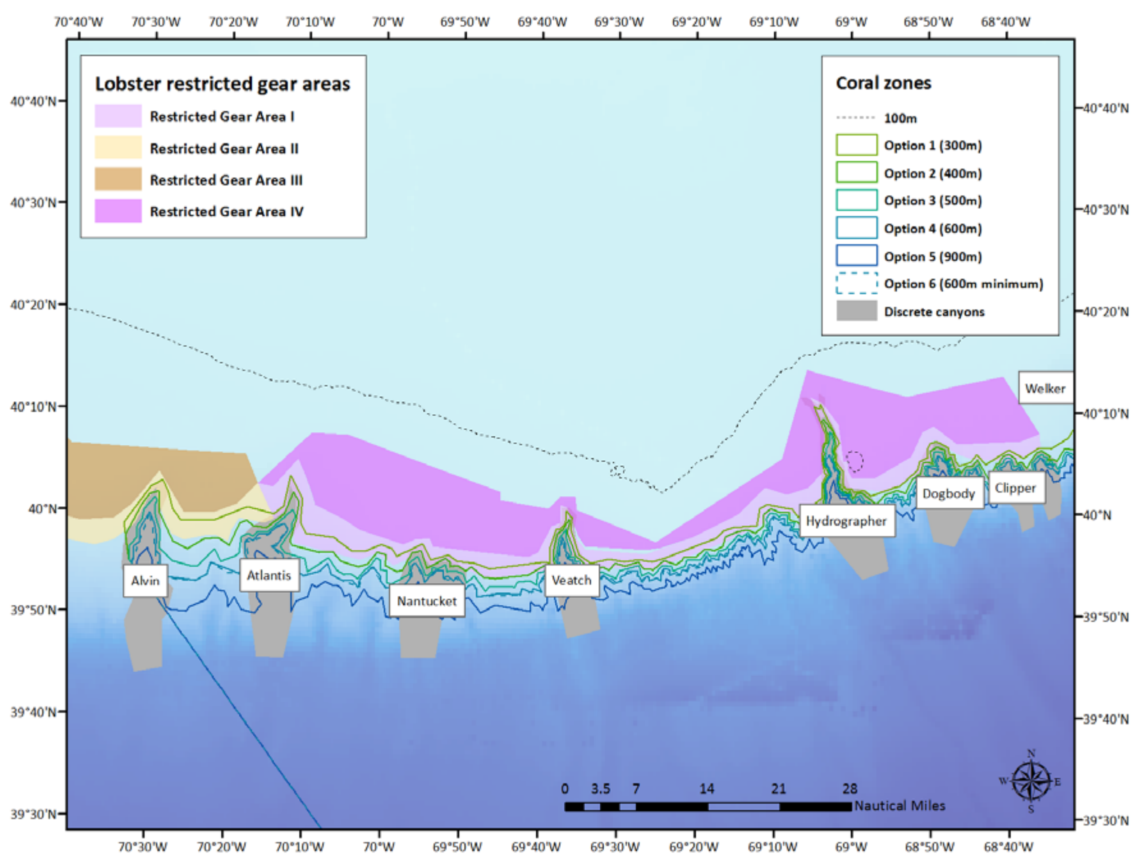
Table 21 – Distribution of managed resources and their fisheries relative to the alternatives under consideration

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
Jonah crab	ASMFC	All shelf break particularly in western 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 22; 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 22 – 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: The overall trend since the start of sector management through 2013 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."

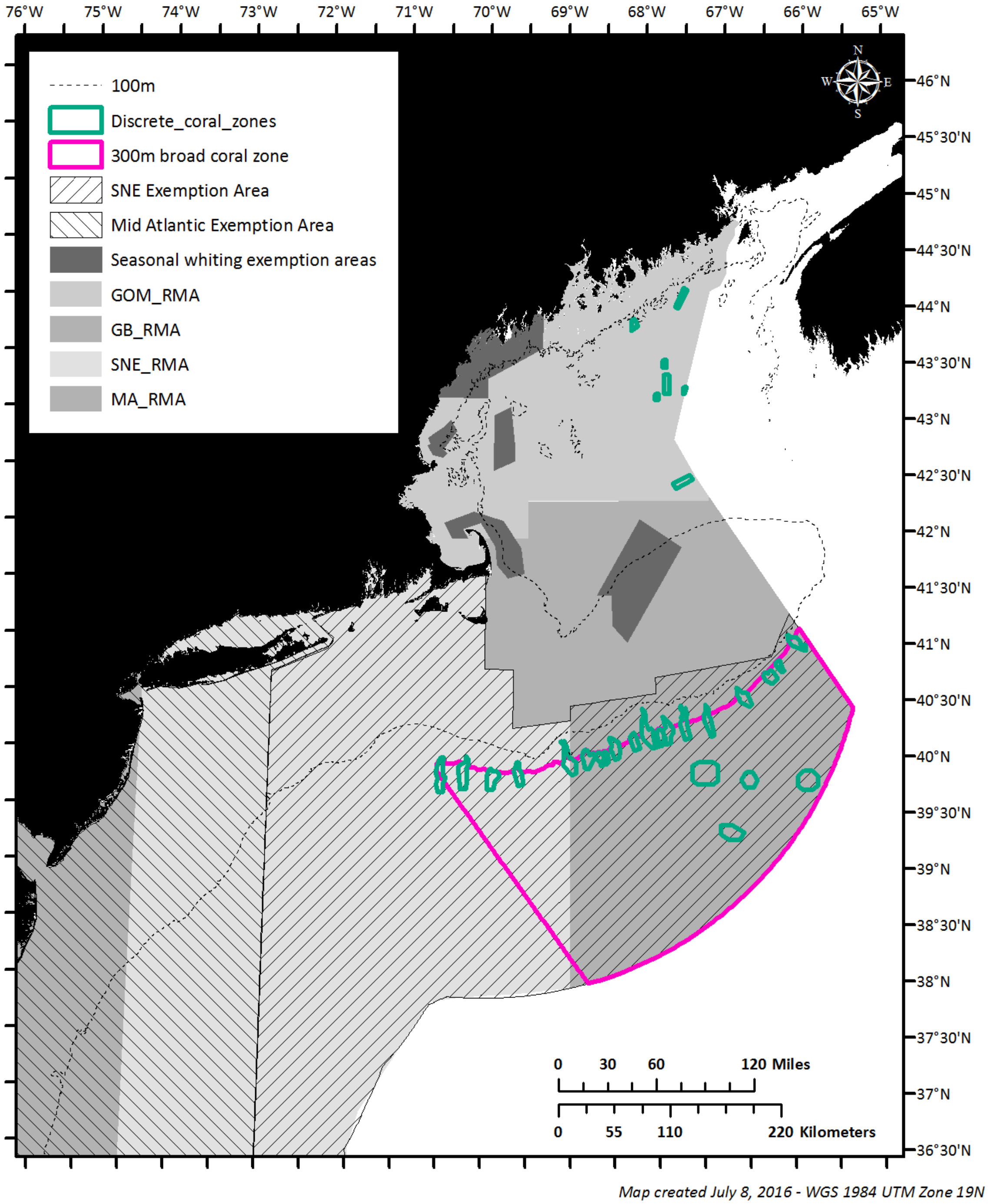
Population status: Silver hake *(Merluccius bilinearis*) occur throughout the Gulf of Maine and in moderate to deeper depths on Georges Bank and in the Mid-Atlantic Bight. In the NEFSC trawl survey, larger and older fish are found further north and in deeper waters, and smaller younger fish are found 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 inch 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).

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



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.

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 significant 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.

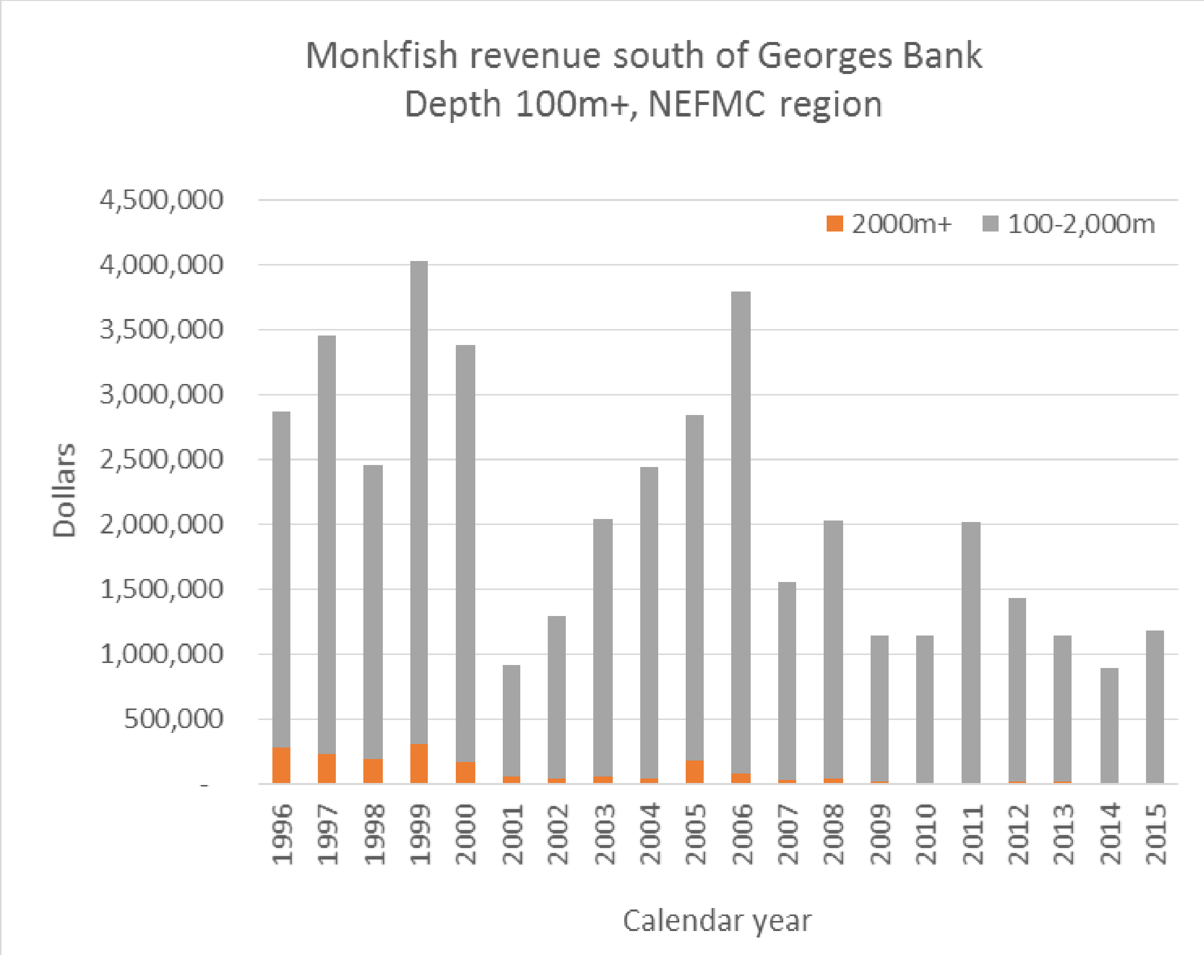
The canyon and slope coral zones overlap the Offshore Fishery Program Area, which was established by Amendment 2 (2005). The offshore program allows vessels to declare into the area for the year, in which case NMFS issues them a Category F permit. Although this permit includes a lower number of days 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).

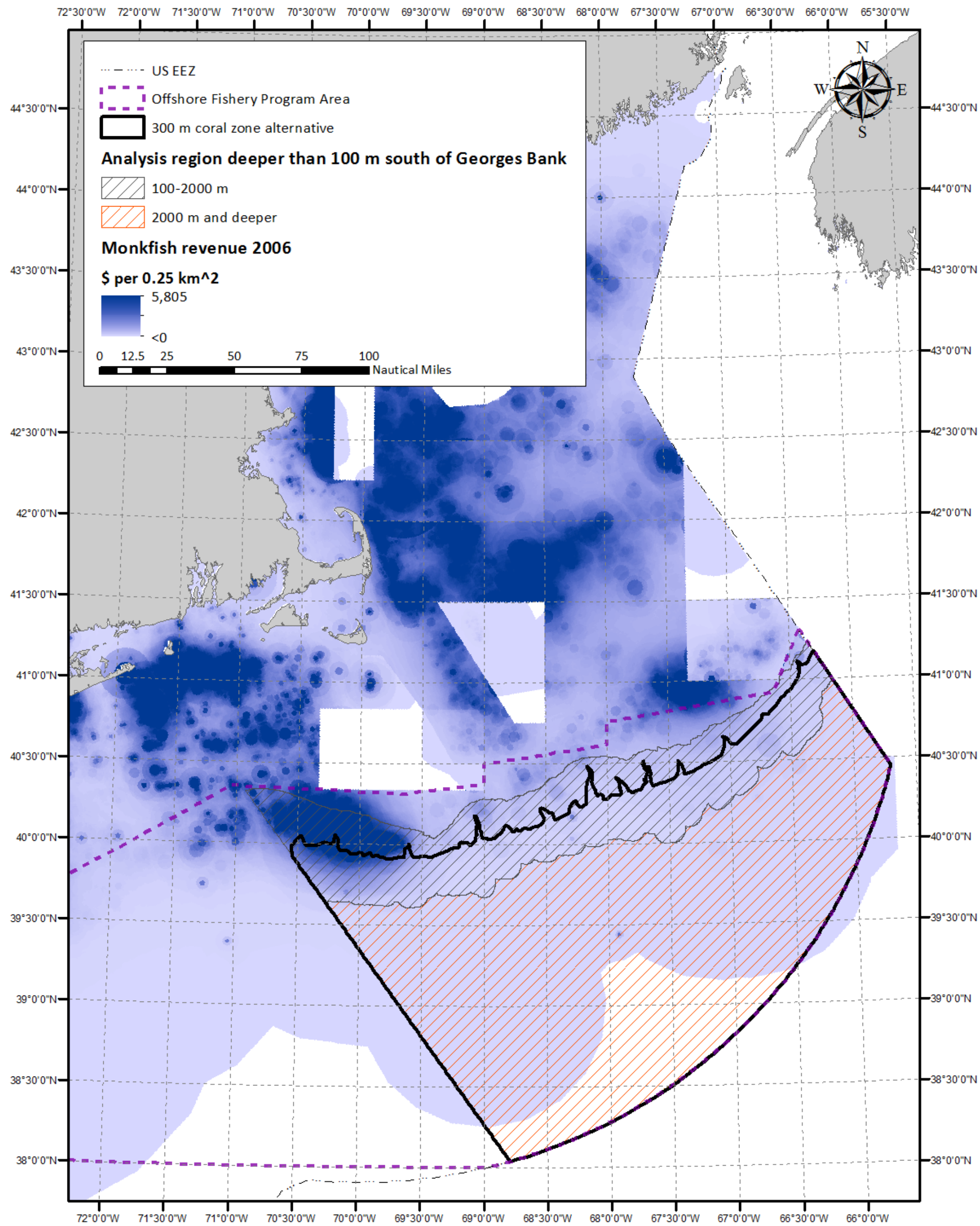
Considering just the area deeper than 100 m south of Georges Bank and within the NEFMC management region (essentially the New England part of the Offshore Fishery Program Area), recent monkfish revenues are lower than they have been historically. Since calendar year 2007, revenues for this location have 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.



Notes: **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 significant 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 is at record abundance, but that neither stock is experiencing overfishing. 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 23). 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 23 – 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 24). 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 24 – 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).								

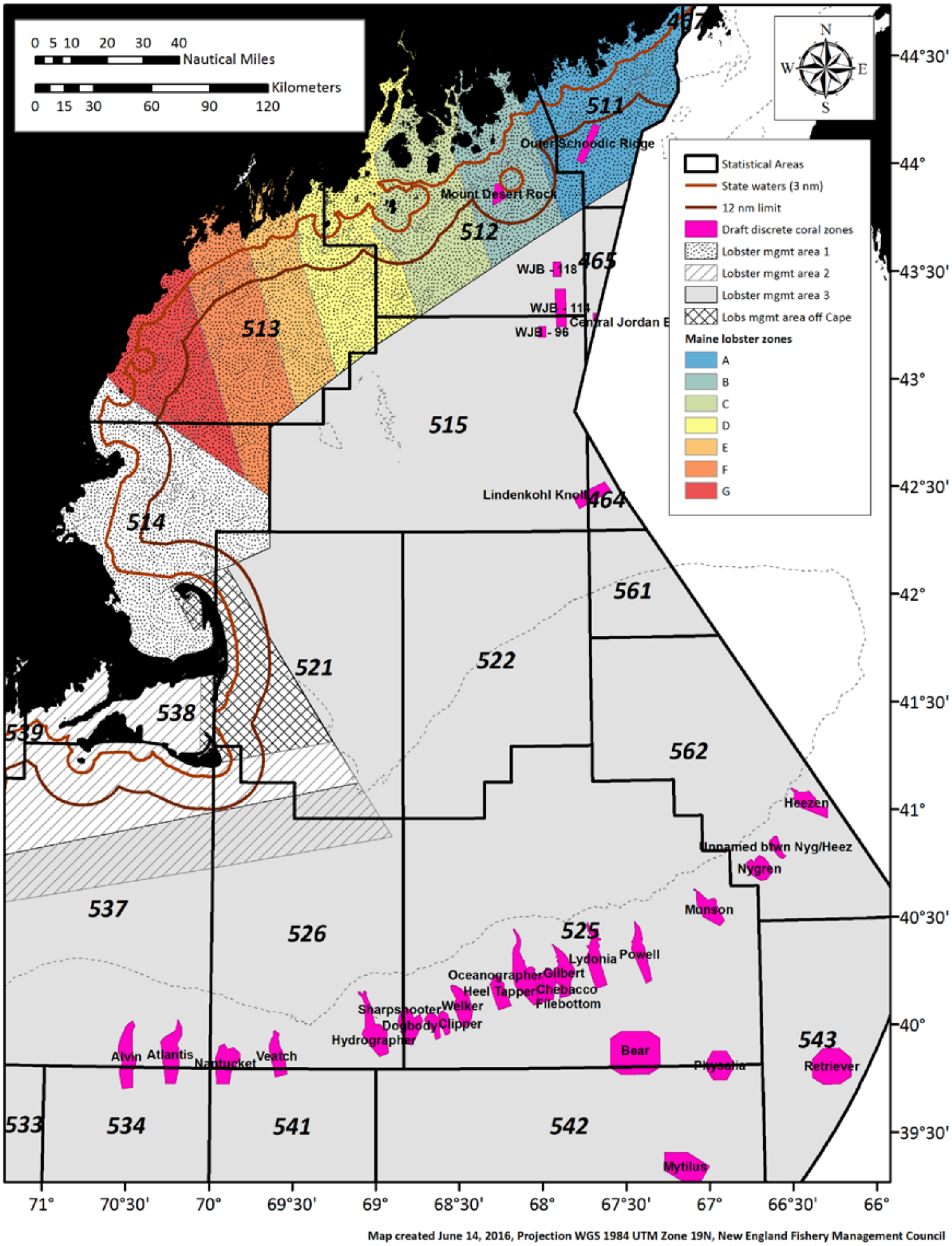
6.7.8 Jonah crab

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.

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).

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



6.7.9 Other species and fisheries

The VTR analysis (Section 7.1.3.2) indicates that other species and their associated fisheries overlap, or at least appear to overlap, with the deep-sea coral zones (Table 25). In some cases (sea scallop and summer flounder), this apparent overlap may be the result of spatially imprecise vessel trip report data.

Table 25 – Other species and fisheries that may overlap deep-sea coral zones

Species	FMP	Gear
Atlantic sea scallop	Atlantic sea scallop (NEFMC)	Generally dredge, some bottom trawl
Atlantic mackerel	Mackerel/squid/butterfish (MAFMC)	Generally midwater trawl, some bottom trawl
Summer flounder (fluke)	Summer flounder/scup/black seabass (MAFMC)	Generally 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 (Map 72). Mackerel catch was under 1,000 mt between 2012 and 2014 for the statistical areas overlapping the coral zones (Map 69, MAFMC 2016). Summer flounder catches are concentrated in southern New England and the Mid-Atlantic (Map 70). 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 26). 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 26 – 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*
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. § 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 significant 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 27). 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 28) 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 (Colburn and Jepson 2012; 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 28). 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 27 – 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 28 – 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
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

State	Community (& ports within community)	2014 Population	Community Index	
			Engagement	Reliance
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				

Steuben, ME. 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 (Colburn and Jepson 2012).

In 2015, Steuben was the homeport and primary landing port identified for 26 federal fishing permits (GARFO 2017). Total landings in Steubenwere 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 29; ACCSP, 2017).

Table 29 – Top five species landed by value in Steuben ME, 2015

Species	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, ME. 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 (Colburn and Jepson 2012).

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 30; ACCSP, 2017).

Table 30 – Top five species landed by value in Stonington ME, 2015

Species	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

Species	Revenue ($)	Vessels	Dealers
Note: Data for one of the five top species landed are confidential. *Source:* ACCSP, as of March 2017.			

Portland, ME. 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 (Colburn and Jepson 2012).

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 31; ACCSP, 2017).

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

Species	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.			

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 (Colburn and Jepson 2012).

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).

Gloucester, MA. 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 (Colburn and Jepson 2012).

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 32; ACCSP, 2017).

Table 32 – Top five species landed by value in Gloucester MA, 2015

Species	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 (Colburn and Jepson 2012).

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 33; ACCSP, 2017).

Table 33 – Top five species landed by value in New Bedford MA, 2015

Species	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 (Colburn and Jepson 2012).

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 34; ACCSP, 2017).

Table 34 – Top five species landed by value in Newport, RI 2015

Species	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 (Colburn and Jepson 2012).

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 35; ACCSP, 2017).

Table 35 – Top five species landed by value in Point Judith, RI 2015

Species	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 (Colburn and Jepson 2012).

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 35; ACCSP, 2017).

Table 36 – Top five species landed by value in Montauk, NY 2015

Species	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.			

6.8.2 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 (Table 38). 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. 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. 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.

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. 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: www.nmfs.noaa.gov/pr/sars/region.htm
- BOEM and NOAA data portal: marinecadastre.gov/
- Information on cusk: http://www.nmfs.noaa.gov/pr/species/esa/candidate.htm

Fishing gears that could be regulated via this amendment include bottom-tending gears of various types, specificially trawls, dredges, traps, gillnets, and longlines, as described in Section 6.7. In terms of the potential for interactions with marine mammals (ESA listed or not), NMFS publishes an annual list of fisheries defined by gear type and region (Table 37). 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 2017 List of Fisheries is available at 82 FR 3655. 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).

NMFS reports document interactions between fishing gears and protected resources, and support the determinations in the annual list of fisheries. These include the US Atlantic and Gulf of Mexico marine mammal stock assessments: Hayes et al. 2017, Waring et al. 2016, and earlier reports: https://www.nefsc.noaa.gov/publications/tm/, in addition to Northeast Fisheries Observer Program: Incidental Take Reports: http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html.

Table 37 – Marine mammal stocks incidentally killed or 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
	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
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

Potential interactions between fisheries and sea turtles or protected species of fishes and the need for any mitigation measures are determined via Section 7 consulations under the Endangered Species Act. Section 7 consultations relevant to this action include NMFS 2013 (batched, seven FMPs), NMFS 2014 (lobster), NMFS 2001 (tilefish), and NMFS 2002 (deep-sea red crab). A list of all active and archived Biological Opinions relevant to the Greater Atlantic Region is

available at:
https://www.greateratlantic.fisheries.noaa.gov/protected/section7/bo/biological_opinions.html#Active.

Table 38 lists protected resources present in the affected environment of the deep-sea coral amendment, summarizing their status and whether the species is potentially affected by the action. MMPA Strategic Stocks are identified in the table. 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 (Section 3 of the MMPA of 1972). Thus, impacts to strategic stocks are of particular interest.

Note that cusk, *Brosme brosme*, is a 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, this species will not be discussed further in this and the following sections. NMFS recommends that any proposed action consider conservation actions to limit the potential for adverse effects on candidate species. Additional information on cusk can be found at http://www.nmfs.noaa.gov/pr/species/esa/candidate.htm.

Table 38 – 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 (E=ESA endangered, T=ESA threatened, P=MMPA protected)	MMPA strategic stock?	Potentially affected by action?
Large cetaceans	N. Atlantic right whale (*Eubalaena glacialis*)	E, P	Yes	Yes
	Humpback whale, West Indies DPS (*Megaptera novaeangliae*)	P	No	Yes
	Fin whale (*Balaenoptera physalus*)	E, P	Yes	Yes
	Minke whale (*B. acutorostrata*)	P	No	Yes
	Pilot whale (*Globicephala spp.*)[a]	P	Yes	Yes
	Sei whale (*B. borealis*)	E, P	Yes	No
	Blue whale (*B. musculus*)	E, P	Yes	No
	Sperm whale (*Physeter macrocephalus*	E, P	Yes	No
	Pygmy sperm whale (*Kogia breviceps*)	P	No	No
	Dwarf sperm whale (*K. sima*)	P	No	No
	Beaked whales (*Ziphius and Mesoplodon spp*)[b]	P	No	No
	Risso's dolphin (*Grampus griseus*)	P	No	Yes

Group	Species (DPS = Distinct Population Segment)	Status (E=ESA endangered, T=ESA threatened, P=MMPA protected)	MMPA strategic stock?	Potentially affected by action?
Small cetaceans	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	Yes	Yes
	Striped dolphin (*S. coeruleoalba*)	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
	Shortnose sturgeon (*Acipenser brevirostrum*)	E	n/a	No
Critical habitat	North Atlantic Right Whale Critical Habitat	Protected (ESA)	n/a	No

[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.

6.9.1 Species and Critical Habitat not likely to be affected

Below, direct effects refer to interaction with gear, and indirect effects refer to prey removal and habitat modification.

6.9.1.1 Large cetaceans

Various whale species include the sei whale, blue whale, sperm whale, dwarf sperm whale, pygmy sperm whale, and beaked 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 influenced by the management actions in the amendment.

The general distribution of sei whales is discussed in Section 6.9.2.1 below. This species is not likely to be affected by this amendment, given that there have been no observed U.S. Atlantic fishery-related mortalities or serious injuries to sei whales to date (Waring et al. 2010; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html).

Blue whales do not regularly occur in waters of the U.S. EEZ (Waring et al. 2010), with none observed during the Cetacean and Turtle Assessment Program (CeTAP) surveys of the Mid- and North Atlantic areas of the outer continental shelf (CeTAP 1982). Calving occurs in low latitude waters and outside of the area where Greater Atlantic Region fisheries operate. Blue whales feed on krill which are too small to be captured in fishing gear (Sears 2002), such that their forage base will not be removed by the operation of any Greater Atlantic Region fishery. Because fisheries of the Greater Atlantic Region do not overlap with blue whale occurrence or habitat, direct (e.g., interaction with gear) or indirect (e.g., prey removal, habitat modification) effects from the operation of any of the Greater Atlantic Region fisheries are not expected. This conclusion is supported by the fact that there have been no observed U.S. Atlantic fishery-related mortalities or serious injuries to blue whales to date (Waring et al. 2010; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html).

Sperm whales regularly occur in waters of the U.S. EEZ, but primarily on the continental shelf edge, over the continental slope, and into mid-ocean regions (Waring et al. 2015). The average depth at which sperm whales were observed during the CeTAP surveys was 1,792 m (CeTAP 1982). Female sperm whales and young males almost always inhabit waters deeper than 1,000 m at latitudes below 40° N (Whitehead 2002). 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 of sperm whales or their prey (Whitehead 2002). While sperm whale habitat occurs within the deeper portions of coral protection zones proposed in this action, because no overlap between sperm whale prey and fishing activity is expected, it is unlikely that the forage base of sperm whales will be removed by the operation of any Greater Atlantic Region fishery. Calving for the species occurs in low latitude waters and therefore, outside of the area where Greater Atlantic Region fisheries operate.

Similar to sperm whales, pygmy and dwarf sperm whales occur primarily in oceanic waters (≥1,000 m), with some incursions into continental shelf waters (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).

Overall, fisheries of the Greater Atlantic Region are not expected to overlap with sperm whale, pygmy sperm whale, dwarf sperm whale, or beaked whale occurrence or habitat, and therefore, direct or indirect effects to these whales from the operation of any of the Greater Atlantic Region fisheries are not expected. This conclusion is supported further by the fact that there have been no observed U.S. Atlantic fishery-related interactions with sperm whales to date (http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; Waring et al. 2014a, 2015).

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 Section 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 7ºC to 17ºC, and depths between 6 to 28 m (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 Atl ntic right whale critical habitat (NMFS 2015b; NMFS 2015c; 81 FR 4837 (January 27, 2016)).

6.9.1.2 Small cetaceans

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 m; Payne et al. 1984; Mullin and Fulling 2003; Waring et al. 2014a).

These dolphin species are primarily deep water (≥ 1,000 m), 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 fishery interactions, this action is unlikely to result in direct or indirect effects on striped dolphins or Atlantic spotted dolphins.

6.9.1.3 Pinnipeds

All pinnipeds occurring in the region are potentially affected by this amendment.

6.9.1.4 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 2013a; 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.

6.9.1.5 Fishes

Shortnose sturgeon occupy the deep channel sections of large rivers rivers along the western Atlantic coast from St. Johns River in Florida to the Saint John River in New Brunswick, Canada. The species moves from fresh to salt water over its lifetime; and is anadromous in the southern portion of its range (i.e., south of Chesapeake Bay), while some northern populations migrate at various points in their life history, not only for breeding (amphidromous, NMFS 2010a). Given that the species remains 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

Below, direct effects refer to interactions with fishing gear, and indirect effects refer to prey removal and habitat modification that result from fishing gear operation.

6.9.2.1 Large cetaceans

Right, humpback, fin, sei, and minke whales are found throughout the waters of the Northwest Atlantic Ocean. In general, these species follow an annual pattern of migration between low latitude (south of 35ºN) wintering/calving grounds and high latitude spring/summer foraging grounds (primarily north of 41ºN; Waring et al. 2014a; Waring et al. 2015; Waring et al. 2016; NMFS 1991, 2005, 2010b, 2011a, 2012b). This, however, is a simplification of whale movements, particularly 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 (Waring et al. 2014a; Waring et al. 2015; Waring et al. 2016; 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 please refer to: Waring et al. 2014a; Waring et al. 2015; Waring et al. 2016; NMFS 1991, 2005, 2010b, 2011a, 2012b. To further assist in understanding how fisheries may overlaps in time and space with the occurrence of large whales, a general overview on species occurrence and distribution in the area of operation for the 13 Greater Atlantic Region fisheries is provided in Table 39.

Table 39 – Large whale occurrence in the Greater Atlantic Region

Species	Prevalence and approximate months of occurrence
North Atlantic Right whale	Distributed throughout all continental shelf waters from the Gulf of Maine to the South Atlantic Bight throughout the year. New England waters (Gulf of Maine and Georges Bank regions) are foraging Grounds from January through October. Seasonally important foraging grounds include: Cape Cod Bay (January-April); Great South Channel (April-June); Western Gulf of Maine (April-May, and July-October); Jordan Basin (August-October); Wilkinson Basin (April-July); and the northern edge of Georges Bank (May-July). Mid-Atlantic waters are a migratory pathway to/from northern foraging and southern calving grounds. The South Atlantic Bight includes calving and nursing grounds. Increasing evidence of wintering areas (approximately 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 (Southern New England included), Gulf of Maine, and Georges Bank throughout the year. New England waters (Gulf of Maine and Georges Bank regions) are foranging grounds from March to November. Mid-Atlantic waters are a migratory pathway to/from northern foraging and southern calving grounds in the West Indies. Increasing evidence of whales remaining in mid- and high- latitudes throughout the winter. Specifically, increasing evidence of wintering areas (for juveniles) in Mid-Atlantic (e.g., waters in the vicinity of Chesapeake and Delaware Bays; peak presence approximately January through March) and Southeastern coastal waters.

Species	Prevalence and approximate months of occurrence
Fin whale	Distributed throughout all continental shelf waters of the Mid-Atlantic (Southern New England included), Gulf of Maine, and Georges Bank throughout the year. Mid-Atlantic waters are a migratory pathway to/from northern foraging and southern calving grounds. Possible offshore calving area (October-January). Evidence of wintering areas in mid-shelf areas east of New Jersey, Stellwagen Bank, and eastern perimeter of Georges Bank. New England (Gulf of Maine and Georges Bank)/Southern New England waters are foraging grounds, with greatest densities March-August; lower densities September-November. Important foraging grounds include: Massachusetts Bay (especially Stellwagen Bank); Great South Channel; waters off Cape Cod (~40-50 m contour); Gulf of Maine; perimeter (primarily eastern) of Georges Bank; and mid-shelf area off the east end of Long Island.
Sei whale	Primarily found in deep waters along the shelf edge, shelf break, and ocean basins between banks. Uncommon in shallow, inshore waters of the Mid-Atlantic (SNE included), Georges Bank, and Gulf of Maine; however, occasional incursions during peak prey availability and abundance. Spring through summer, found in greatest densities in offshore waters of the Gulf of Maine and Georges Bank; sightings concentrated along the northern, eastern (into Northeast Channel) and southwestern (in the area of Hydrographer Canyon) edge of Georges Bank.
Minke whale	Widely distributed throughout continental shelf waters (<100 m) of the Mid-Atlantic (Southern New England included), Gulf of Maine, and Georges Bank. Most common in the EEZ from spring through fall, with greatest abundance New England waters
Pilot whales	
Sources: NMFS 1991, 2005, 2010b, 2011a, 2012b; 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. 2014a; Waring et al. 2015; Waring et al. 2016; 81 FR 4837 (January 27, 2016); NMFS 2015c; Bort et al. 2015.	

6.9.2.2 Small cetaceans

Small cetaceans can be found throughout the year in waters of the Northwest Atlantic Ocean (Waring et al. 2014a; Waring et al. 2015; Waring et al. 2016). 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 provided in Table 42. For additional information on the biology, status, and range-wide distribution of each species please refer to Waring et al. (2014a), Waring et al. (2015), and Waring et al. (2016).

Table 40 – 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).
Atlantic white-sided dolphin	Distributed throughout the continental shelf waters (primarily to 100 m isobath) of the Mid-Atlantic (north of 35 N), 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), low densities found year-round, with 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 42N). Mid-summer-fall: occur primarily on Georges Bank with small numbers present in the Gulf of Maine. 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).
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.

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 provided in Table 41. For additional information on the biology, status, and range-wide distribution of each species of pinniped refer to Waring et al. (2007), Waring et al. (2014a), Waring et al. (2015), and Waring et al. (2016).

Table 41 – 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 New England to NJ
Grey seal	Distributed in waters from NJ to ME. Year-round: waters from ME to MA; September-May: waters from RI to NJ
Harp seal	Winter-Spring (approximately January-May): waters fromME to NJ.
Hooded seal	Winter-Spring (approximately January-May): waters of New England.
Sources: Waring et al. 2007 (for hooded seals); Waring et al. 2014a; Waring et al. 2015; Waring et al. 2016	

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, 2013b, 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).

Leatherbacks, a pelagic species, are known to use coastal waters of the U.S. continental shelf and to have a greater tolerance for colder water than hard-shelled sea turtles (James et al. 2005; Eckert et al. 2006; Murphy et al. 2006; NMFS and USFWS 2013b; Dodge et al. 2014). Leatherback sea turtles 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). They are found in more northern waters (i.e., Gulf of Maine) later in the year (similar time frame as hard-shelled sea turtles), 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 Fishes

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).

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). Several marine aggregation areas have been identified adjacent to estuaries and/or coastal features formed by bay mouths and inlets along the eastern U.S. seaboard. Depths in these areas are generally no greater than 25 m (Stein et al. 004a; Laney et al. 2007; Dunton et al. 2010; Erickson et al. 2011). Although additional studies are still needed to clarify why these particular sites are chosen, there is some indication that they may serve as thermal refuges, 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).

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.

7 Environmental impacts of the alternatives

This section describes the potential positive and negative impacts associated with the management alternatives considered in this amendment. These analyses 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, four sets of areas that are grouped for analysis are the No Action areas, canyon coral zones, seamount coral zones, and Jordan Basin 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 four 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.

7.1 Impacts analysis methods by VEC

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

7.1.1 Deep-sea corals

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.

7.1.1.1 Coral presence

All zones under consideration in this amendment have corals documented during recent camera surveys, and some of the zones have pre-2012 (“historical”) 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 42. 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 43. 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 42 – 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
600 m minimum (Opt. 6)		386	73	58	8	525
900 m (Option 5)		290	72	52	8	422
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
Unnamed Canyon	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 43 – 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)	36 dives during 2002, 2003, 2013 and 2014, 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.

7.1.1.2 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, but 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 44). 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, 7.3.1, etc.).

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

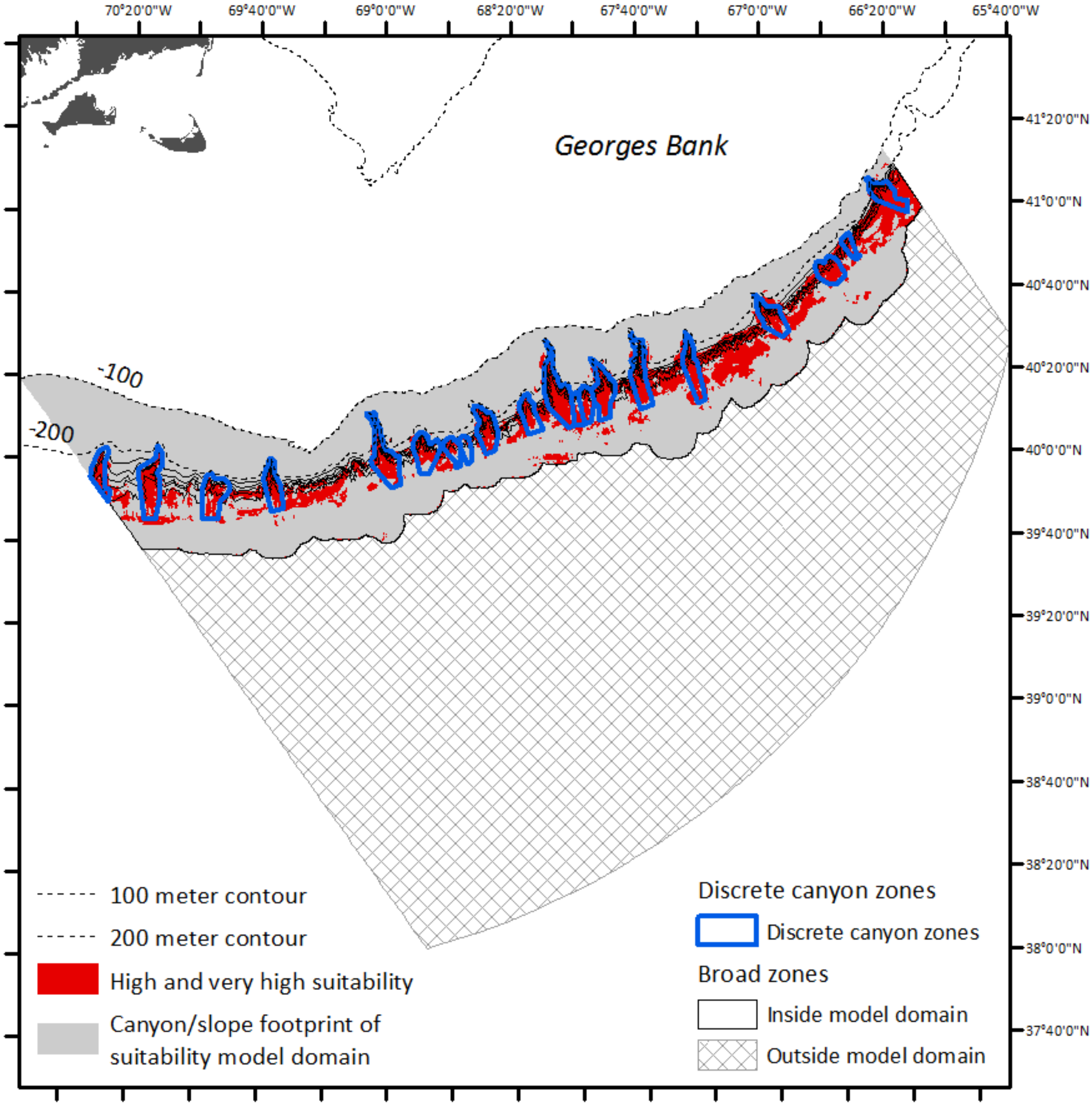


Table 44 – Suitable habitat for deep-sea corals by management area. Analysis considers portions of management areas within the suitability model domain only.

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)				

[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 meters 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.

7.1.1.3 Bathymetry and slope

Table 45 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 meters). 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 meters, 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.

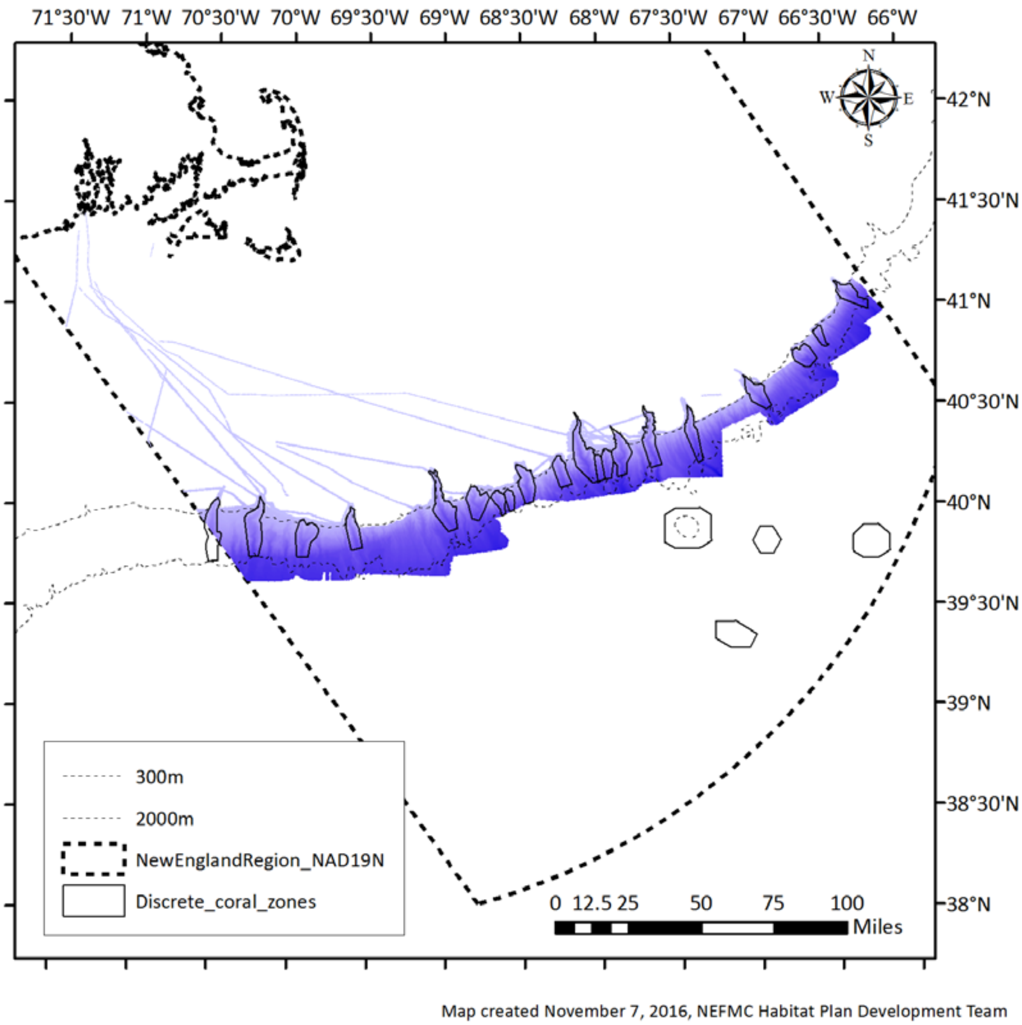
The high slope areas are difficult to visualize on a regional map, so Map 49 shows where high slope areas occur within Oceanographer Canyon. The ACUMEN bathymetry and slope datasets are not without artifacts, and in locations where datasets from individual cruises were stitched together, false areas 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 46.

Table 45 – 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	168.62
Tilefish GRA – Oceanographer	-131	-1,262	1,131	-368	-453.7	271.80
Tilefish GRA – Lydonia	-145	-860	715	-332	-359.5	150.84
Monkfish-MSB – Oceanographer	-197	-1,906	1,709	-962	-979.5	464.02
Monkfish-MSB – Lydonia	-166	-1,672	1,506	-637	-721.9	372.93
Monument – Canyon section	-88	-2,094	2,006	-214	-534.3	537.07
Monument – Seamount section	-1,088	-4,434	3,346	-3832	-3,705.2	601.05
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	954.58
400 m (Option 2)	-191	-4,434	4,243	-3,140	-3,022.7	921.01
500 m (Option 3)	-248	-4,434	4,186	-3,151	-3,045.6	892.94
600 m (Option 4)	-390	-4,434	4,044	-3,162	-3,068.1	867.78
900 m (Option 5)	-556	-4,434	3,878	-3,180	-3,108.4	818.08
600 m minimum (Option 6)	-389	-4,434	4,045	-3,161	-3069.4	861.80
Empirically-derived (Option 7)						
Canyons						
Zone name	***Shallow/ min***	***Deep/ max***	***Range***	***Median***	***Mean***	***Standard deviation***
Alvin	-307	-1,955	1,648	-936	-1,022.8	472.73
Atlantis	-315	-1,998	1,683	-914	-968.8	426.35
Nantucket	-330	-1,935	1,605	-945	-999.9	422.08
Veatch	-230	-1,792	1,562	-844	-913.9	439.02
Hydrographer	-141	-1,949	1,808	-1,001	-991.8	521.02
Dogbody	-322	-1,835	1,513	-1,043	-1,059.9	415.07
Clipper	-440	-1,801	1,361	-979	-1,038.2	386.91
Sharpshooter	-441	-1,884	1,443	-1,082	-1,092.7	413.90
Welker	-290	-2,083	1,793	-881	-966.7	475.23
Heel Tapper	-321	-1,765	1,444	-1,009	-1,003.5	409.86
Oceanographer	-280	-2,026	1,746	-904	-999.7	498.57
Filebottom	-413	-1,965	1,552	-1,407	-1,340.1	442.83
Chebacco	-403	-1,925	1,522	-1,192	-1,182.4	436.72
Gilbert	-199	-2,094	1,895	-969	-1,035.8	480.87
Lydonia	-156	-1,960	1,804	-761	-859.0	492.65
Powell	-271	-2,146	1,875	-1203	-1,177.5	544.89
Munson	-202	-2,000	1798	-998	-1,006.1	445.86
Nygren	-344	-1,774	1430	-1108	-1,105.7	447.10

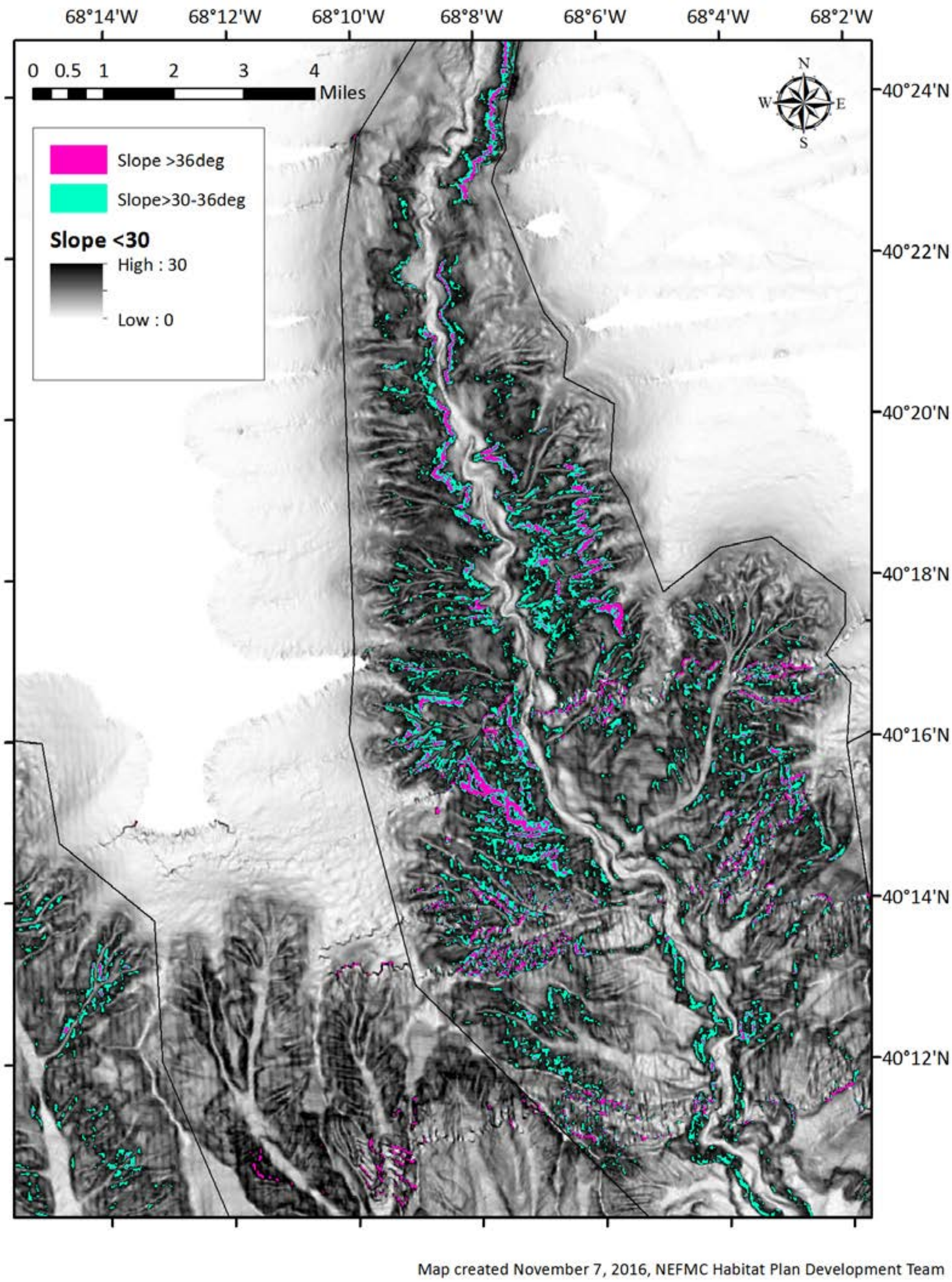
Unnamed canyon between Nygren and Heezen	-392	-1,573	1,181	-940	-932.3	348.83
Heezen	-151	-2,084	1,933	-909	-1,034.2	537.90
Seamounts						
Zone name	***Shallow/ min***	***Deep/ max***	***Range***	***Median***	***Mean***	***Standard deviation***
Bear	-1,088	-3,204	2,116	-2,255	-2,225.3	533.58
Mytilus	-2,382	-4,190	1,808	-3,653	-3,429.7	532.20
Physalia	-1,902	-3,691	1,789	-3,200	-3,054.2	405.60
Retriever	-1,946	-4,048	2,102	-3,561	-3,338.9	552.77
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	22.50
Mount Desert Rock (Option 2)	-106	-203	97	-164	-160.8	27.00
Outer Schoodic Ridge	-144	-211	67	-172	-172.3	15.93
Western Jordan Basin - 114 Fathom Bump (Option 1)	-213	-251	38	-241	-237.7	7.80
Western Jordan Basin - 114 Fathom Bump (Option 2, #1)	-239	-247	8	-243	-242.9	1.75
Western Jordan Basin - 114 Fathom Bump (Option 2, #2)	-231	-248	35	-241	-238.8	6.99
Western Jordan Basin - 114 Fathom Bump (Option 2, #3)	-223	-239	16	-229	-229.5	4.03
Western Jordan Basin - 114 Fathom Bump (Option 2, #4)	-224	-235	11	-231	-229.7	3.54
Western Jordan Basin - 96 Fathom Bump (Option 1)	-188	-222	34	-209	-209.2	7.32
Western Jordan Basin - 96 Fathom Bump (Option 2)	-188	-222	34	-208	-207.6	10.12
Western Jordan Basin - 118 Fathom Bump (Option 1)	-221	-265	44	-242	-244.2	9.32
Western Jordan Basin - 118 Fathom Bump (Option 2)	-221	-239	18	-235	-232.5	5.71
Central Jordan Basin (Option 1)	-215	-232	17	-226	-225.3	4.21
Central Jordan Basin (Option 2, #1)	-221	-230	9	-227	-226.5	3.10
Central Jordan Basin (Option 2, #2)	-215	-230	15	-223	-223.8	5.01
Lindenkohl Knoll (Option 1)	-165	-256	91	-210	-209.8	16.89
Lindenkohl Knoll (Option 2, #1)	-188	-216	28	-200	-199.5	9.62
Lindenkohl Knoll (Option 2, #2)	-189	-248	59	-222	-218.2	17.54
Lindenkohl Knoll (Option 2, #3)	-198	-254	56	-229	-225.1	15.16

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



Notes: 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



Notes: 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 46 – Area of high slope by management area. Analysis considers portions of management areas within the ACUMEN footprint only.

Management Area	Area of slope > 30° (km²)[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)		

[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.

7.1.1.4 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.

7.1.3.1 Confidentiality requirements

MSA Section 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. Thus, the fishery data in this action are aggregated to at least three reporting units, to preserve confidentiality. Any data with less than three reporting units are 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.

7.1.3.2 Approach to fishery impact analysis

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 fishing trips and estimate trip attributes (e.g., landings) spatially.
- *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 included in this document (Map 54 to Map 82) 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.

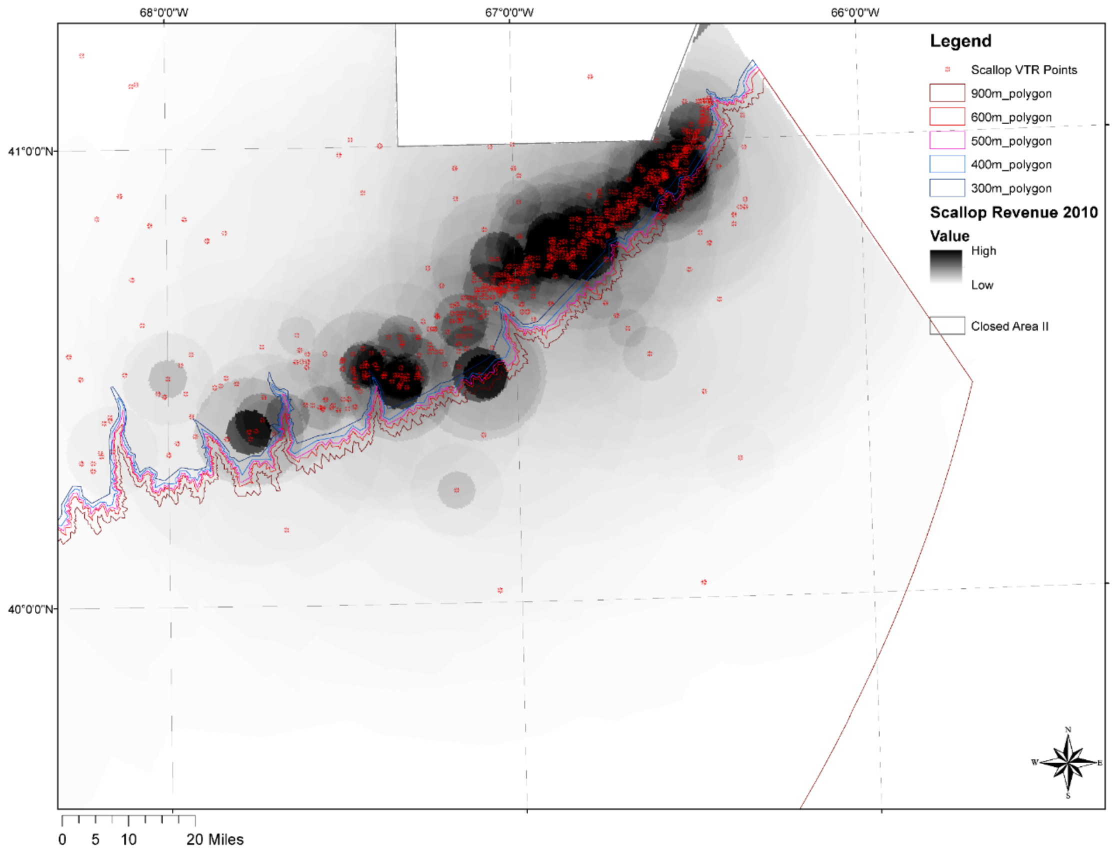
1. For some fishing modes, there are limited haul-by-haul location data to develop a reliable effort/revenue distribution model. For example, the lobster fishery has a low at-sea sampling rate, and available data indicate that VTRs can be highly imprecise. Since lobster and bottom trawl trips were statistically 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.



Note: **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[3] (data for individual statistical areas and years beyond

[3] 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.

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 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 7.6.3). 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 47.

Table 47 – 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 48). 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 48 - 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 49). 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).

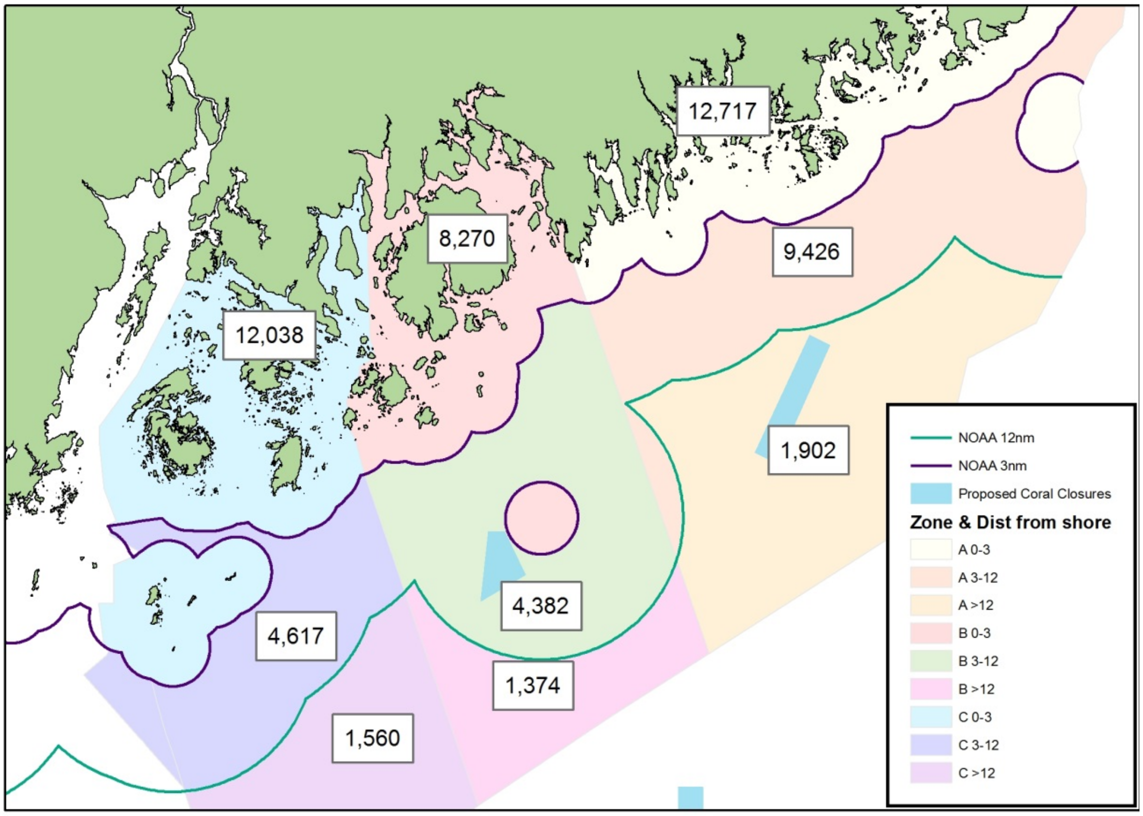
The Maine lobster fishery has no fleet-wide reporting requirements that provide data on the spatial resolution of fishing locations finer than the Zone level. The MEDMR harvester report data are not a census of lobster fishing activity, as they are submitted by about 10% of lobster permit holders, those 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 49 – 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

Zone	Federal No VTR	Federal w VTR	State Only	Total	Federal	% federal
Permit numbers						
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%

Note: **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

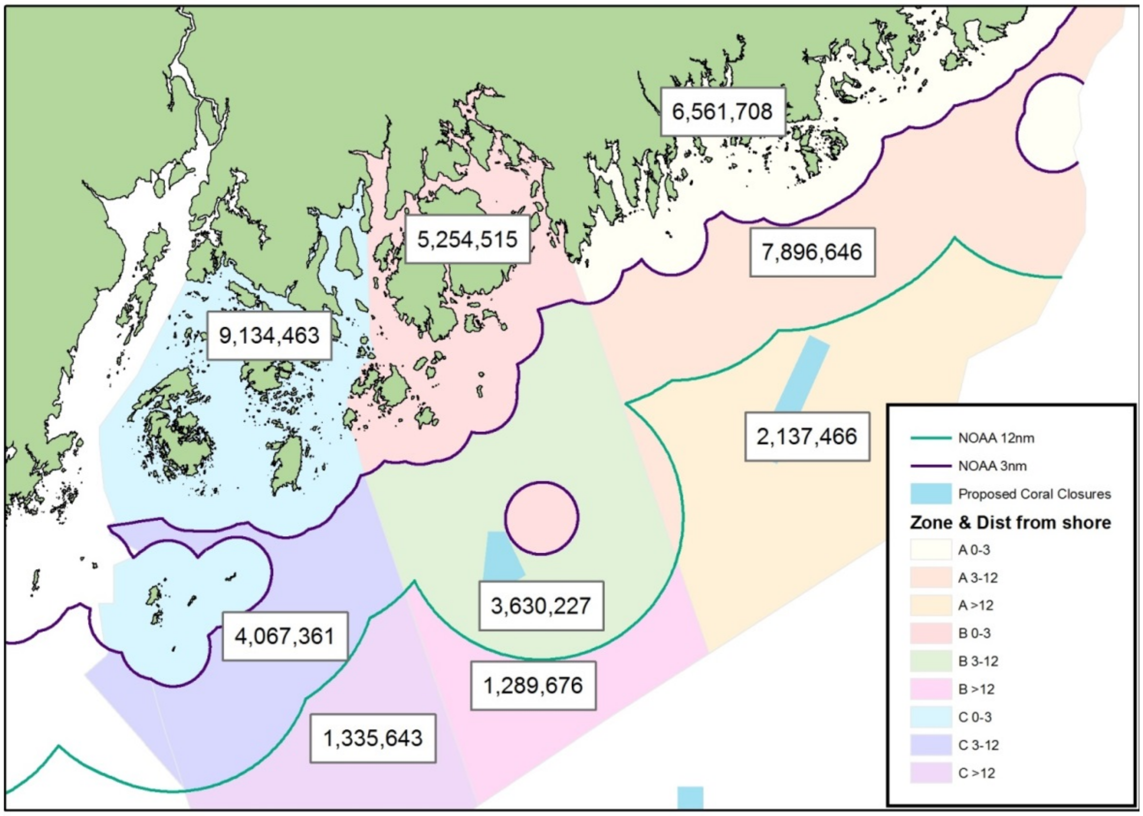


Source: **ASMFC (2017).**

Note: **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.**

	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

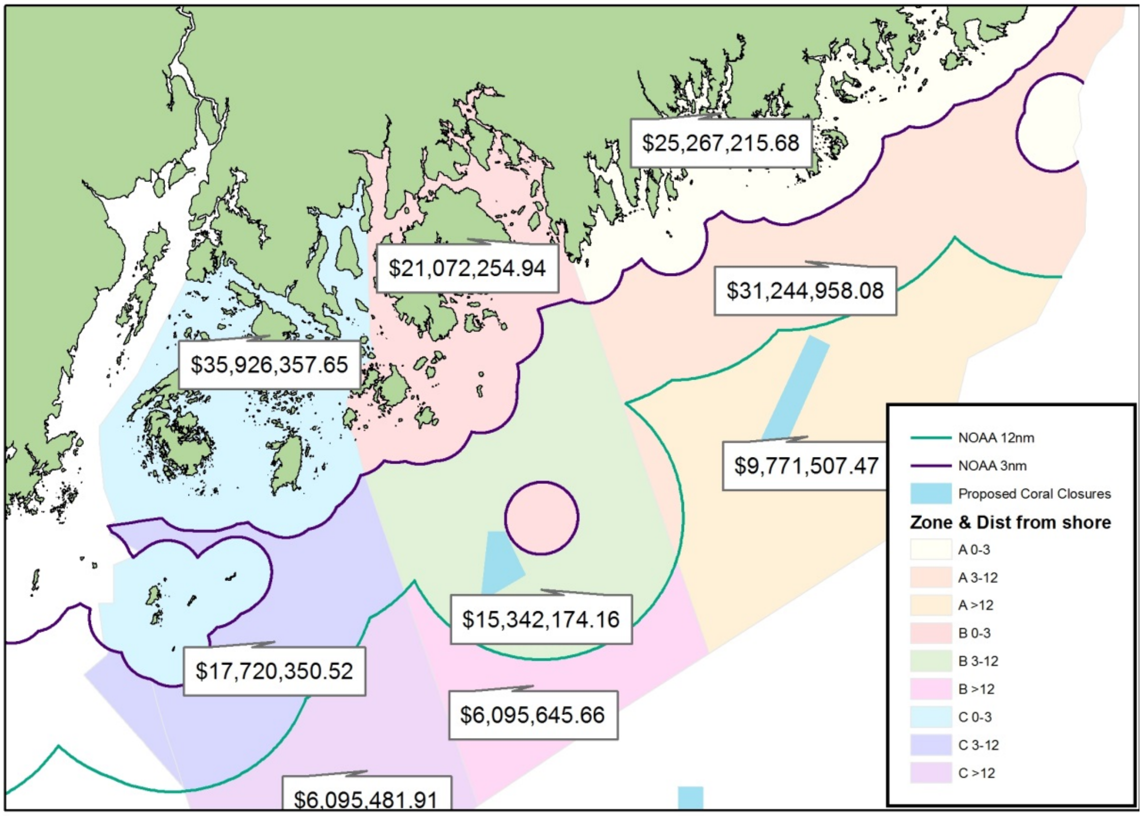


Source: **ASMFC (2017).**

Note: **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.**

	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



Source: **ASMFC (2017).**
Note: **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.**

	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.

7.1.3.3 Approach to fishing community impact analysis

The fishing communities that are potentially impacted by the management alternatives are identified and discussed. There are, however data limitations and data confidentiality standards that constrain the extent of the analysis in this document. 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.

Communities at the port of landing and city of vessel registration could be impacted by the alternatives under consideration. 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.

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.

In addition to the ports explicitly identified, other ports are impacted but cannot be detailed due to data confidentiality. Background information on several communities is in Section 6.8.1 and at: http://nefsc.noaa.gov/read/socialsci/communitySnapshots.php.

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.

7.1.3.4 Approach to sociocultural impact analysis

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 begining 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.

7.1.3.5 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.

7.1.3.6 Non-use value of corals

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.

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 will always 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 even then are 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 interaction risks are broadly related to the total amount of gear in the water, soak or tow time, and co-occurrence with protected species. Gear type is important, with some gear/species combinations having higher rates of interaction, and other combinations having few or no documented interactions. 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 fishing behavior, which may influence the potential for regional fisheries to interact with protected resources.

Gear interaction risks could increase, stay the same, or decrease, if fishing effort is redistributed spatially. 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. Generally speaking, if shifts in effort result in more gear being present for a longer period of time in areas of higher protected species co-occurrence, this is likely to result in increased interaction risks.

Effort controls in regional fisheries limit the magnitude of increased risk. Management plans for the fisheries operating in New England limit the overall amount of fishing effort, mainly through annual catch limits on target stocks, but also through permit and trap limits in the case of the lobster and crab fisheries. Given these existing limits, the changes proposed in this amendment are not expected to significantly increase the amount of gear in the water. It is possible that gear use could increase somewhat if coral closures shift effort from more productive to less productive fishing grounds. Theoretically, this would be possible in the lobster fishery, where individuals have limits on the number of traps they can set at any given time, but are not limited to a certain number of fishing days. This could also be possible in fisheries like the multispecies groundfish fishery, where there are limits on catch, but generally not on the number of days fished, for vessels operating as part of a sector. Obviously, there are costs associated with an additional day of fishing (fuel, ice, food, additional wear and tear on the vessel), so effort increase to make up for lower catch rates would be constrained by economic and practical limits.

For this analysis, because the coral zones are small relative to the overall size of fishing grounds, it is assumed that shifts in effort will occur locally. The possibilities for effort shifts are also controlled by the fisheries management plan.

In the inshore Gulf of Maine coral zones, the vast majority of effort is lobster trap (see Sections 7.6.3 and 7.7.3). 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 most of the effort must stay within the permitted zone. There are also practical limits 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. Because these lobster management zones are already heavily fished, it is reasonable to assume that there are few if any "new" fishing grounds within them that could be exploited by displaced vessels that do not currently have lobster gear present. Thus, the likely outcome is that gear will be 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 areas without any trap gear present.

In the offshore Gulf of Maine coral zones (see Sections 7.8.3 and 7.9.3), the primary fishing types are lobster pot, multispecies gillnet, and multispecies trawl. Multispecies trawl and gillnet vessels are generally flexible to fish throughout the region, but are limited to fishing in other locations where they have quota to cover their catches, and by practical considerations such as distance from port. 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 range of protected resources encountered would not be likely to change, but gear density could increase in some areas relative to current conditions. The offshore lobster fishery in this region 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 zones are landed in NH and ME, with the largest percentage of fixed gear landings attributed to New Hampshire (compare the all bottom tending gear and mobile bottom tending gear totals in Table 81 and Table 86). Fixed gear landings from the canyons and slope 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, it is most likely that effort will shift to other grounds in the Gulf of Maine, and not to the canyons and slope. 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. As noted for the inshore Gulf of Maine, increased gear density could increase interaction rates. If the offshore Gulf of Maine zones were closed to lobster pot gear, the result would be areas where protected resources could forage with risk of entanglement. Because the areas are small, in most cases around 1-2 miles across, a short distance relative to the range of most protected resources, the magnitude of any change in interaction risk is not likely to be hugely positive or negative.

In the canyon and slope region south of Georges Bank, the broad coral zones encompass a relatively larger geographic area, and vary in size and extent based on their shallow or 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 become more concentrated in 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 is 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. 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. While the broad zones in particular would result in large areas not fished by bottom tending gear, the magnitude of positive impacts of such an area on protected resouces will be limited, given that the vast majority of each broad zone is not fished with bottom tending gear, and effort is limited to the shallow margin of each.

7.2 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 seven years from the date of designation (i.e., 2023).

For this impacts analysis, the No Action closures have been group 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.

7.2.1 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 43) as well as earlier sampling (Table 42). Of all the management areas under consideration, the existing monkfish-mackerel/squid/butterfish closures are the most efficient 93% (Table 44) at encompassing areas predicted to be high suitability habitat for soft corals, and have the largest percent area of high slope (7%, Table 46). 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 45), 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 44), and 33% of the high slope areas (Table 46).

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, if none of the action alternatives are adopted, 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.

7.2.2 Impacts on managed species and essential fish habitats

To be completed.

7.2.3 Impacts on human communities

Under No Action, the fishing restrictions 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 place. The Monument has been closed to all commercial fishing since November 2016, with the exception of the lobster and red crab fisheries, which have seven years to cease operations within the Monument. The overall impacts of No Action on human communities are expected to be slightly negative.

At present, there is evidence of small amounts mobile bottom-tending gear use around the existing closures implemented by the Councils (tilefish, monkfish, squid; see data below). This is unsurprising given that they have now been closed for a number of years. 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, continued implementation of these closures will likely have slightly negative to negligible impacts on regulated fisheries.

With the Monument implementation, it is difficult to determine if some types of fishermen would be precluded from fishing altogether or be able to shift effort to other areas when excluded from the monument. 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, because other lobstermen are already established in nearby fishing grounds. The industry input from the NEFMC coral workshops was consistent with these findings from the literature (NEFMC, 2017). Lobster trap fishermen are not restricted under the tilefish, monkfish, and squid closures. Patterns of behavior in the lobster industry 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 as displaced fishermen attempt to relocate their traps into new areas.

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 monument, once implemented for that fishery, will have the effect of reducing fishing east of the monument as well, increasing activity west of the monument in New England, and in the Mid-Atlantic region. The reason given for this is that 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. Given the proportion of red crab grounds included within the monument itself and the areas east of the monument, assuming fishing for red crab is limited across this entire range, and assuming some reductions in catchability associated with concentrating effort to the west, the monument could have negative impacts on the red crab fishery. If catchability does not decrease in response to effort concentration west of the monument, and effort continues east of the monument, these negative impacts would be reduced.

Effort in fisheries other than red crab and lobster has already shifted in response to the monument. Data from 2017 would document these patterns but has not yet been processed.

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 fishery removals 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 negative to slightly negative impacts on affected fishery stakeholders.

7.2.3.1 Fishery impacts

Impacts analyses prepared at the time the No Action fishery management closures were designated are summarized briefly below. The remainder of the section reflects data from the more recent 2010-2015 period. Due to data limitations, it is impossible to know the true amount of fishing activity that has occurred within the No Action areas. Thus, multiple approaches are used to estimate 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 these 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 (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.

Mackerel/Squid/Butterfish Areas: In 2008, Lydonia and Oceanographer (same boundaries as the monkfish closure) were closed to bottom trawl fishing for mackerel, squid, or butterfish via Amendment 9 to that FMP – with the intent of reducing EFH impacts. 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 impacted 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 via Amendment 1 to the Tilefish FMP – with the intent of reducing impacts known clay outcrop tilefish habitat. The VTR-based impacts analysis indicated that, in 2005, $207,096 in revenue from all fisheries in was derived from these canyons (just 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 was 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.

7.2.3.1.1 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. With the exception of lobster trap gear, revenues are 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 7.1.3.2). Maps of revenue by gear type and species are in Section 13 (p. 424 onward).

Revenue by gear

From 2010-2015, an annual average of $0.4M of fishing revenue is attributed to the area of the Monkfish/MSB/Tilefish areas, with higher than average values in 2014 and 2015 (Figure 4). The recent revenue attributed to fishing with mobile bottom-tending gear from these areas is about 47% of the total, or $207K annually. 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. Since bottom trawl was prohibited in these areas during 2010-2015, comparison with the more spatially refined VMS data (see Section 7.2.3.1.2 below) helps shed additional light on this finding.

The Northeast Canyons and Seamounts Marine National Monument (Monument, Figure 5), which is larger and shallower, has a more revenue attributed to it, averaging $1.8M annually. 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 may explain these high 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. 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.

Revenue by species

Lobster, Jonah and red crabs, and scallops are the highest value species of the top 10 species with landings attributed to the Monkfish/MSB/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 resources include flounders, mackerel, and haddock. There have been recent increases in effort in the Jonah crab fisheryRevenues 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 is particularly prominent in 2015.

The results for the Monument (Figure 7) are similar in terms of many of the top 10 species captured, but emphasize sea scallop revenues relative to the Monkfish/MSB/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 can be compared to those for the monument as a whole. Revenues from Filebottom, Chebacco, and Gilbert Canyons, plus Lydonia and Oceanographer Canyons, are summarized in Figure 62, p. 323 (Section 7.4.3.1). 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 61), monkfish was within the top ten species, but approximately $100,000 or less annually. Some of this revenue may be an artifact 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 62, p. 323). The VTR analysis indicates that mackerel, squid, and butterfish were within the top ten species landed by revenue in the five canyons that overlap the monument, although revenues were limited to $120,000 or less annually. These moderate revenues 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 61), revenues for butterfish and squid were within the top ten species attributed each year during this recent time period, about $250,000 or less annually (Figure 61). At least some of this revenue may be an artifact of the VTR analysis, with true fishing locations in shallower waters.

Owners and permits

Between 2013 and 2015, the number of vessel owners with revenue attributed to the Monkfish/MSB/Tilefish areas and the National Monument respectively average 120 and 90 annually. For both sets of areas, the percent revenue for owners fishing 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 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 – VTR-derived percent of vessel owner revenue attributed to the No Action Monkfish/MSB/tilefish areas, 2013-2015.Figure 8 and Figure 10) against the MBTG-only percentages (Figure 9 and Figure 11) indicates that the most highly exposed owners fishing within the Monkfish/MSB/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 National Monument, where a small number of owners employing MBTG present high exposure to the No Action alternative.

7.2.3.1.2 VTR vs. VMS comparison

Table 50 shows how many of the trips overlapping the No Action areas from the VTR data are captured in the VMS data, and Table 51 summarizes hours fished, permits, and trips for fishing activities capturd 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/MSB/Tilefish areas, making these the dominant gear types used on VTR-documented trips occurring in and around the No Action areas. While bottom trawls are well captured in the VMS data, pots are not.

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 withVMS data is high for scallop dredge (93-100%), bottom trawl (84-94%), and Separator and Ruhle trawl trips (71-84%; Table 50). 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/MSB/Tilefish areas, bottom longline and gillnet VMS data have not been processed and there is no coverage in the VMS dataset (Table 50).

While more spatially precise than VTR data, VMS data are still just 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/MSB/Tilefish areas. Although less of an issue with the larger National 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 51). Although the magnitude differs 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/MSB/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 National 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 51), which is unsurprising as the monkfish/MSB/tilefish closures prohibit bottom trawls. Considering the bottom trawl category (not squid, which is analyzed separately) in the Monkfish/MSB/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/MSB/Tilefish areas and the National 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/MSB/Tilefish areas to the revenue/hours fished in the National 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 51) 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, again, with more permits being fished around the Monkfish/MSB/Tilefish areas, which include Veatch Canyon, identified as an important lobster ground (Whitmore et al. 2016). Some use of gillnet gear is indicated in the Monkfish/MSB/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/MSB/Tilefish areas expend less than 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/MSB/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 MBTG 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 continue to be consistent with the VTR-derived owner exposure (Figure 8-Figure 11).

7.2.3.1.3 ASMFC survey

The trap fishery for lobster and Jonah crab is not constrained by the Monkfish/MSB/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 7.1.3.2) did not ask lobstermen to identify their fishing activity within the No Action Monkfish/MSB/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/MSB/Tilefish may be more important to lobstermen relative to surrounding areas. 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).

7.2.3.1.4 Summary of fishery impacts

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 exposed are better assessed through VMS rather than VTR. Conversely, 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 high uncertainty regarding these estimates might upon first blush seem problematic, 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.

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.

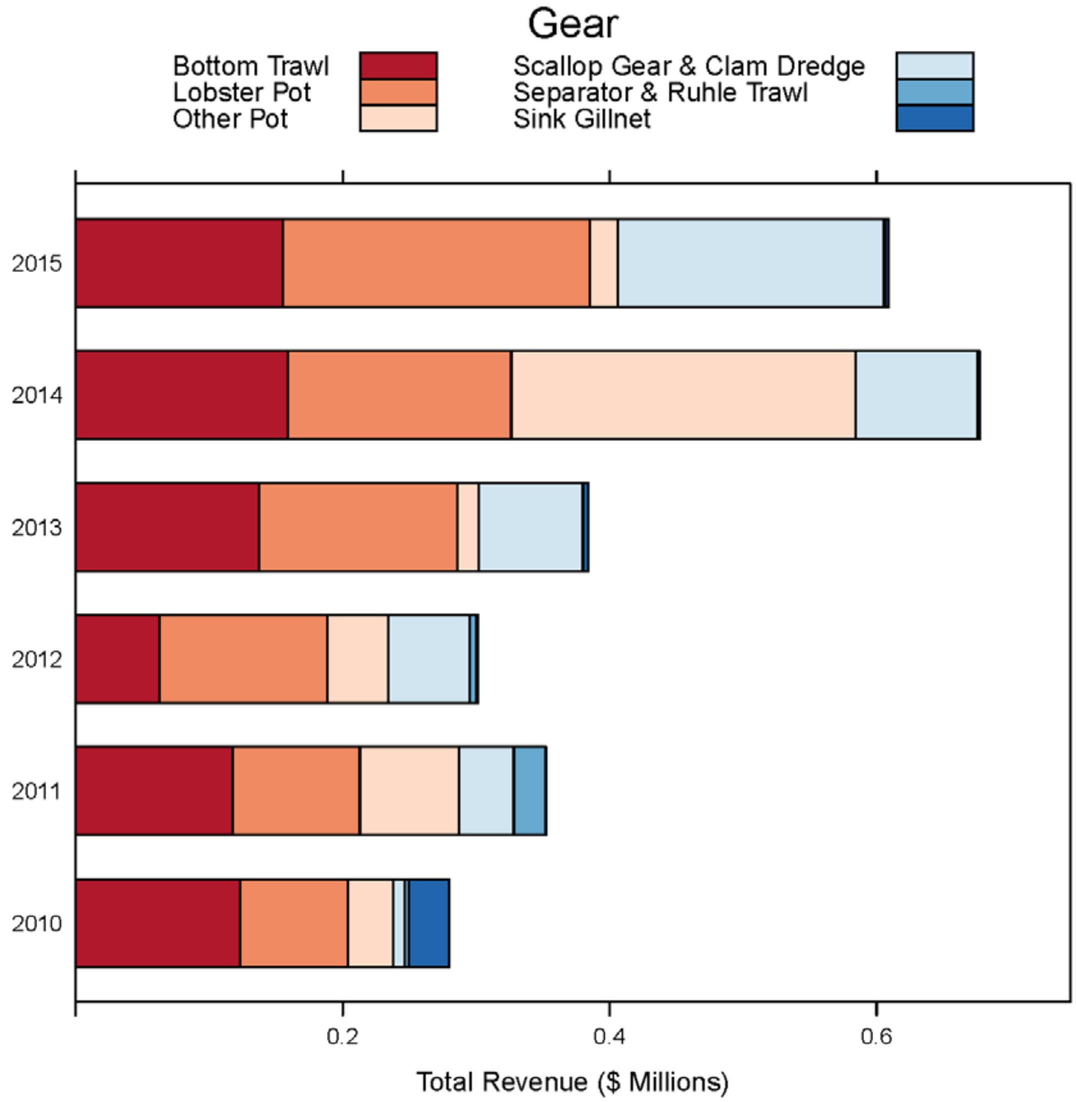


Figure 5 – VTR-derived revenue by gear type attributed to the Northeast Canyons and Seamounts Marine National Monument, 2010-2015.

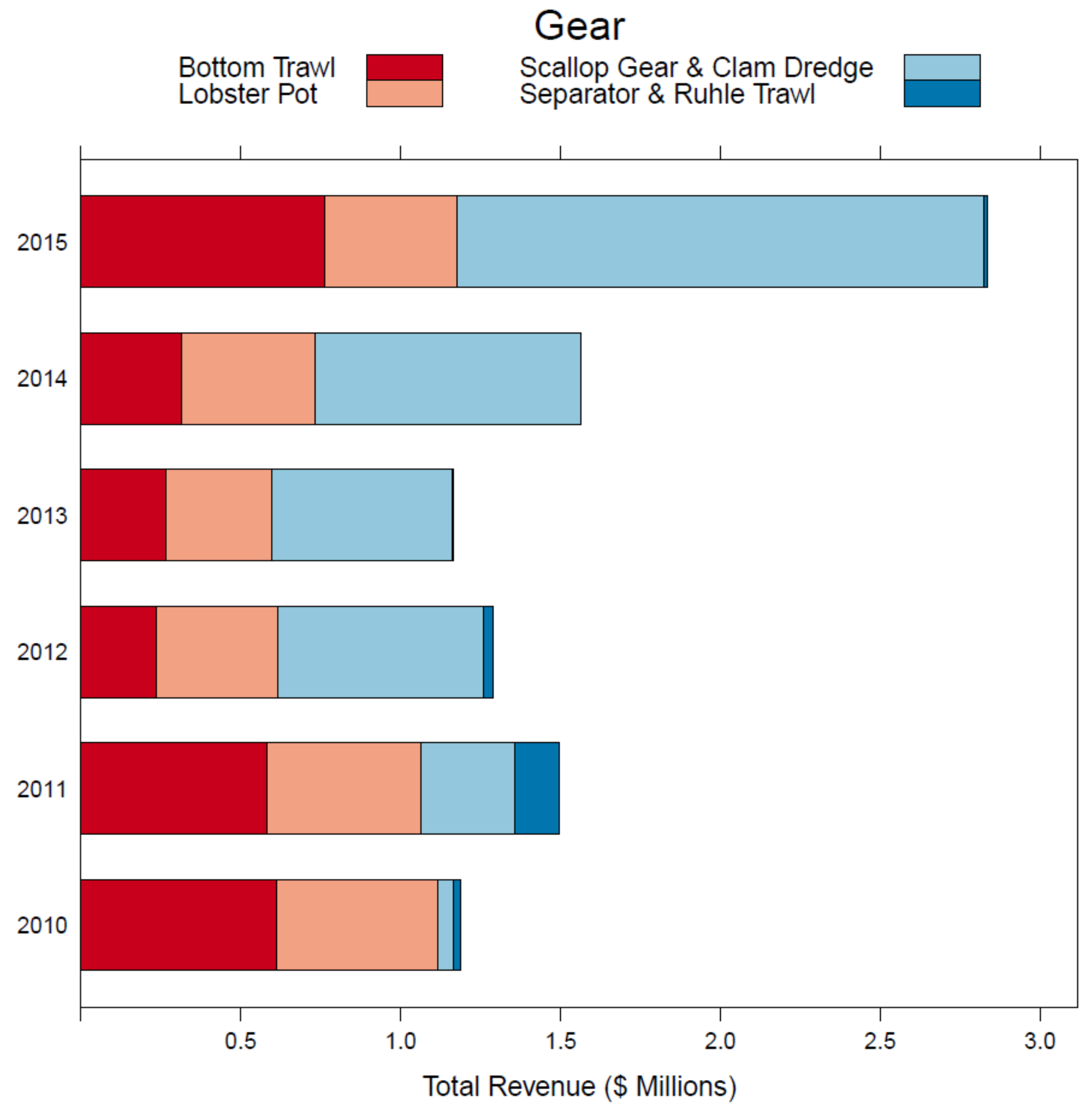


Figure 6 – VTR-derived revenue by species (top 10) attributed to the No Action Monkfish/MSB/Tilefish areas within Veatch, Oceanographer, and Lydonia Canyons, 2010-2015.

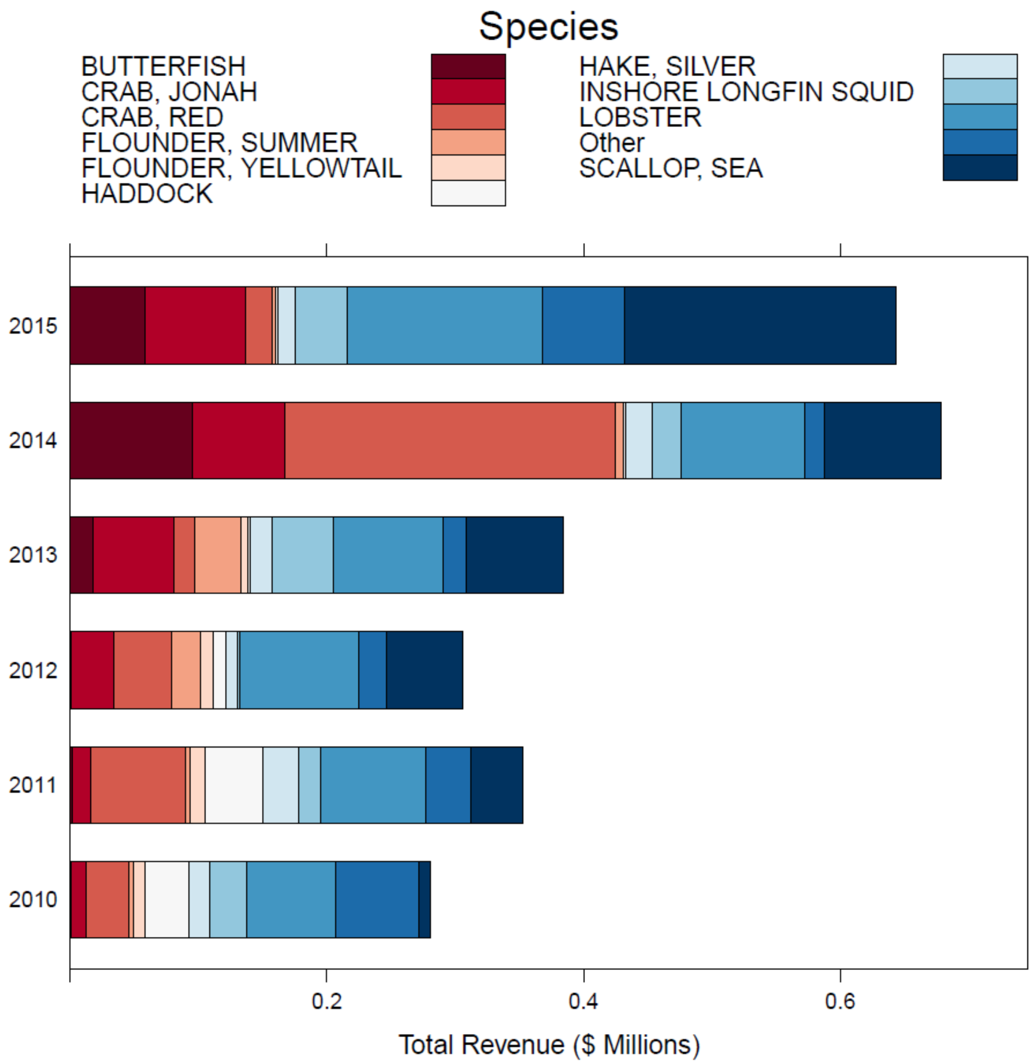


Figure 7 – VTR-derived revenue by species (top 10) attributed to the Northeast Canyons and Seamounts Marine National Monument, 2010-2015.

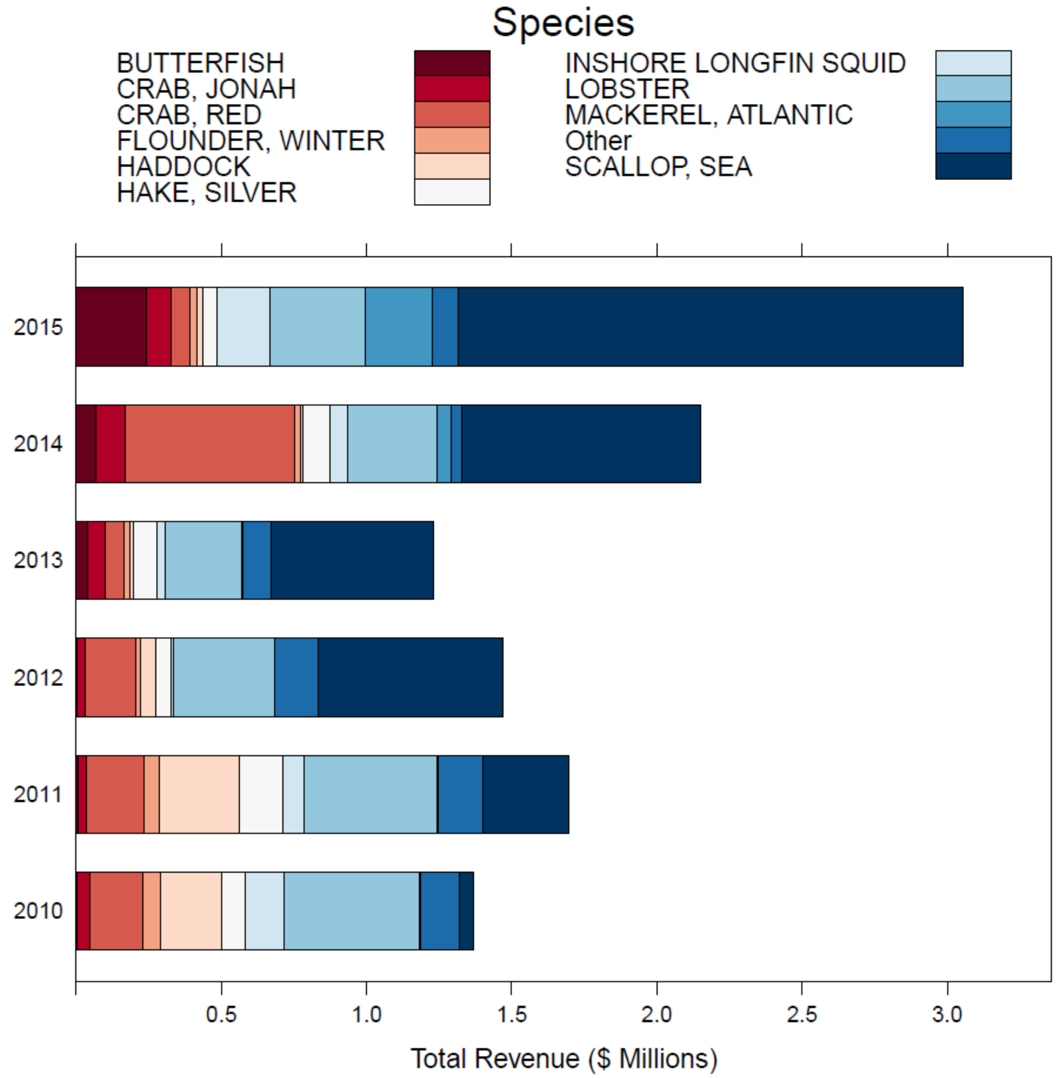
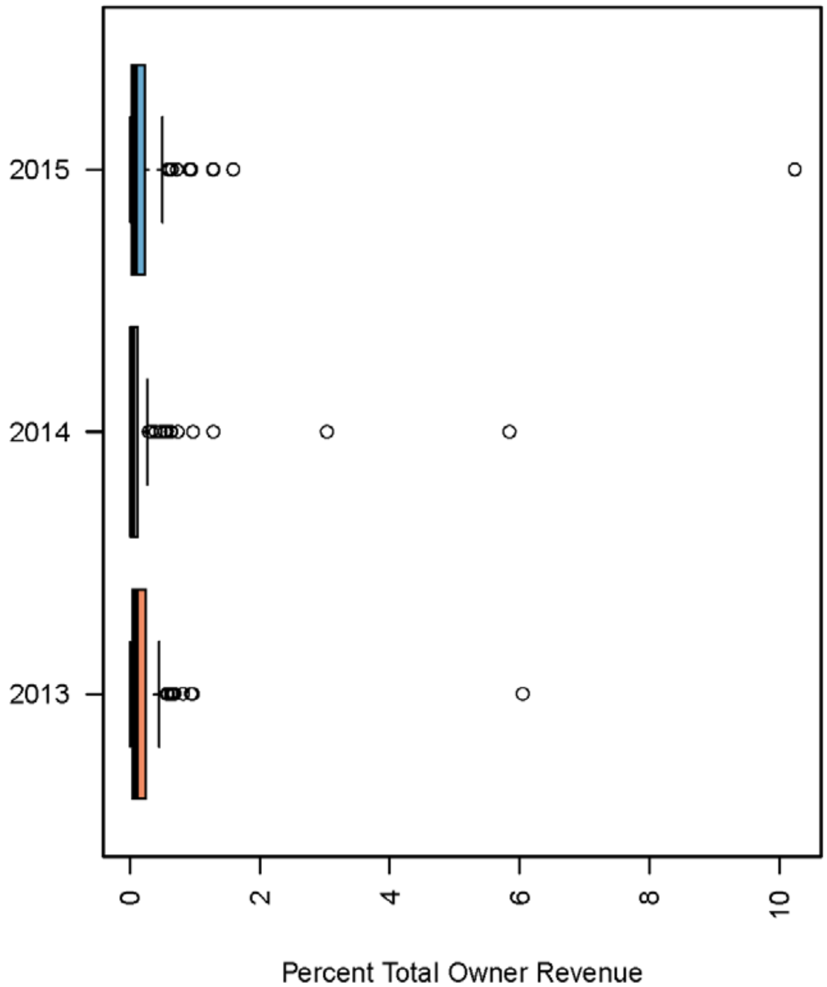
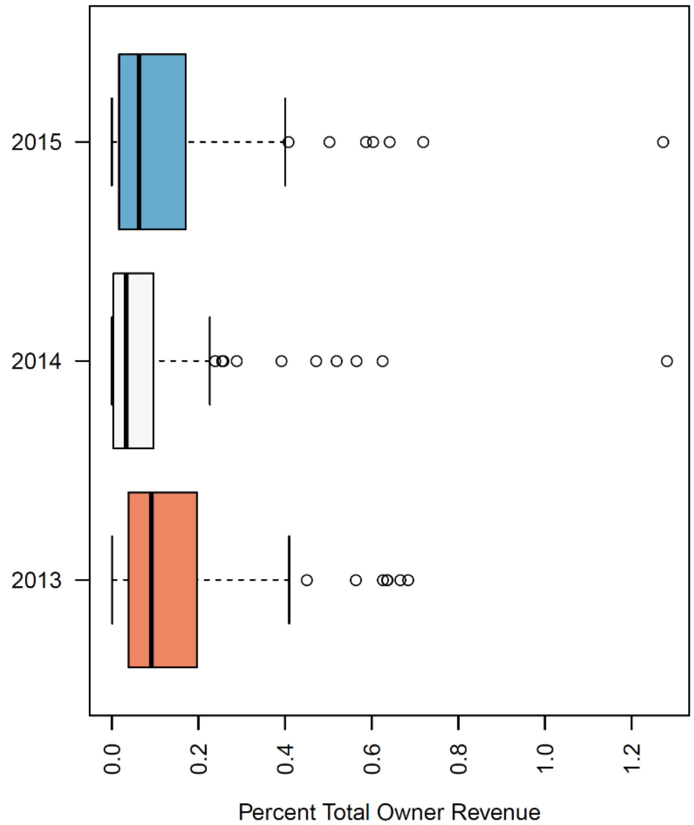


Figure 8 – VTR-derived percent of vessel owner revenue attributed to the No Action Monkfish/MSB/tilefish areas, 2013-2015.



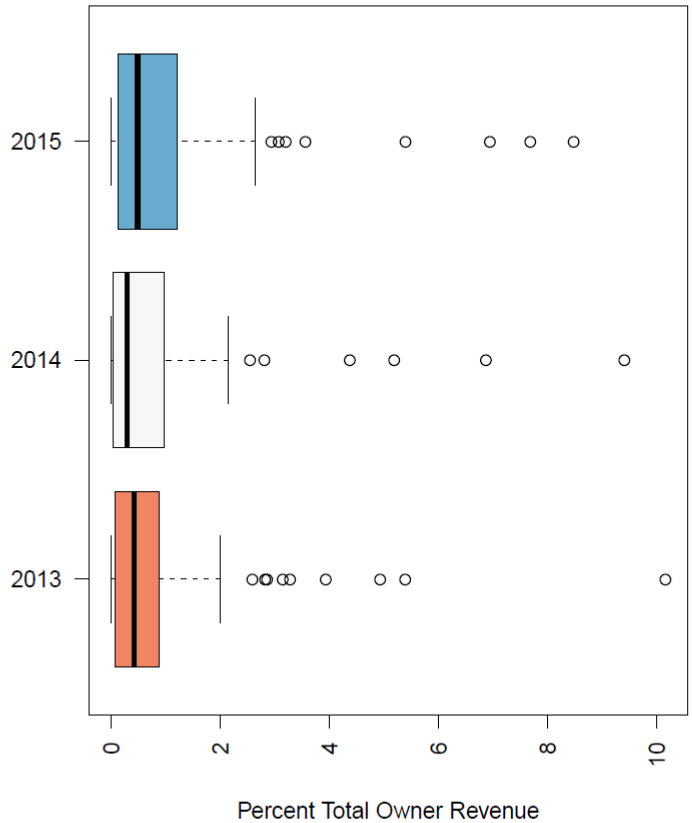
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 9 – VTR-derived percent of vessel owner revenue attributed to MBTG within the No Action Monkfish/MSB/tilefish areas, 2013-2015.



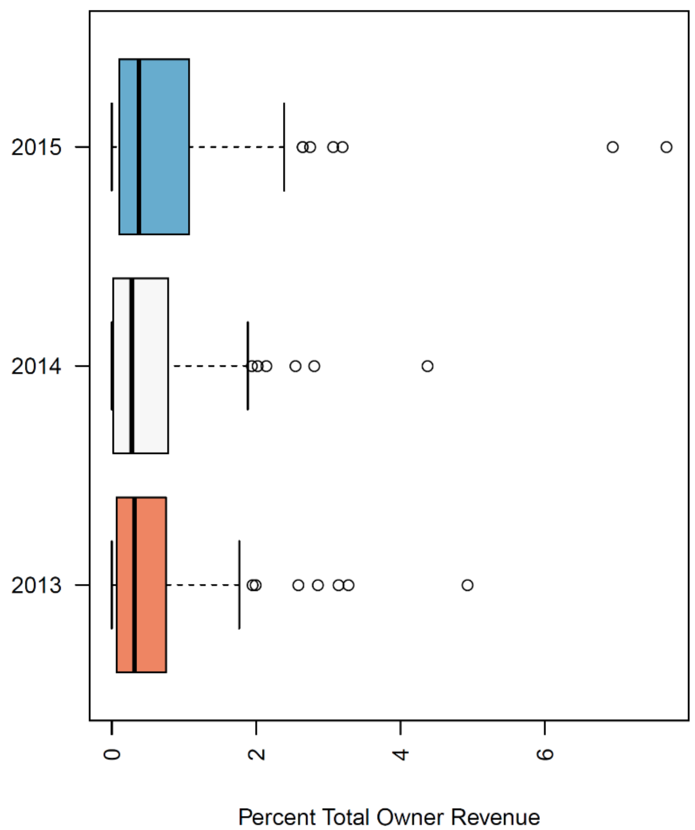
Note: Open circles are individual owners with a % total revenue 1.5 times above the 75% percentile.

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 50 – Percentage of VTR trips by gear type attributed to the No Action management areas that have VMS coverage, 2010-2012.

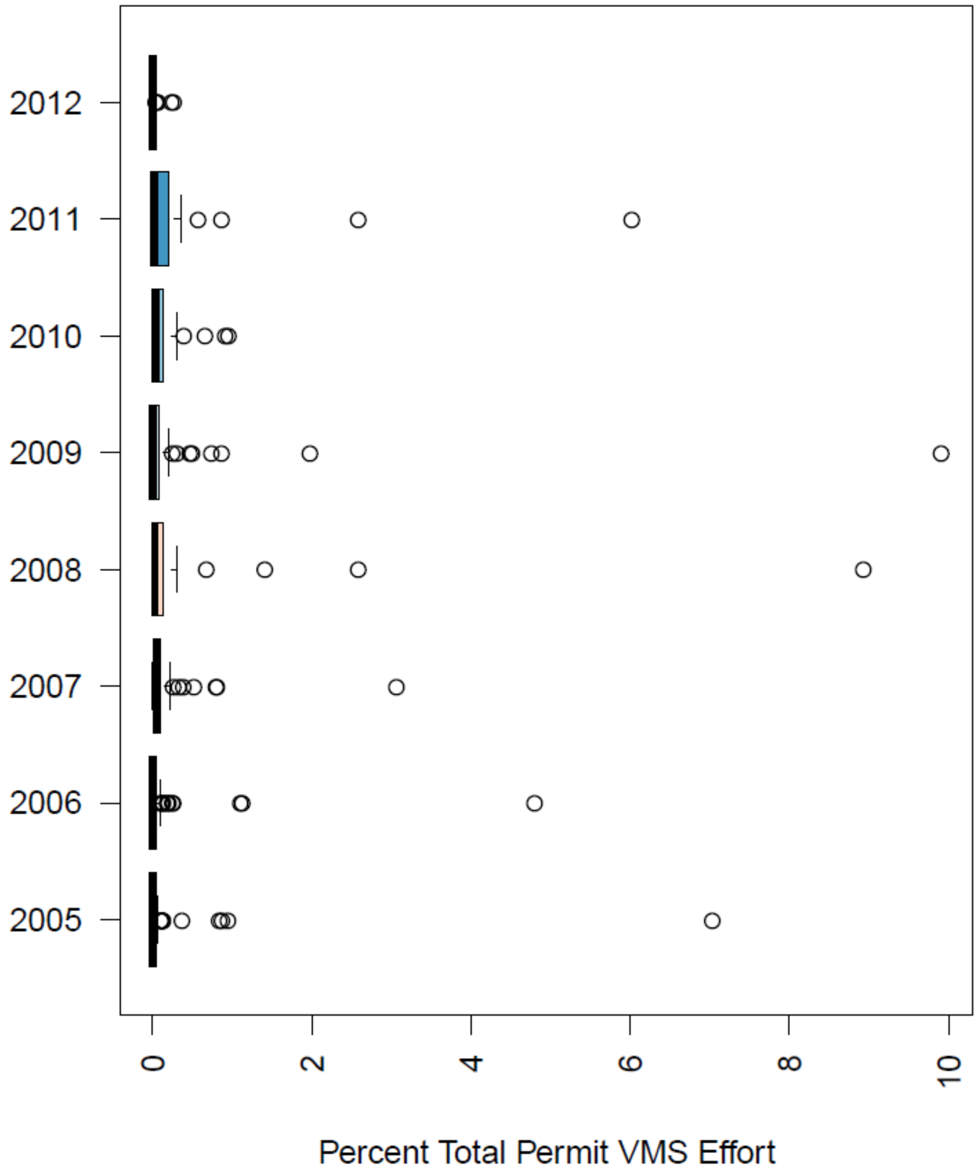
		No Action Monkfish Tilefish Areas				National Monument			
Gear	Year	Permits	VTR Trips	VMS Trips	Coverage	Permits	VTR Trips	VMS Trips	Coverage
Bottom Trawl	2010	117	575	539	94%	107	545	513	94%
Bottom Trawl	2011	99	481	430	89%	90	459	411	90%
Bottom Trawl	2012	100	351	296	84%	71	280	235	84%
Lobster Pot	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 51 – 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

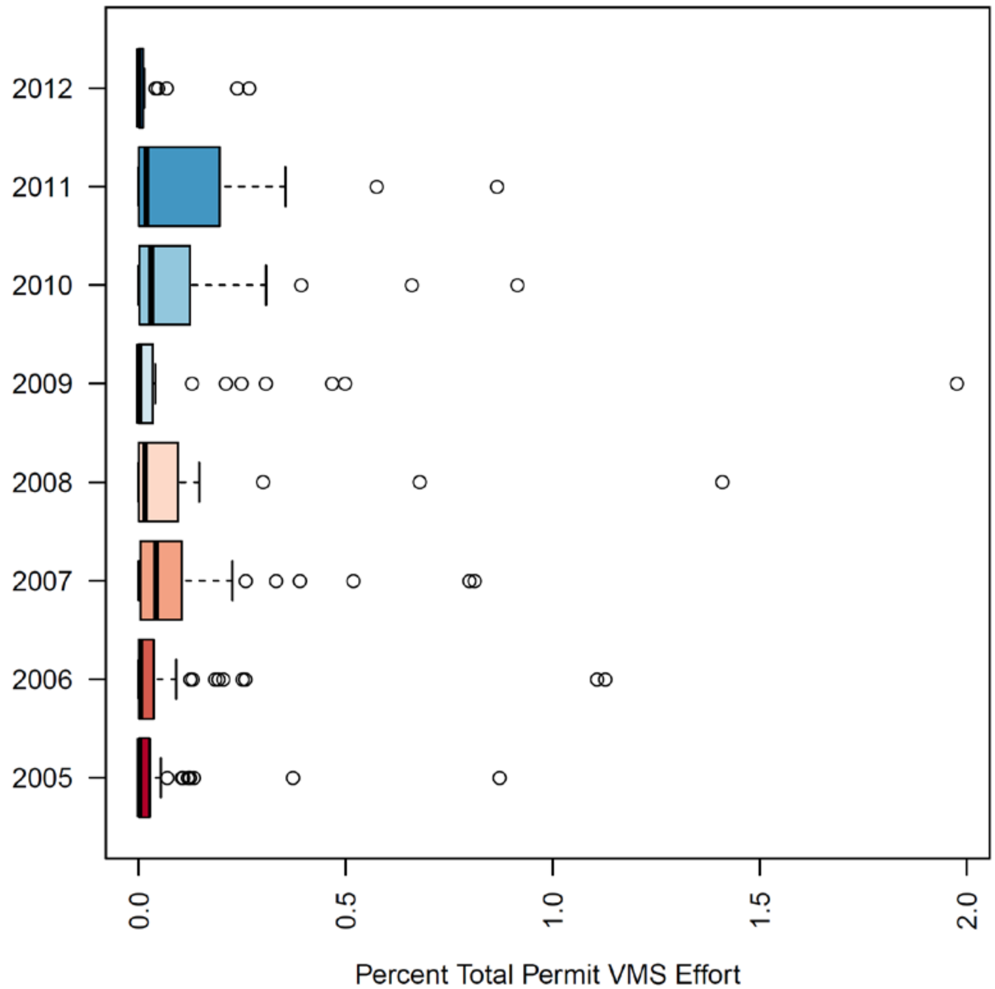
Note: LA and GC refer to limited access and limited access general category scallop gears, respectively.

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.



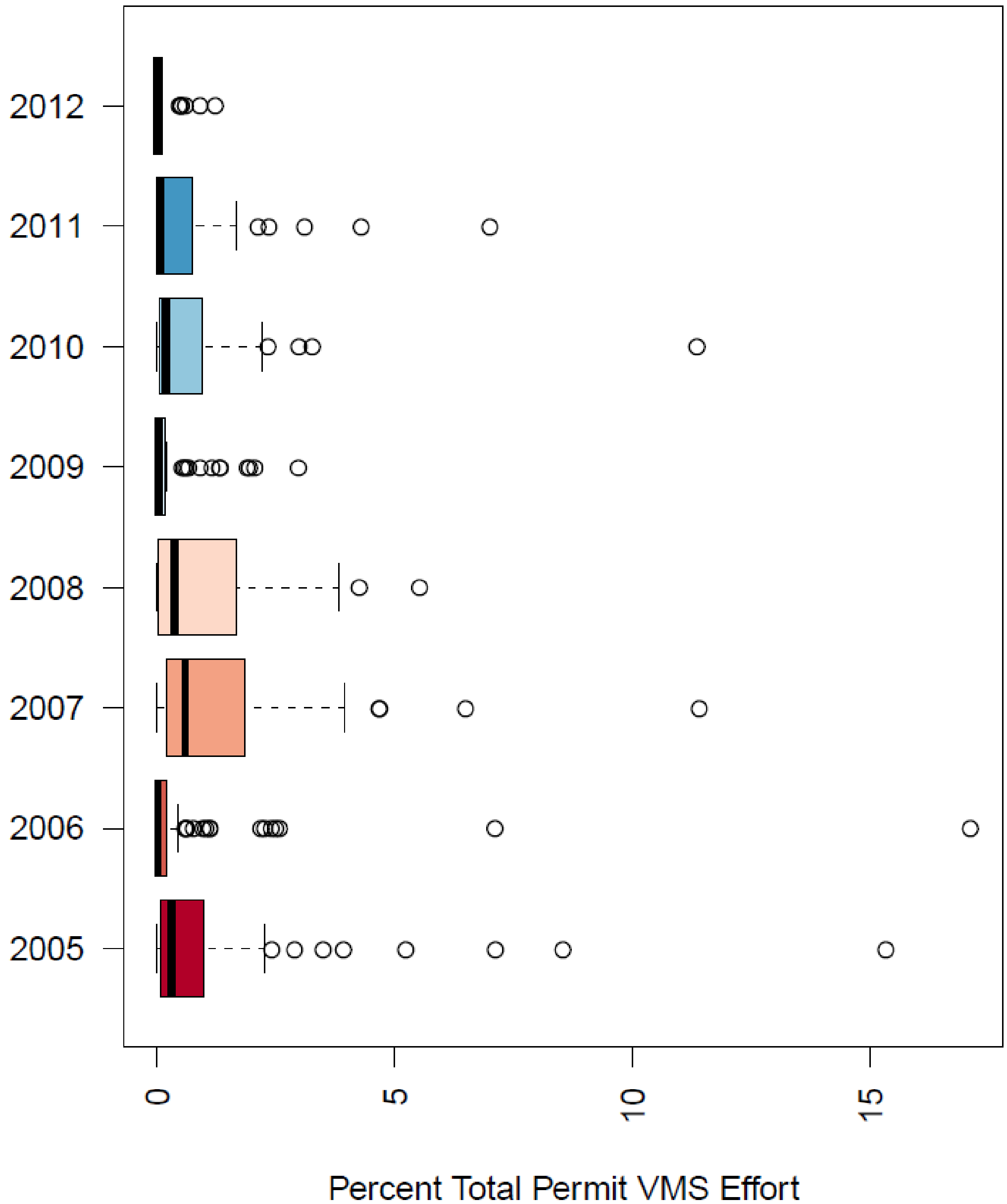
Note: Open circles are individual owners with a % total revenue 1.5 times over the 75% percentile.

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.



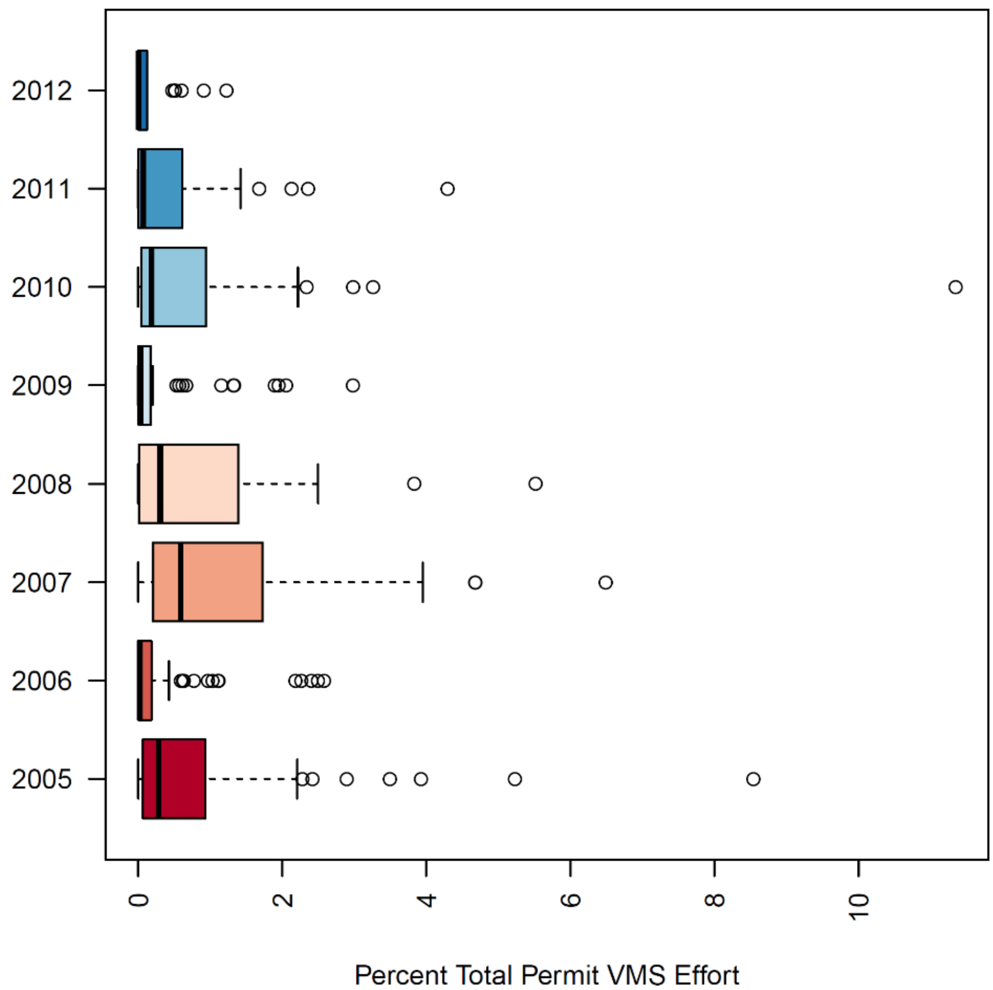
Note: Open circles are individual owners with a % total revenue 1.5 times over the 75% percentile.

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.

7.2.3.2 Fishing community impacts

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 52 and Table 53, the revenues by state, region, and port attributed to recent fishing within the No Action coral zones.

7.2.3.2.1 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 52). 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 No Action Monkfish/MSB/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, p. 234).

Table 52 – 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.

7.2.3.2.2 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 53). 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.44).

Table 53 – 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.

7.2.3.3 Sociocultural impacts

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. As discussed in the introduction to Section 7.2.3, some lobster effort in particular may be difficult to shift into other nearby grounds. 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 vessels track the migration of this species along the continental shelf break, so the future Monument closure 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.

7.2.4 Impacts on protected resources

The extent to which continuing the No Action alternative may positively or negatively affect protected resources depends on the species of protected resources present in the area under management, the nature of the interaction between the fisheries and protected resources occurring in the No Action areas, the affects of the No Action alternative on fishing distributions, and whether the areas to which effort is displaced are likely to have greater, lesser, or roughly the same interaction rates as would be found in the No Action areas.

The protected resources potentially affected by this amendment are described in Section 6.9.2. It is assumed that effort displaced from the No Action areas generally remains in relatively deep water along the shelf break, such that species occurring inshore are unlikely to be affected by the No Action alternative. Thus, the list of species that might be impacted by the No Action alternative (Table 54) is smaller than the list of species potentially affected by the amendment (Table 38). Minke whales and Atlantic white-sided dolphins are distributed to the 100 m contour, which is the shallow depth limit of the No Action areas, such that they are likely not affected by the No Action alternative. Pinnipeds found in the affected environment of this amendment (harbor, grey, harp, and hooded seals) are nearshore, coastal species, and also unlikely to be affected. Similarly, leatherback turtles are also a coastal species in New England waters. Both fish species potentially affected by the amendment are coastal as well. Atlantic sturgeon generally occur to 50 m, well inside the depth contours that define the No Action management areas. Atlantic salmon are most likely to be found in coastal waters of the Gulf of Maine.

The major gear types fished in and around the No Action areas are bottom trawl (fish trawl, squid trawl, and separator and Ruhle trawls) and lobster trap. Minor gear types include scallop dredge (shallow waters of monument), sink gillnet, and red crab trap.

Bottom trawl effort for squid, whiting, butterfish, and other demersal fishes is already prohibited in all No Action areas. The result is that effort in these fisheries is likely more concentrated along other portions of the continenal margin than it would be in the absence of the No Action areas. Lobster trap effort for lobster and Jonah crab is likely to be redistributed along other portions of the continental margin once the monument closes to lobster pot fishing in 2023.

Table 54 – Occurrence of protected resources in the No Action management areas

Species grouping	May occur in No Action areas, but limited spatial overlap with deep-water habitats	Potentially more prevalent in No Action areas; species occur in deep waters along the continental margin
Large cetaceans	North Atlantic right whale, humpback whale, fin whale	Sei whale, Pilot whales
Small cetaceans	None; all deep-water species.	Risso's dolphin, short-beaked common dolphin, harbor porpoise, bottlenose dolphin (WNA Offshore Stock)
Pinnipeds	None; all nearshore, coastal species.	None; all nearshore, coastal species.
Turtles	Green, loggerhead, and Kemp's Ridley	None; more commonly found on inner shelf
Fishes	None; shallower waters only.	None; shallower waters only.

Both 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, 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 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 (Map 60). 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 2227.2.3, red crab trap effort is likely to remain at similar depths but redistribute to the west once the monument closes to this gear type.

7.2.4.1 Large cetaceans

Other than minke whales, which are not expected to overlap substantially with the No Action management areas or adjacent grounds to which effort would be displaced, there have been no observed interactions with trawls and large whales. No large whale mortalities, serious injuries, or interactions have been documented in scallop dredge gear.

Gillnet and trap/pot gears pose the greatest entanglement risk to large whales. The northeast sink gillnet and northeast/Mid-Atlantic lobster trap/pot fisheries are placed in Category III, 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, and not likely to be affected by continuing No Action. Lobster pot effort, however, will be displaced out of the monument and into adjacent fishing grounds in 2023. The species most likely to occur in deep waters, the sei whale, has had no confirmed serious injuries or mortalities from 2010-2014, but there have been interactions with North Atlantic right whales, humpback whales, and fin whales.

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. This suggests that in 2023 when effort is displaced from the monument that gear will become more densely concentrated in existing fishing grounds. If these grounds cannot accommodate additional traps, effort could decline. Traps could become concentrated along the eastern and western edges of the monument, but probably not along the shallow boundary of the monument that runs along the margin of Georges Bank. 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 in this depth zone. If the total amount of gear in the water decreases because adjacent fishing grounds cannot accommodate additional trawls of traps, then impacts to large whales could decrease under No Action. However, if effort remains constant, but gear is more concentrated, interactions could increase as it would be more difficult for whales to avoid gear in more heavily fished locations. It is very unlikely that lobster trap effort would increase as a result of No Action.

Interaction rates in the lobster trap fishery are reduced via measures in the Atlantic Large Whale Take Reduction Plan. These 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.

7.2.4.2 Small cetaceans

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, between 2007 and 2012 these interactions were concentrated in specific locations, and have not been observed along the continental margin south of Georges Bank where the monument and monkfish/MSB/tilefish areas occur. Therefore, although the potential exists for interactions in the bottom trawl fishery, any impacts on small cetaceans that result from spatial shifts in trawl effort out of the No Action areas are likely to be slight. 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.

No small cetacean mortalities, serious injuries, or interactions have been documented in scallop dredge gear. Thus, the likely minimal spatial shifts in scallop dredge effort associated with the monument are not expected to have an effect on small cetaceans.

Direction observations of fishing with trap/pot gear (and rod and reel, which is not relevant to these management measures) are limited, so interaction information for small cetaceans and trap/pot gear is partly inferred from evidence of gear on stranded animals. These strading 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.

7.2.4.3 Sea turtles

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 interacting (e.g., bycaught) with bottom trawl gear. Turtle excluder devices allow for escapement, but are only required in the southern fishing grounds for summer flounder, which is well south of the No Action management areas.

Hard-shelled sea turtle takes occur in the sea scallop dredge fishery, but are predominantly observed in the Mid-Atlantic. Given this distribution of takes, and the limited overlap between the scallop dredge fishery and the monument, no negative impacts on sea turtles are expected to result from continued implementation of the No Action management areas. While gear modification requirements are in effect, they are outside of the areas encompassed by the No Action alternative.

Leatherback (a coastal species), 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. 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 (Balazs 1985, STDN 2016). As a result, sea turtles can incur injuries and in some cases, mortality immediately or at a later time. Most of the observed interactions were leatherbacks, which tend to occur inshore of these management areas STDN 2016). Thus, at most any negative impacts of trap/pot effort displacement are likely to be slight.

7.3 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 55). 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 55 – 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

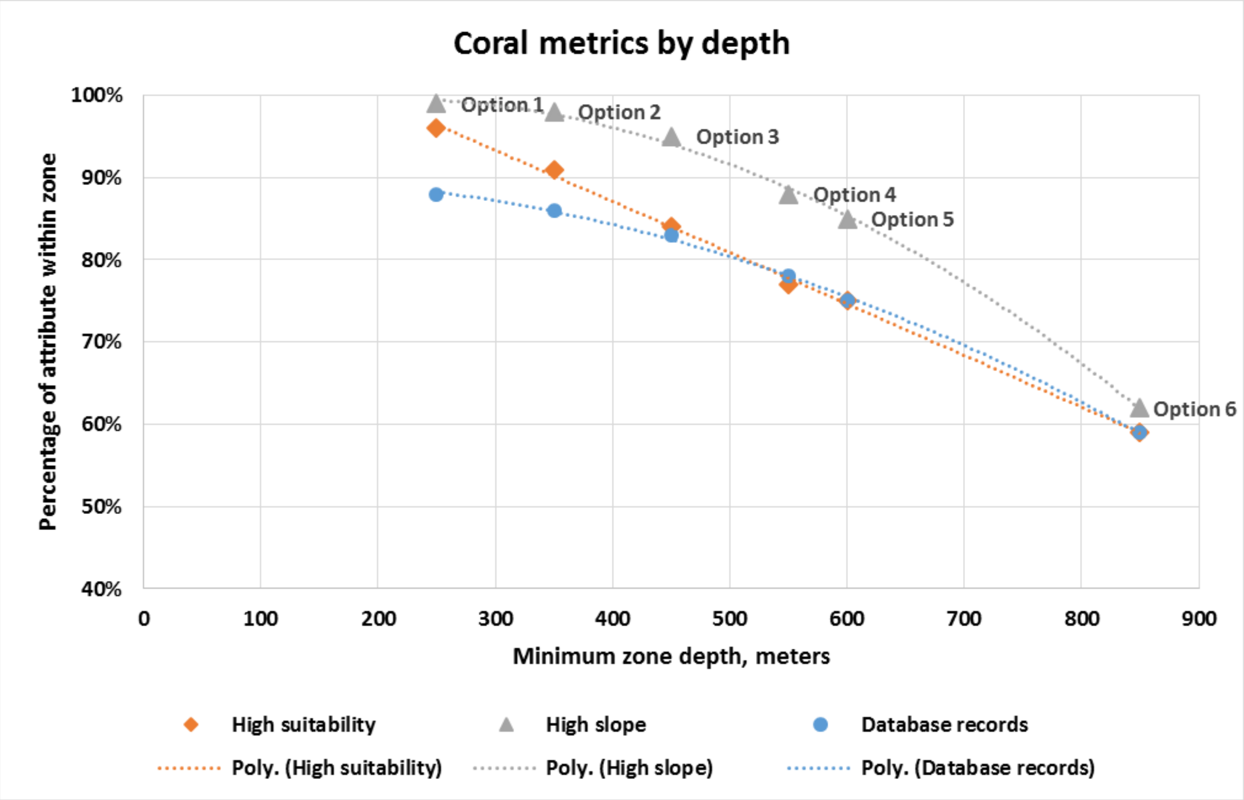
7.3.1 Impacts on deep-sea corals

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 meter 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). Data on coral distributions (Table 42), soft coral habitat suitability (Table 44), and area of high slope (Table 46) 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 56.

Table 56 – Summary of coral attributes for the broad zone options

Broad zone option	Coral records (pre-2012 database). Number and percentage of continental margin observations.[1]	Area (km^2) and percent of high suitability habitat encompassed	Area (km^2) and percent of high slope habitat encompassed
300 m (Option 1)	627 (88%)	4,582 (96%)	164 (99%)
400 m (Option 2)	615 (86%)	4,354 (91%)	162 (98%)
500 m (Option 3)	592 (83%)	4,042 (84%)	156 (95%)
600 m (Option 4)	553 (78%)	3,700 (77%)	145 (88%)
600 m minimum (Option 6)	525 (75%)	3,587 (75%)	139 (85%)
900 m (Option 5)	422 (59%)	2,821 (59%)	103 (62%)
Note: See Table 42 (coral records), Table 44 (habitat suitability), and Table 46 (high slope) for additional 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 56.



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 roughly 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 meter and 650 meter 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.

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, summarized below, confirm the presence of coral habitats in shallower areas. The remaining dive sites within the canyons occurred within the 900 m zone, i.e. deeper than 850 meters. 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.

- <u>Nygren Canyon</u> – 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.
- <u>Unamed Canyon</u> – 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.
- <u>Heezen Canyon</u> – 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 in the future, vs. displacing existing fishing activity that could be currently impacting coral habitats, depends on the zone and the type of fishing. Section 7.3.3.1 details the overlap between fishing effort and coral zones. Based on the feedback provided during the workshops, there are no or very limited fishing activities 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, 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 (Section 7.3.3.1) 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, coral habitat protected decreases (see Table 56 and Figure 16 above).

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 Option 1 with fishing restriction Option 1 will have the greatest magnitude of positive impacts to corals, and zone Option 3 with fishing restriction Option 2 will have the lowest magnitude of positive impacts to corals. It is a bit difficult to evaluate the distribution of corals in relatively shallow waters given than 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.

7.3.2 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 commission tend to be shallower water species, and therefore the shallowest broad zone is most likely to encompass both corals and managed fishery resources that may use these corals as habitat.

Some species managed by New England Fishery Management Council are distributed entirely outside continental slope depths encompassed by the broad coral zones, but others do occur along the slope (Table 20). 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. While all of the broad zones will have some degree of positive impact on managed resources via protection of benthic habitats, the shallower zones will have a greater magnitude of positive impacts.

Because there are no dedicated fishery resources 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 zones. Given these potential changes, the long range projections about the benefits of different broad zone to managed species are uncertain.

7.3.3 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 negative for the fisheries and communities that would be constrained, to the degree that fisheries are constrained. 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 lobster fishery is particularly territorial (Acheson 1987; 2006).

7.3.3.1 **Fishery impacts**

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 zones.

7.3.3.1.1 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 7.1.3.2). 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 Section 13 (p. 424 onward) 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.

Summarize Option 6 and 7.

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 10 with yellowtail flounder, Illex squid, and skates.

Summarize Option 6 and 7.

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), Figure 36 (Option 6), and Figure 37 (Option 7). Similar plots for just mobile bottom-tending gears are shown in Figure 38 (Option 1), Figure 39 (Option 2), Figure 40 (Option 3), Figure 41 (Option 4), Figure 42 (Option 5), Figure 43 (Option 6), and Figure 44 (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.

7.3.3.1.2 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 57). 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. It is unknown whether these same levels of overlap between VMS and VTR trips existed prior to 2010, given that VMS coverage has not been consistent across time.

Figure 45 through Figure 58 show the percentage of a permit's effort (hours fished) that overlap the coral zones. Data for all bottom tending gears are in Figure 45 (Option 1), Figure 46 (Option 2), Figure 47 (Option 3), Figure 48 (Option 4), Figure 49 (Option 5), Figure 50 (Option 6), and Figure 51 (Option 7). Figure 52 (Option 1), Figure 53 (Option 2), Figure 54 (Option 3), Figure 55 (Option 4), Figure 56 (Option 5), Figure 57 (Option 6), and Figure 58 (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 35 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.

For the other broad zones under consideration (400-900 m), the VMS analysis indicates a much steeper decline in exposure across depth contours than the VTR. As previously stated, this result is driven primarily by the spatial imprecision of VTR data. However, the low coverage of lobster pot trips in the VMS analysis is a source of substantial uncertainty in regards to the overall exposure metric as derived from this dataset.

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 58). This is likely due to the spatial imprecision of the VTR, which does not support differentiating areas with boundaries so close together. 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. 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. 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.

However, of note is that some of the most highly exposed individual owners identified in the 2010-2015 VTR data set were not indentified 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 52-Figure 58). 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.

7.3.3.1.3 ASMFC survey

The ASFMC survey of Area 3 lobster permit holders (Section 7.1.3.2) 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 48). 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).

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).

7.3.3.1.4 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).

7.3.3.1.5 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.

7.3.3.1.6 Summary of fishery impacts

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 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 tends to present an upper bound on the estimate of revenue derived from lobster pots within the broad zones, and likely overstates revenue at 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 undertaken by bottom trawl, scallop gear and clam dredge, and separator and Ruhle trawl at deeper depths. The VMS data suggest effort for these gears drops off quickly. 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 have not been processed for the gillnet, bottom longline, and other gear categories. Nevertheless, the VTR analysis suggests that only a very small amount bottom longline and gillnet activity occur 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, this fact suggests the estimate is likely due to the imprecision of VTR rather than actual fishing activity.

Figure 17 – VTR-derived revenue by gear type attributed to the Option 1 300 m broad coral zone, 2010-2015.

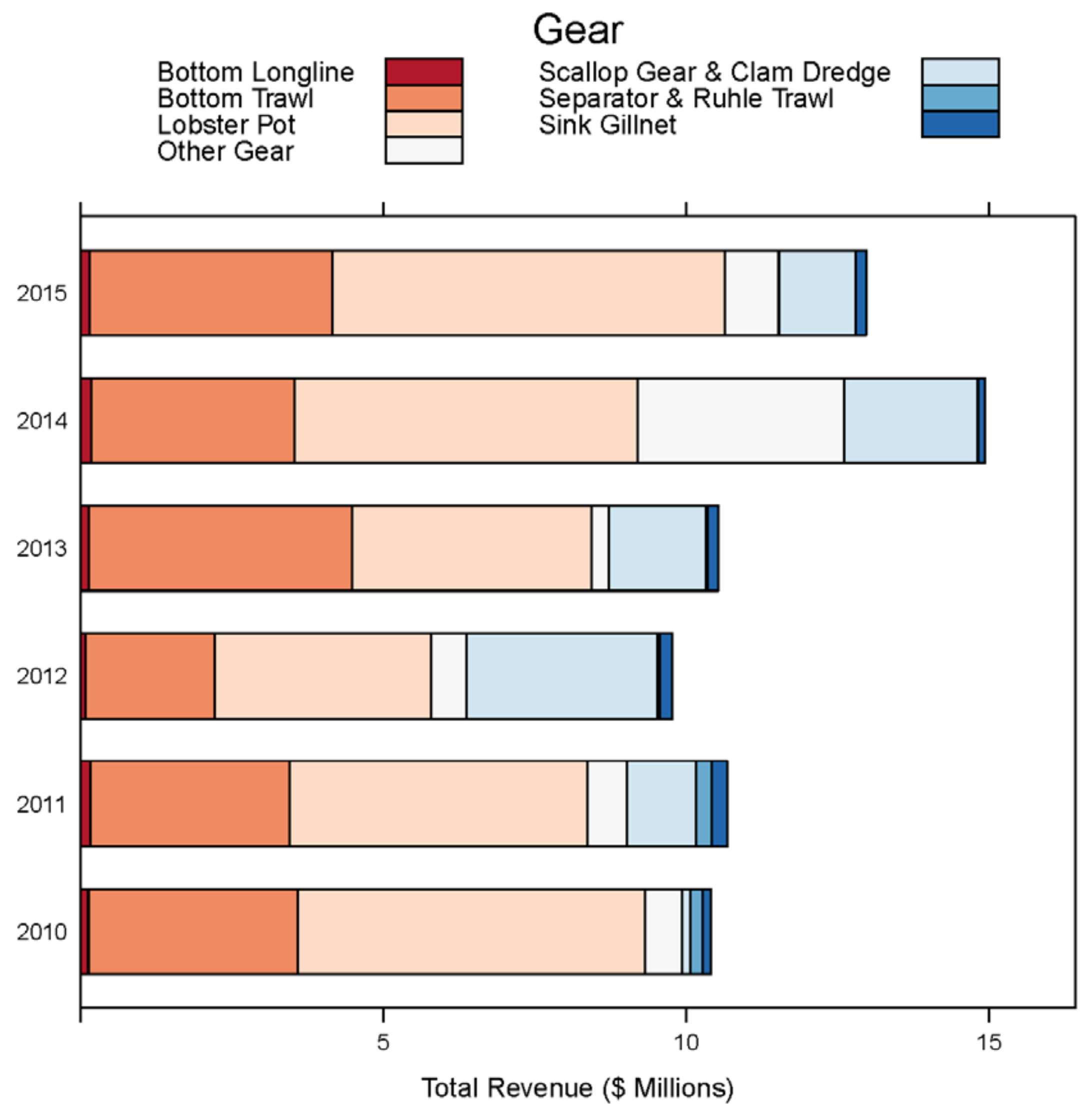


Figure 18 – VTR-derived revenue by gear type attributed to the Option 2 400 m broad coral zone, 2010-2015.

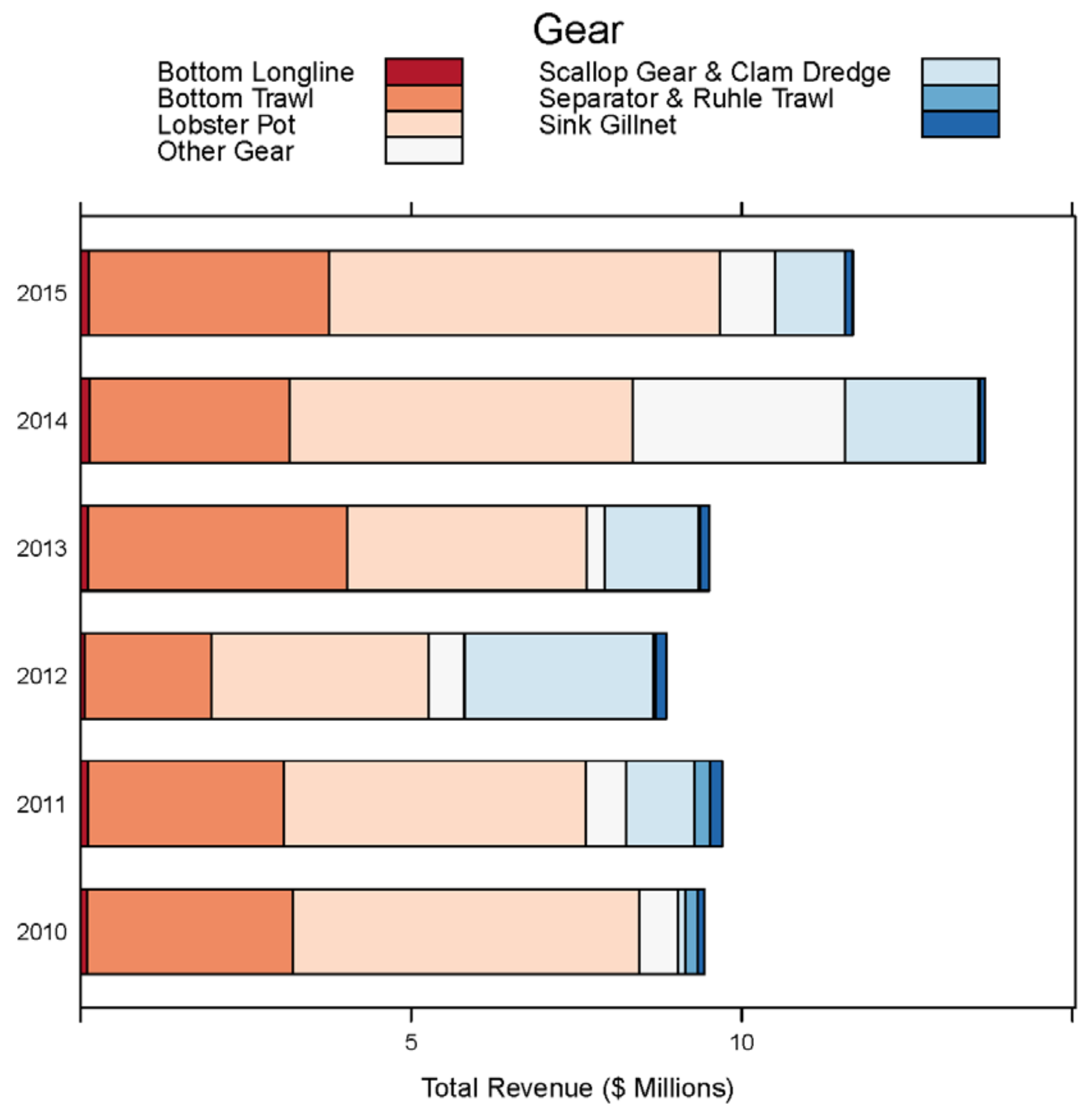


Figure 19 – VTR-derived revenue by gear type attributed to the Option 3 500 m broad coral zone, 2010-2015.

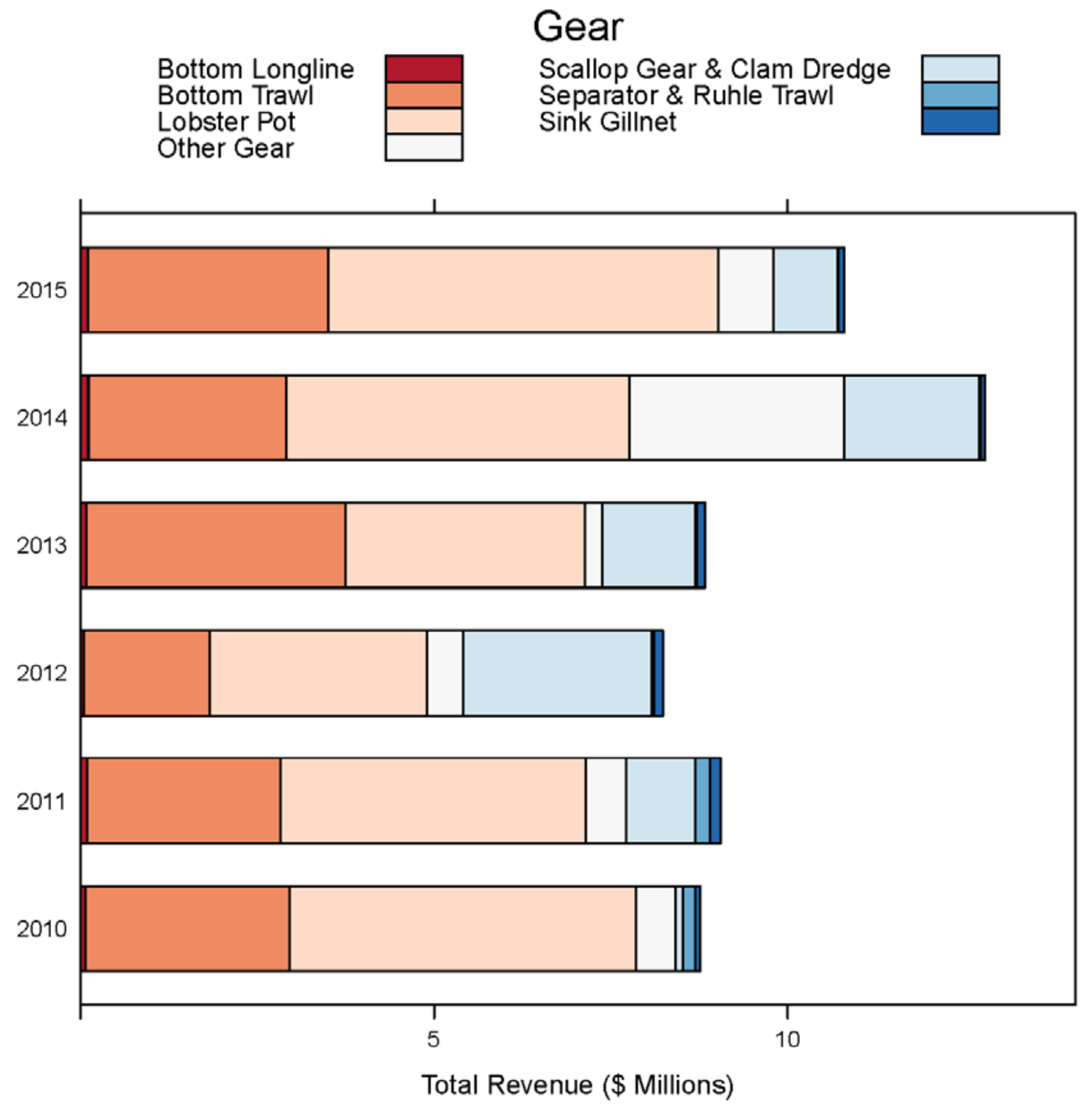


Figure 20 – VTR-derived revenue by gear type attributed to the Option 4 600 m broad coral zone, 2010-2015.

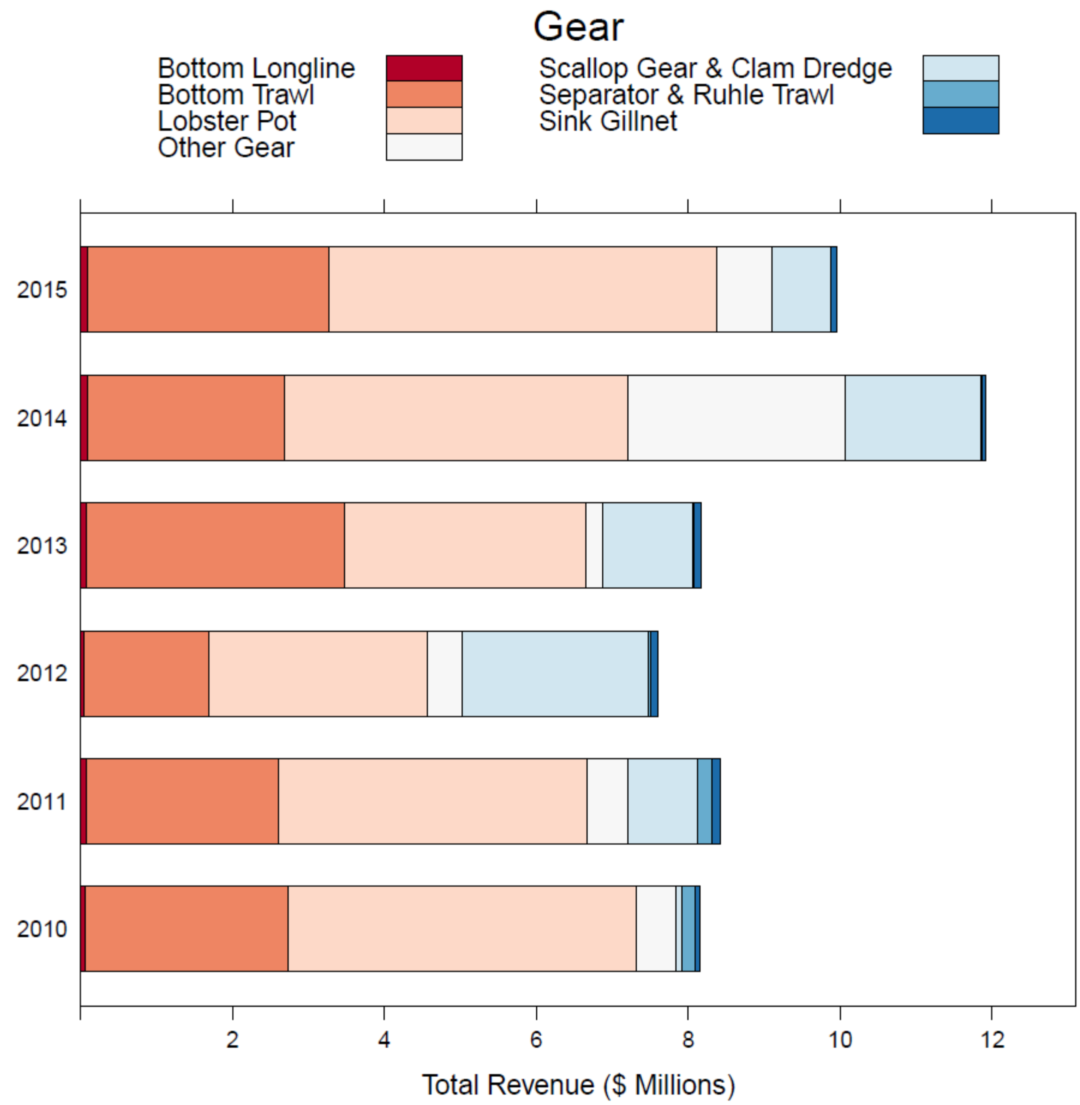


Figure 21 – VTR-derived revenue by gear type attributed to the Option 5 900 m broad coral zone, 2010-2015.

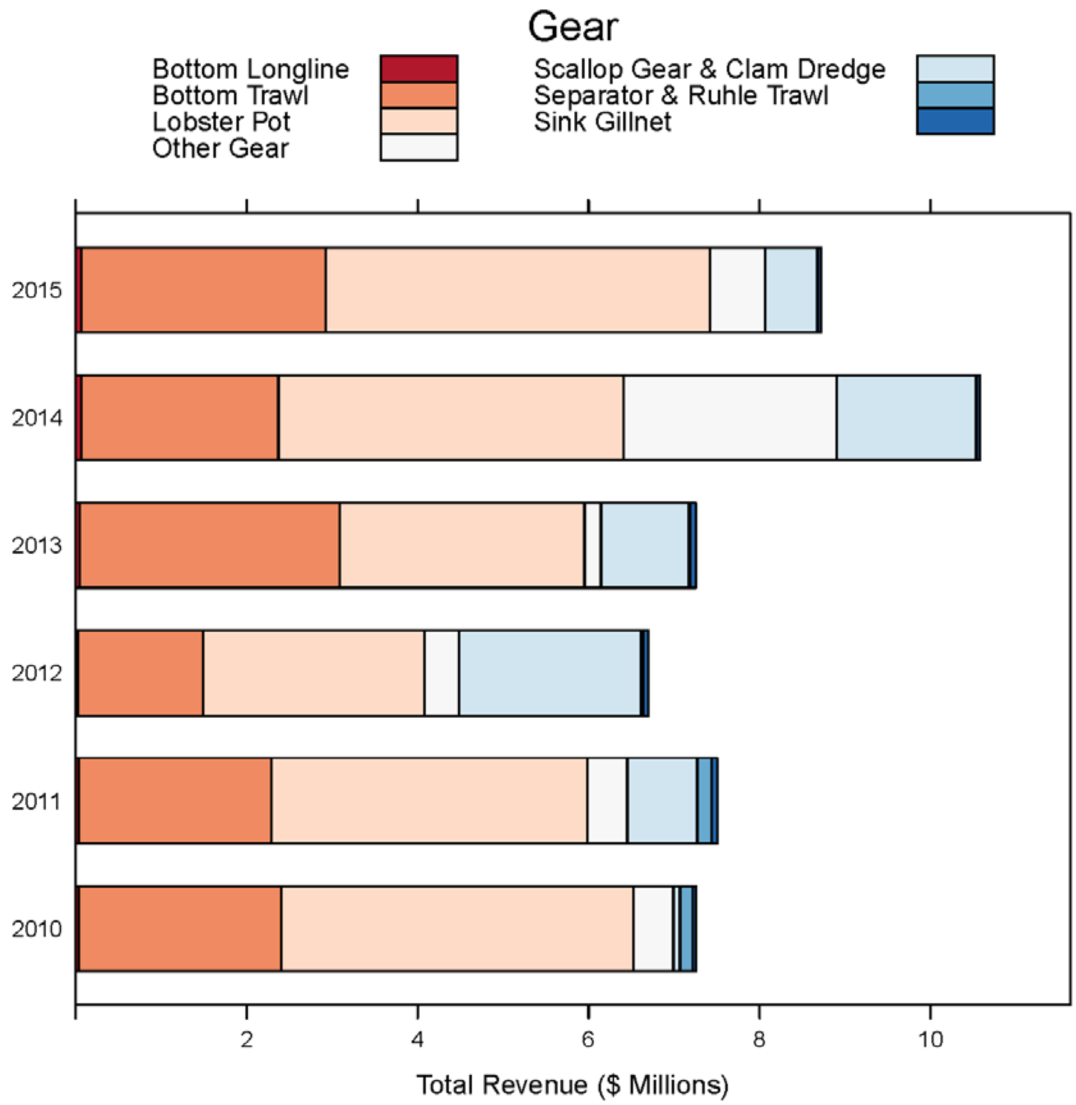


Figure 22 – VTR-derived revenue by gear type attributed to the Option 6 600 m minimum broad coral zone, 2010 – 2015.

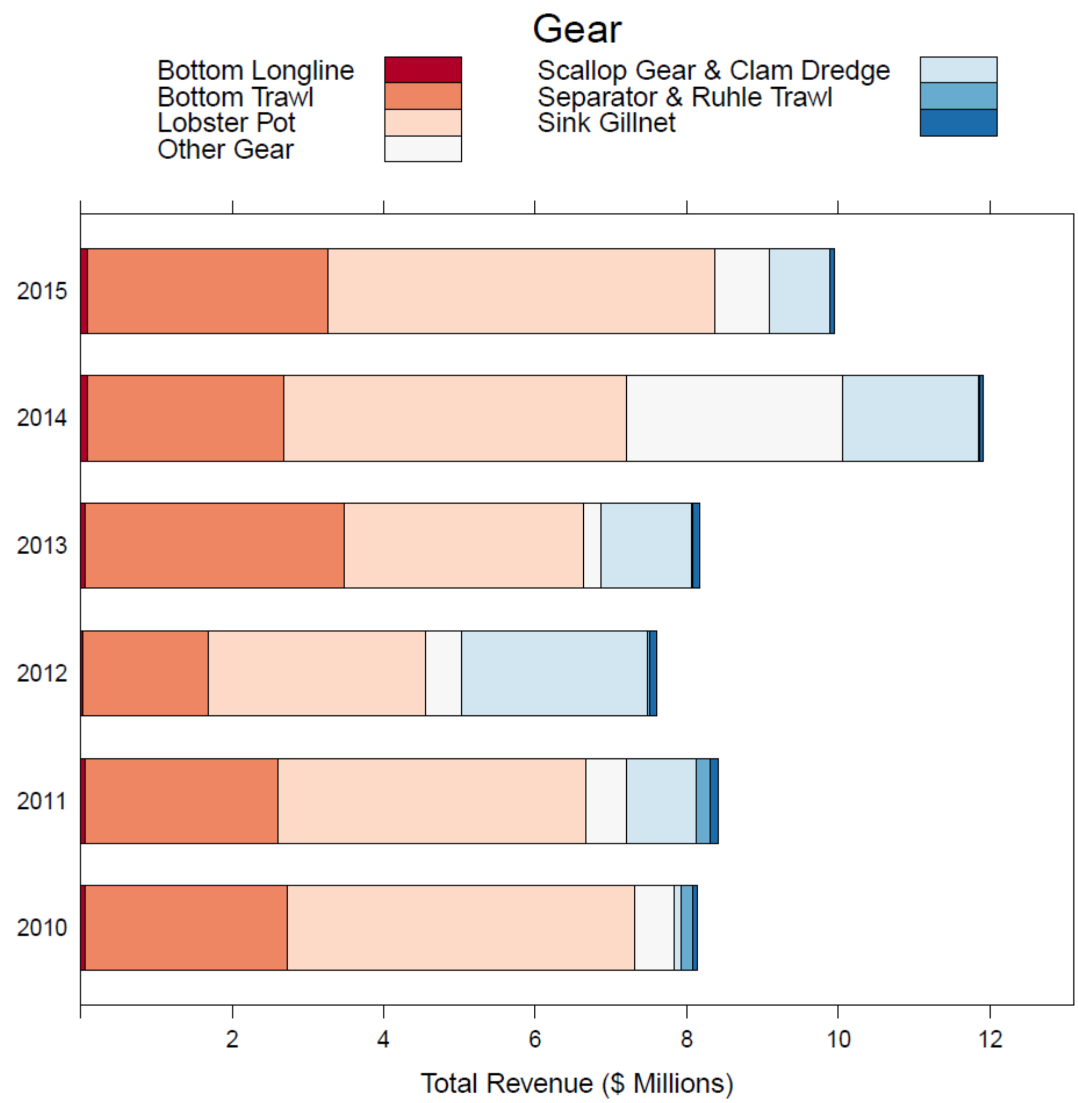
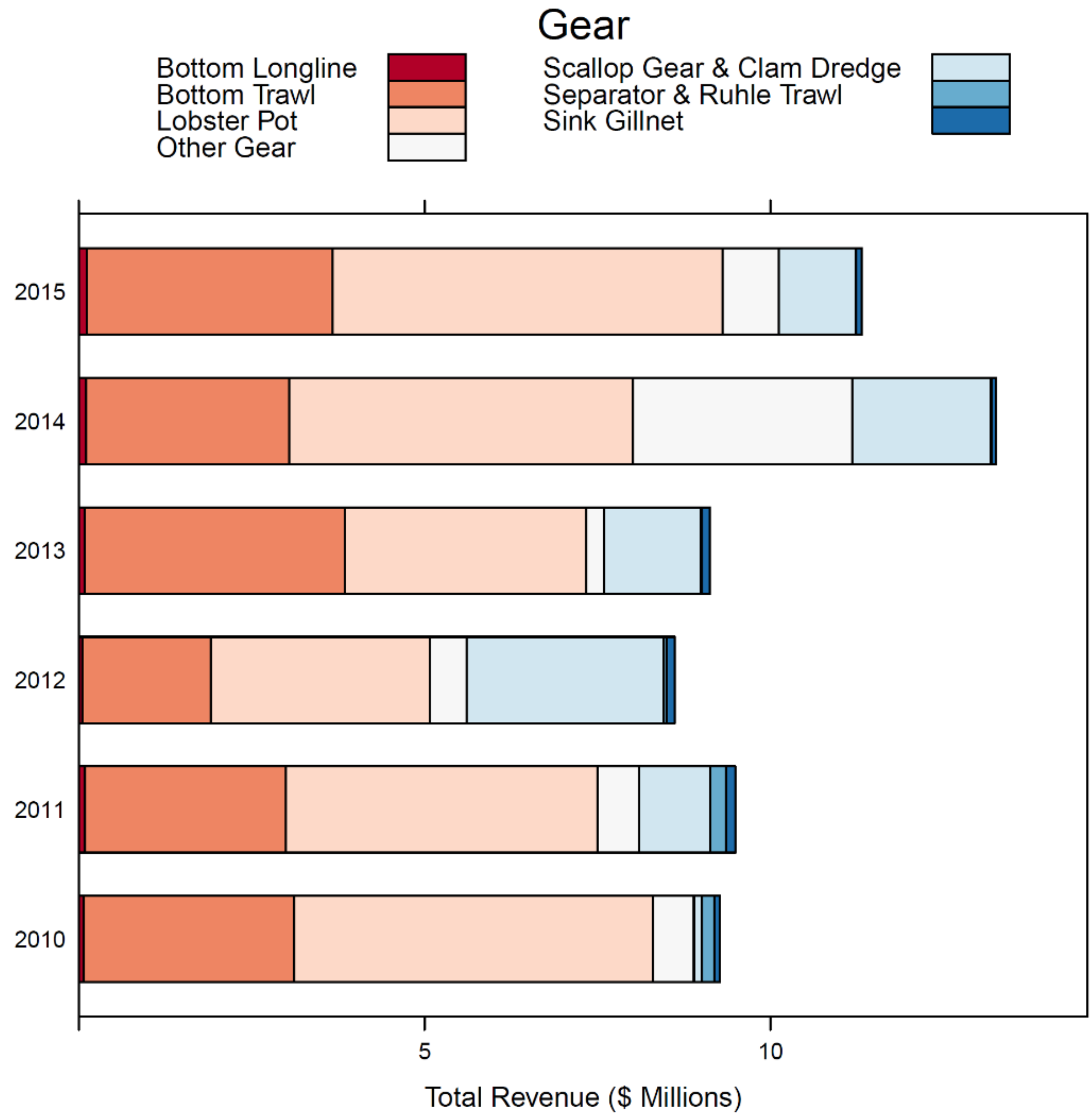


Figure 23 – VTR-dereived revenue by gear type attributed to Option 7 coral zone, 2010-2015.



Note: Option 7 would only restrict Mobile Bottom Tending Gear, which includes only Bottom Trawl, Other Gear, Scallop Gear & Clam Dredge, and Separator & Ruhle Trawl in the figure.

Figure 24 – VTR-derived revenue by species (top 10) attributed to the Option 1 300 m broad coral zone, 2010-2015.

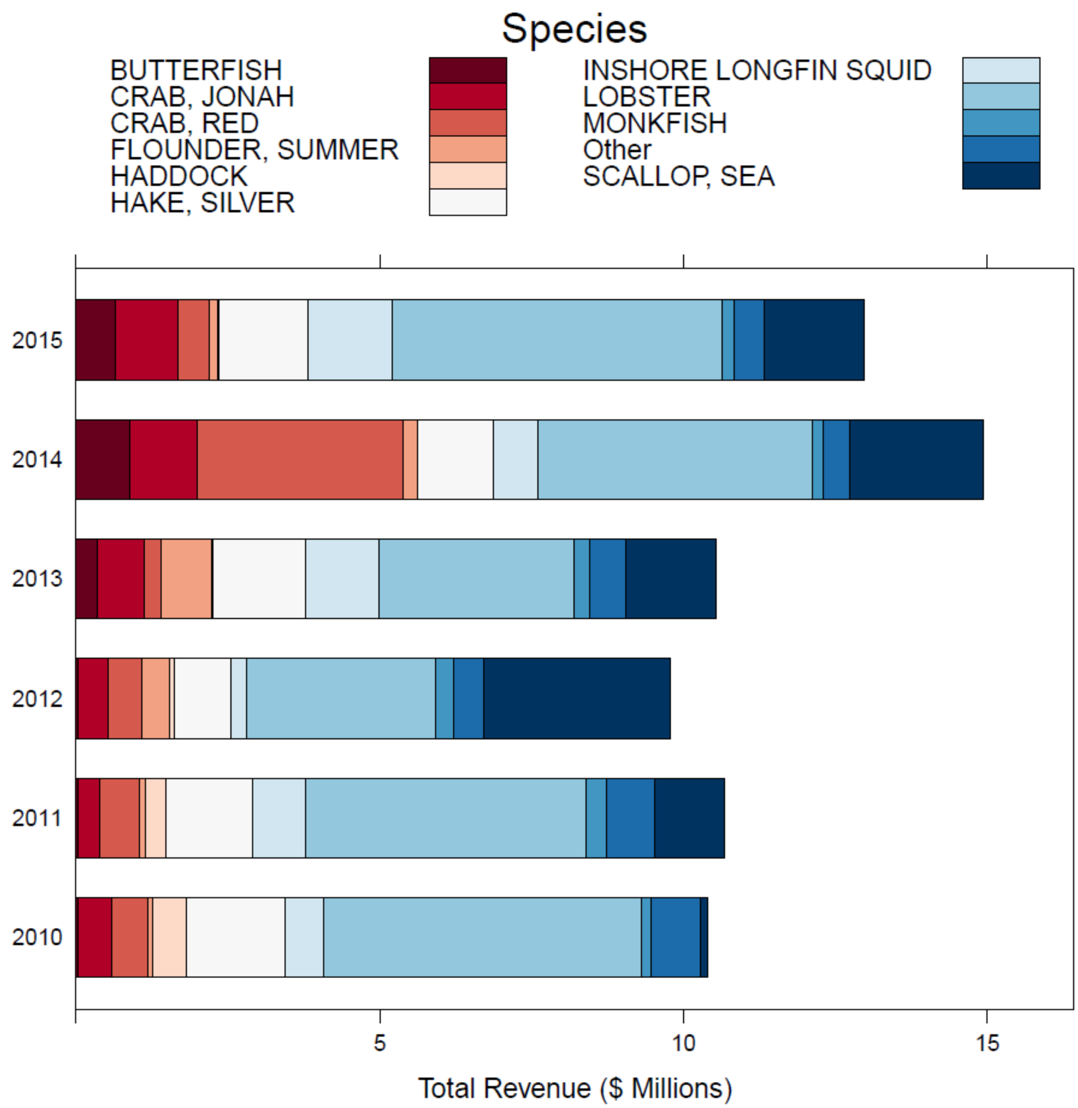


Figure 25 – VTR-derived revenue by species (top 10) attributed to the Option 2 400 m broad coral zone, 2010-2015.

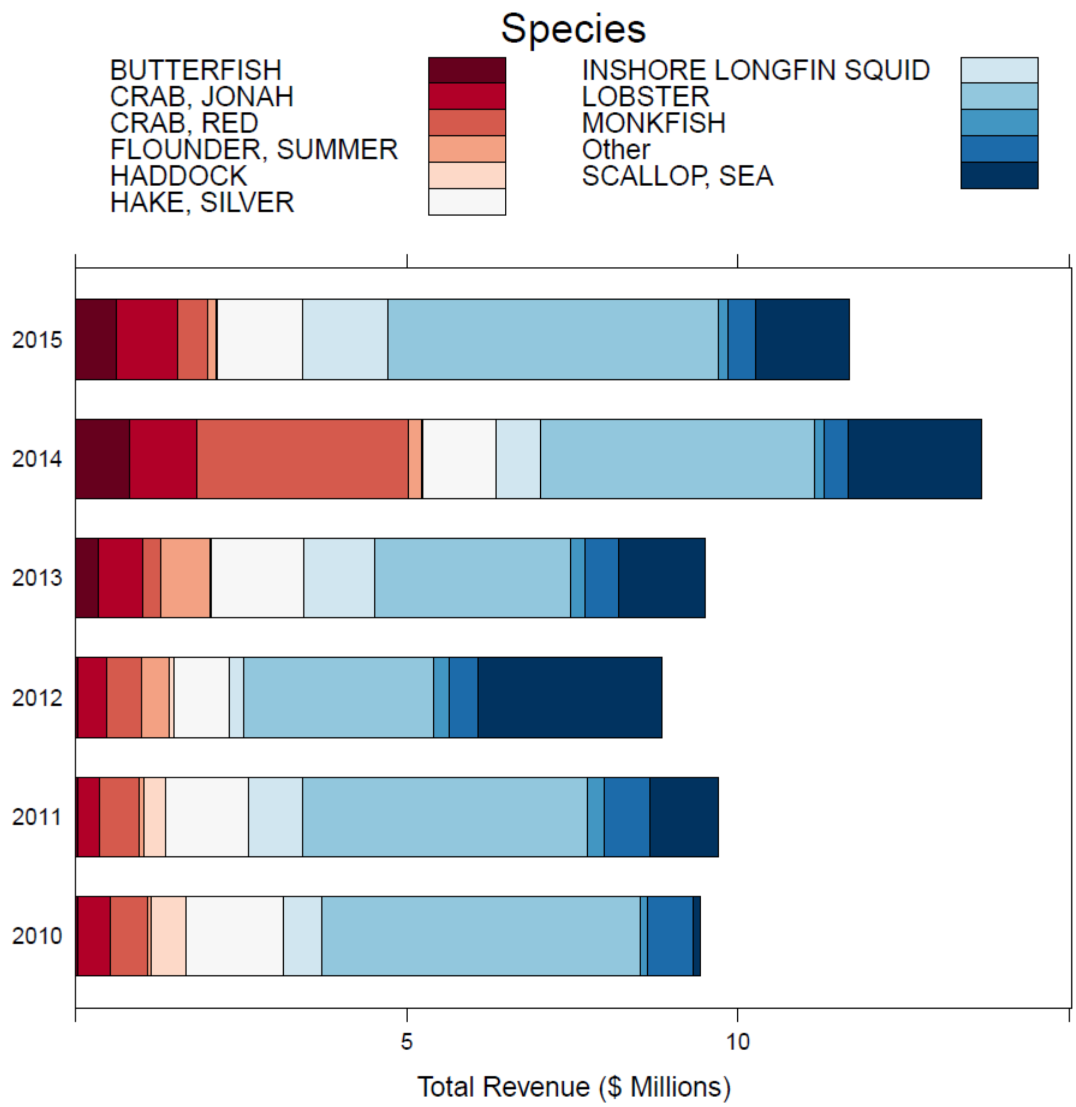


Figure 26 – VTR-derived revenue by species (top 10) attributed to the Option 3 500 m broad coral zone, 2010-2015.

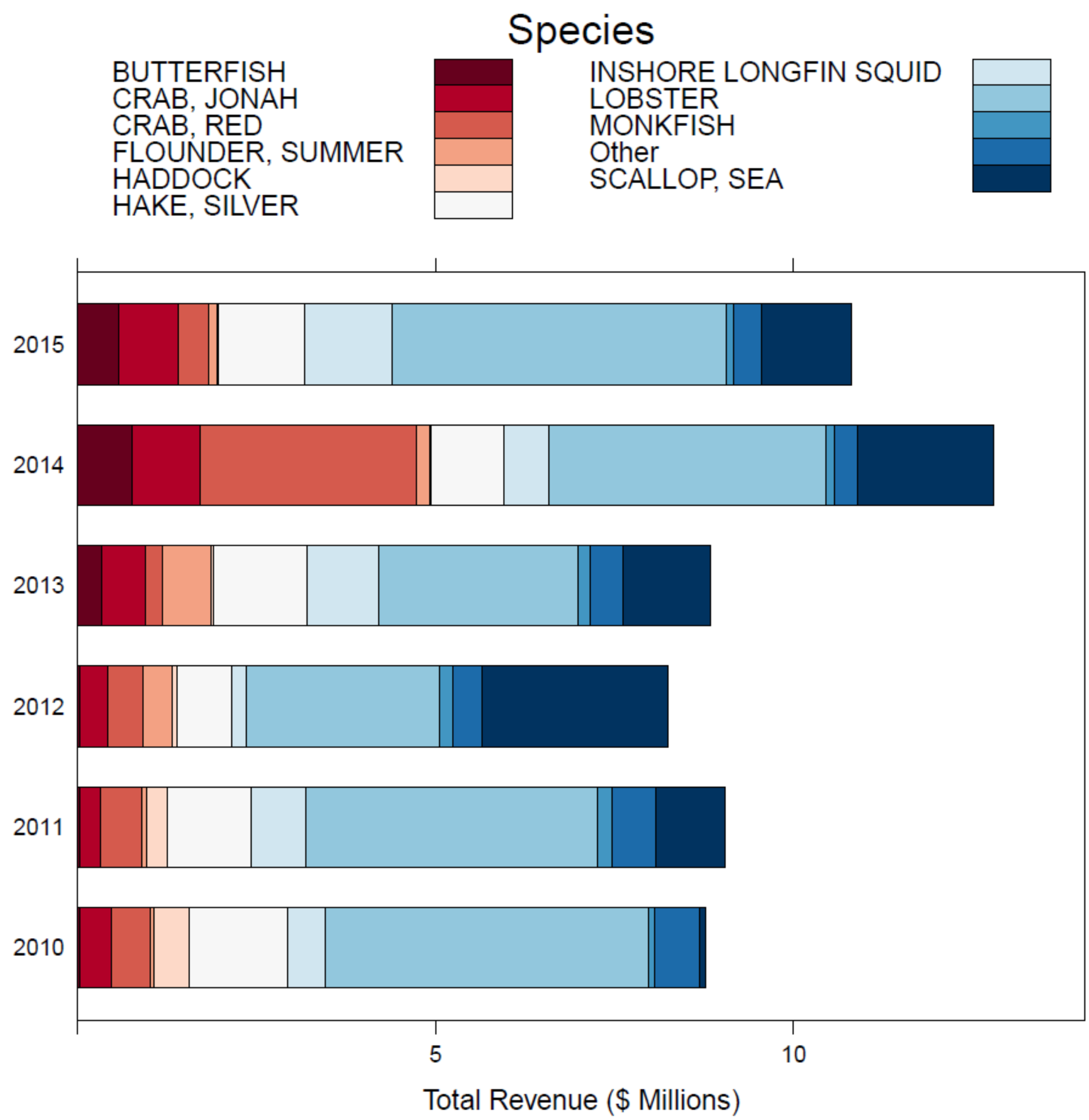


Figure 27 – VTR-derived revenue by species (top 10) attributed to the Option 4 600 m broad zone, 2010-2015.

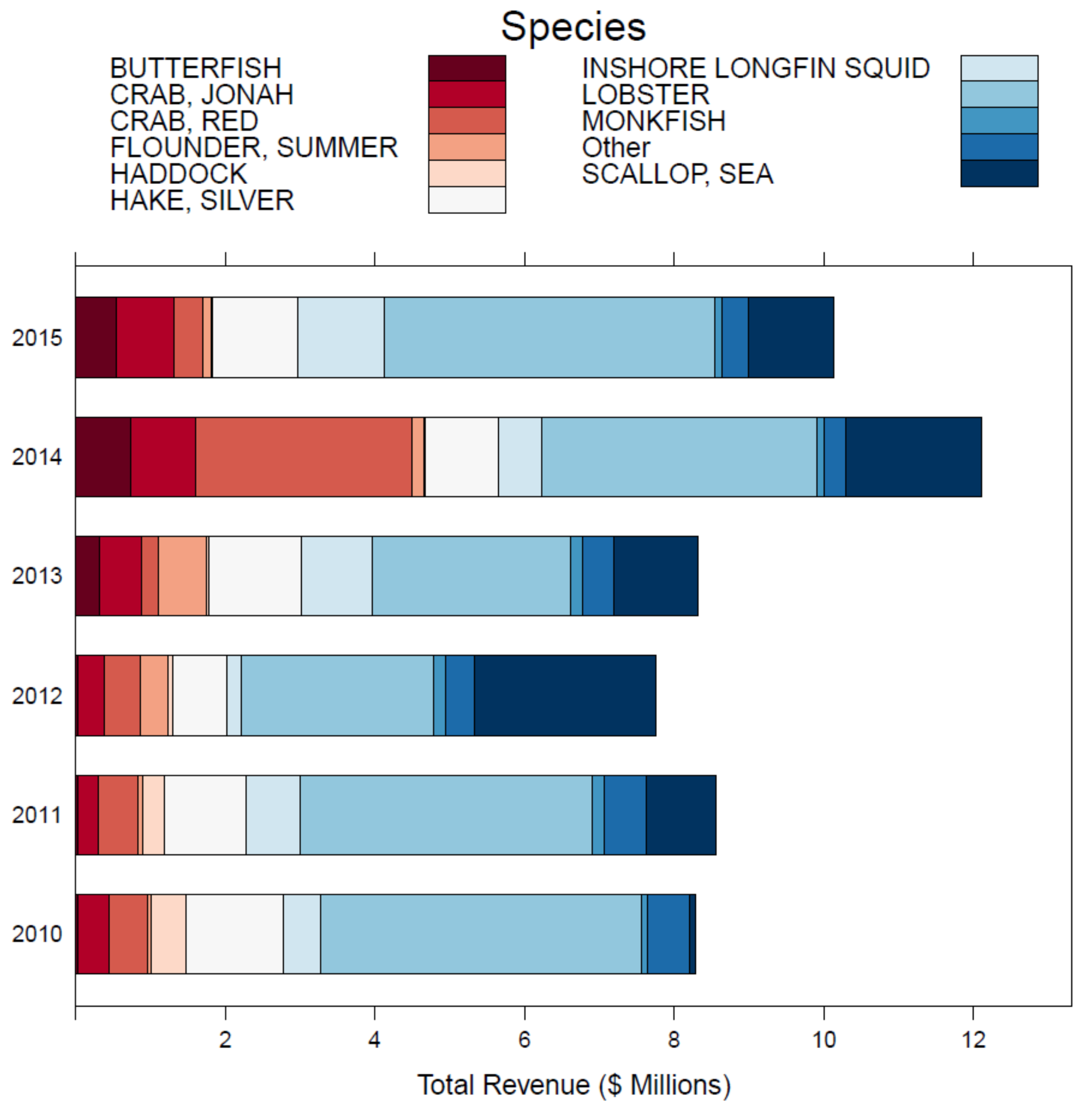


Figure 28 – VTR-derived revenue by species (top 10) attributed to the Option 5 900 m broad zone, 2010-2015.

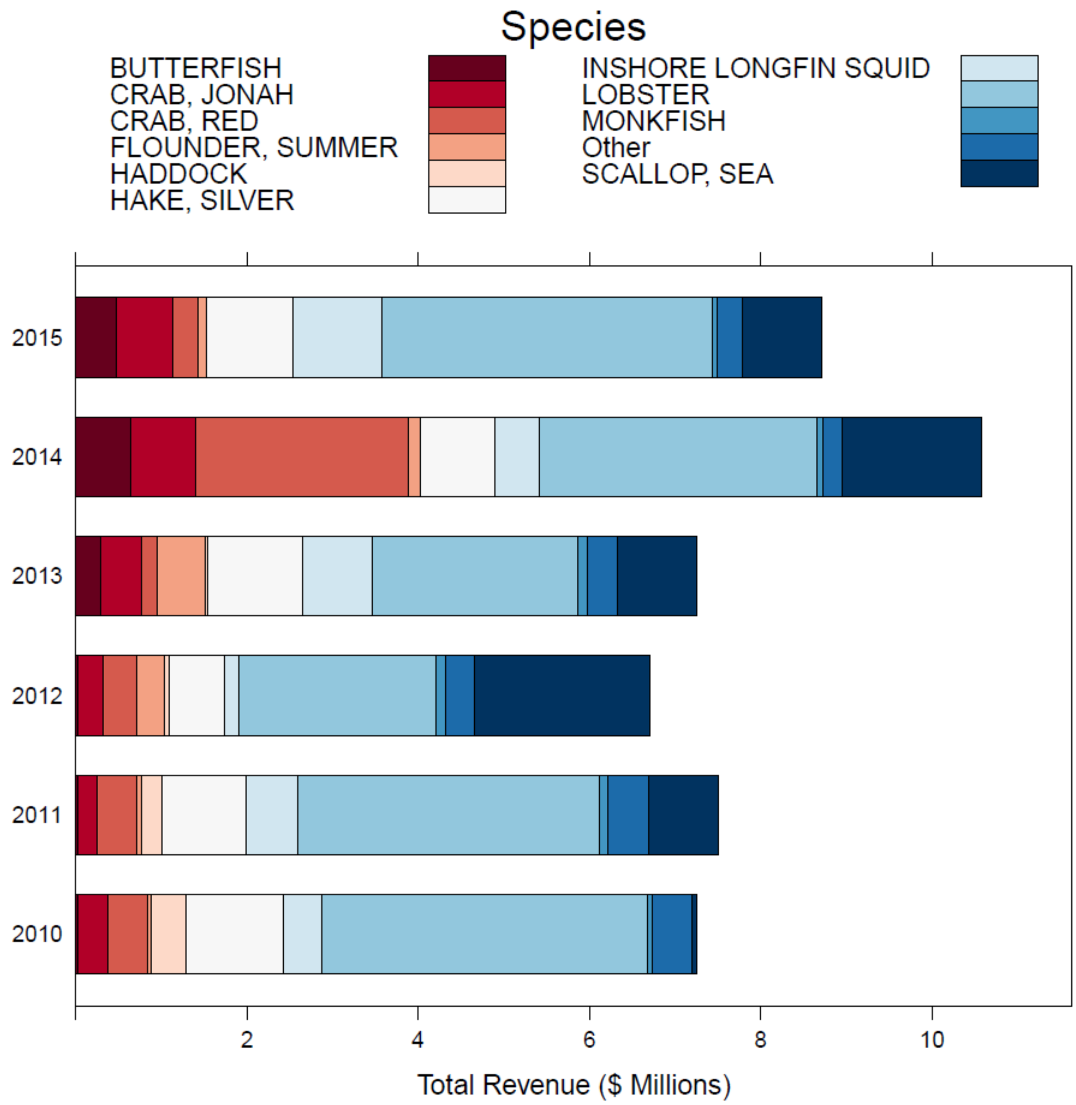


Figure 29 – VTR-derived revenue by species (top 10) attributed to the Option 6 600 m minimum broad zone, 2010-2015.

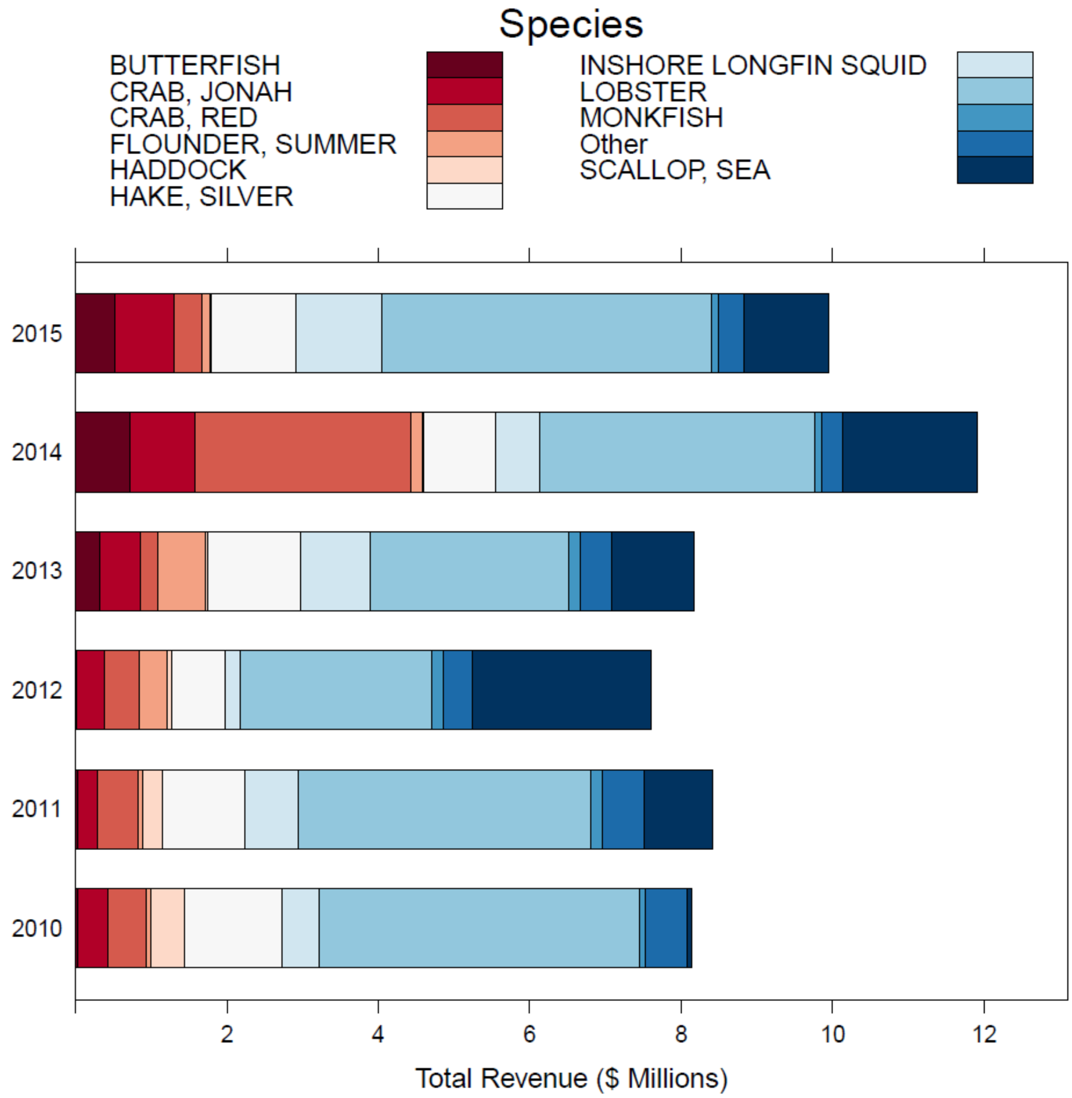
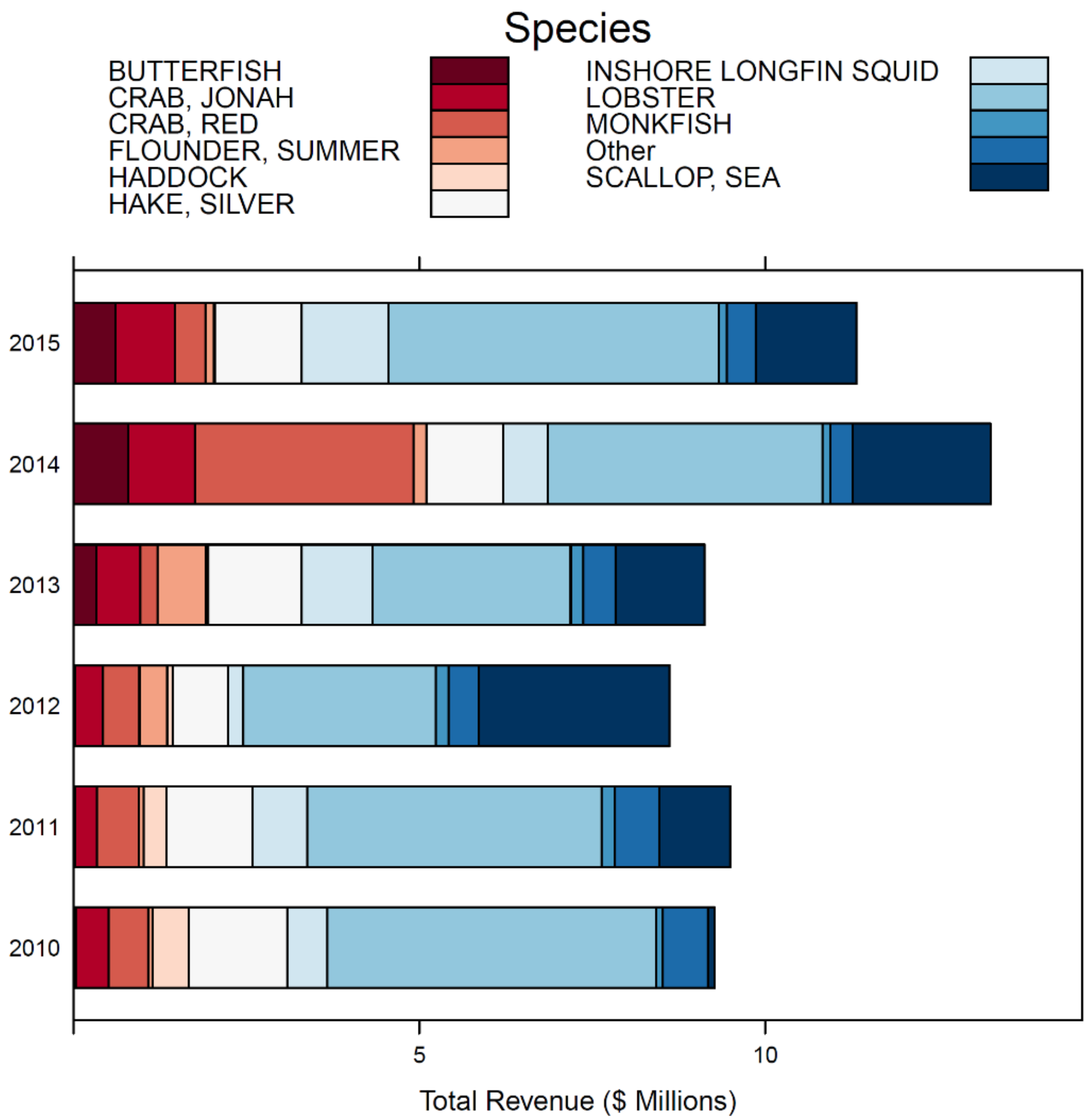
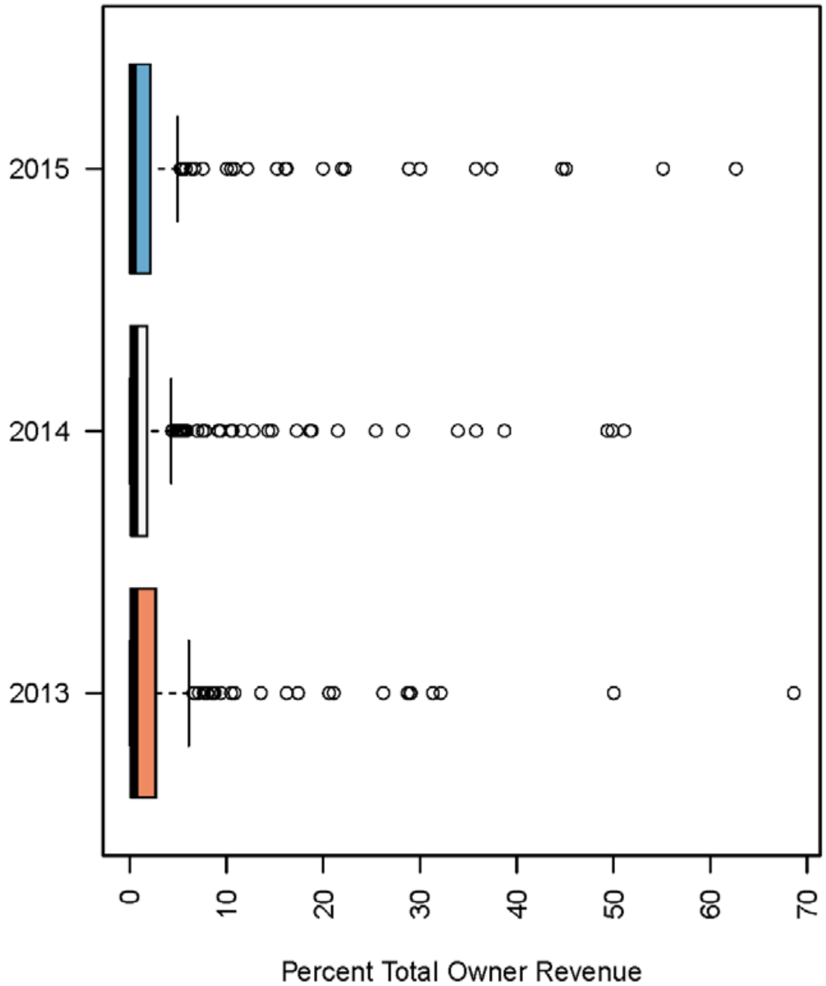


Figure 30 – VTR-derived revenue by species (top 10) attributed to the Option 7 coral zone, 2010-2015.



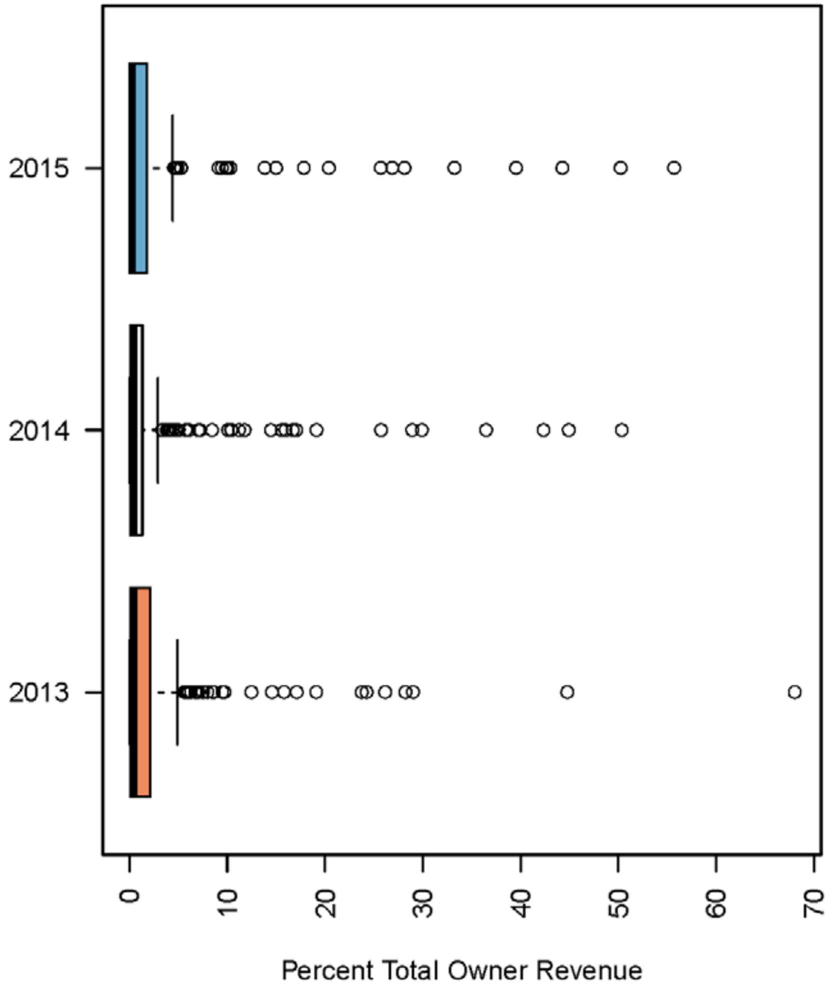
Note: Option 7 would only restrict Mobile Bottom Tending Gear. If fixed gears were excluded from this analysis, this would replace the crustaceans in the figure with Yellowtail flounder, *Illex* squid, and Atlantic Mackerel to encompass the top 10 species.

Figure 31 – VTR-derived percent of vessel owner revenue attributed to the Option 1 300 m broad coral zone, 2013-2015.



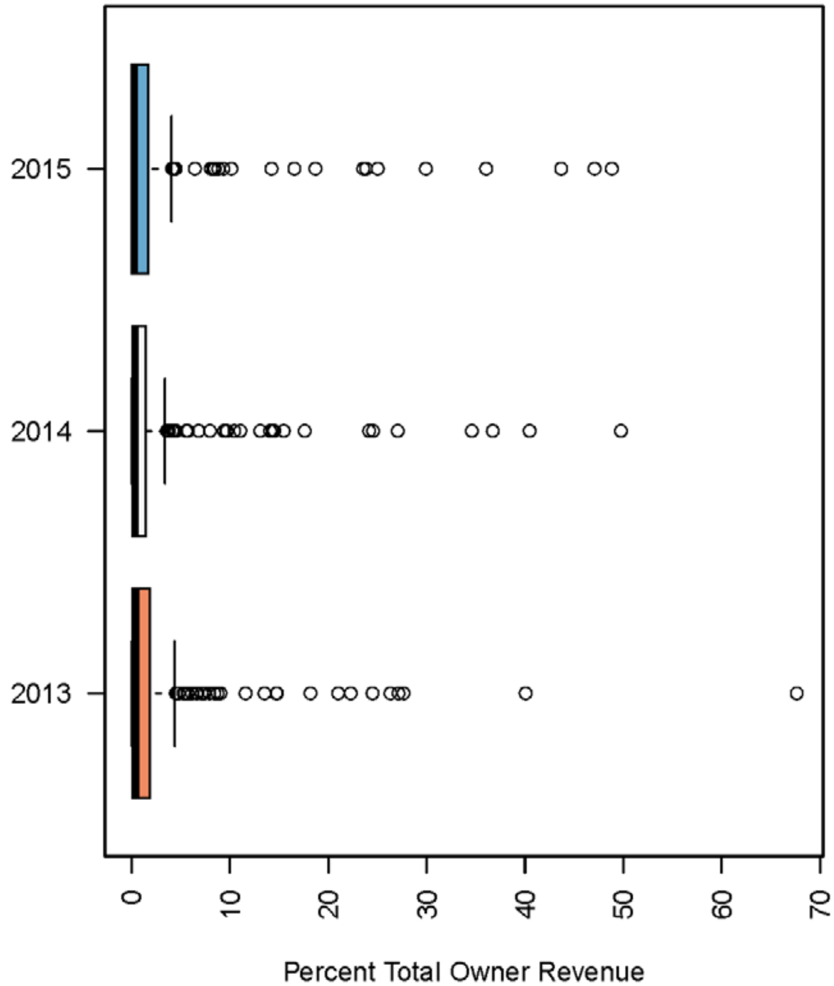
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 32 – VTR-derived percent of vessel owner revenue attributed to the Option 2 400 m broad coral zone, 2013-2015.



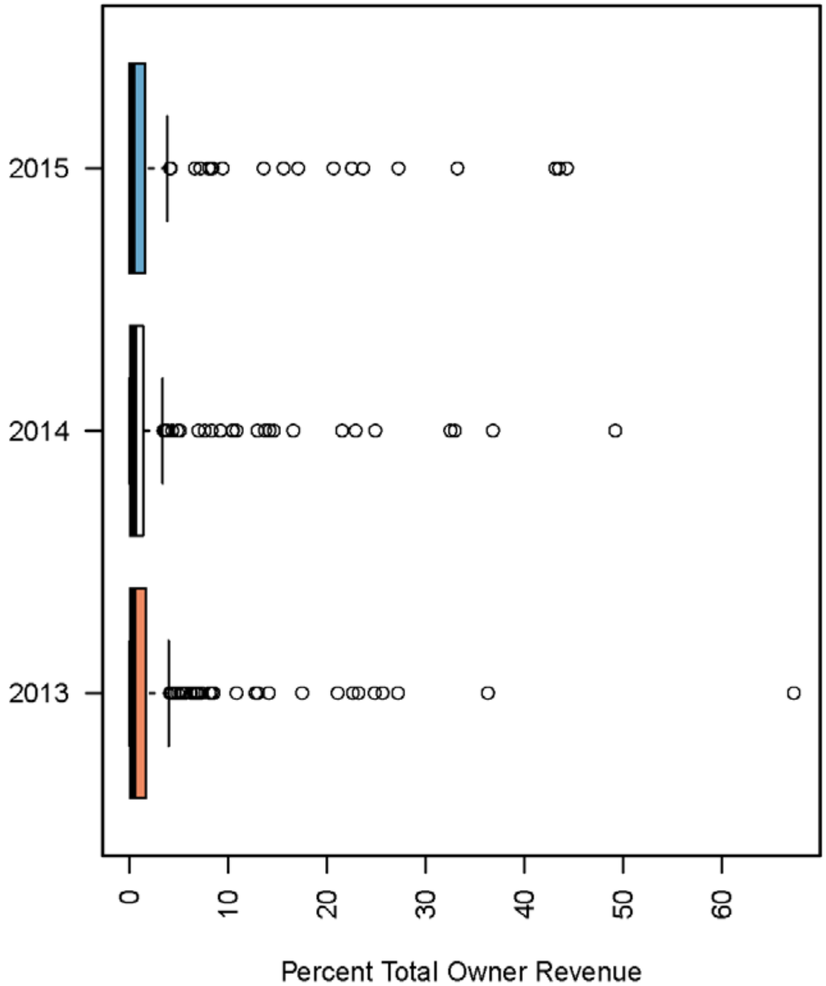
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 33 – VTR-derived percent of vessel owner revenue attributed to the Option 3 500 m broad coral zone, 2013-2015.



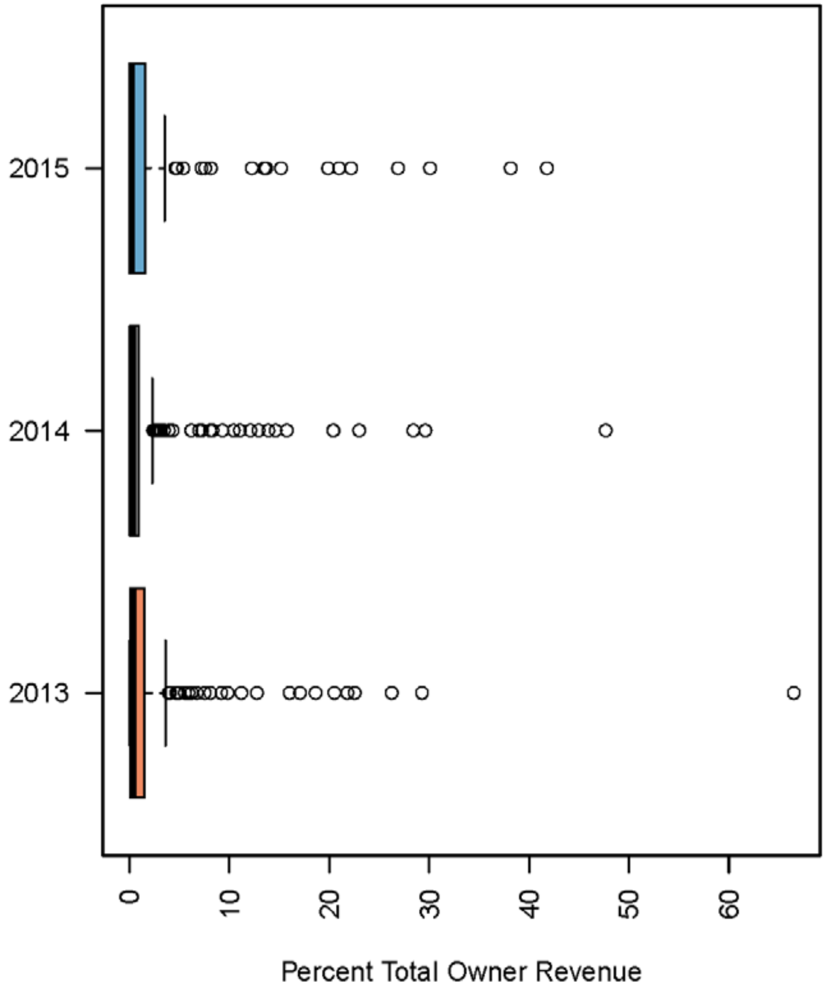
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 34 – VTR-derived percent of vessel owner revenue attributed to the Option 4 600 m broad coral zone, 2013-2015.



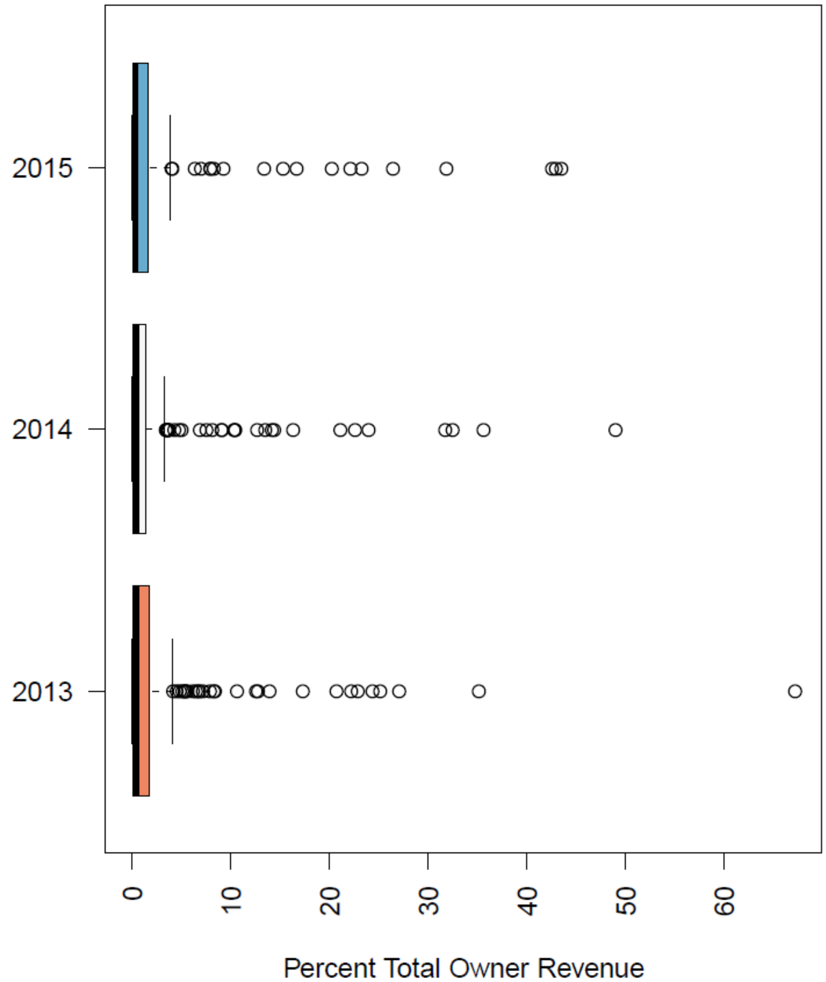
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 35 – VTR-derived percent of vessel owner revenue attributed to the Option 5 900 m broad coral zone, 2013-2015.



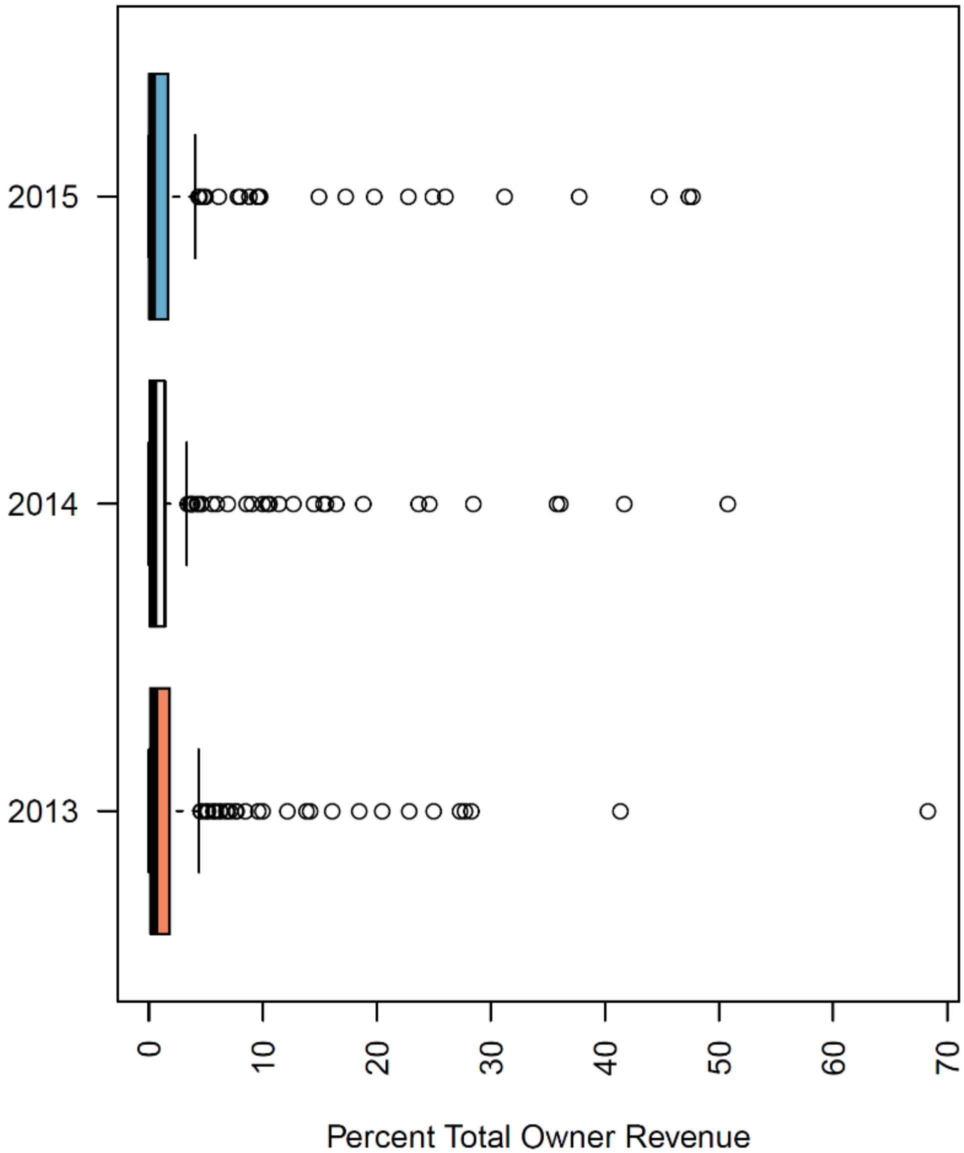
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 36 – VTR-derived percent of vessel owner revenue attributed to the Option 6 600 m minimum broad coral zone, 2013-2015.



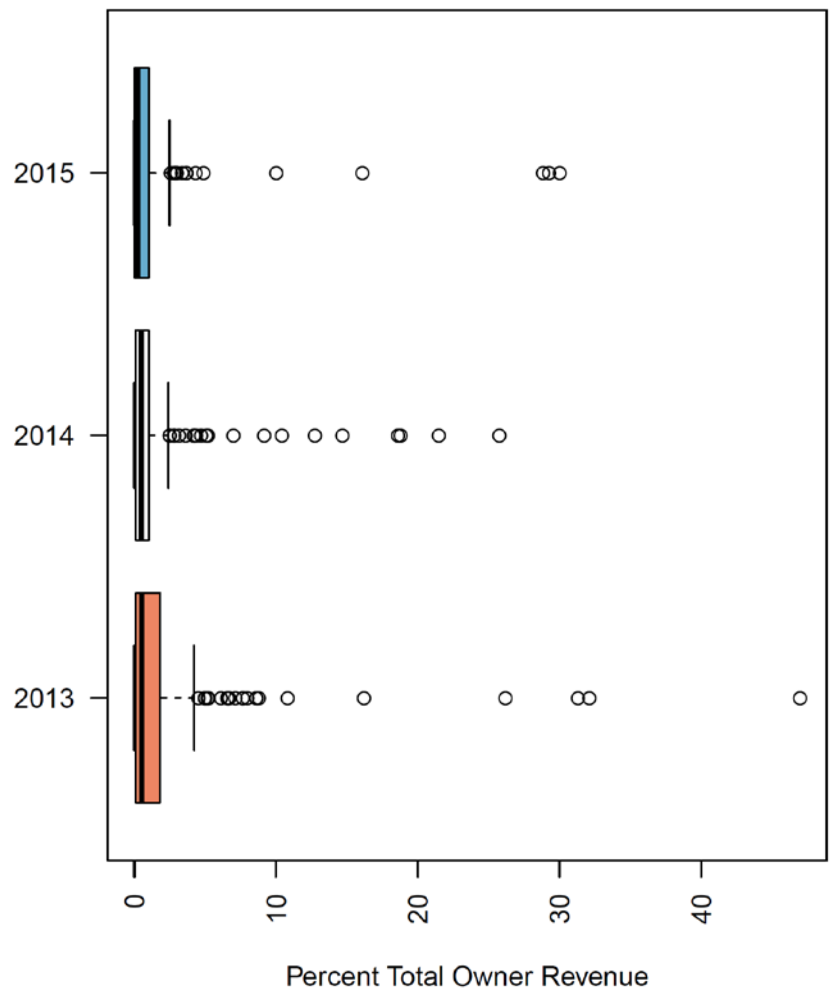
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 37 – VTR-derived percent of vessel owner revenue attributed to the Option 7 broad coral zone, 2013-2015.



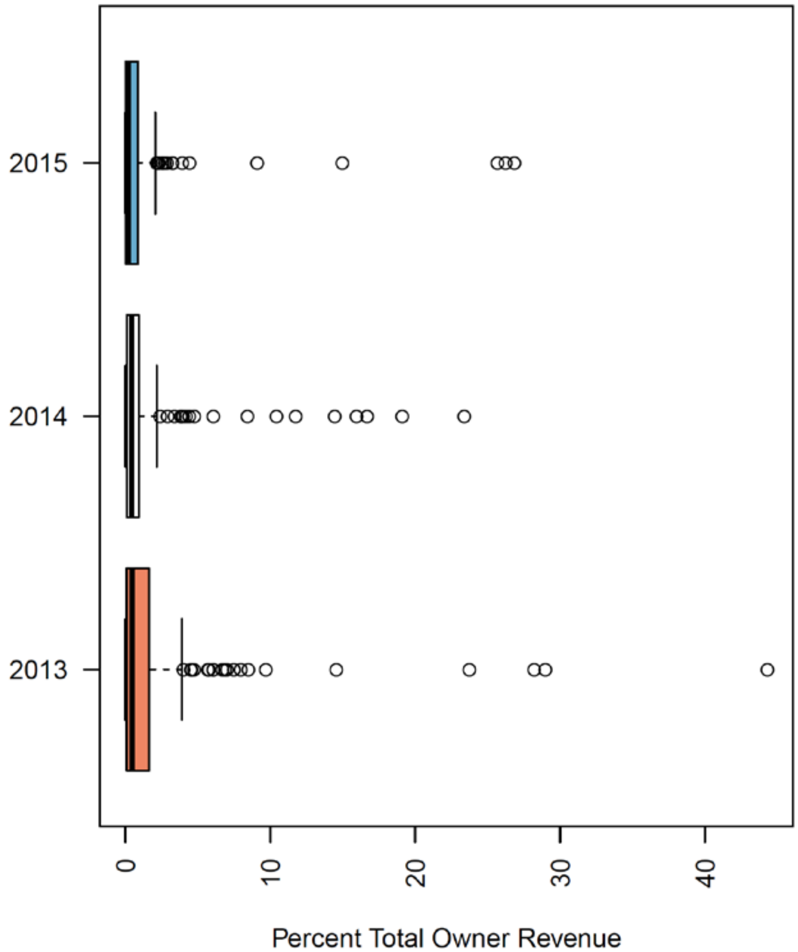
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 38 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 1 300 m broad coral zone, 2013-2015.



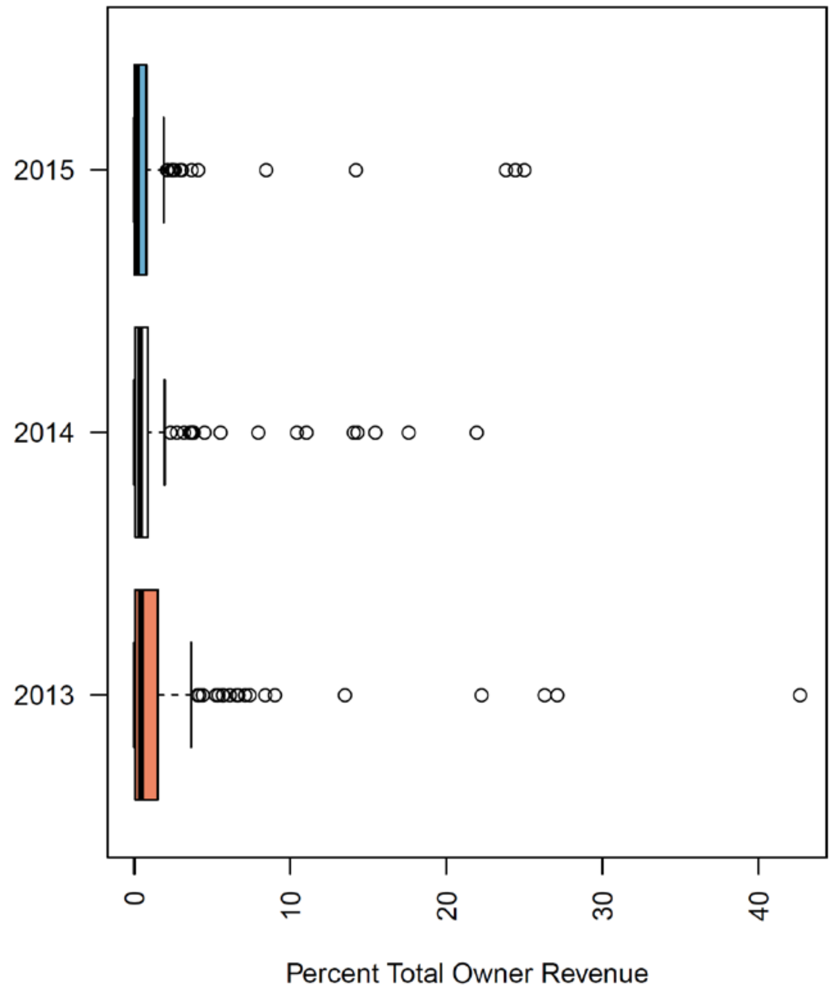
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 39 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 2 400 m broad coral zone, 2013-2015.



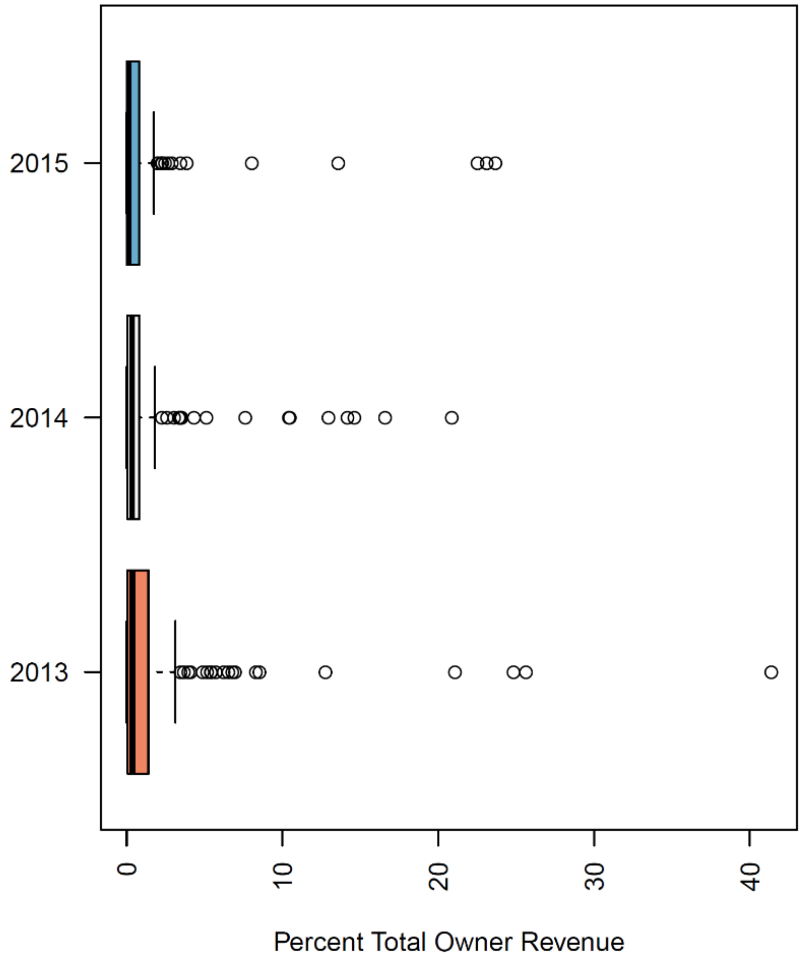
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 40 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 3 500 m broad coral zone, 2013-2015.



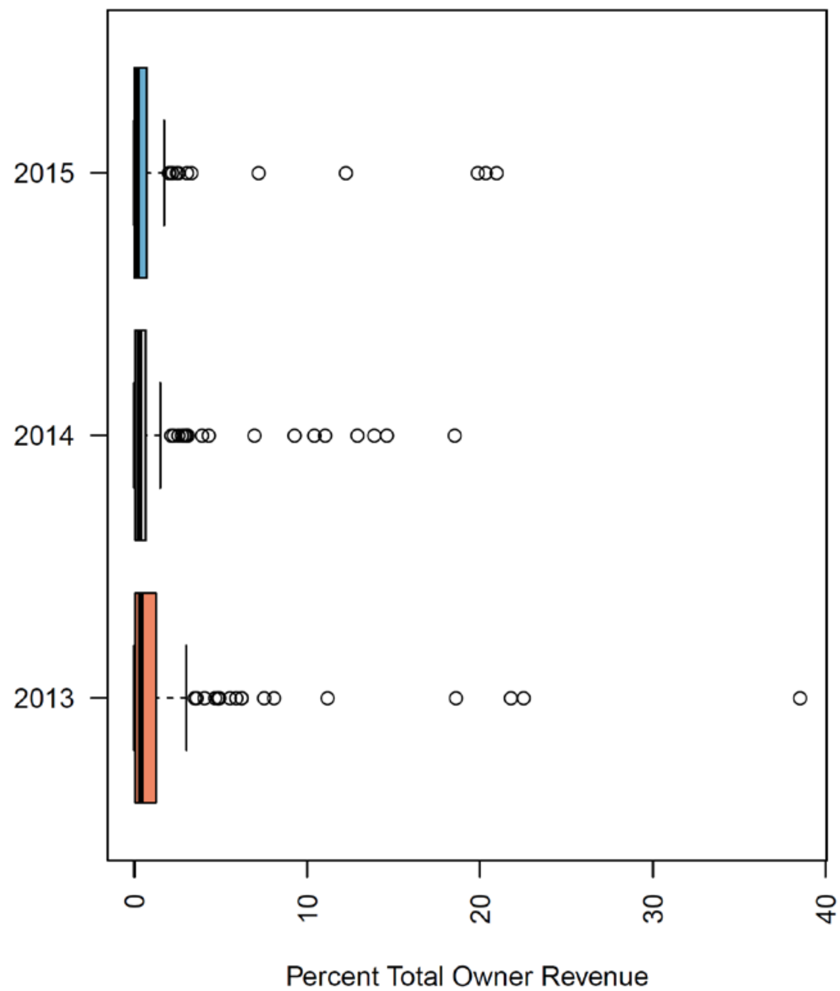
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 41 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 4 600 m broad coral zone, 2013-2015.



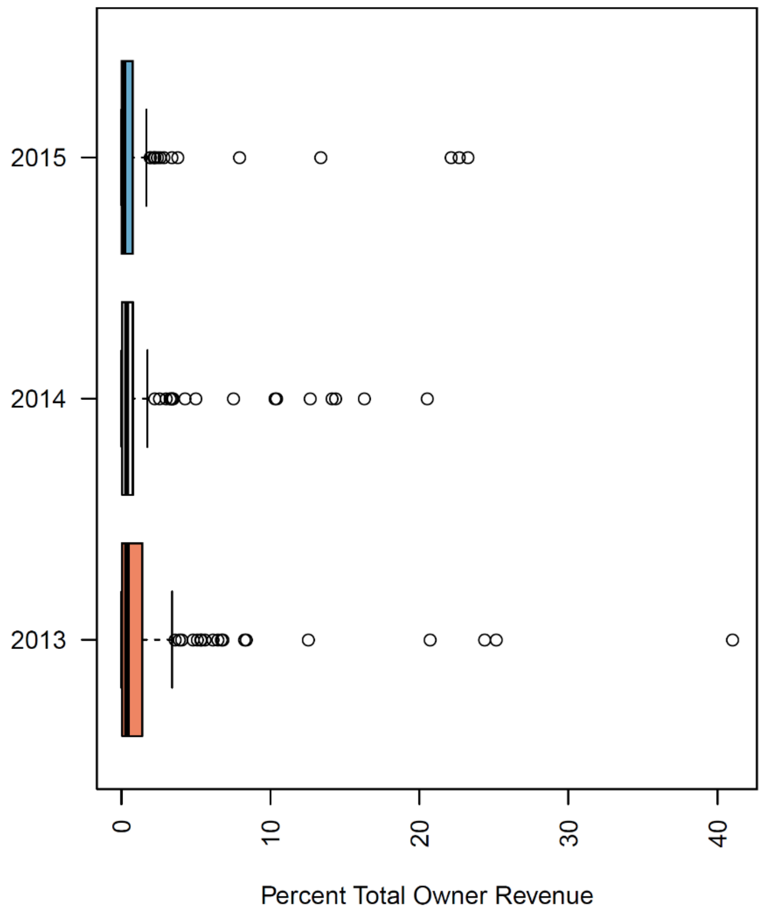
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 42 – VTR-derived percent of vessel owner MBTG revenue attributed to the Option 5 900 m broad coral zone, 2013-2015.



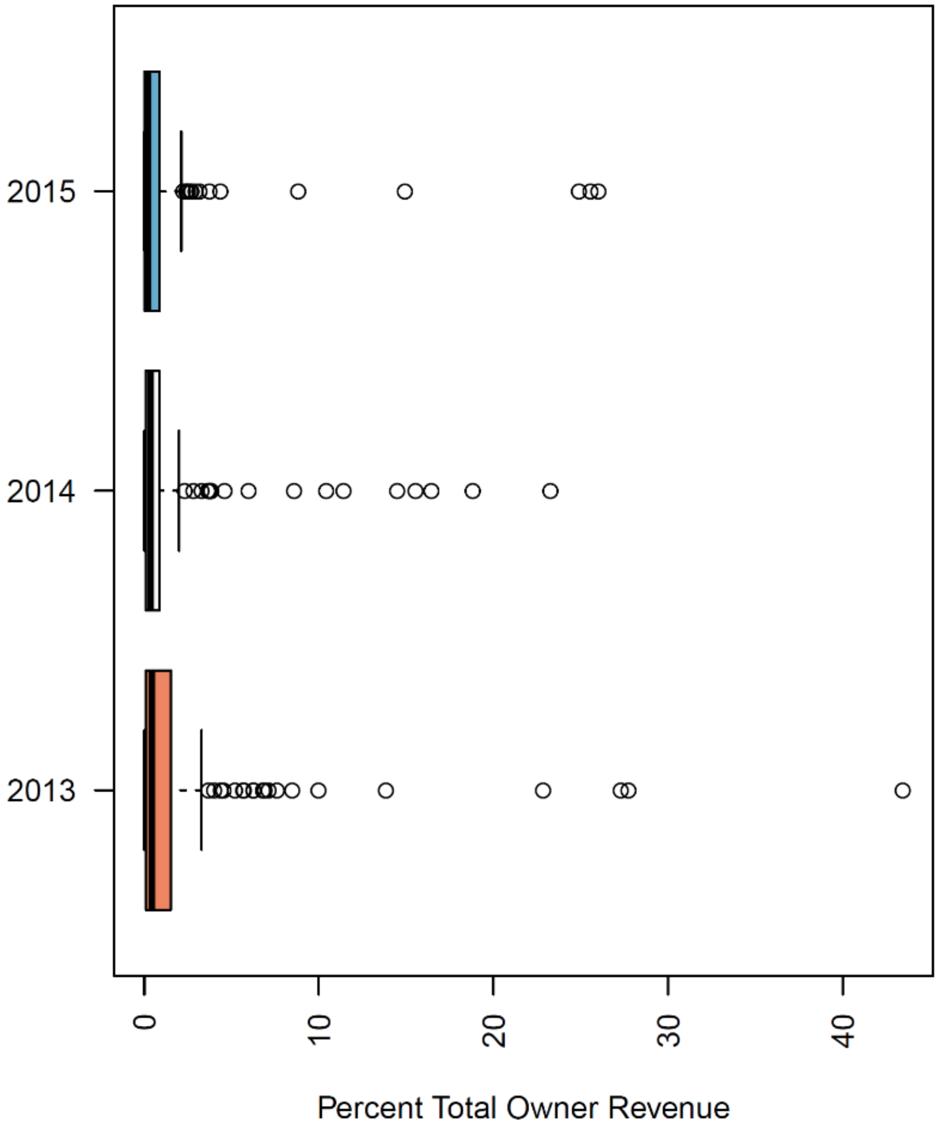
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 43 – 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 44 – 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 57 – Percentage of VTR trips, by gear type attributed to the broad coral zones south of Georges Bank, that have VMS coverage, 2010-2012

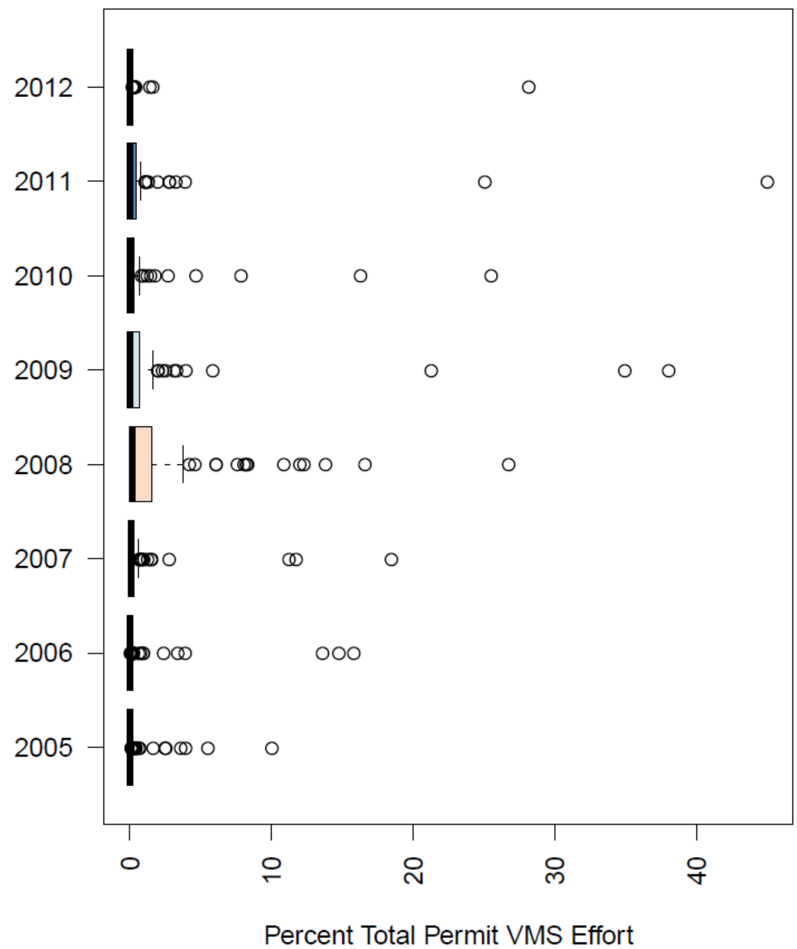
		300m				400 m				500 m			
Gear	Year	Permits	VTR Trips	VMS Trips	Coverage	Permits	VTR Trips	VMS Trips	Coverage	Permits	VTR Trips	VMS Trips	Coverage
Bottom Trawl	2010	137	1005	946	94%	136	987	928	94%	131	961	903	94%
Bottom Trawl	2011	129	881	794	90%	128	867	785	91%	125	848	768	91%
Bottom Trawl	2012	142	744	644	87%	141	723	626	87%	138	704	612	87%
Lobster Pot	2010	53	965	144	15%	51	947	139	15%	51	928	137	15%
Lobster Pot	2011	46	805	73	9%	45	788	72	9%	45	779	71	9%
Lobster Pot	2012	44	734	58	8%	44	725	58	8%	43	717	55	8%
Other Gear	2010	5	32	0	0%	5	32	0	0%	5	32	0	0%
Other Gear	2011	5	24	0	0%	5	24	0	0%	5	24	0	0%
Other Gear	2012	9	47	0	0%	8	46	0	0%	8	46	0	0%
Scallop Gear & Clam Dredge	2010	31	32	30	94%	21	22	20	91%	18	18	16	89%
Scallop Gear & Clam Dredge	2011	94	116	112	97%	88	110	106	96%	82	99	95	96%
Scallop Gear & Clam Dredge	2012	210	291	282	97%	199	276	268	97%	193	262	254	97%
Separator & Ruhle Trawl	2010	20	73	55	75%	20	72	54	75%	20	71	53	75%
Separator & Ruhle Trawl	2011	33	136	115	85%	33	136	115	85%	33	133	112	84%
Separator & Ruhle Trawl	2012	20	49	35	71%	20	49	35	71%	20	49	35	71%
Sink Gillnet	2010	25	-	-	0%	25	-	-	0%	25	-	-	0%
Sink Gillnet	2011	36	-	-	0%	35	-	-	0%	34	-	-	0%
Sink Gillnet	2012	30	-	-	0%	29	-	-	0%	28	-	-	0%
Bottom Longline	2010	6	-	-	0%	6	-	-	0%	6	-	-	0%
Bottom Longline	2011	6	-	-	0%	6	-	-	0%	6	-	-	0%
Bottom Longline	2012	8	-	-	0%	8	-	-	0%	8	-	-	0%

		600 m				600 m minumum				900 m			
Gear	Year	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%	131	935	880	94%	130	882	832	94%
Bottom Trawl	2011	121	824	747	91%	121	824	747	91%	118	784	710	91%
Bottom Trawl	2012	135	678	589	87%	135	678	589	87%	132	644	563	87%
Lobster Pot	2010	51	918	137	15%	51	918	137	15%	51	847	127	15%
Lobster Pot	2011	45	778	71	9%	45	778	71	9%	44	764	65	9%
Lobster Pot	2012	42	707	55	8%	42	707	55	8%	42	696	55	8%
Other Gear	2010	5	32	0	0%	5	32	0	0%	5	32	0	0%
Other Gear	2011	5	24	0	0%	5	24	0	0%	5	24	0	0%
Other Gear	2012	8	46	0	0%	8	46	0	0%	8	46	0	0%
Scallop Gear & Clam Dredge	2010	17	17	15	88%	17	17	15	88%	13	13	11	85%
Scallop Gear & Clam Dredge	2011	74	89	85	96%	74	89	85	96%	54	65	62	95%
Scallop Gear & Clam Dredge	2012	193	256	248	97%	193	256	248	97%	176	232	224	97%
Separator & Ruhle Trawl	2010	20	69	51	74%	20	69	51	74%	20	60	46	77%
Separator & Ruhle Trawl	2011	33	131	111	85%	33	131	111	85%	33	127	107	84%
Separator & Ruhle Trawl	2012	20	49	35	71%	20	49	35	71%	20	48	34	71%
Sink Gillnet	2010	24	-	-	0%	24	-	-	0%	22	-	-	0%
Sink Gillnet	2011	33	-	-	0%	33	-	-	0%	30	-	-	0%
Sink Gillnet	2012	27	-	-	0%	27	-	-	0%	27	-	-	0%
Bottom Longline	2010	6	-	-	0%	6	-	-	0%	6	-	-	0%
Bottom Longline	2011	6	-	-	0%	6	-	-	0%	6	-	-	0%
Bottom Longline	2012	8	-	-	0%	8	-	-	0%	8	-	-	0%

Table 58 – VMS estimates of effort (total hours fished, trips, and permits) within the broad and discrete coral zones south of Georges Bank, by gear type.

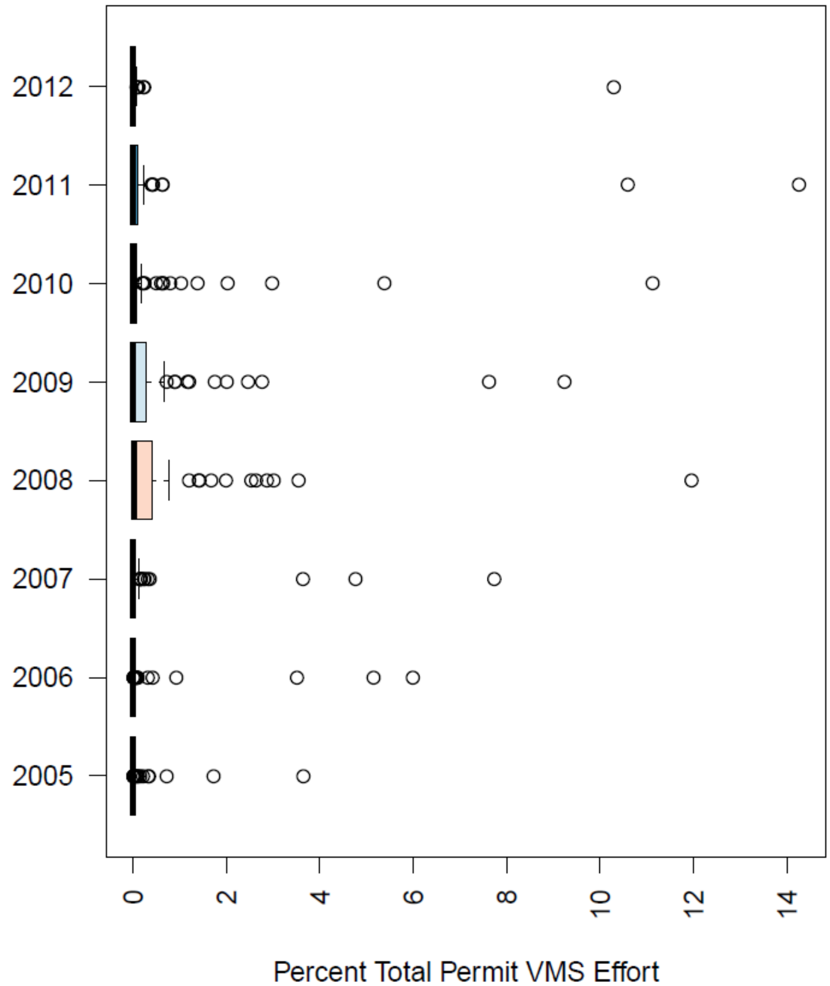
		300m			400 m			500 m			600 m			600 m Minimum			900 m		
Gear	Year	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits
Bottom Trawl	2005	218.63	54	27	26.23	32	22	7.74	18	16	1.85	12	10	1.841780062	11	9	0.17	4	4
Bottom Trawl	2006	184.01	66	32	33.60	44	24	6.75	35	21	0.75	18	15	0.480692398	13	11	0.00	5	4
Bottom Trawl	2007	258.02	128	54	24.94	61	35	12.86	36	23	9.13	20	14	8.776140497	18	12	5.37	11	9
Bottom Trawl	2008	1442.01	143	52	249.90	101	40	22.89	61	30	4.43	30	19	3.905183135	31	20	0.80	12	8
Bottom Trawl	2009	489.07	118	37	222.19	90	35	26.19	56	26	12.89	32	18	10.25006958	24	16	6.07	14	9
Bottom Trawl	2010	391.78	137	43	180.78	95	34	32.04	64	27	21.98	52	23	20.56616762	47	19	12.86	17	7
Bottom Trawl	2011	379.99	91	33	70.28	66	28	20.40	43	20	12.70	32	15	12.31394365	29	15	7.49	11	6
Bottom Trawl	2012	114.18	85	38	24.12	61	34	7.31	46	27	5.44	35	22	5.291759809	28	18	2.10	15	11
Squid Trawl	2005	11.50	59	30	4.44	40	22	3.01	33	19	1.44	24	17	1.437039482	21	15	0.26	7	9
Squid Trawl	2006	40.33	96	42	5.90	73	35	2.89	52	28	1.71	37	23	1.271775446	33	21	0.56	11	18
Squid Trawl	2007	40.61	123	43	21.16	94	38	11.14	68	31	6.34	51	26	5.732156905	45	22	3.27	16	28
Squid Trawl	2008	8.27	16	11	2.18	14	10	0.26	12	9	0.16	12	9	0.142018886	11	8	0.02	4	5
Squid Trawl	2009	43.92	25	8	15.64	24	7	7.80	19	5	3.05	17	5	2.741923118	17	5	0.88	5	15
Squid Trawl	2010	11.98	30	11	2.74	23	10	0.89	18	8	0.20	13	7	0.203731946	13	7	0.02	3	4
Squid Trawl	2011	35.59	23	10	8.19	21	10	5.41	19	10	2.63	15	7	2.087880292	15	7	0.12	7	9
Squid Trawl	2012	5.45	12	10	2.47	10	8	0.51	8	7	0.32	4	4	0.178721718	4	4	0.06	3	3
Pot/Trap	2005	11.11	5	3	3.84	5	3	2.13	5	3	-	-	2	-	-	2	-	-	1
Pot/Trap	2006	319.91	81	6	104.47	69	4	30.63	61	4	18.26	51	4	21.61941799	64	5	4.36	32	3
Pot/Trap	2007	337.25	75	3	130.95	66	3	46.65	62	3	24.61	51	3	25.50896508	56	4	7.33	36	3
Pot/Trap	2008	350.63	57	5	140.42	49	5	49.60	44	5	31.85	37	3	27.49525122	34	3	12.04	26	3
Pot/Trap	2009	275.17	50	5	85.65	39	4	30.72	30	3	20.24	28	3	17.82354117	29	4	-	-	2
Pot/Trap	2010	307.01	62	4	125.77	56	4	44.03	51	3	-	-	2	23.61622095	48	4	-	-	2
Pot/Trap	2011	260.73	44	4	98.56	37	3	32.57	29	3	19.18	27	3	16.67031005	26	4	-	-	2
Pot/Trap	2012	216.55	36	3	-	-	1	-	-	1	-	-	1	-	-	2	-	-	1
GC Scallop	2006	-	-	1	-	-	1	-	-	1	-	-	1	-	-	1	0.00	0	0
GC Scallop	2011	-	-	1	-	-	1	-	-	1	-	-	1	-	-	1	-	1	-
GC Scallop	2012	-	-	1	-	-	1	-	-	1	-	-	1	-	-	1	0.00	0	0
LA Scallop	2005	0.06	77	58	0.05	71	57	0.04	53	64	0.03	51	62	0.033471107	61	50	0.01	49	60
LA Scallop	2006	0.47	151	68	0.14	138	65	0.07	63	131	0.04	60	121	0.032979571	118	59	0.02	57	106
LA Scallop	2007	0.02	26	23	0.01	25	23	0.00	19	20	0.00	15	16	0.001792082	15	14	0.00	9	10
LA Scallop	2008	0.04	17	16	0.00	17	16	0.00	14	15	0.00	11	12	0.000341936	10	9	0.00	6	7
LA Scallop	2009	5.13	31	29	0.94	30	28	0.36	27	29	0.06	27	28	0.16874183	28	27	0.01	25	26
LA Scallop	2010	0.41	37	35	0.18	35	33	0.04	28	28	0.01	25	25	0.00630954	23	23	0.00	16	16
LA Scallop	2011	0.19	27	20	0.04	26	19	0.03	19	23	0.02	18	21	0.008281497	21	18	0.00	13	13
LA Scallop	2012	0.56	39	31	0.46	34	28	0.44	27	32	0.02	25	29	0.018338915	28	24	0.01	21	23

Figure 45 – VMS-derived percent of total annual permit fishing effort attributed to the Option 1 300 m broad zone between 2005 and 2012.



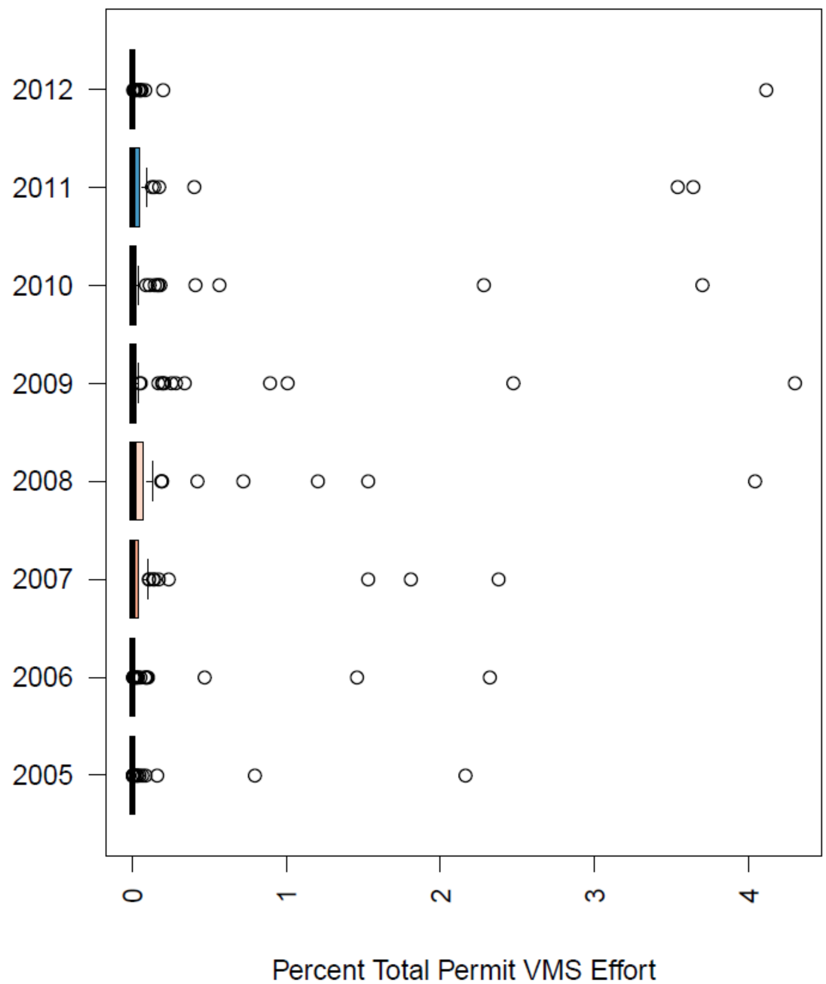
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 46 – VMS-derived percent of total annual permit fishing effort attributed to the Option 2 400 m broad zone between 2005 and 2012.



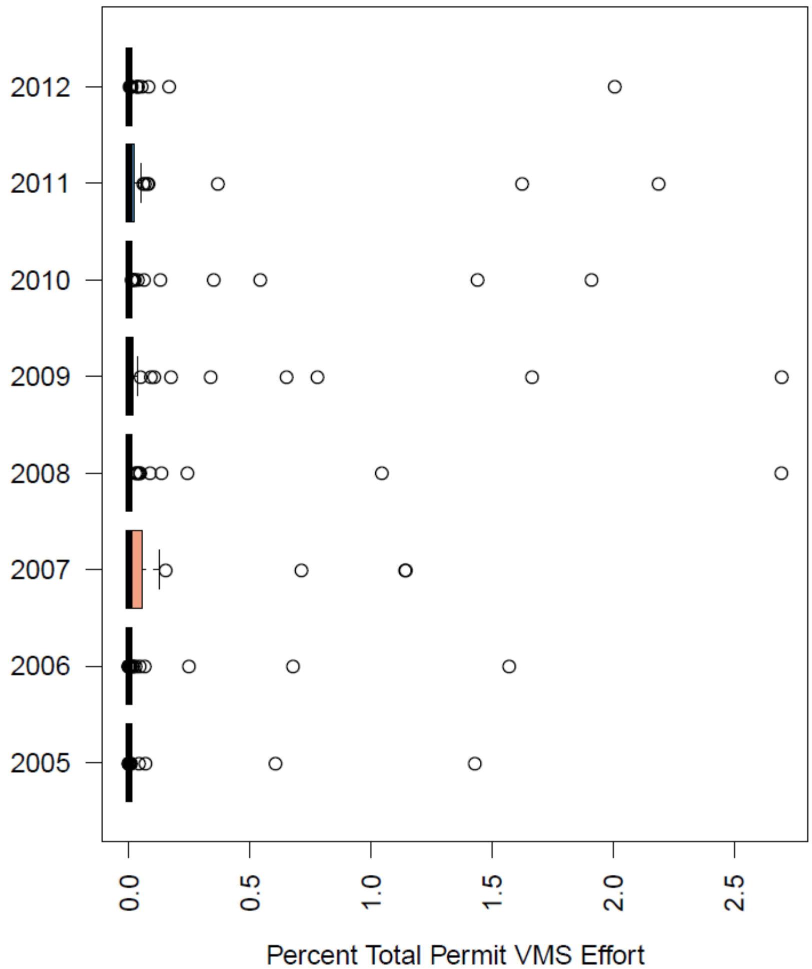
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 47 – 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



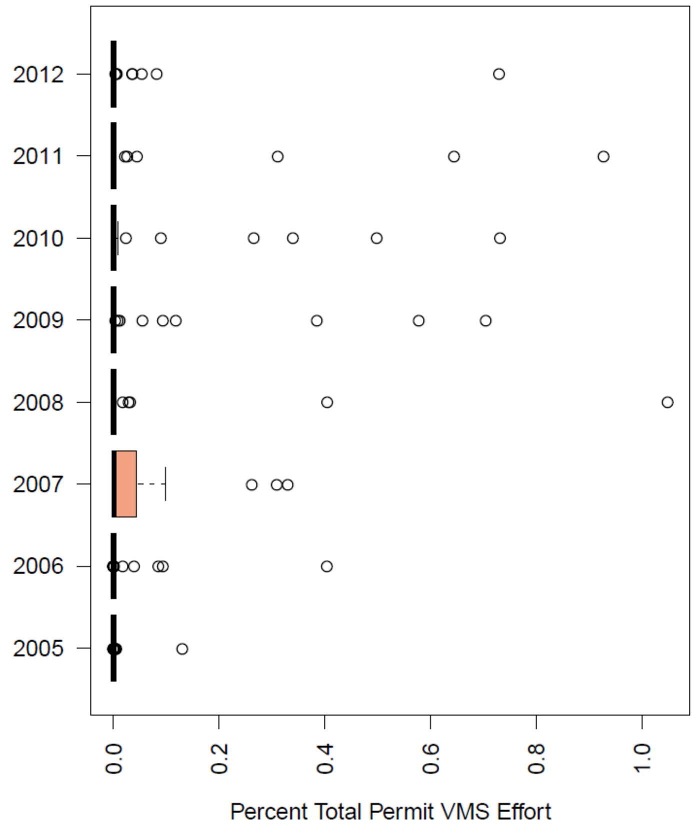
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 48 – 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 49 – VMS-derived percent of total annual permit fishing effort attributed to the Option 5 900 m broad zone between 2005 and 2012.



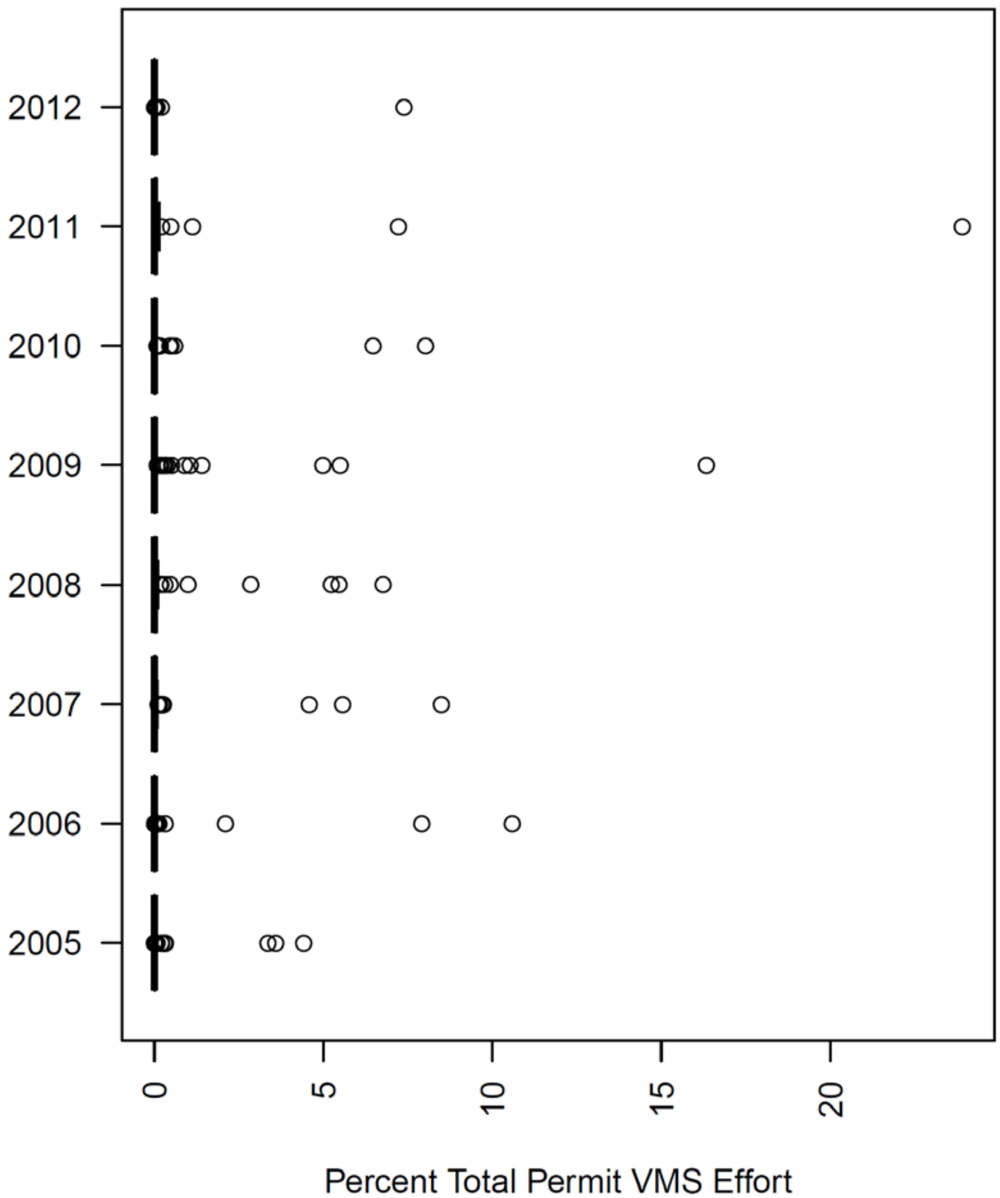
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 50 – VMS-derived percent of total annual permit fishing effort attributed to the Option 6 600 m minimum broad zone between 2005 and 2012.

[To be inserted. XXX]

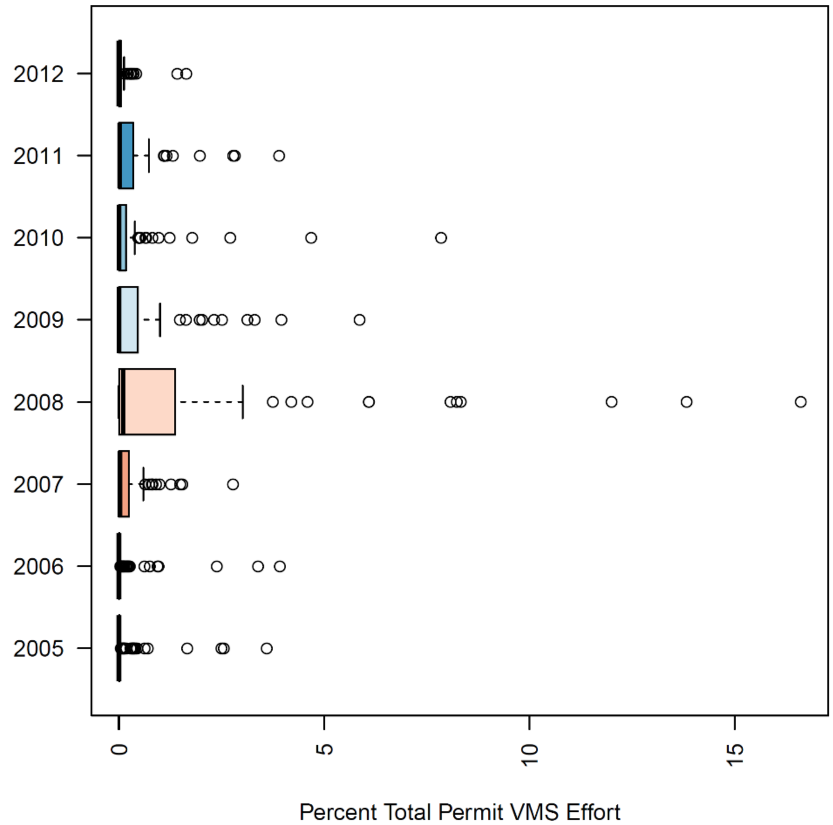
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 51 – VMS-derived percent of total annual permit fishing effort attributed to the Option 7 broad zone between 2005 and 2012.



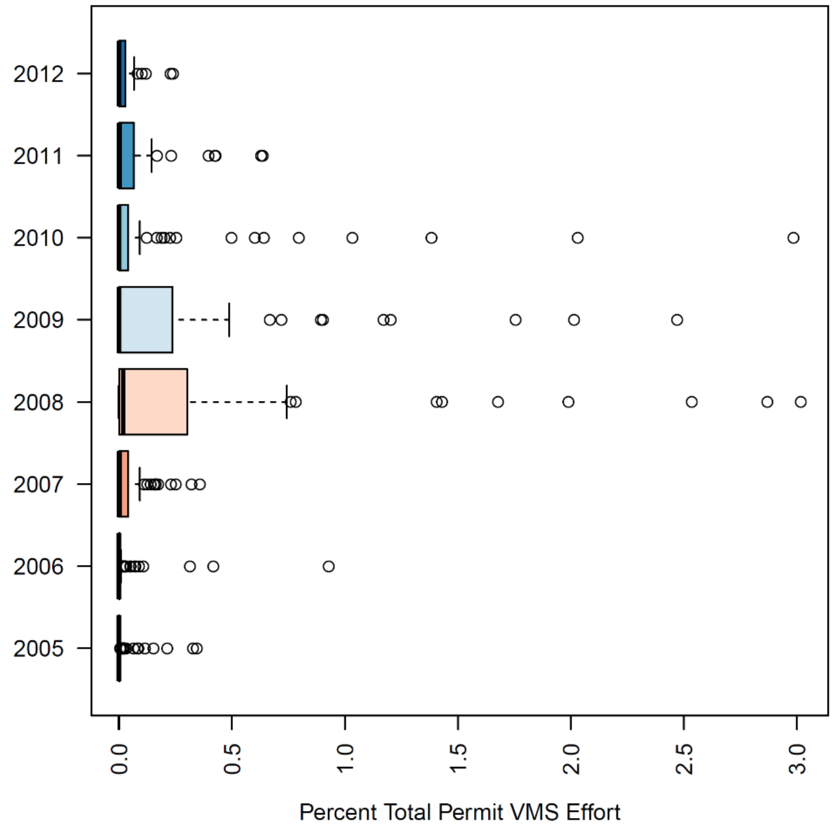
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 52 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 1 300 m broad zone between 2005 and 2012.



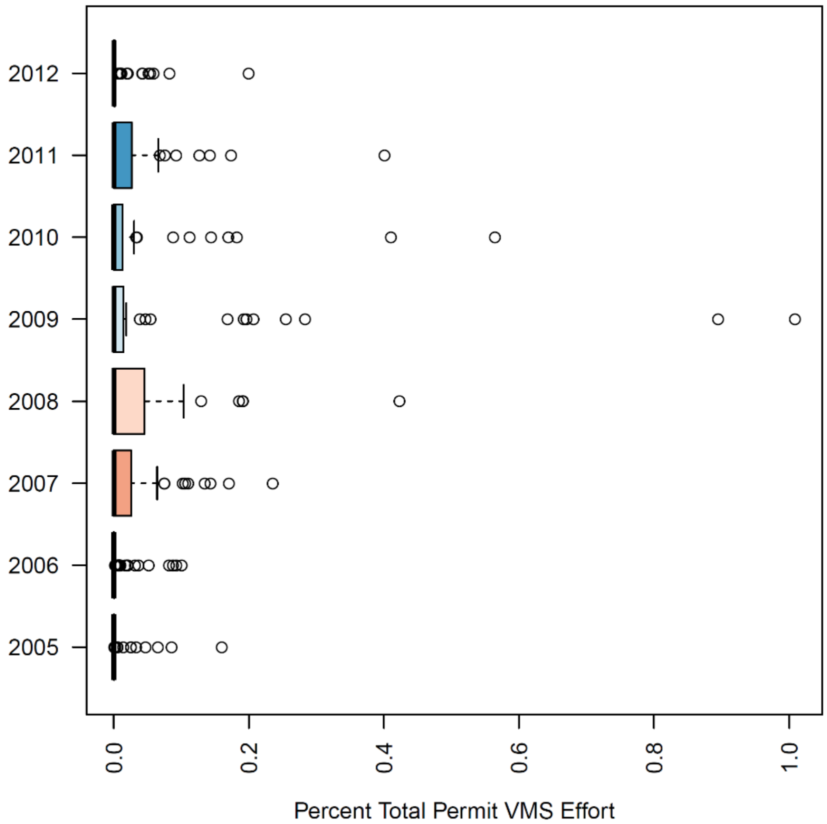
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 53 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 2 400 m broad zone between 2005 and 2012.



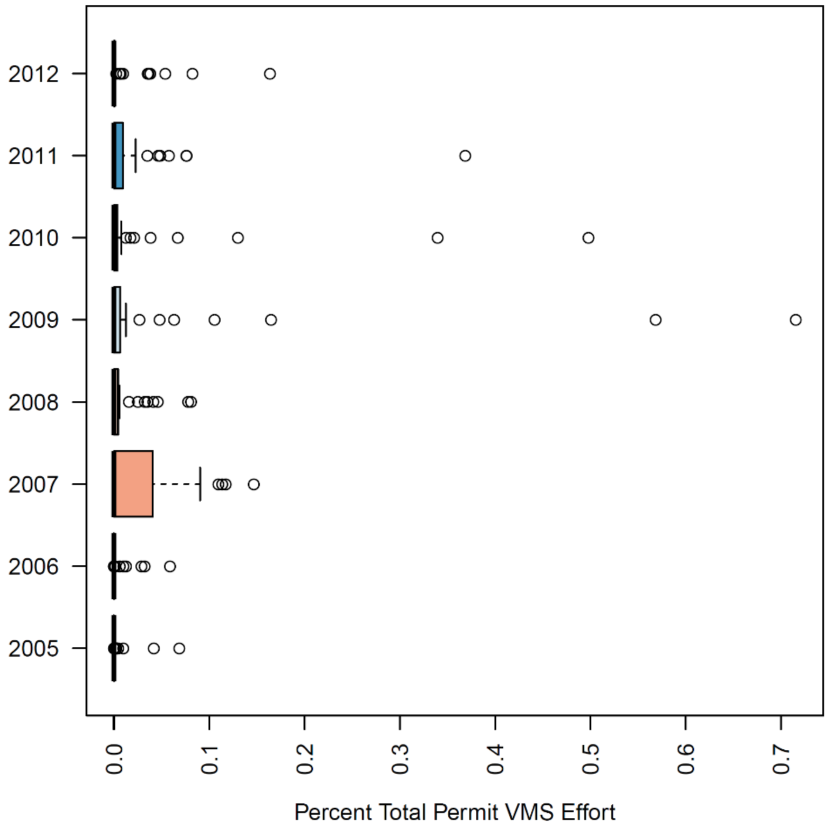
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 54 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 3 500 m broad zone between 2005 and 2012.



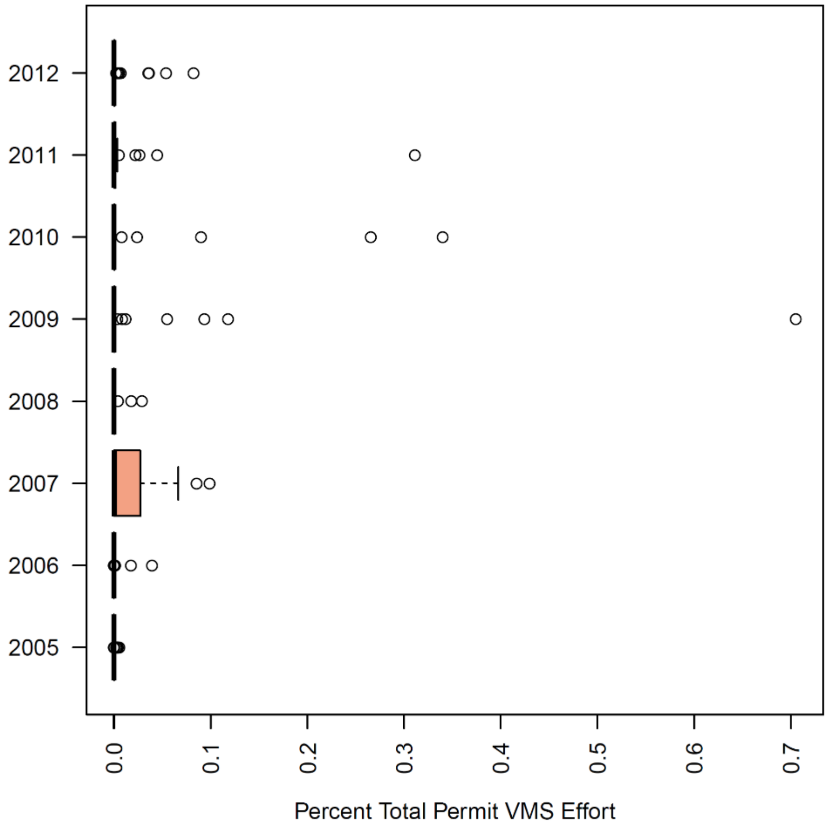
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 55 – VMS-derived percent of total annual permit fishing effort attributed to MBTG within the Option 4 600 m broad zone between 2005 and 2012.



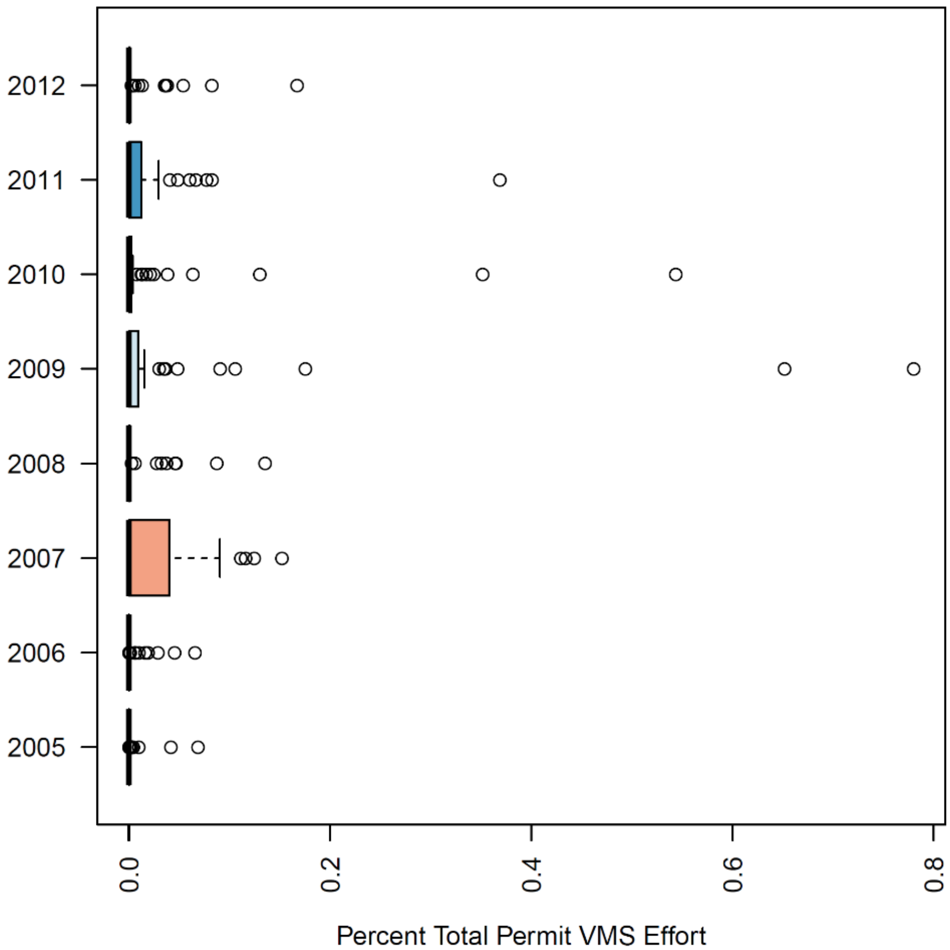
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 56 – 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



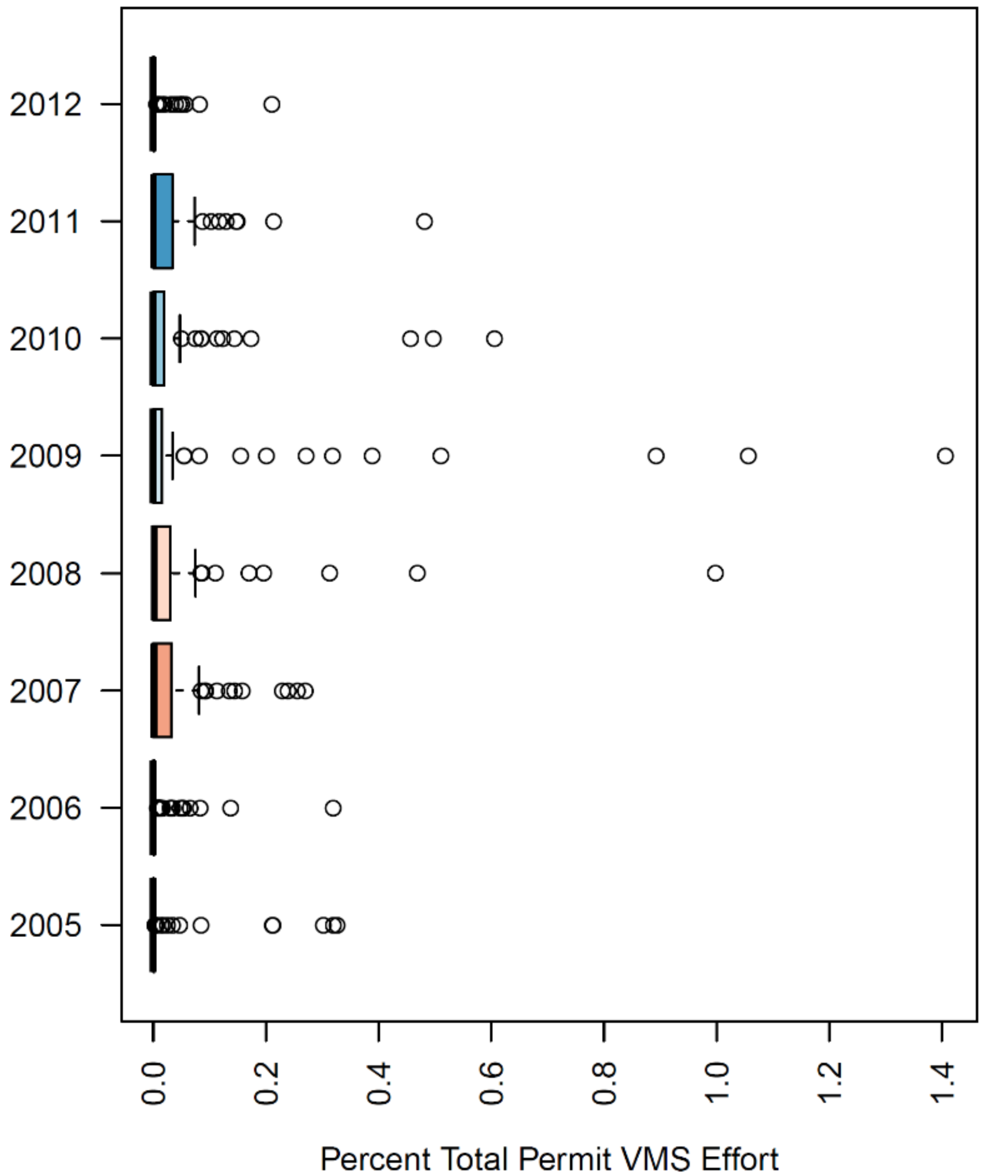
Note: Open circles are individual owners with a % total revenue 1.5 time above the 75% percentile.

Figure 57 – 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 58 – 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.

7.3.3.2 Fishing community impacts

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 59 to Table 63, 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 28). 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.

7.3.3.2.1 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 59), 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. 275).

Table 59 – 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.

7.3.3.2.2 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 60).

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. 276).

Table 60 – 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.

7.3.3.2.3 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 61). 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. 277).

Table 61 – 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).

7.3.3.2.4 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 62).

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 62 – 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.

7.3.3.2.5 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 63).

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 63 – 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.

7.3.3.2.6 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 63).

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 64 – 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 65 – 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.

7.3.3.2.7 Option 7: Empirically-derived zone

To be completed.

7.3.3.3 Sociocultural impacts

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, relative 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.

7.3.4 Impacts on protected resources

To be completed.

7.4 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 66). 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, 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 66 - 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 (in 2023), Monument fishing restrictions will exceed those that might be associated with the coral zones.

7.4.1 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 43 and Table 42), as well as areas of high slope and modeled suitable habitat (Table 46 and Table 44). 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 45). 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 44), 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 (7.3.1) 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. This is because 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.

7.4.2 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 45). 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.

Similar to the coral impacts discussion in the previous section, the canyon zones will clearly 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.

7.4.3 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 constrained, 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 provide habitat for fishery species, there may be long-term benefits to fisheries and society, but these are difficult to project.

7.4.3.1 **Fishery impacts**

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; p. 312).

7.4.3.1.1 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 7.1.3.2). 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 Section 13 (p. 424 onward).

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 59), and annual revenue attributed to the Monument canyons is between $170-400K, averaging $298K (Figure 60). 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 59). 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 60). 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 61), 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 62). 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 10 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 63 and Figure 64). 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 55 and Figure 66, 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.

7.4.3.1.2 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 67. 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 67). 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 69), 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 67 and Figure 68). 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 63 and Figure 64 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 69 and Figure 70 present 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 suggest 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.

7.4.3.1.3 ASMFC survey

The ASFMC survey of Area 3 lobster permit holders (Section 7.1.3.2) 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 63, Figure 64).

7.4.3.1.4 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 61). 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).

7.4.3.1.5 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.

7.4.3.1.6 Summary of fishery impacts

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 suggests it can provide a more nuanced spatial analysis when compared to the VTR, and suggests no substantial scallop effort in the region. Though the VMS analysis does indicate bottom trawl effort in the region, the percentage of total effort expended by a permit this represents is low for the vast majority of individuals fishing in the region. Nevertheless, when non-Monument and Monument discrete canyon zones are summed, both the VMS and VTR analysis suggests 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 waters falling within the discrete canyon zones. Pots seem to represent the higher exposure rates when compared to MBTG, indicating that fishing gear restriction Option 2 would likely mitigate a subsantail portion of these impacts.

Figure 59 – Revenue by gear type attributed to the discrete non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), 2010-2015, as derived from VTR.

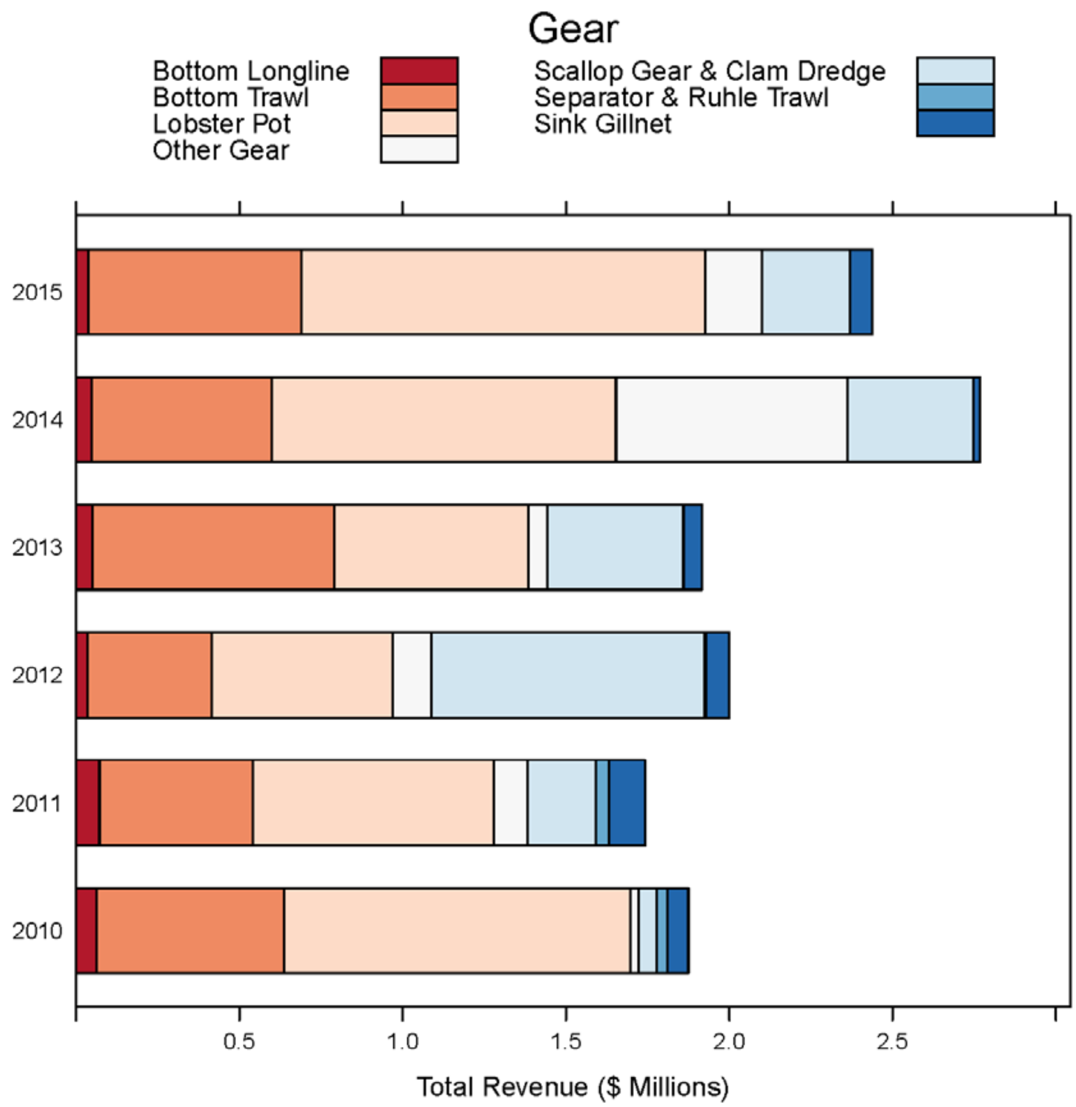


Figure 60 – Revenue by gear type attributed to the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), 2010-2015, as derived from VTR.

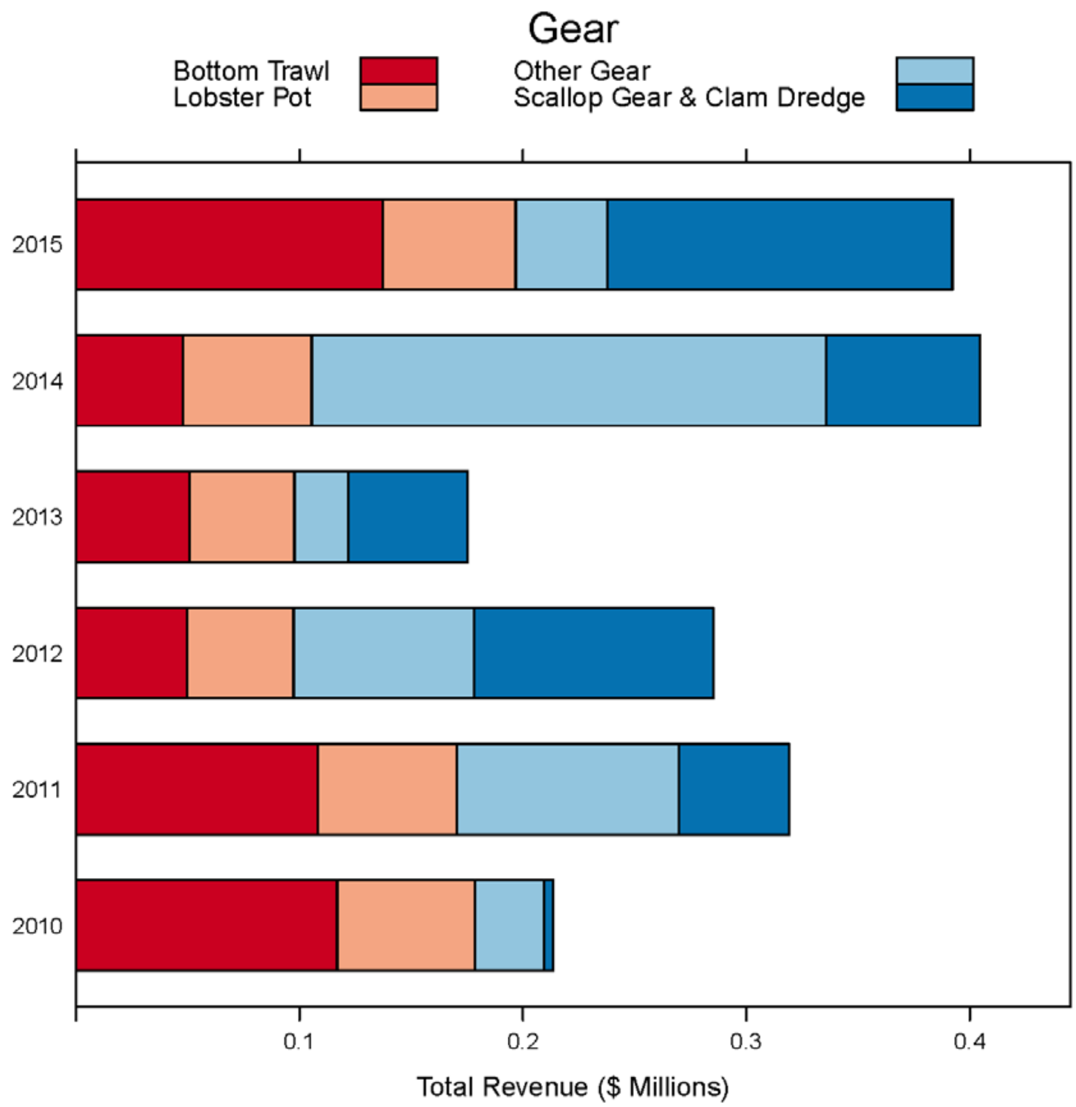


Figure 61 – Revenue by species (top 10) attributed to the discrete non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), 2010-2015, as derived from VTR.

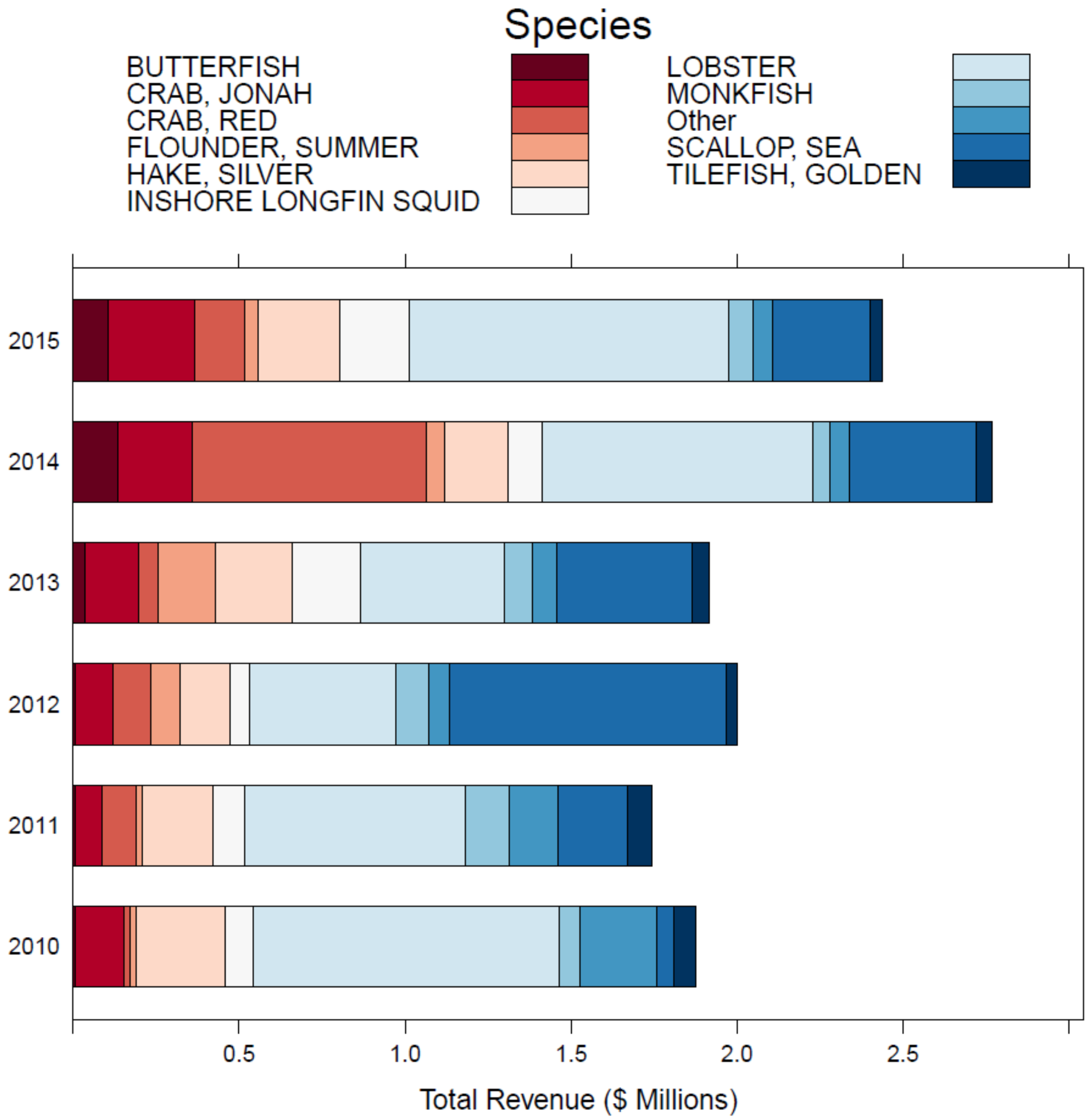


Figure 62 – Revenue by species (top 10) attributed to the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), 2010-2015, as derived from VTR.

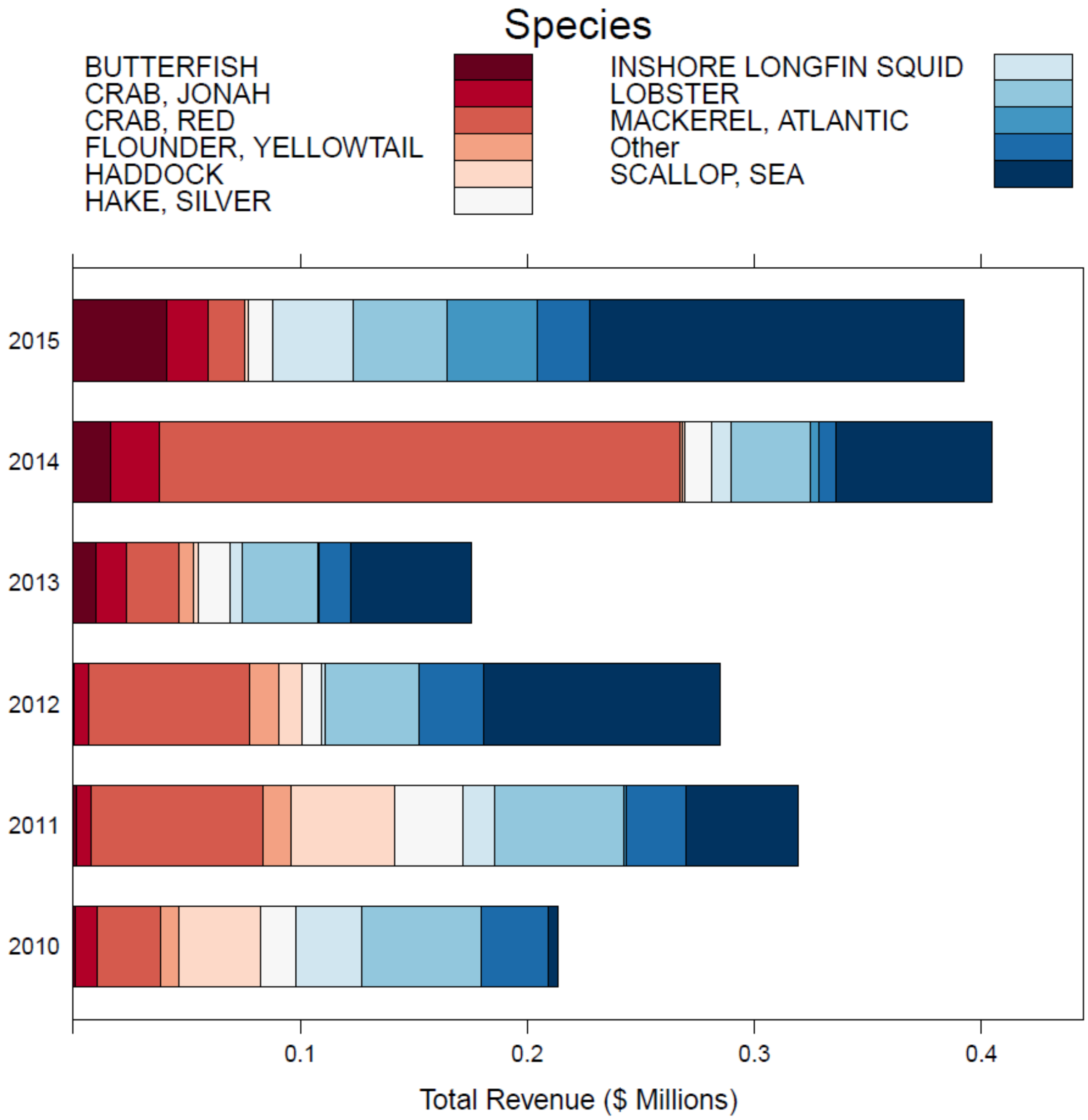


Figure 63 – Percent of vessel owner revenue attributed to the discrete non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), 2013-2015, as derived from VTR.

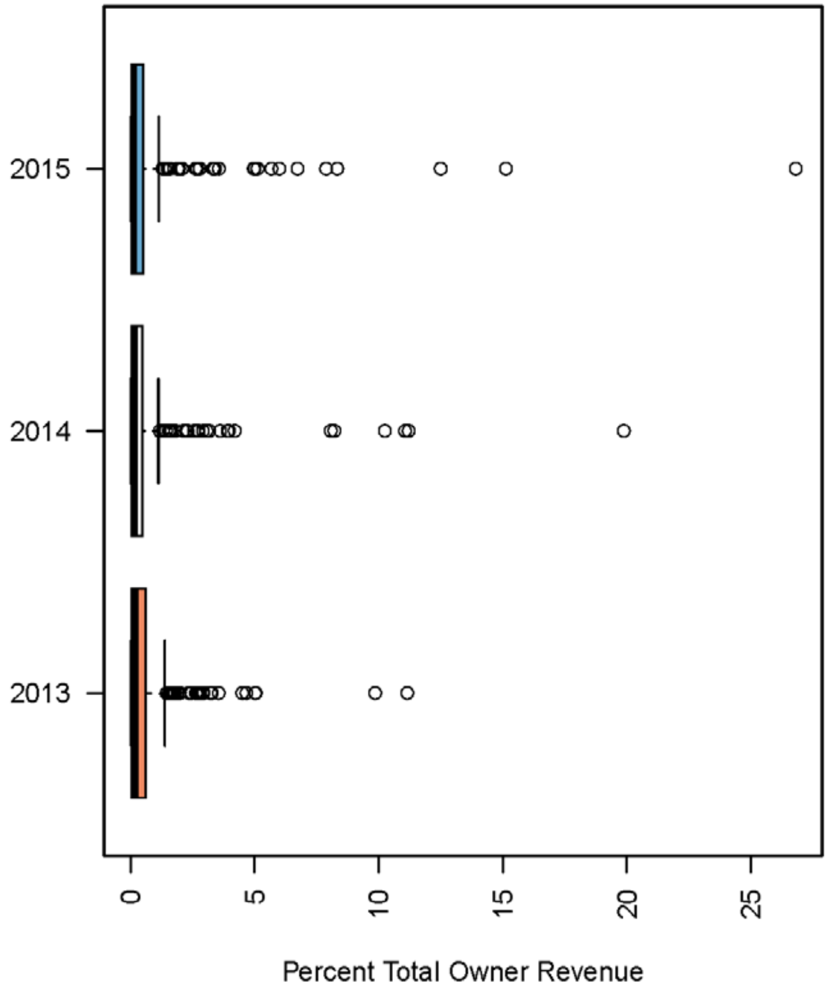


Figure 64 – Percent of vessel owner revenue attributed to the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), 2013-2015, as derived from VTR.

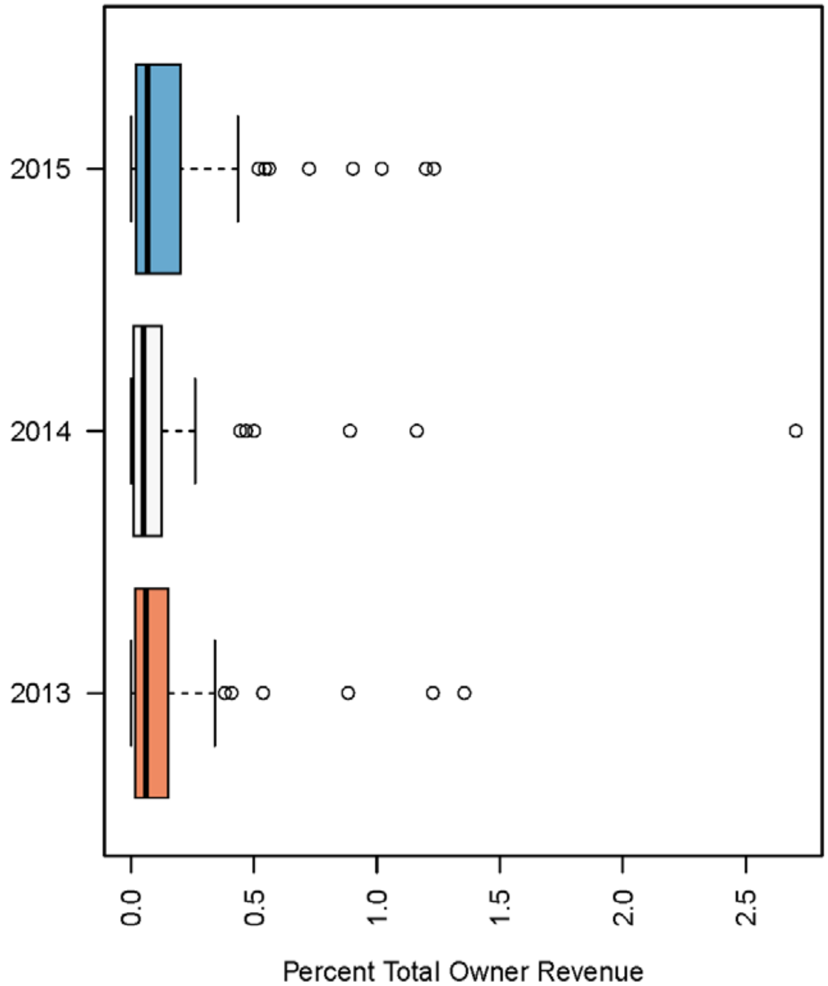


Figure 65 – Percent of vessel owner revenue attributed to MBTG in the discrete non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), 2013-2015, as derived from VTR

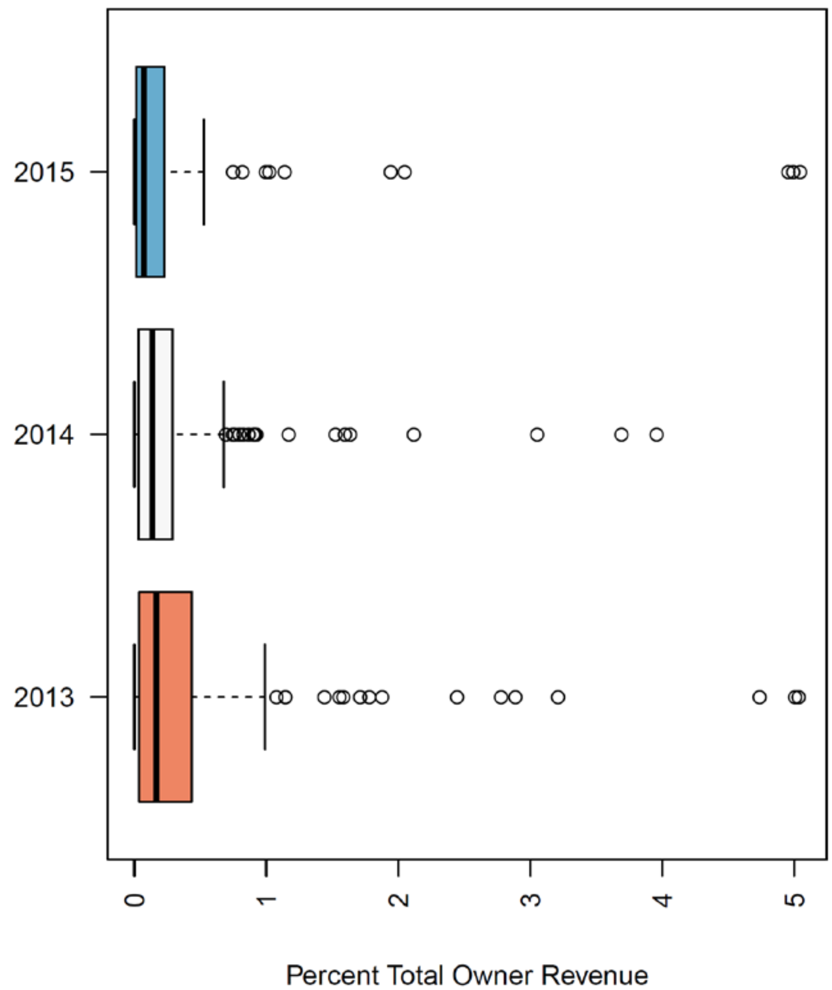


Figure 66 – Percent of vessel owner revenue attributed to MBTG in the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), 2013-2015, as derived from VTR.

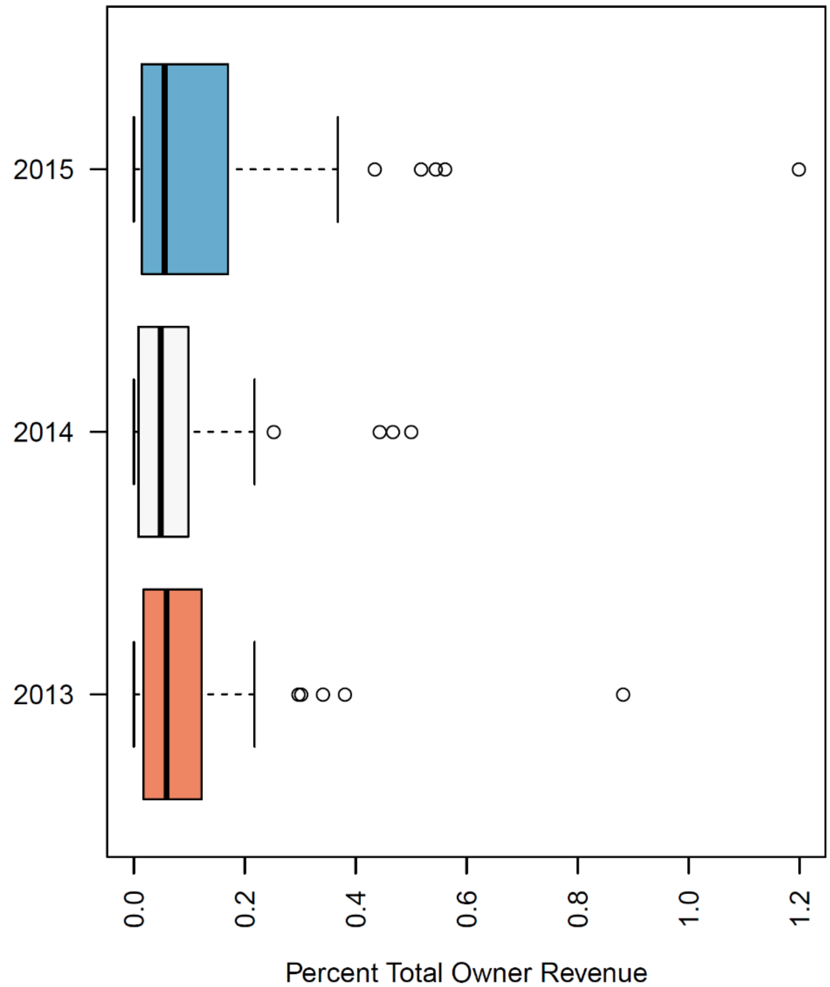


Table 67 - Percentage of VTR trips, by gear type attributed to the discrete canyon coral zones south of Georges Bank, that have VMS coverage, 2010-2012.

		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 68 – 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 67 – 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.

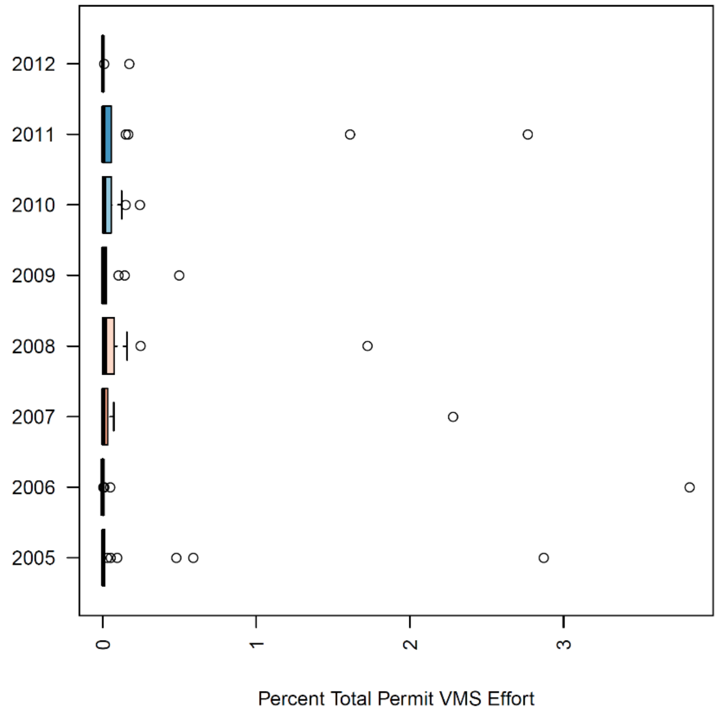


Figure 68 – Percent of total annual permit fishing activity attributed to the non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), between 2005 and 2012, as derived from VMS.

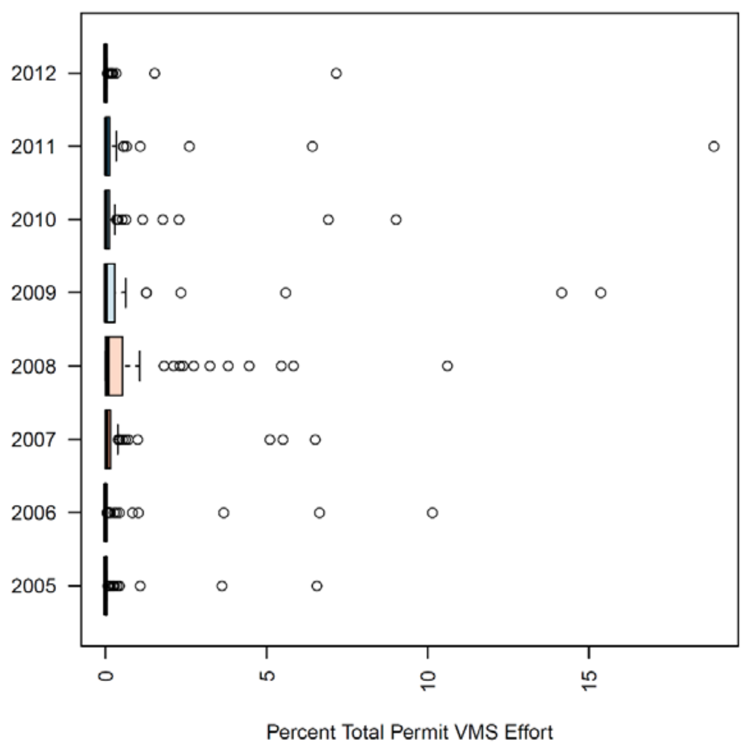


Figure 69 – Percent of total annual permit fishing activity attributed to MBTG within the discrete Monument canyons (Oceanographer, Filebottom, Chebacco, Gilbert, Lydonia), between 2005 and 2012, as derived from VMS.

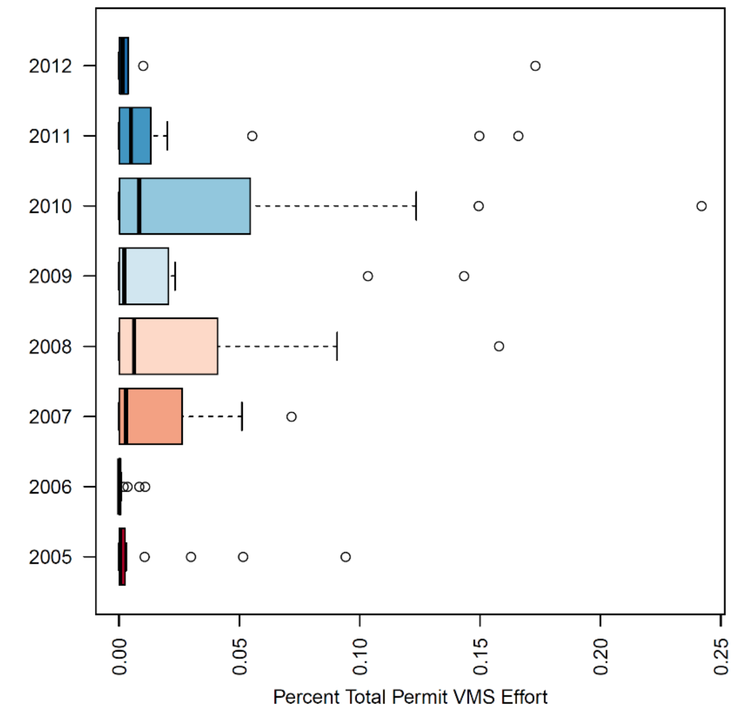
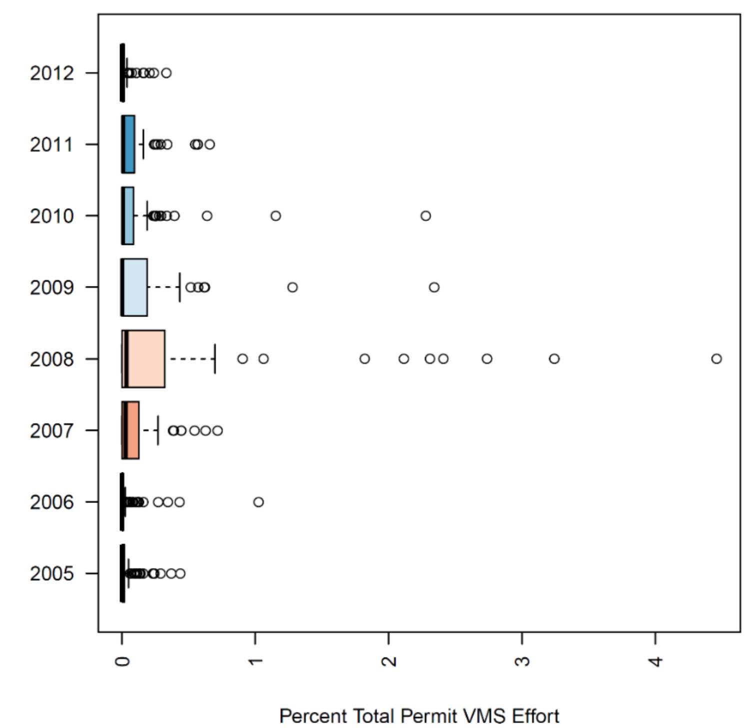


Figure 70 – Percent of total annual permit fishing activity attributed to MBTG within the non-Monument canyons (Alvin-Heel Tapper, Powell-Heezen), between 2005 and 2012, as derived from VMS.



7.4.3.2 Fishing community impacts

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 69 and Table 69, 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 69).

Table 69 - 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 64).

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 28). 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 70). 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 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-high for Newport (Table 28). 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 70 – 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	$21	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.

7.4.3.3 Sociocultural impacts

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.

7.4.4 Impacts on protected resources

To be completed.

7.5 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 precluded from the zones (Section 4.3, Table 71). 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 71 - 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

7.5.1 Impacts on deep-sea corals

Corals have been recorded on the seamounts in both older and recent data (Table 42 and Table 43). All four types of corals are known to occur within the management zones. The seamounts are not within the footprint of the habitat suitability model. Because fishing is not known to 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.

7.5.2 Impacts on managed species and essential fish habitats

With the exception of red crab, 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.

7.5.3 Impacts on human communities

Under this alternative, coral zones would be established around four seamounts, with options for which gear types would be precluded 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, but 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 precluded 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.

7.5.3.1 Fishery impacts

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.

7.5.3.1.1 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 7.1.3.2). Maps of revenue by gear type and species are in Section 13 (p. 424 onward).

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 Section 13 (p. 424 onward).

Revenue by gear

Annual revenue by fishing attributed to the seamount coral zones ranges from $30K-65K, averaging $46K (Figure 71). 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.

Species landed

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 74). 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 75).

7.5.3.1.2 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 72). 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.

7.5.3.1.3 ASMFC survey

The ASFMC survey of Area 3 lobster permit holders (Section 7.1.3.2) did not collect data for fishing in depths below 500 m (ASMFC 2017). Thus, the survey provides little insight into fisheries on the seamounts.

7.5.3.1.4 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.

7.5.3.1.5 Summary of fishery impacts

The impacts to the fishing industry are expected to be negligible. Both the VTR and VMS analyses suggest that recent fishing with bottom-tending gear does not occur frequently within the seamount zone, 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 seamounts alternative, the low VTR-derived revenue values for the lobster pot and other gear categories versus the number of trips and permits estimated to have fished in the vicinity of the seamounts suggests that the probability of these trips actually occurring in the region is low.

Figure 71 – Revenue by gear type attributed to the four seamount coral zones, 2010-2015, as derived from VTR.

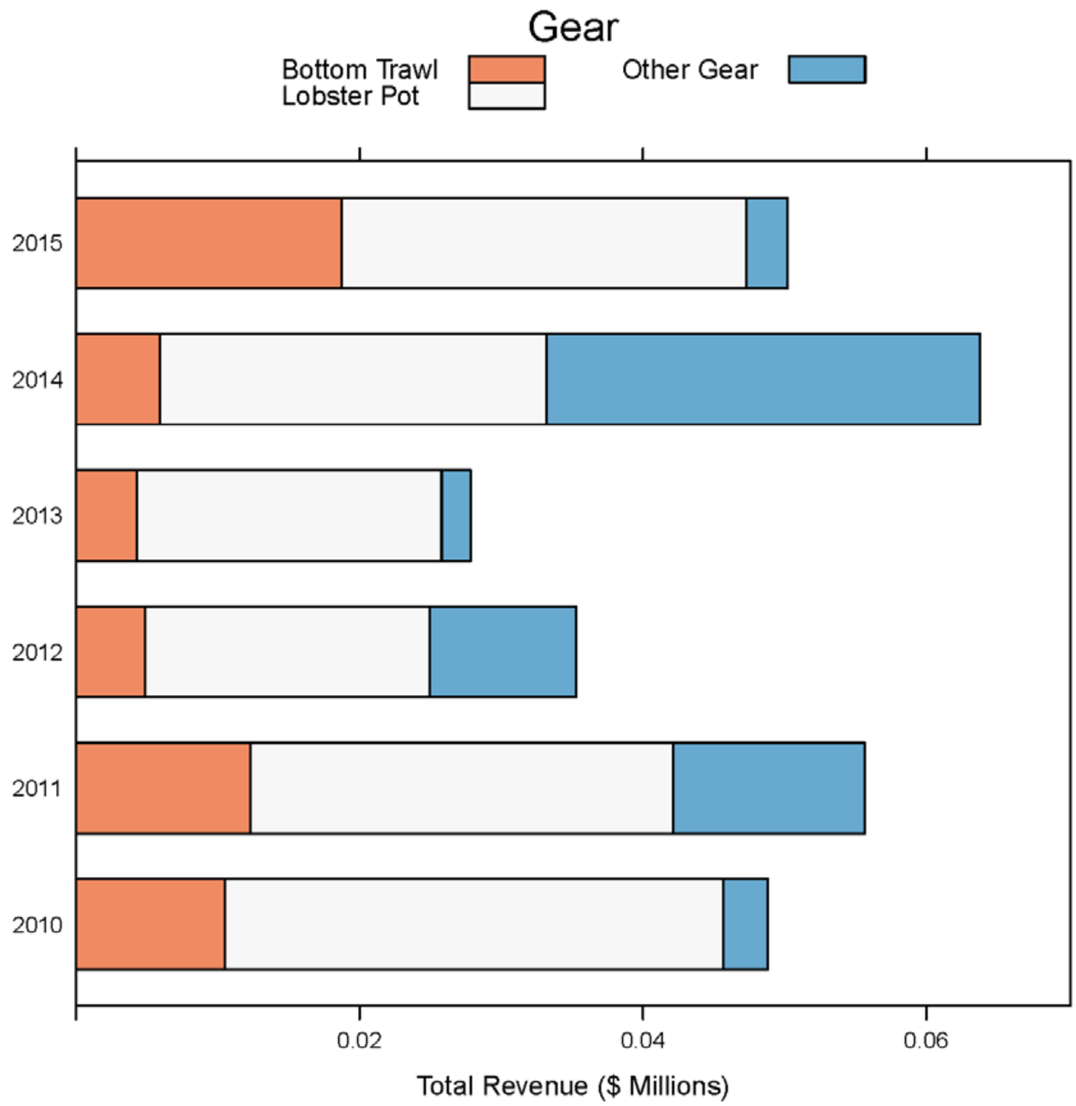


Figure 72 – Trips by gear type attributed to the four seamount coral zones, 2010-2015, as derived from VTR.

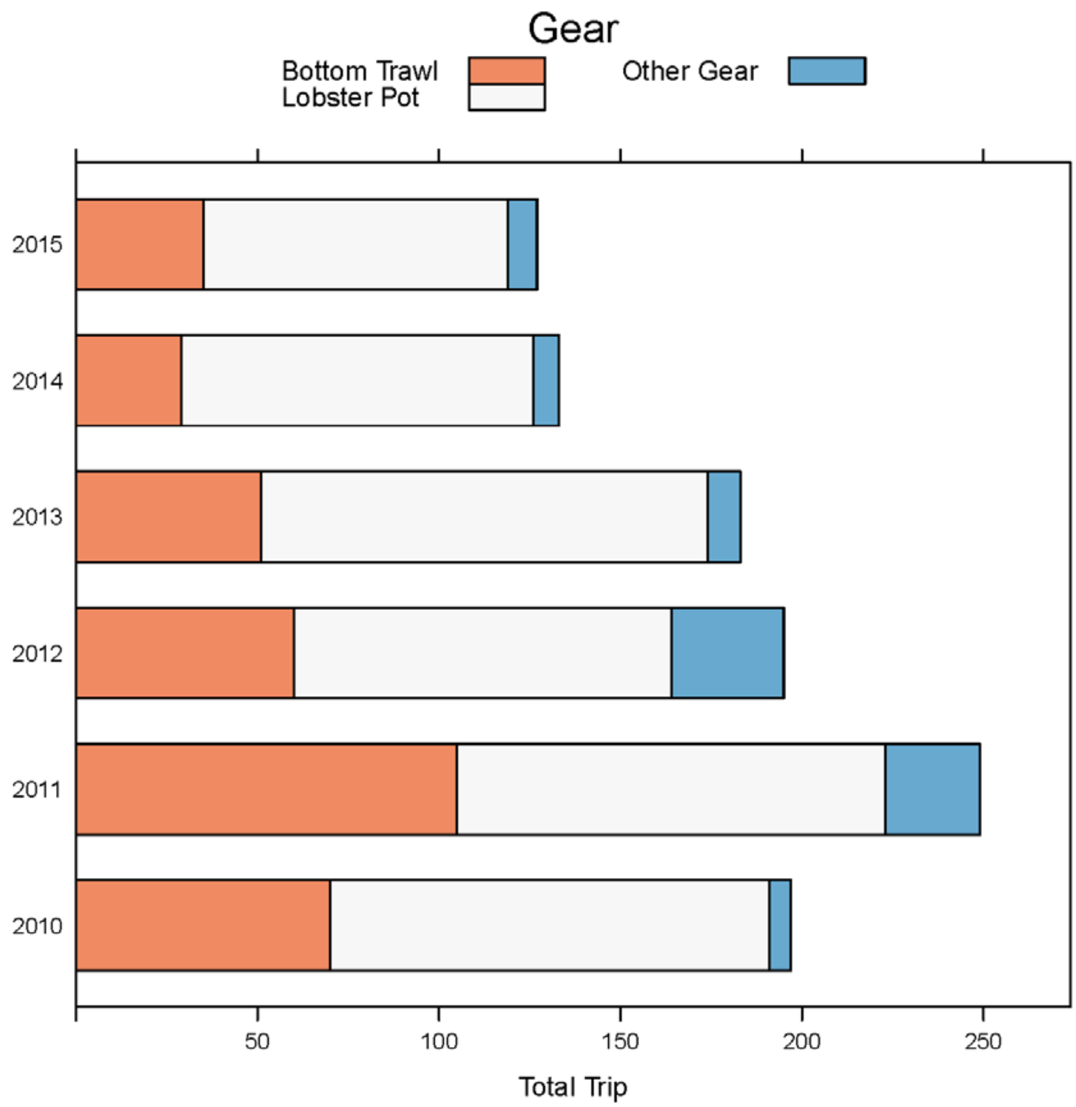


Figure 73 – Permits by gear type attributed to the four seamount coral zones, 2010-2015, as derived from VTR.

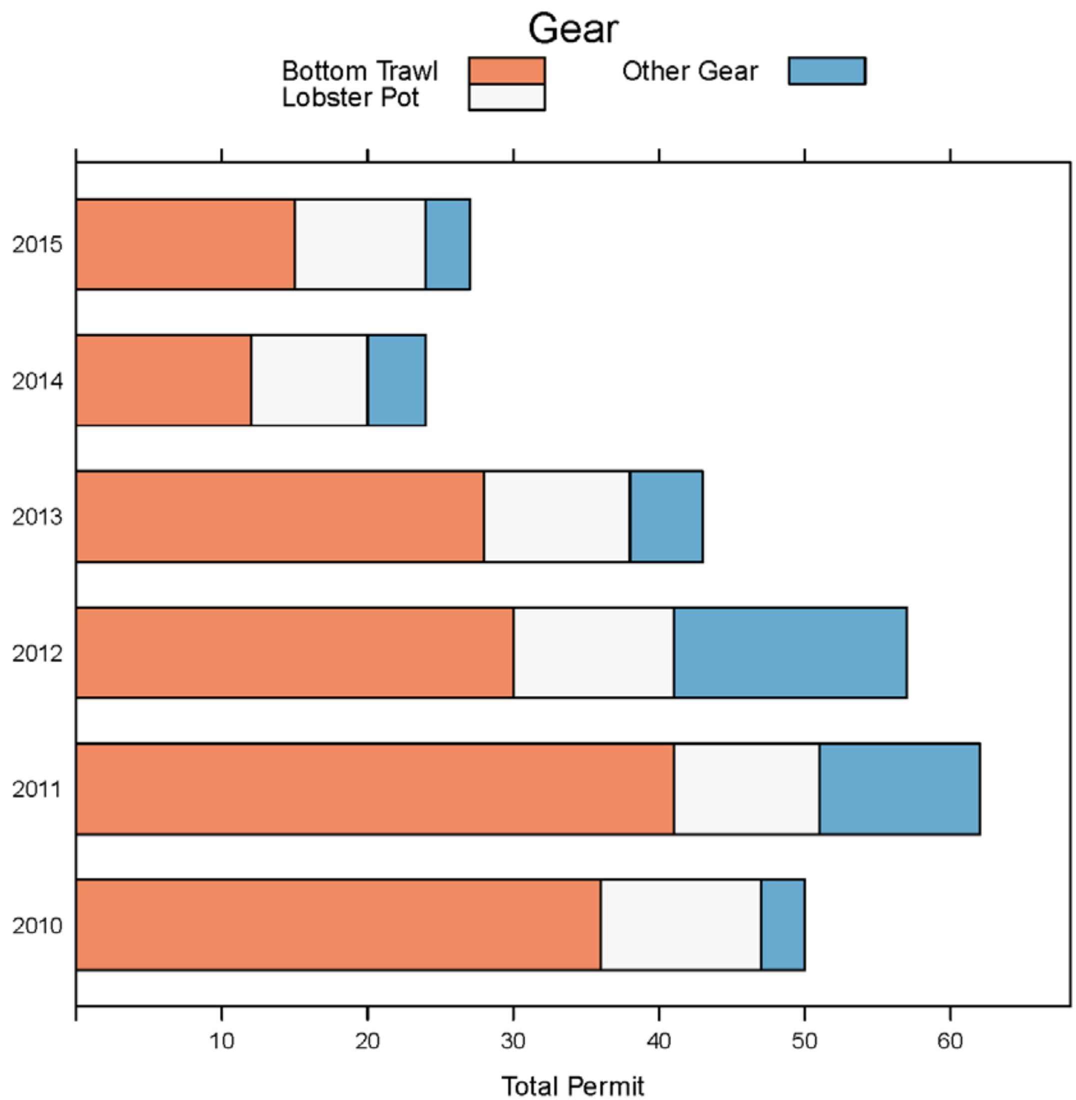


Figure 74 – Revenue by species (top 10) attributed to the four seamount coral zones, 2010-2015, as derived from VTR.

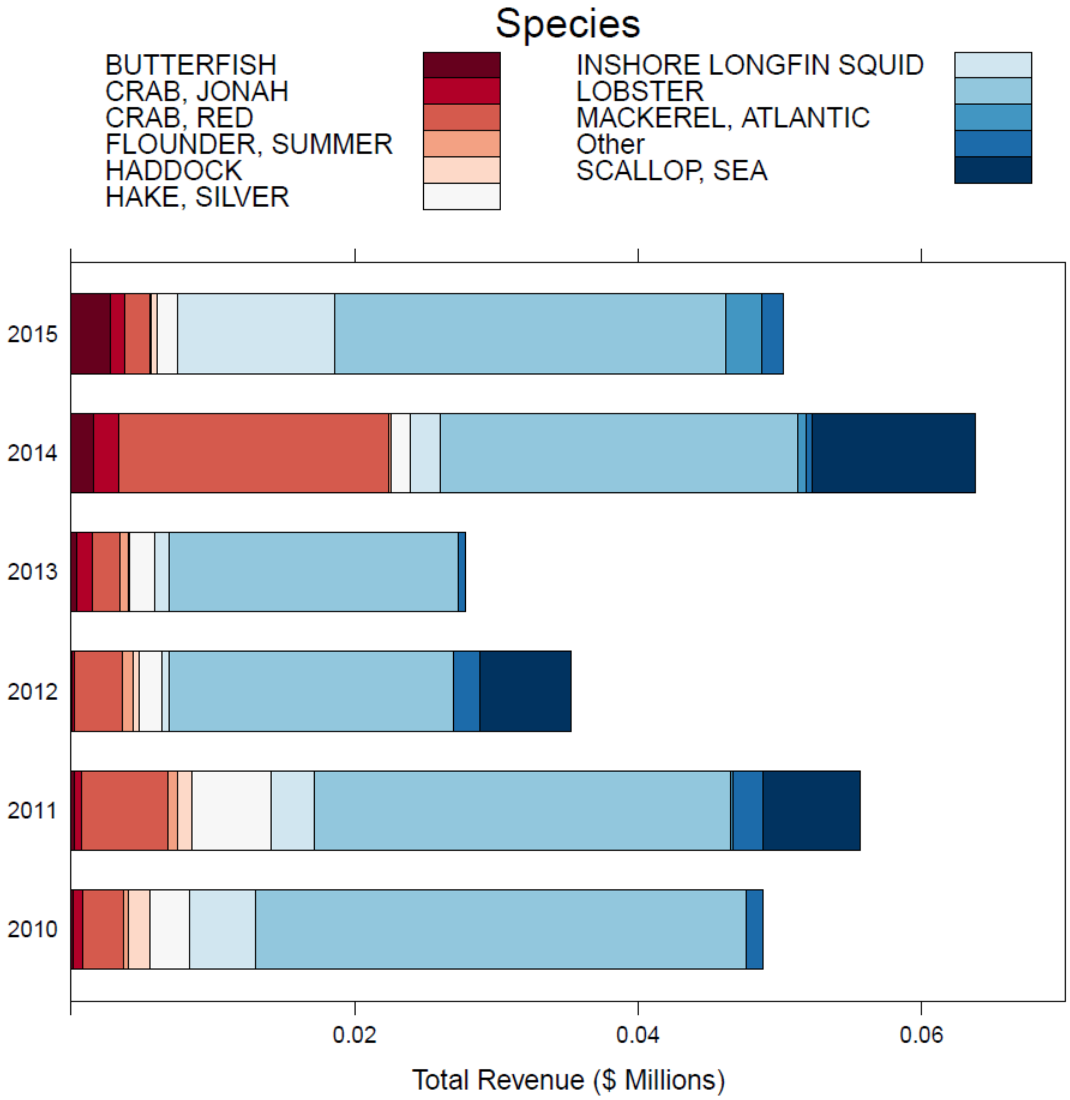


Figure 75 – Percent of total owner revenue attributed to the seamount coral zones, 2013-2015, as derived from VTR.

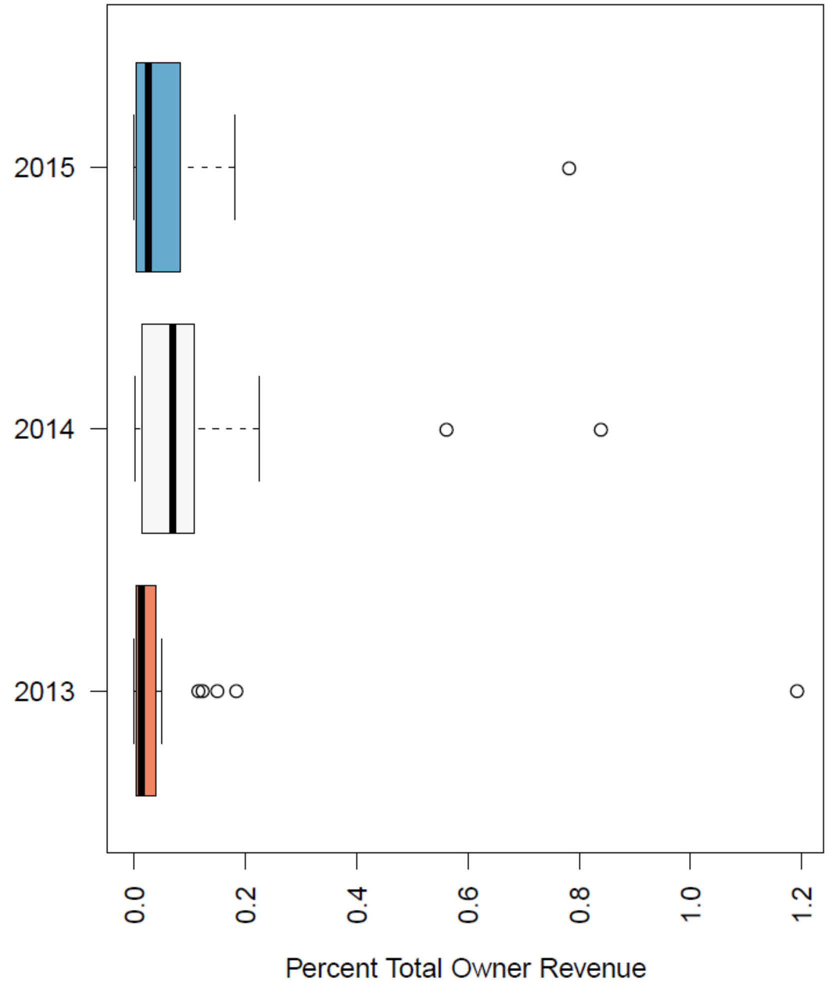


Table 72 – Percentage of VTR trips, by gear types attributed to the seamount zones that have VMS coverage, 2010-2012.

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%

7.5.3.2 Fishing community impacts

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 70, 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 as discussed in Section 7.5.3.1, 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 73).

Table 73 – 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 28). 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.

7.5.3.3 Sociocultural impacts

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.

7.5.4 Impacts on protected resources

To be completed.

7.6 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 zones and options for which gear types would be precluded from the zone (Table 74). 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 74 – 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.	

7.6.1 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 43, 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 water depths (Table 45), the smaller Option 2 boundary focuses on areas around the dive sites with steep slopes (Map 31). These steep terrain features are thought to be most likely to contain coral habitats. Thus, while the larger Option 1 boundary is more precautionary, and will more certainly 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 7.6.3), 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 6.5.3). 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 a mobile bottom-tending gear restriction is adopted in the zone (gear restriction Option 2), zone designation would have indirect, slightly positive impacts on coral habitats. While there would be limited if any reductions in direct impacts of gear on corals, because mobile bottom-tending gear usage at Mt. Desert Rock appears to be very limited, designation of the site would highlight the importance of the area 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. The same impacts would be expected if the Council selects a restriction on all bottom-tending gears, but exempts trap fisheries.

Selection of gear restriction Option 1 with sub-option B (BTG closure with an exemption for trap fisheries) would likely have similar impacts to adoption of the zone with gear restriction Option 2 (MBTG closure). Based on available VTR data, effort with non-mobile bottom-tending gears (i.e. sink gillnets or bottom longlines) appears to be very limited at this site.

7.6.2 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 magnitude of positive impacts, while a smaller zone (Option 2) with less-restrictive management approaches (Option 2) will have a smaller magnitude of positive impacts. As discussed in the previous section, 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 that 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 have a lesser degree of overlap (below 25% of the zones, by area), including 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.

7.6.3 Impacts on human communities

Under this alternative, a coral zone would be established just southwest of Mt. Desert Rock, with two options for the size of the zones and options for which gear types would be precluded from the zones. 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. These negative impacts would be additive to the negative fishery impacts of No Action, though the No Action areas do not overlap Mt. Desert Rock and the directly impacted fishermen are likely to be distinct from those fishing south of Georges Bank. As with No Action, 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 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.

7.6.3.1 Fishery impacts

The Mt. Desert Rock zones are located in federal waters between 3-12 nm from shore within the Maine Lobster Management Zones B and Federal Lobster Management Area 1 (Map 46), thus, a federal permit is required to fish in the zones. Fishing activity in the area has been dominated by the lobster fishery, whereas the fisheries in the deeper zones considered (e.g., canyon/slope region) have been more diverse. Due to data limitations, it is impossible to know the true amount of fishing activity that has occurred within the Mt. Desert Rock coral zone. Thus, multiple approaches are used to estimate recent fishing activity and characterize the potential fishery impacts of the alternatives under consideration.

7.6.3.1.1 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 49, 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, 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 this 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.

7.6.3.1.2 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 7.1.3.2). Maps of revenue by gear type and species are in Section 13 (p. 424 onward).

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 requirement. The 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 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

For 2010-2015, annual revenues from VTR-reporting vessels ranges from about $20K-40K for all bottom tending gear, averaging $36K (Figure 76). This is likely an underestimate of true revenue recently generated from this zone, given the caveats above. The vast majority of revenue (93%), number of trips, and number of permits is from fishing with fixed gear, primarily lobster pots. Lobster generate the vast majority of species revenue within the Option 1 zone (Figure 77). Thus, although an underestimate of the magnitude of impacts, the VTR data suggest that the lobster fishery would likely be most impacted by the Option 1 zone, as compared to other fishing modes. The recent revenue attributed to fishing with mobile bottom-tending gear from this zone is 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. Conversely, given the dominance of lobster and lobster pots in the VTR analysis, fishing gear restriction Option 1 Sub-option B and Option 2 would be expected to mitigate the vast majority of impacts to the commercial fishery active in the region, while negating any coral conservation value of the management measure.

Option 2

For 2010-2015, annual revenues from VTR-reporting vessels ranges from about $5K-20K for all bottom tending gear, averaging $14K (Figure 78). This is likely an underestimate of true revenue recently generated from this zone, given the caveats above. As for Option 1, fixed gear dominates revenue, trips, and permits, lobsters are the primary revenue generator (Figure 79), and the lobster fishery would likely be most impacted by the Option 2 zone (depending on the gear restriction selected). The recent revenue attributed to fishing with mobile bottom-tending gear from this zone is about $1K 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. Conversely, given the dominance of lobster and lobster pots in the VTR analysis, fishing gear restriction Option 1 Sub-option B and Option 2 would be expected to mitigate the vast majority of impacts to the commercial fishery active in the region, while negating any coral conservation value of the management measure.

The low levels of VMS coverage within the inshore lobster pot fishery negates the use of this data source in assessing the potential impacts of this alternative on permit owners utilizing the area. Although there is some very small amount of bottom trawl effort calculated by VMS polls to fall within both Mt. Desert Rock 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 Mt. Desert Rock coral zone Option 1, with 0.8 hours of fishing effort calculated to have fallen within its bounds. Although some limited access scallop VTR polls fall within the Outer Schoodic Ridge zone, it cannot be reported due to confidentiality reasons.

7.6.3.1.3 Impacts additive to the current Whale Take Reduction rules

The Atlantic Large Whale Take Reduction Plan (ALWTRP) is designed to reduce fishery interactions with, and injuries and deaths of, large whales. In Eastern Maine waters, the primary concern for potential interactions with large whales is with lobster trap gear, and 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. 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 would likely 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).

7.6.3.1.4 Summary of fishery impacts

The impacts to the fishing industry are expected to be negative, but more negative for zone Option 1 relative to zone Option 2. It is impossible to know the true amount of revenue generated within the Mt. Desert Rock coral zones. Regardless of the data source examined, it is clear that lobster fishing is the predominant activity in the region which would be impacted by either Mount Desert Rock option, and that zone Option 2 likely mitigates some of these impacts on fishermen. The MEDMR data 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 Option 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.

Figure 76 – 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.

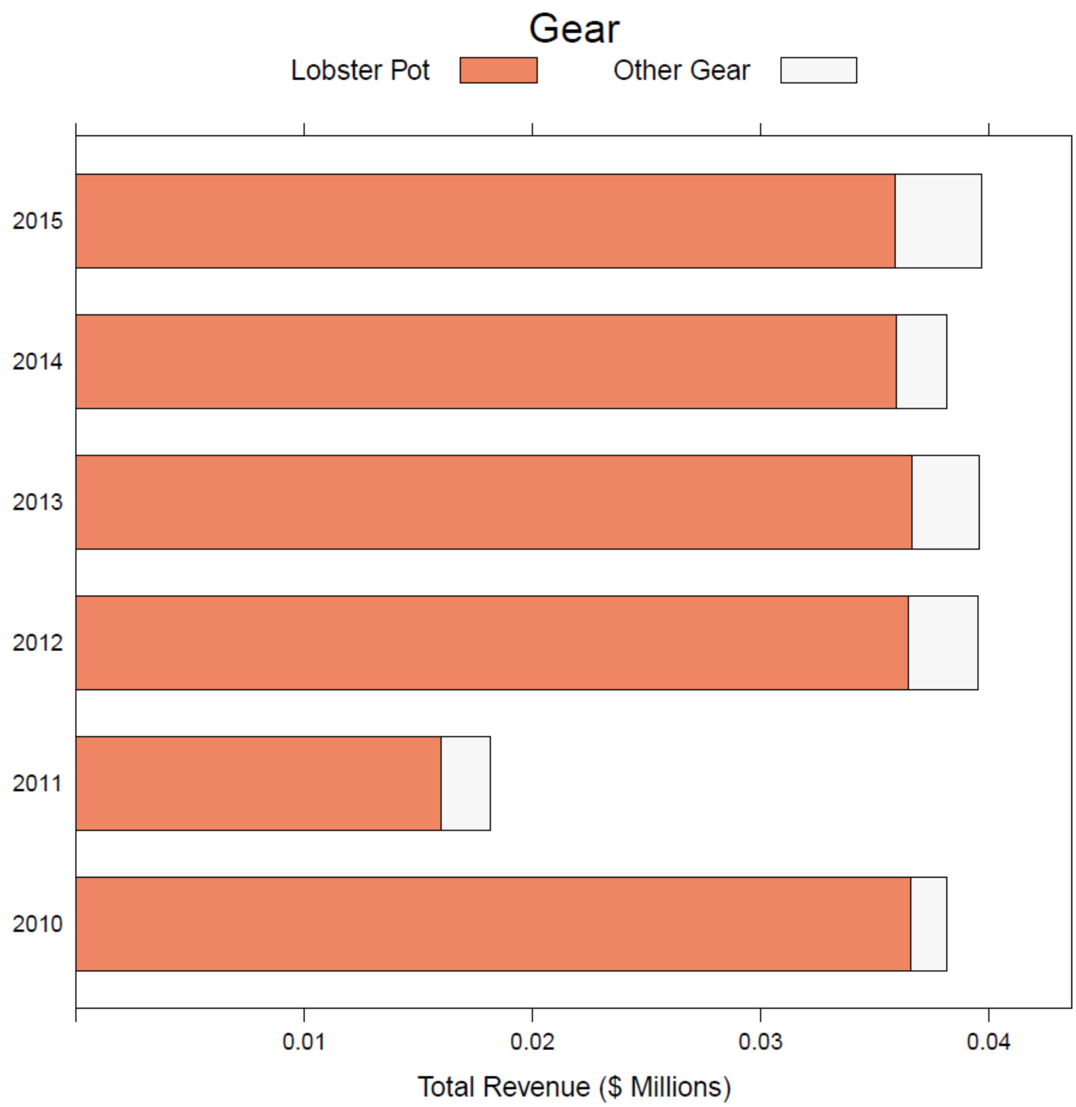


Figure 77 – VTR-derived revenue by species (top 10) within the Mt. Desert Rock coral zone Option 1, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.

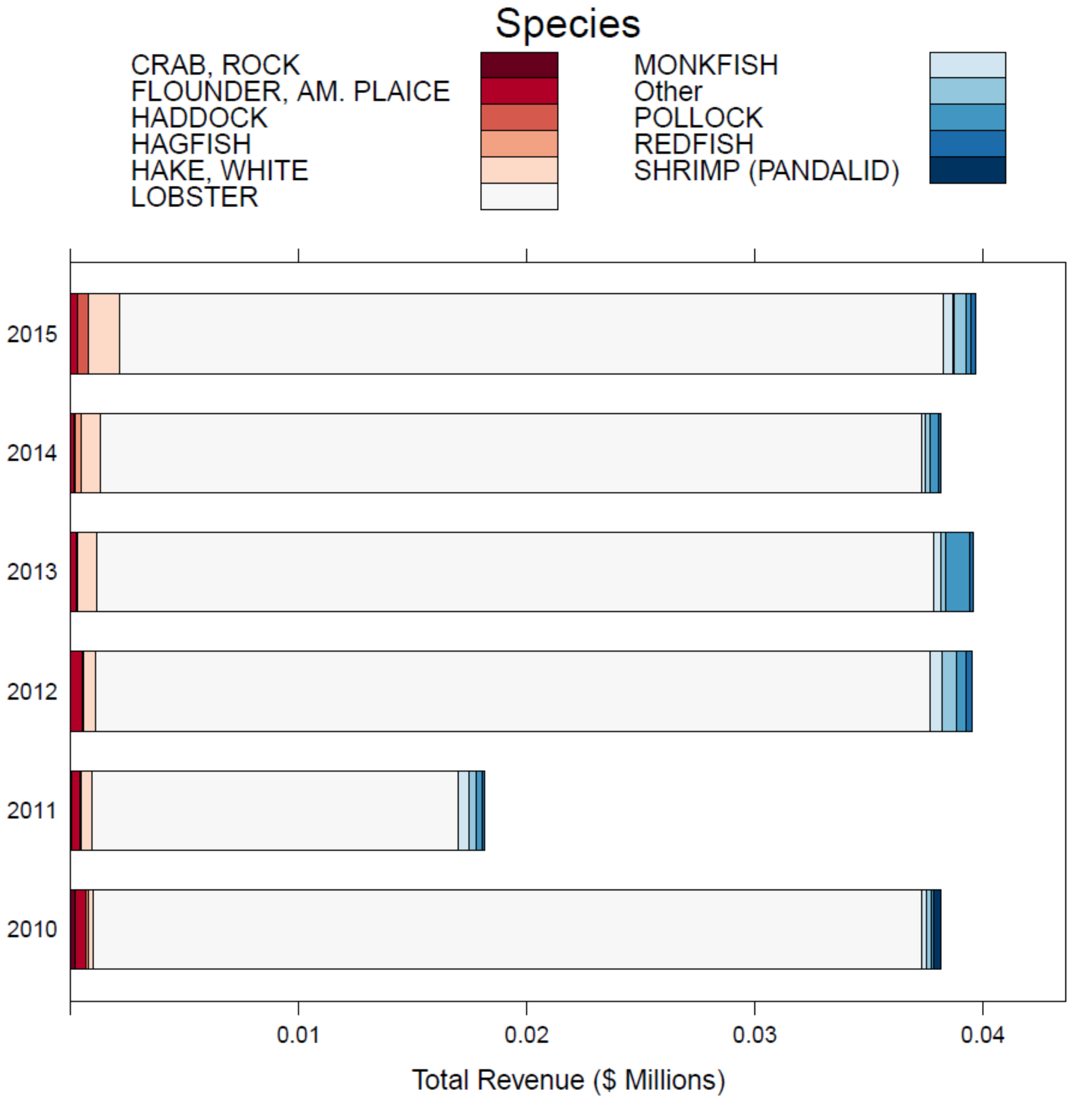


Figure 78 – VTR-derived revenue by gear type within the Mt. Desert Rock coral zone Option 2, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.

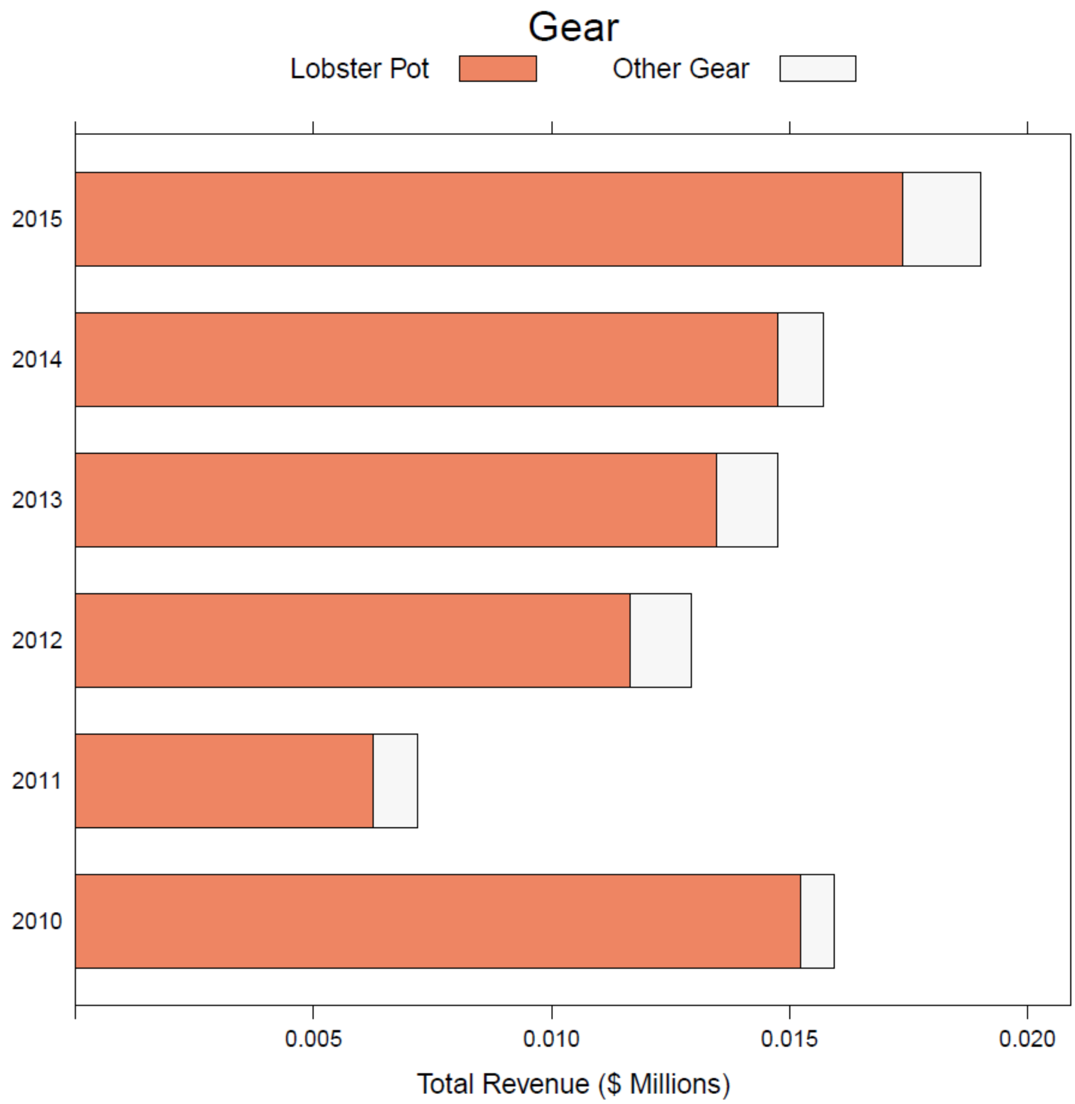
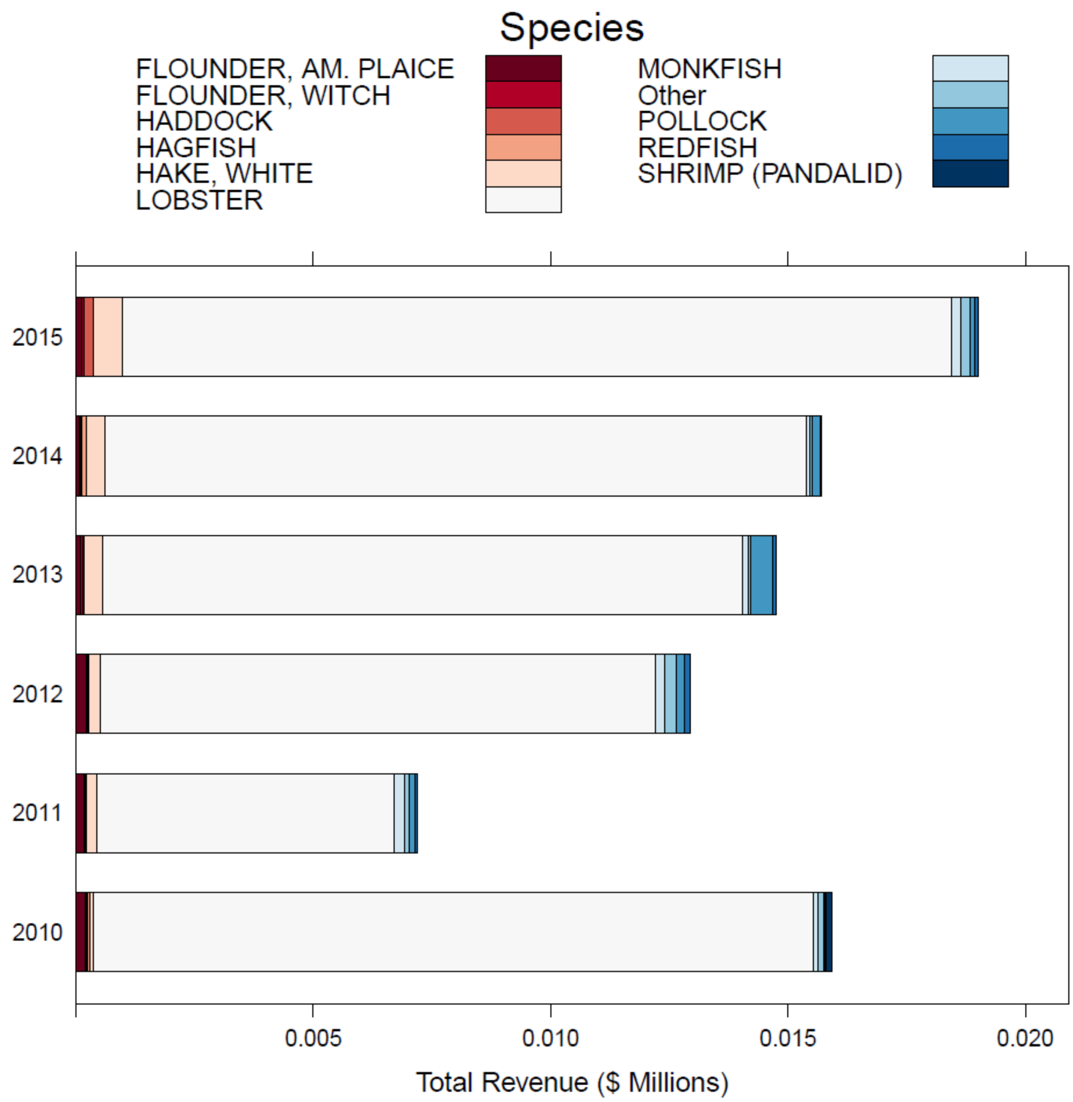


Figure 79 – VTR-derived revenue by species (top 10) attributed within the Mt. Desert Rock coral zone Option 2, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.



7.6.3.2 Fishing community impacts

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 Mt. Desert Rock coral zone options, as reported with VTRs.

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 28). 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 is becoming increasingly valuable in recent years. The area is fished year-round by a small number of fishermen and seasonally in late fall to spring, as lobstermen follow the seaward migration of lobsters in winter. Most of these vessels employ a captain and two crew members. Additionally, areas around the coral zone are fished heavily, so effort displacement would likely cause gear conflicts (ASMFC 2017).

7.6.3.2.1 Option 1

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 75).

The VTR analysis attributes recent revenue from VTR-reported trips to 117 permits landing in 30 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 75 – 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	$9K	$1K	23
New Bedford	$2K	$0.4K	8
Other (n=1)	$2K	$0.6K	17
Rhode Island	$0.3K	$0.1K	3
Total	**$213K**	**$36K**	**117**
MBTG ONLY			
Maine	$2K	$0.4K	25
Eastern	$0.3K	$0.1K	5
Mid-Coast	$0.8K	$0.8K	6
Southern	$1.1K	$0.2K	14
Portland	$1.1K	$0.2K	14
Massachusetts	$12K	$2K	40
Gloucester	$8.7K	$1.4K	22
New Bedford	$0.7K	$0.1K	6
Other (n-1)	$2.4K	$0.4K	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.

7.6.3.2.2 Option 2

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 2 are primarily located in Maine, with a small amount of activity attributed to ports in Massachusetts, Rhode Island, and other states (Table 76).

The VTR analysis attributes recent revenue from VTR-reported trips to 116 permits landing in 33 ports, and 86% 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 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 indicates such, that the area near the Mt. Desert Rock coral zones is 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 2 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 76 – 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.

7.6.3.3 Sociocultural impacts

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. 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.

7.6.4 Impacts on protected resources

To be completed.

7.7 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 74). 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.

Table 77 – 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.	

7.7.1 Impacts on deep-sea corals

Deep-sea corals are known to occur within the Outer Schoodic Ridge zone based on recent survey work (Table 43, Section 6.2.3.3). Lobster is the dominant fishing activity at the site (Section 7.7.3.1), so the degree to which coral zone designation has a positive impact on corals depends on the fishing restriction measures selected.

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). However, there are observed interactions between trap gear and corals in the Gulf of Maine (Section 6.5.3). We cannot use these observations to estimate coral bycatch rates in the lobster trap fishery or any fishery. 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 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.

7.7.2 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.

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, yellowtail flounder, red hake, silver hake, smooth skate, and thorny skate. Other species have a lesser degree of overlap (below 25% of the zones, by area), specifically Atlantic cod and Atlantic halibut. 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.

7.7.3 Impacts on human communities

Under this alternative, a coral zone would be established on the Outer Schoodic Ridge, with options for which gear types would be precluded from the zone. 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 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 Outer Schoodic Ridge, and the directly impacted fishermen are likely to be distinct from those fishing south of Georges Bank. As with No Action, 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 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.

7.7.3.1 **Fishery impacts**

The Outer Schoodic Ridge zone is located in federal waters between 3-12 nautical miles from shore within the Maine Lobster Management Zone A. The zone is in Federal Lobster Management Area 1 (Map 46), thus, a federal permit is required to fish in the zone. Fishing activity in this zone has been clearly dominated by the lobster fishery, whereas the fisheries in the deeper zones considered (e.g., canyon/slope region) have been more diverse. 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 thus characterize the potential fishery impacts of the alternatives under consideration.

7.7.3.1.1 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 49, 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).

7.7.3.1.2 VTR analysis

Vessel Trip Report data were used to estimate recent (2010-2015) fishing activity, reported with VTR, within the Outer Schoodic Ridge coral zone (method explained in Section 7.1.3.2). Maps of revenue by gear type and species are in Section 13 (p. 424 onward).

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 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. An area-based expansion similar to the one discussed above is problematic, given that the distribution of lobster fishing is unknown within both the management and coral zone, and there is no information to suggest that vessels submitting VTRs are representative of the fishery. The VTR results should be seen as a manner 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 80), 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 (Figure 81). 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. Thus, although expected to be an underestimate, the VTR data suggest that the lobster fishery would likely be most impacted by the Outer Schoodic Ridge zone (depending on the gear restriction selected). The recent revenue attributed to fishing with mobile bottom-tending gear from this zone is 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. Conversely, given the dominance of lobster and lobster pots in the VTR analysis, fishing gear restriction Option 1 Sub-option B and Option 2 would be expected to mitigate the vast majority of impacts to the commercial fishery active in the region, while negating any current conservation value to the management measure.

The low levels of VMS coverage within the inshore lobster pot fishery negates the use of this data source in assessing the potential impacts of this alternative on permit owners utilizing the area. 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. Although some limited access scallop VTR polls fall within the Outer Schoodic Ridge zone, these data cannot be detailed further due to confidentiality reasons.

7.7.3.1.3 Impacts additive to the current Whale Take Reduction rules

The Atlantic Large Whale Take Reduction Plan (ALWTRP) is designed to reduce fishery interactions with, and injuries and deaths of, large whales. In Eastern Maine waters, the primary concern for potential interactions with large whales is with lobster trap gear, and 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.

7.7.3.1.4 Summary of fishery impacts

The impacts to the fishing industry are expected to be negative. It is impossible to know the true amount of revenue generated within the Outer Schoodic Ridge coral zone. The MEDMR data attribute $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.

Figure 80 – 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.

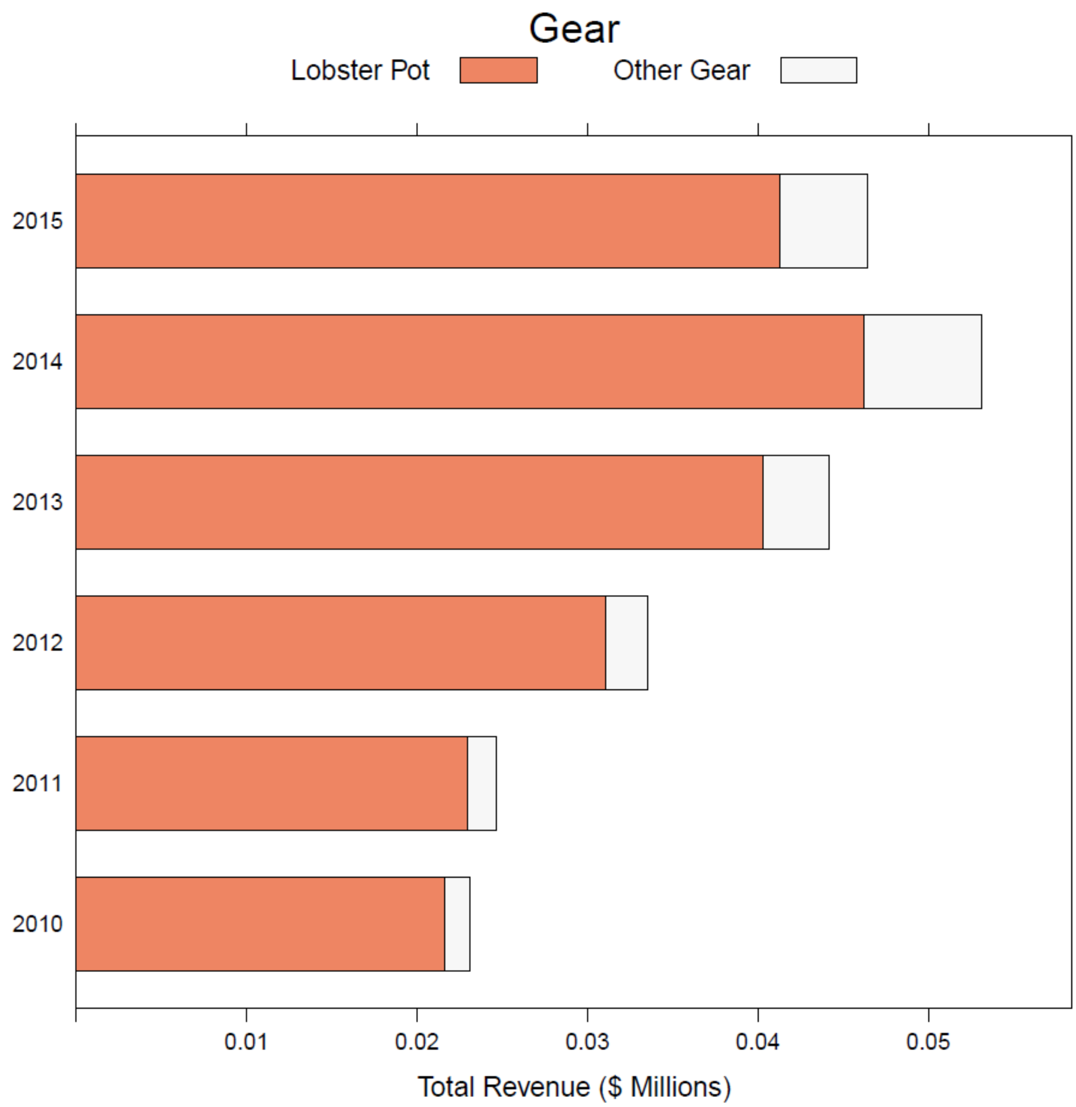
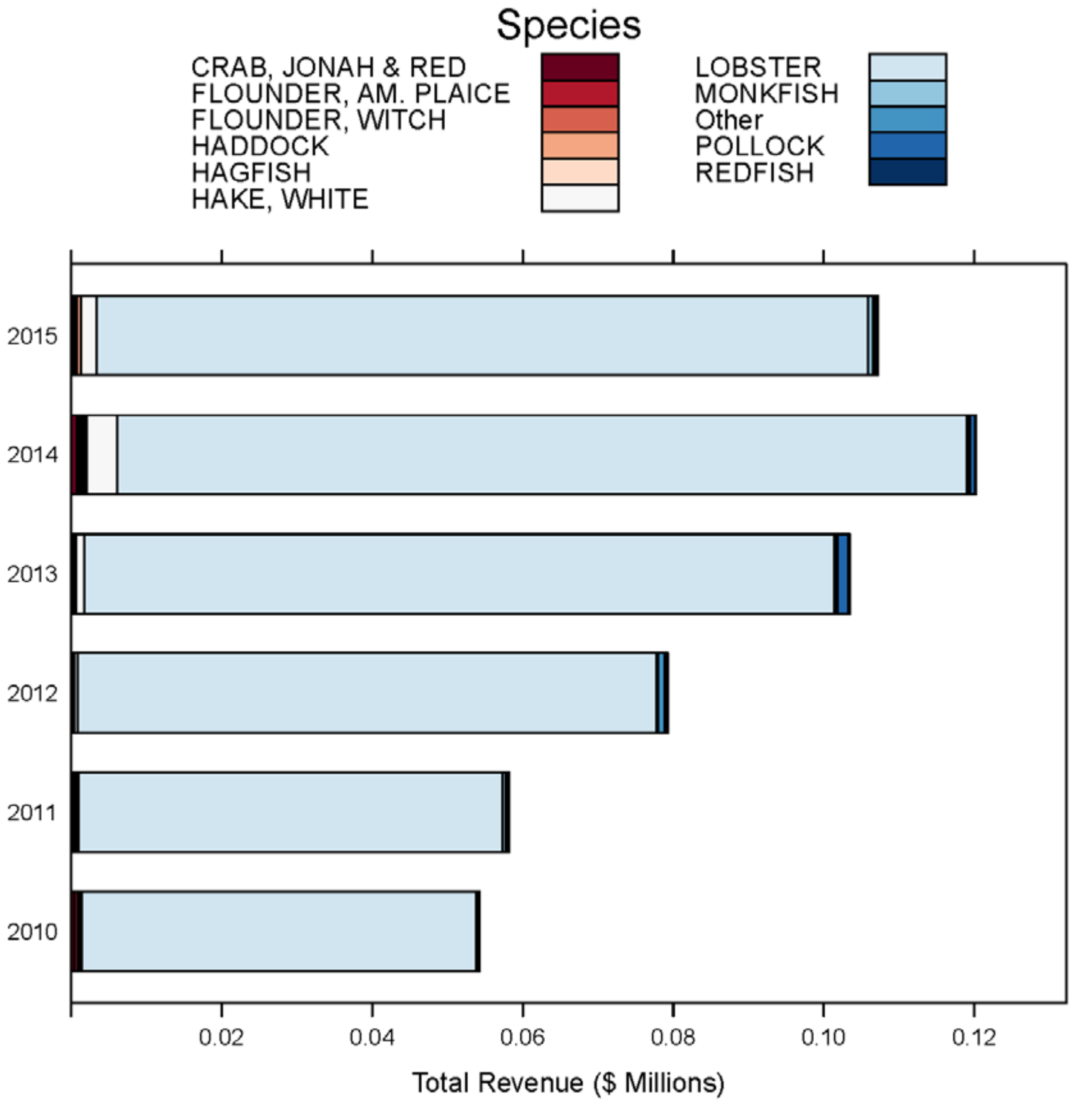


Figure 81 – VTR-derived revenue by species (top 10) within the Outer Schoodic Ridge coral zone, 2010-2015. A minority of federally-permited LCMA 1 vessels submit VTRs.



7.7.3.2 Fishing community impacts

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 78, 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, 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 78).

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 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 28). 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 78 – 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

7.7.3.3 Sociocultural impacts

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. 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.

7.7.4 Impacts on protected resources

To be completed.

7.8 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 size of the zones and options for which gear types would be precluded from the zones (Table 79). 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 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 79 - 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.	

7.8.1 Impacts on deep-sea corals

Deep-sea corals are known to occur within the Jordan Basin coral zones based on recent survey work (Table 43, Section 6.2.3.3). A small number of older soft coral records are also available for these sites (Table 42). 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 surveyed areas.

Low resolution seafloor terrain data limit the usefulness of the coral habitat suitability model in the Gulf of Maine, so unfortunately this dataset cannot be used to estimate the extent of coral habitats, either. (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 bore out 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. Lobster trapping is an important fishing activity at the site, although trawling and gillnetting for groundfish and monkfish also occur (Section 7.8.3). If the Jordan Basin zones are selected with closures 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). However, there are observed interactions between trap gear and corals in the Gulf of Maine (Section 6.5.3). We cannot use these observations to estimate coral bycatch rates in the lobster trap fishery or any fishery. 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 would have positive impacts on coral habitats. The same 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 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. There is a substantial body of evidence suggesting that trawl gears negatively impact corals, but fixed gear effects are not well studied (Section 6.5.2). Trawl bycatch of corals does occur in Jordan Basin (Section 6.5.3), but overall fishery-wide bycatch rates cannot be determined from these data, which are fairly limited.

7.8.2 Impacts on managed species and essential fish habitats

Designation of a series of coral 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 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 in the previous section, 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, haddock, pollock, white hake, witch flounder, red hake, silver hake, smooth skate, and thorny skate. Atlantic cod has 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.

7.8.3 Impacts on human communities

Under this alternative, four coral zones would be established in Jordan Basin, with two options for the size of the zones and options for which gear types would be precluded from the zones. 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. Should these zones close to fishing, 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.

7.8.3.1 Fishery impacts

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 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 Jordan Basin zones.

7.8.3.1.1 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 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 7.1.3.2). Maps of revenue by gear type and species are in Section 13 (p. 424 onward).

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 82), and generally increased through this time series. The recent 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 pot would be exempted under fishing gear restriction Option 1B, leaving primarily bottom trawls but also gillnets as the regulated gears currently fishing within the region.

Over the same period, revenue attributed to the four Jordan Basin zones Option 2, combined, ranged from $40K to $70K, averaging $50K (Figure 83), substantially lower than Jordan Basin Option 1, and generally increased through this time series. The recent revenue attributed to fishing with mobile bottom-tending gear from this zone is about 52% of the total (Figure 82), 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).

Species landed

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 84). 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 10 species in terms of revenue generally mirror those of Option 1, with a similar proportion across species, but overall a smaller magnitude (Figure 85). 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 owners

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 86). Fishing gear restriction Option 2 (MBTG only) presents a very similar distribution of exposure at the owner level (Figure 87).

The number of vessel owners with revenue attributed to the Jordan Basin coral zone Option 2 averages 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 88). The percent of owner revenue exposed under fishing gear restriction Option 2 (MBTG only) is similar in distribution to that of for all BTG (Figure 89).

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 gillnets 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 gillnets permits.

The lobster trip and permit data are not expanded like the lobster revenue data, so estimates for this gear could be low.

7.8.3.1.2 VTR vs. VMS comparison

The majority of trawl gear VTR trips in this area have 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. It is unknown whether these same levels of overlap between VMS and VTR trips existed prior to 2010, given that VMS coverage has not been consistent across time. 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 90 all BTG, Figure 91 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 86 all BTG, Figure 87 MBTG only). However, there are a small number of permits with up to 6% of their total effort in the area (Figure 90 all BTG, Figure 91 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%). Again, it is unknown whether these same levels of overlap between VMS and VTR trips existed prior to 2010, given that VMS coverage has not been consistent across time. 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 92) 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 83 all BTG, Figure 85 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 92 all BTG, Figure 93 MBTG only), which is slightly higher than the upper bound of the percent of owner revenue detailed in Figure 86, 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.

7.8.3.1.3 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 also indicated that the revenue attributed to these zones from the VTR analysis seem low (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 fishermen have developed agreements over time about sharing fishing grounds, so it may be difficult to adjust to new area closures. Species' habitat preference also constrains the fisheries (e.g., lobsters are not found on mud bottom). The participants indicated that the lobster fishery is territorial; a specific zone may only have been fished by one or two 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 86).

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 Jordan Basin zone (Figure 84, Figure 85; NEFMC, 2017).

7.8.3.1.4 Summary of fishery impacts

The impacts to the fishing industry are expected to be slightly negative, but more negative for Option 1 relative to Option 2. The fishing effort around Jordan Basin Option 1 & 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 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.

Figure 82 – VTR-derived revenue by gear type attributed to Jordan Basin Option 1, 2010-2015.

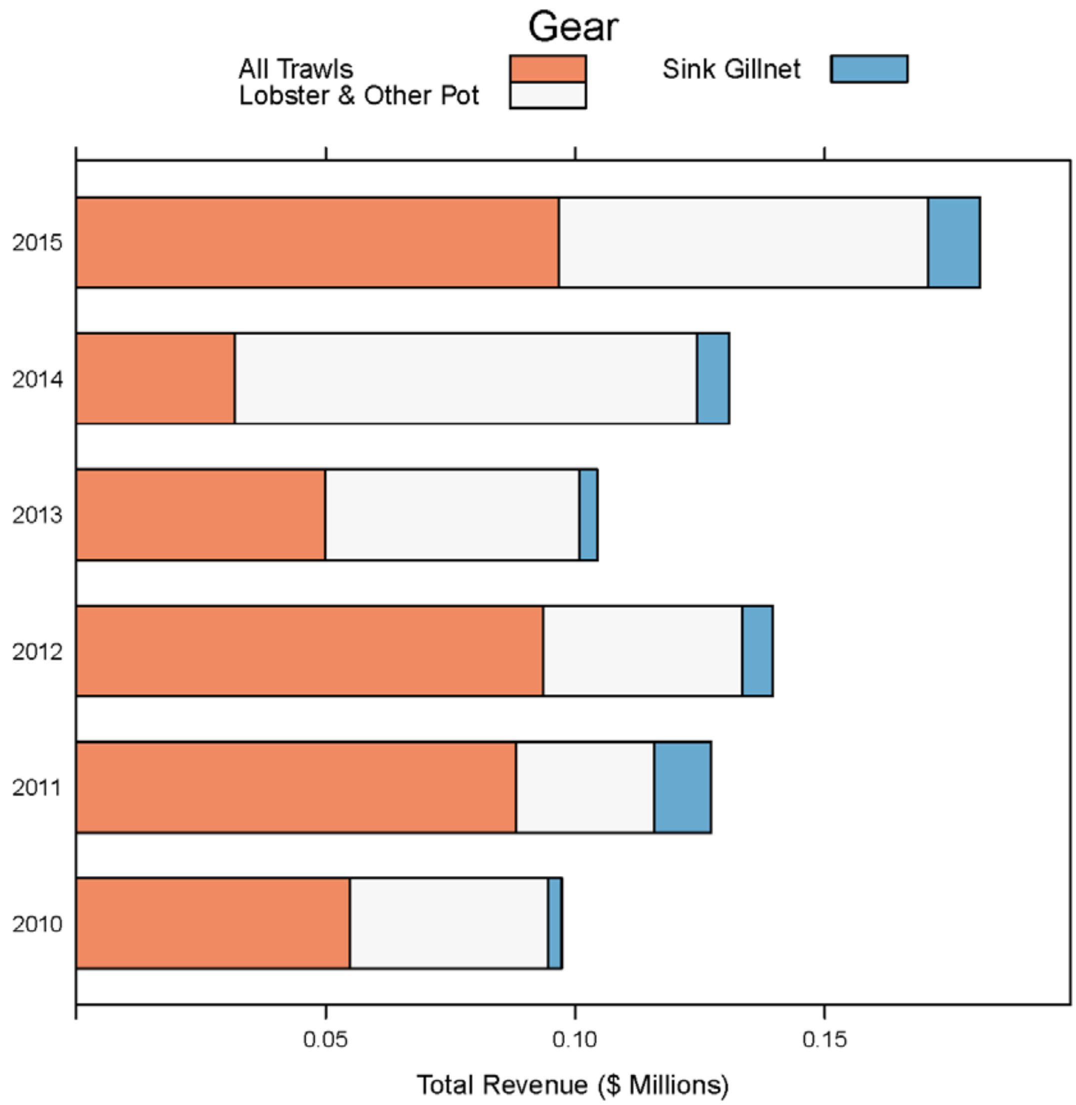


Figure 83 – Revenue by gear type attributed to the four Jordan Basin coral zones Option 2, 2010-2015, as derived from VTR.

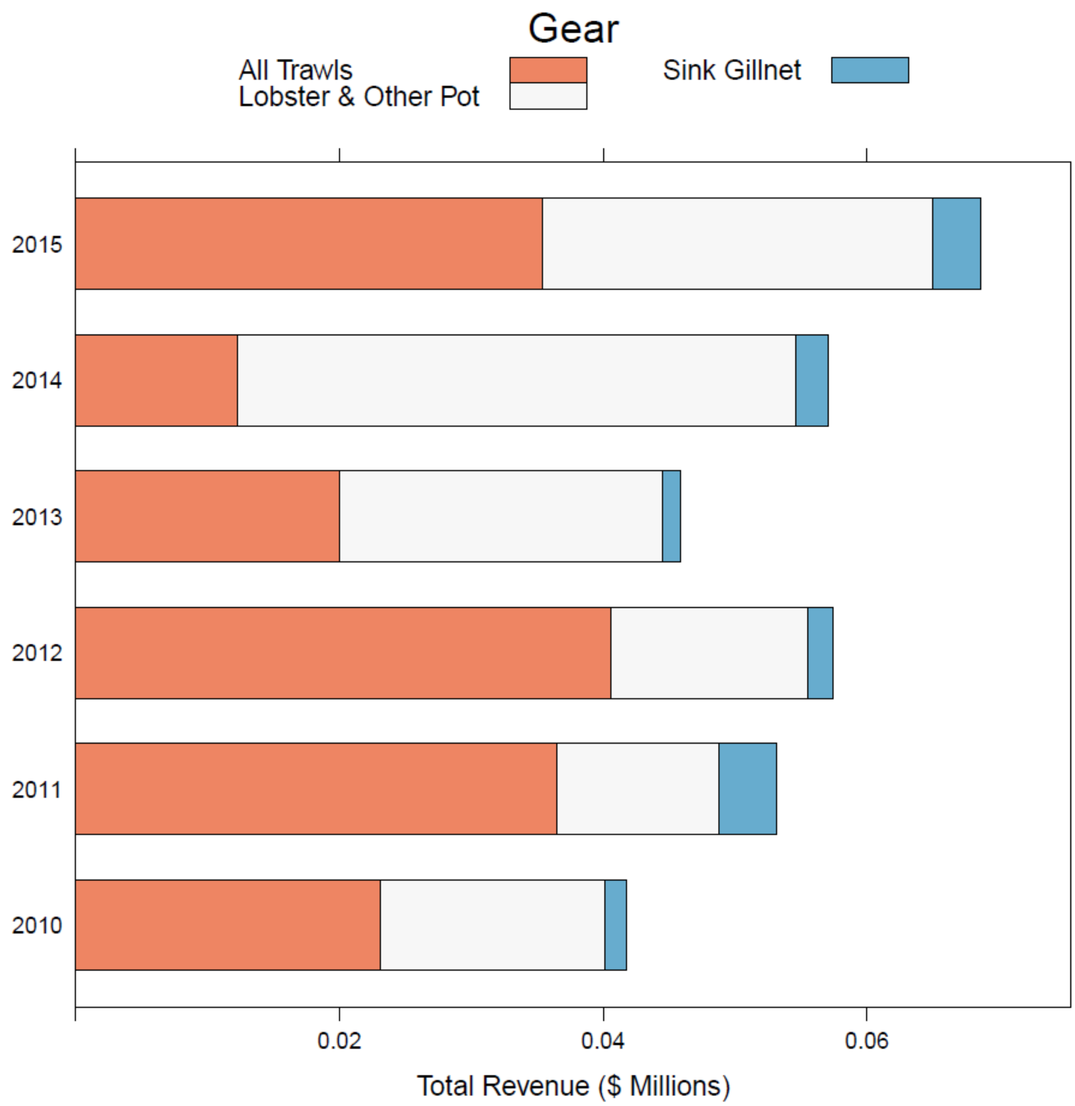


Figure 84 – VTR-derived revenue by species (top 10) attributed Jordan Basin Option 1, 2010-2015.

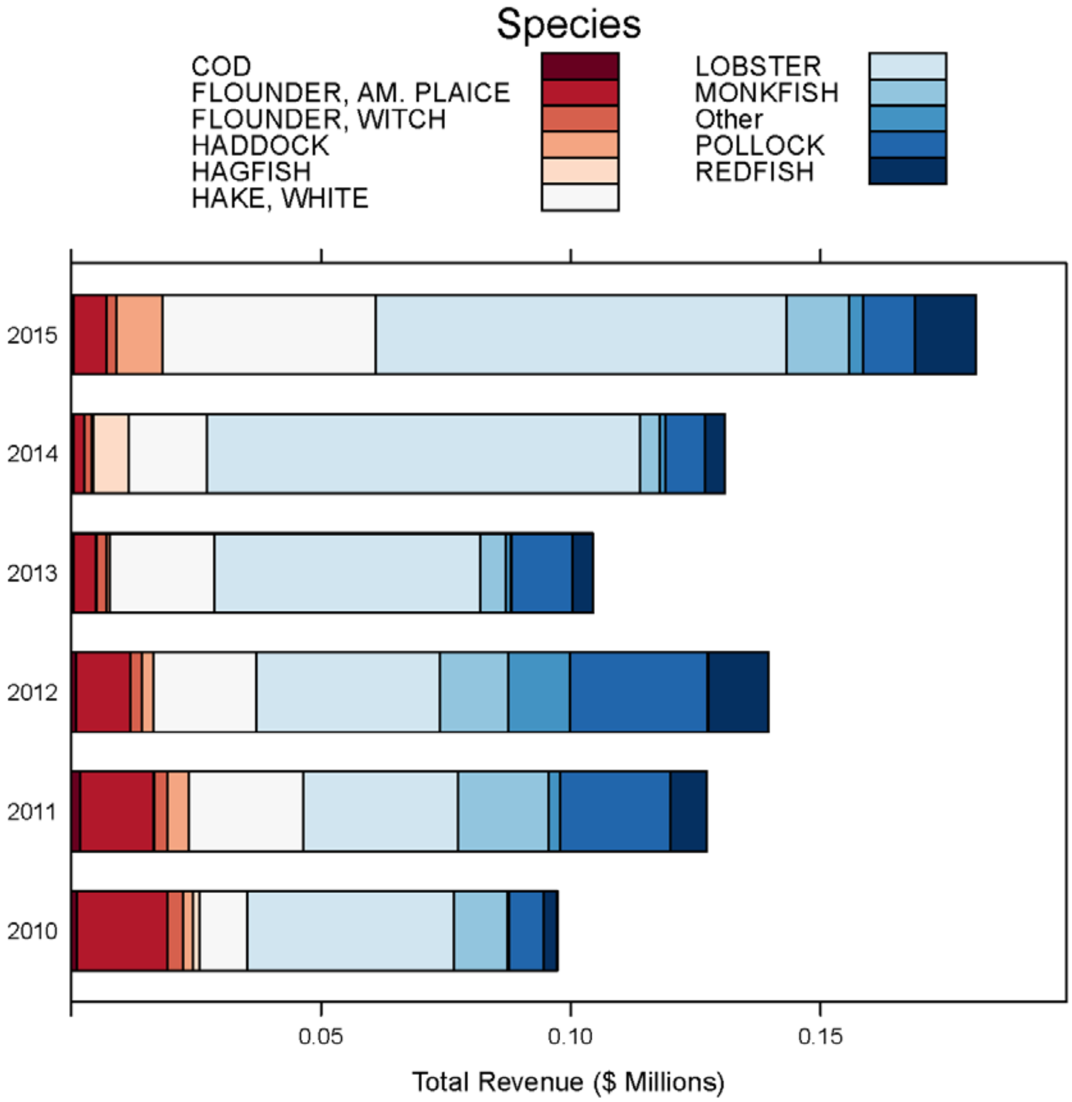


Figure 85 – Revenue by species (top 10) attributed to the four Jordan Basin coral zones Option 2, 2010-2015, as derived from VTR.

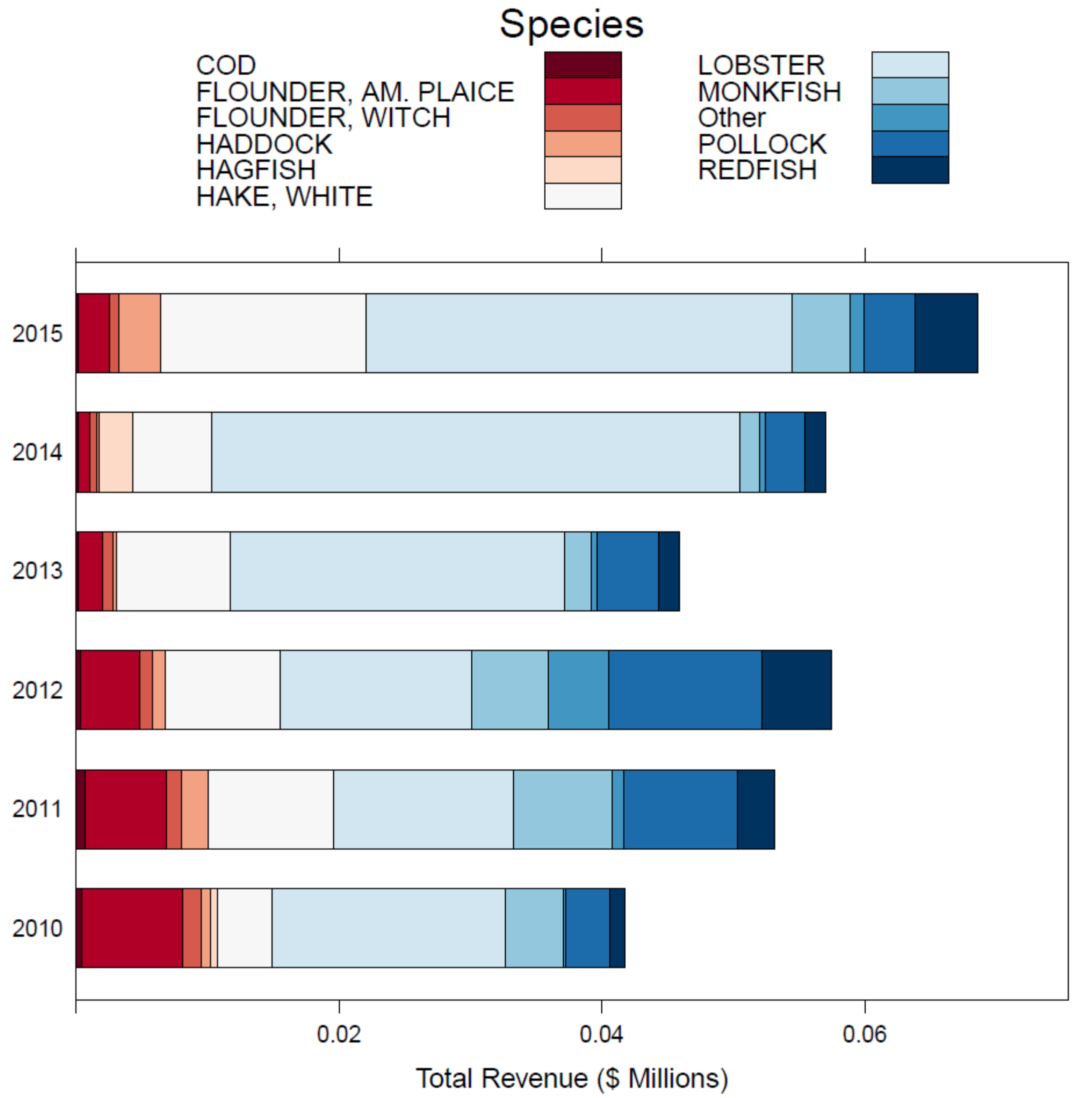


Figure 86 – Percent of vessel owner revenue attributed to the four Jordan Basin coral zones Option 1, 2013-2015, as derived from VTR.

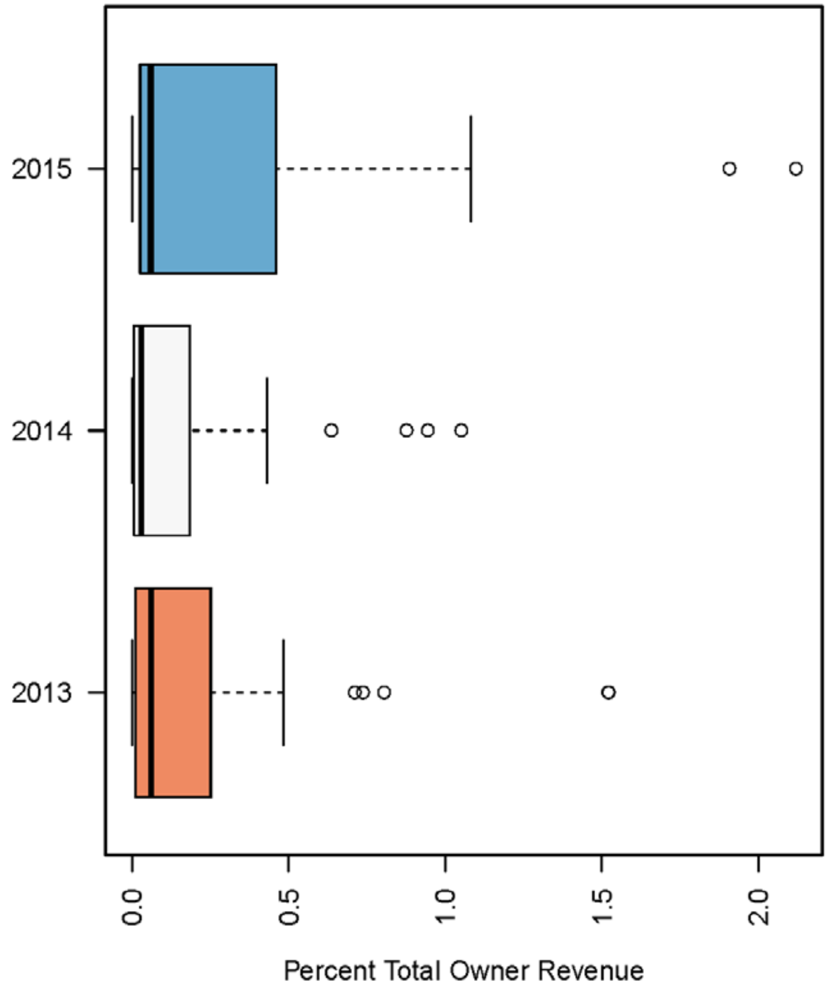


Figure 87– Percent of vessel owner revenue attributed to MBTG within the four Jordan Basin coral zones Option 1, 2013-2015, as derived from VTR.

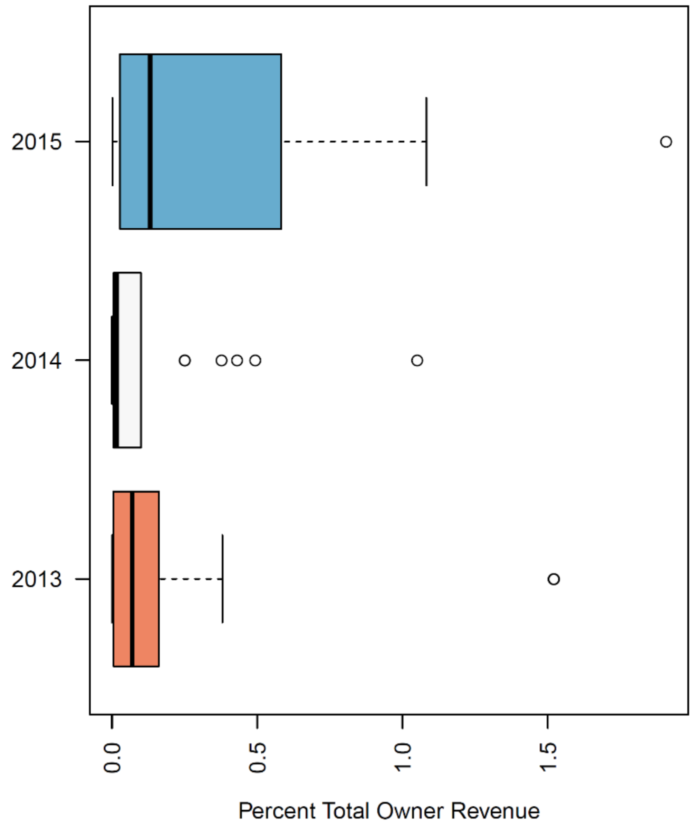


Figure 88 – Percent of vessel owner revenue attributed to the four Jordan Basin coral zones Option 2, 2013-2015, as derived from VTR.

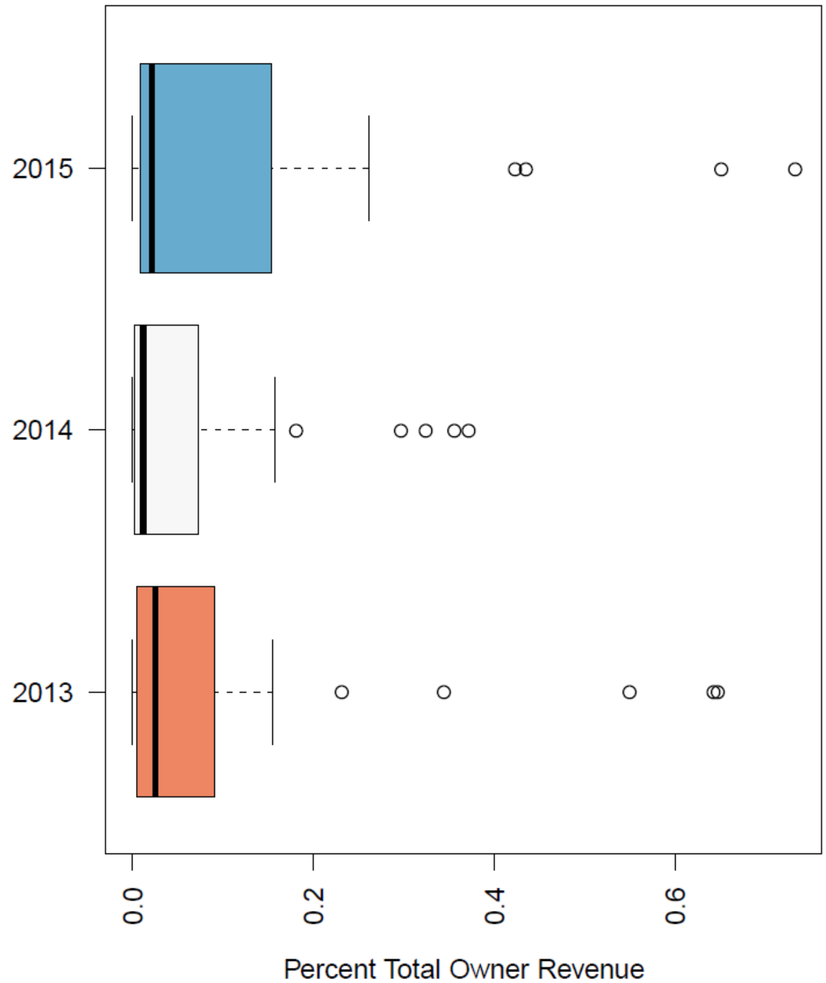


Figure 89 – Percent of vessel owner revenue attributed to MBTG within the four Jordan Basin coral zones Option 2, 2013-2015, as derived from VTR.

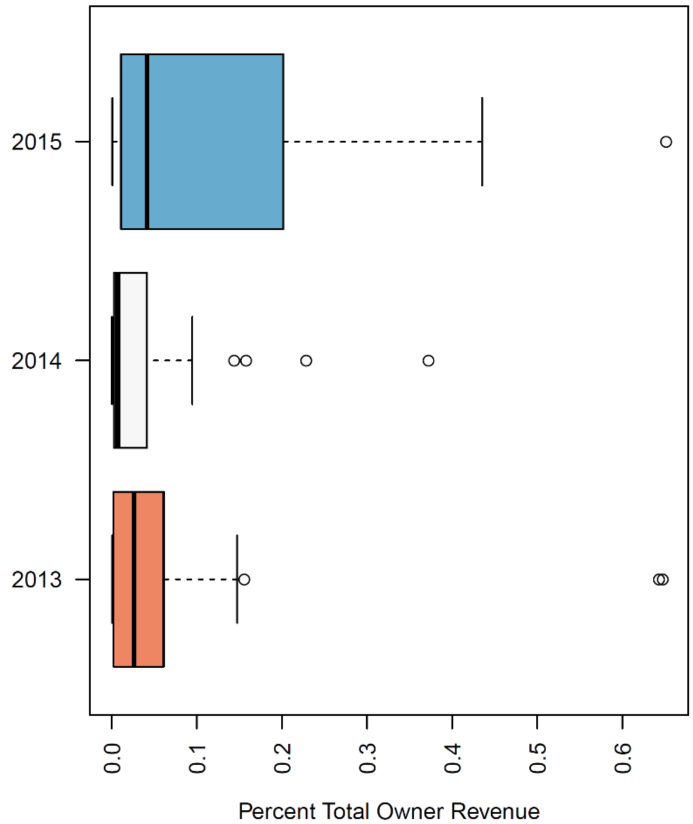


Table 80 – VMS derived estimates of effort attributed to the Jordan Basin coral zones.

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 90 – VMS-derived effort attributed to the Jordan Basin zones Option 1, as a percent of all of a permit's annual effort.

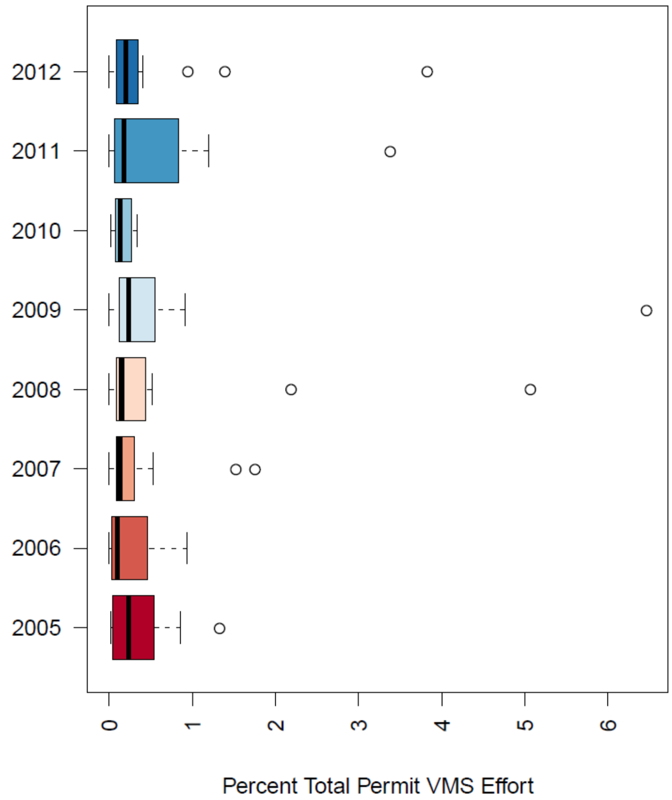


Figure 91 – VMS-derived effort attributed to MBTG within the Jordan Basin zones Option 1, as a percent of all of a permit's annual effort.

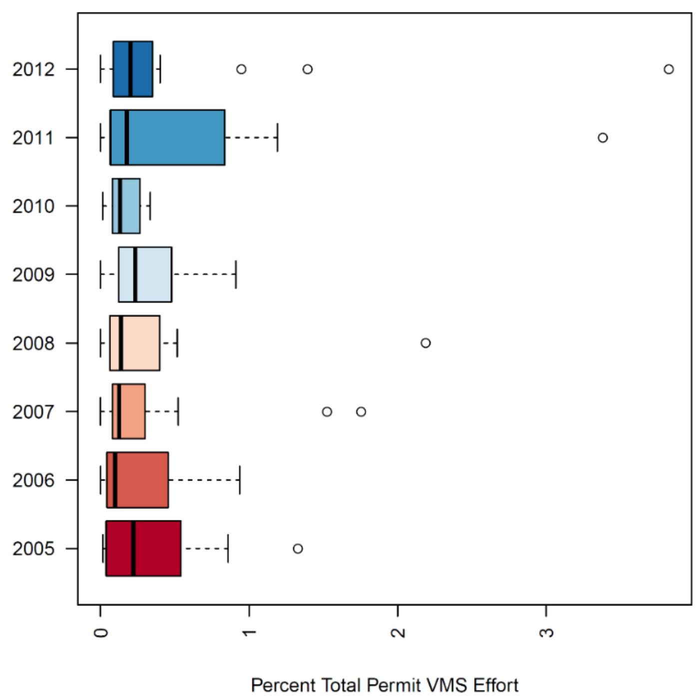


Figure 92 - VMS-derived effort attributed to the Jordan Basin zones Option 2, as a percent of all of a permit's annual effort.

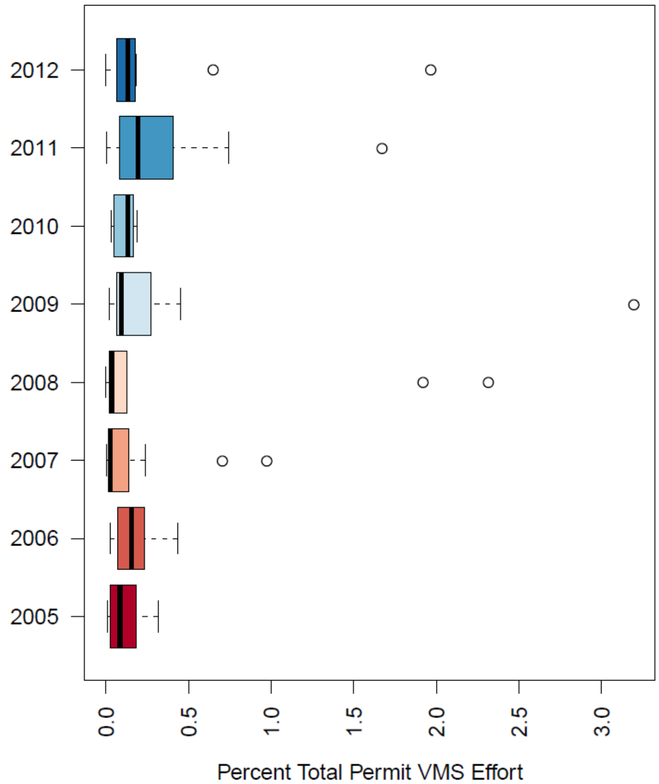
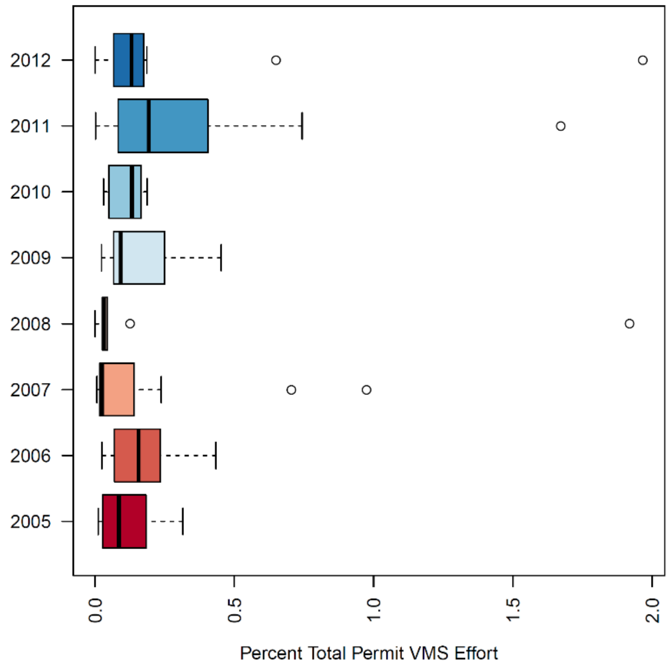


Figure 93 – VMS-derived effort attributed to MBTG within the Jordan Basin zones Option 2, as a percent of all of a permit's annual effort.



7.8.3.2 Fishing community impacts

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 81 and Table 82, 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 28). 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.

7.8.3.2.1 Option 1

Although the VTR analysis has some degree of error, it 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 82). 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, and 49% 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 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 86 and Figure 87).

Table 81 - 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.

7.8.3.2.2 Option 2

Although the VTR analysis has some degree of error, it 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 82). 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, and 49% 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 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 88 and Figure 89).

Table 82 - 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.

7.8.3.3 Sociocultural 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. 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.

7.8.4 Impacts on protected resources

To be completed.

7.9 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 options for which gear types would be precluded from the zone

(Table 83). 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 83 - 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.	

7.9.1 Impacts on deep-sea corals

Deep-sea corals are known to occur at Lindenkohl Knoll based on recent survey work (Table 43, 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. 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 unfortunately this dataset cannot be used to estimate the extent of coral habitats, either. While corals are clearly documented at Lindenkohl Knoll 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 bore out 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 (Section 7.9.3.1).

If the Lindenkohl Knoll zone is selected as a closure 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). However, there are observed interactions between trap gear and corals in the Gulf of Maine (Section 6.5.3). We cannot use these observations to estimate coral bycatch rates in the lobster trap fishery or any fishery. 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 (Section 6.5.2). Trawl and gillnet bycatch of corals does occur in and around the site (Section 6.5.3), but fishery-wide bycatch rates cannot be determined from these data, which are limited.

7.9.2 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 in the previous section, 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. 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 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, haddock, pollock, white hake, witch flounder, red hake, silver hake, smooth skate, and thorny skate. 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.

7.9.3 Impacts on human communities

Under this alternative, a coral zone would be established on Lindenkohl Knoll, with two options for the size of the zone and options for which gear types would be precluded from the zone. 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. 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 provide habitat for fishery species, there may be long-term benefits to fisheries and society, but these are difficult to project.

7.9.3.1 Fishery impacts

The Lindenkohl Knoll coral zone encompasses a relatively small fraction of the Georges Basin overall, 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.

7.9.3.1.1 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 7.1.3.2). Maps of revenue by gear type and species are in Section 13 (p. 424 onward).

Revenue by gear

Between 2010 and 2015, revenue attributed to the Lindenkohl Knoll coral zone Option 1 ranged between $170-370K, averaging $290K (Figure 94). 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 95). 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), in contrast to the Jordan Basin zones, in which groundfish revenue was more prominent (Figure 96). Data for Option 2 suggests lobster revenues of $40K annually, more in 2015 (Figure 97). 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 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 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 $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 98). 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 99 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 100). 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 103 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 101 indicates that fishing gear restriction Option 2 substantially decreases what exposure exists at the owner level.

VMS – VTR Comparison

Table 84 presents the VMS coverage for VTR trips occurring in the vicinity of Lindenkohl Knoll coral zone Options 1 and 2. Table 85 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 84). 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 this data set.

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 102 shows the percent of each permit holder's total effort falling within Lindenkohl Knoll coral zone Option 1. The analysis suggests higher exposure rates then suggested by the VTR analysis presented in Figure 98. 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 indicates substantially lower levels of exposure to zone Option 2, averaging 37% of the effort in zone Option 1 (Table 85). This result is also borne out in the permit level estimate of effort exposure presented inFigure 103, 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 presents higher exposure rates then suggested by the VTR analysis presented in Figure 100. Nevertheless, most permit holders present low levels of exposure, with only a small number of outliers exerting any real effort in the region.

7.9.3.1.2 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. 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 also indicated that the revenue attributed to these zones from the VTR analysis seem low (NEFMC 2017).

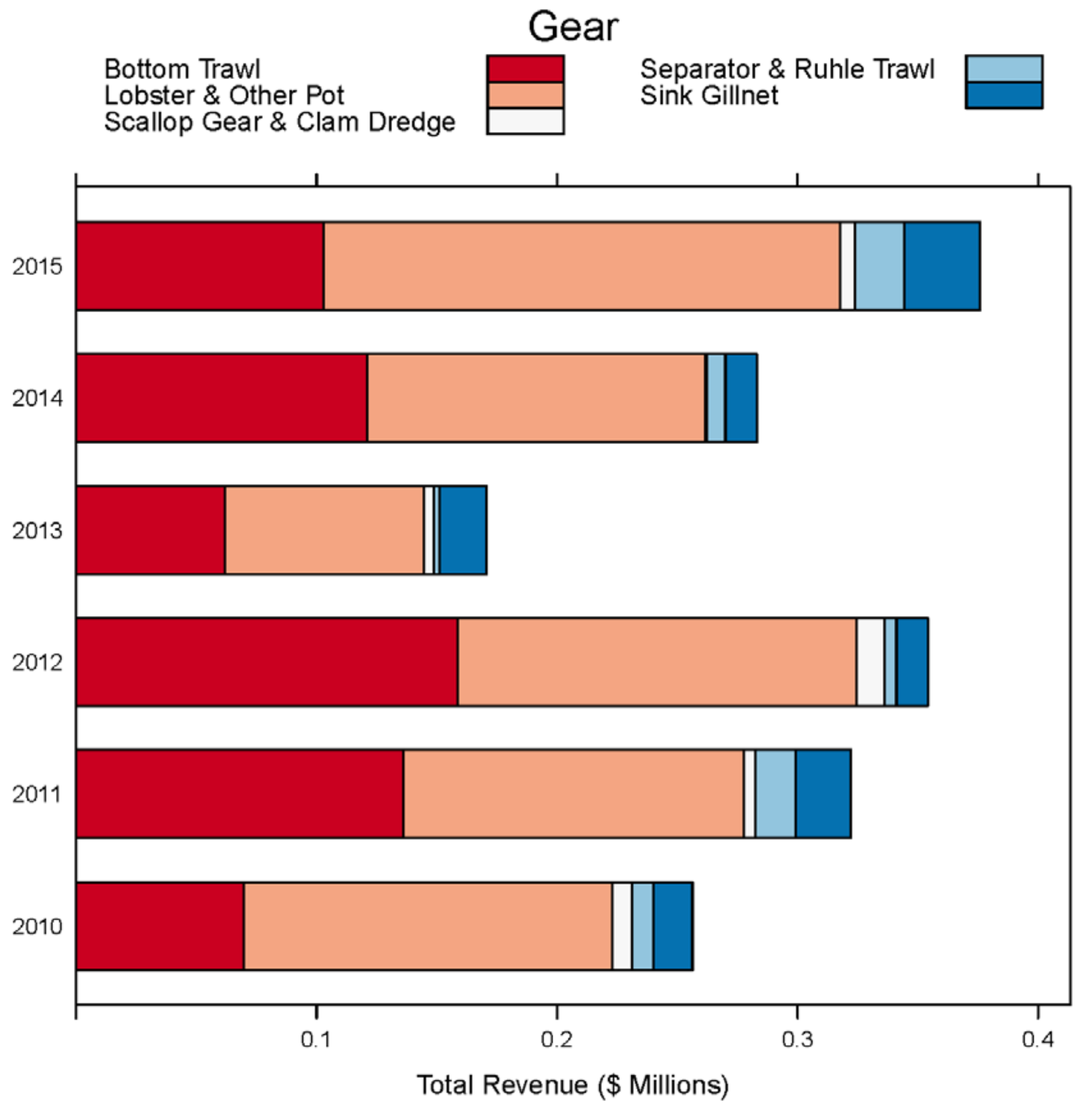
The workshop discussed the potential to adjust effort relative to a closure. Shifting effort to areas remaining open may be difficult for displaced fishermen. The fishermen have developed agreements over time about sharing fishing grounds, so it may be difficult to adjust to new area closures. Species' habitat preference also constrains the fisheries (e.g., lobsters are not found on mud bottom). The participants indicated that the lobster fishery is territorial; a specific zone may only have been fished by one or two 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 86).

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 96; NEFMC, 2017).

7.9.3.1.3 Summary of fishery impacts

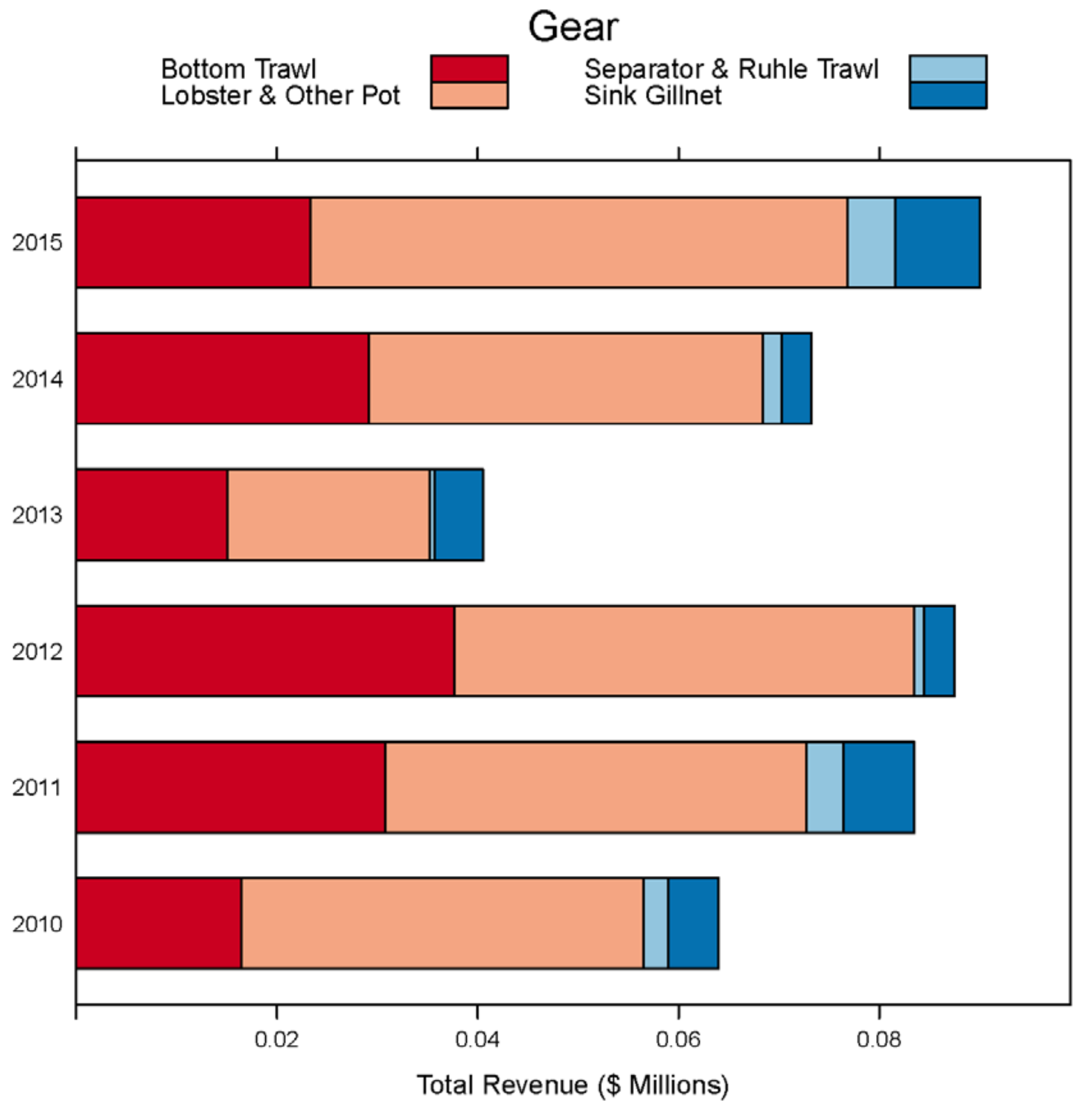
The impacts to the fishing industry are expected to be slightly negative to negative, but more negative for zone Option 1 relative to zone Option 2. The VMS coverage is adequate to assess fishing effort by VMS for trawl gears, and both Option 1 and Option 2 have relatively substantial levels of effort by this gear within their bounds. Bottom trawl effort in zone Option 1 average 560 hours a year, with substantial variability across years, and zone Option 2 generally presents 1/3 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 falling within zone Option 1 and 5% within zone Option 2. VMS coverage is insufficient to represent the other gears which VTR suggests is fishing 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.

Figure 94 – Revenue by gear type attributed to the Lindenkohl Knoll coral zone Option 1, 2010-2015.



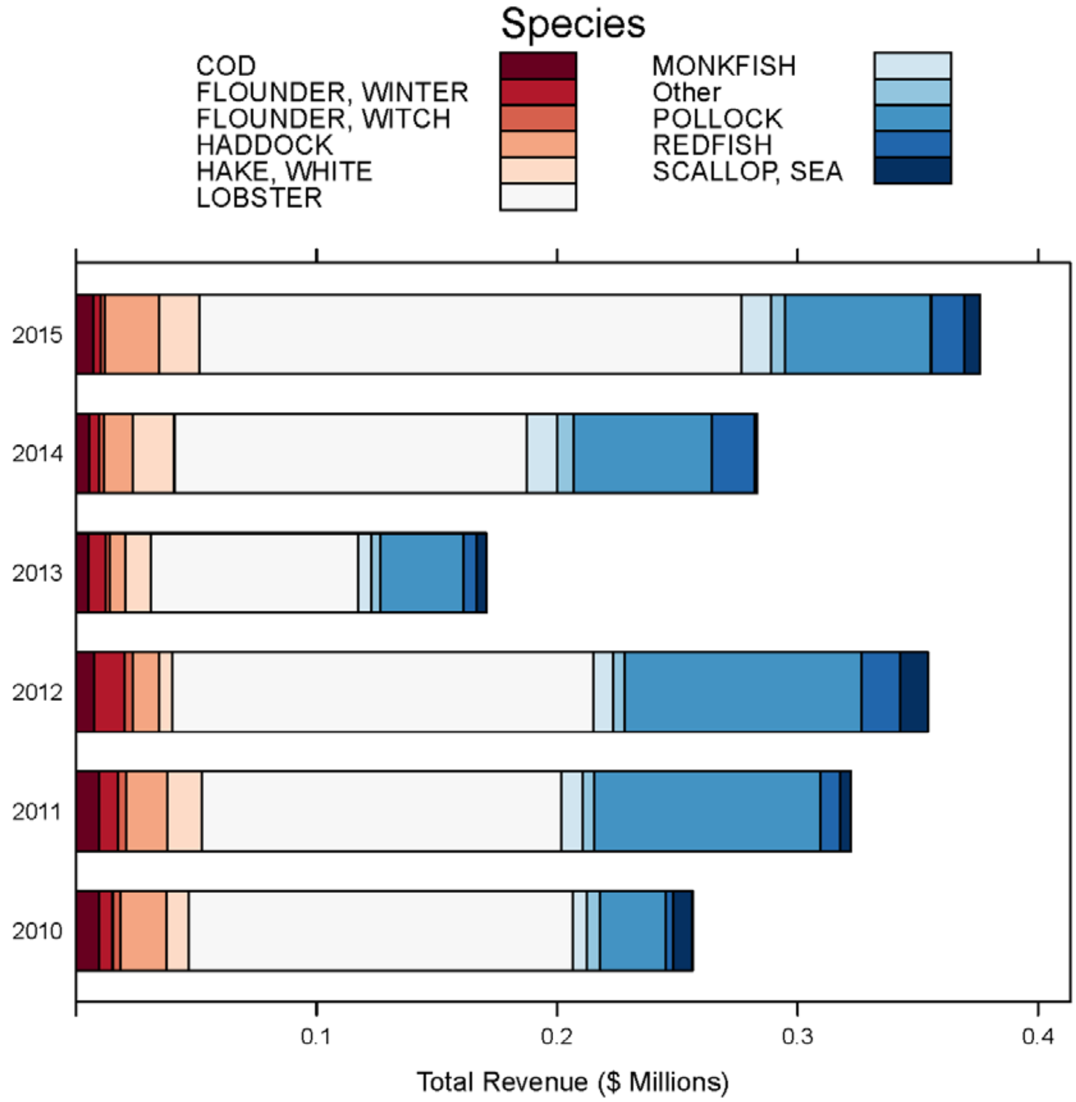
Source: **VTR analysis.**

Figure 95 – Revenue by gear type attributed to the Lindenkohl Knoll coral zone Option 2, 2010-2015.



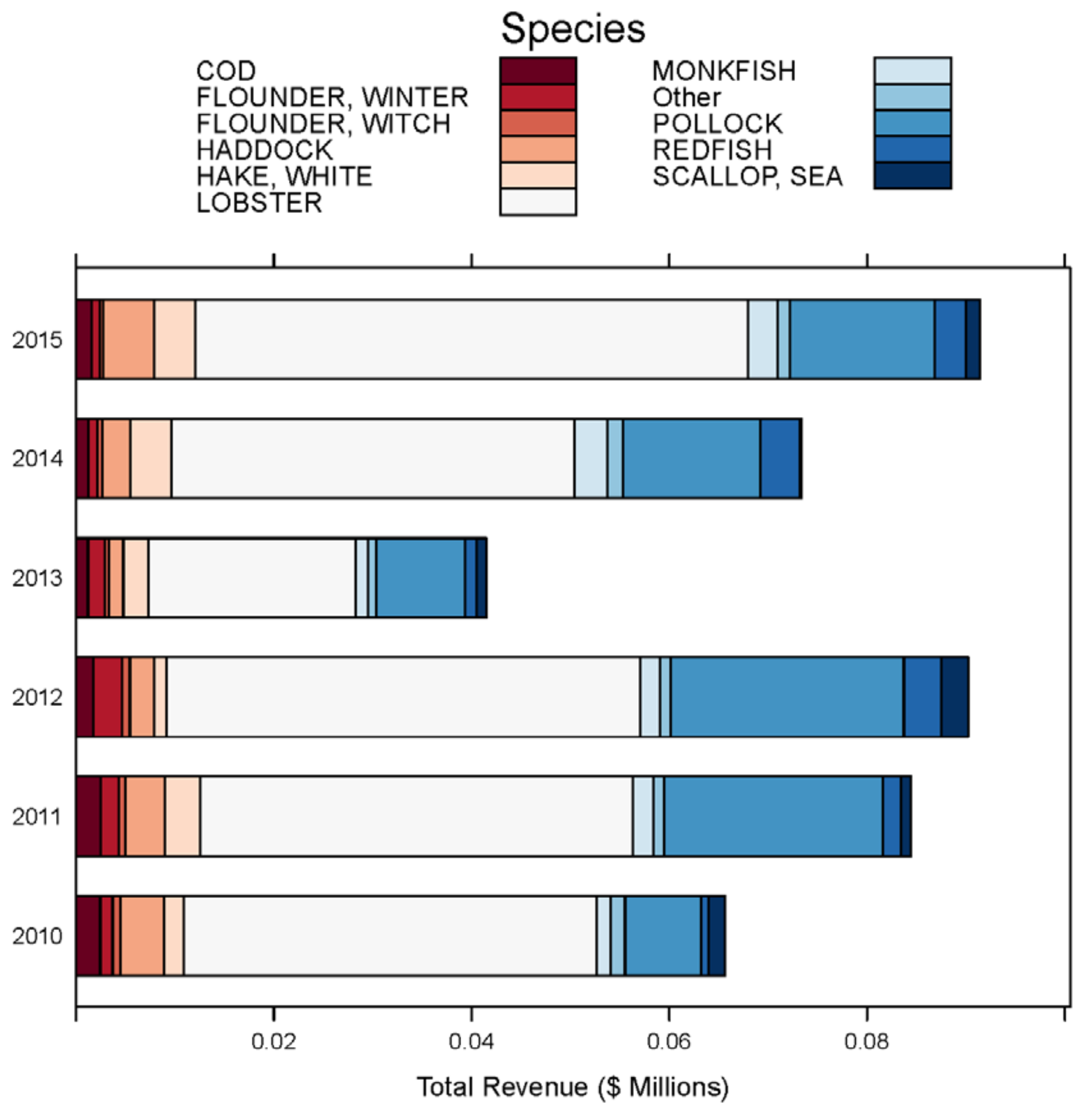
Source: **VTR analysis.**

Figure 96 – Revenue by species (top 10) attributed to the Lindenkohl Knoll coral zone Option 1, 2010-2015.



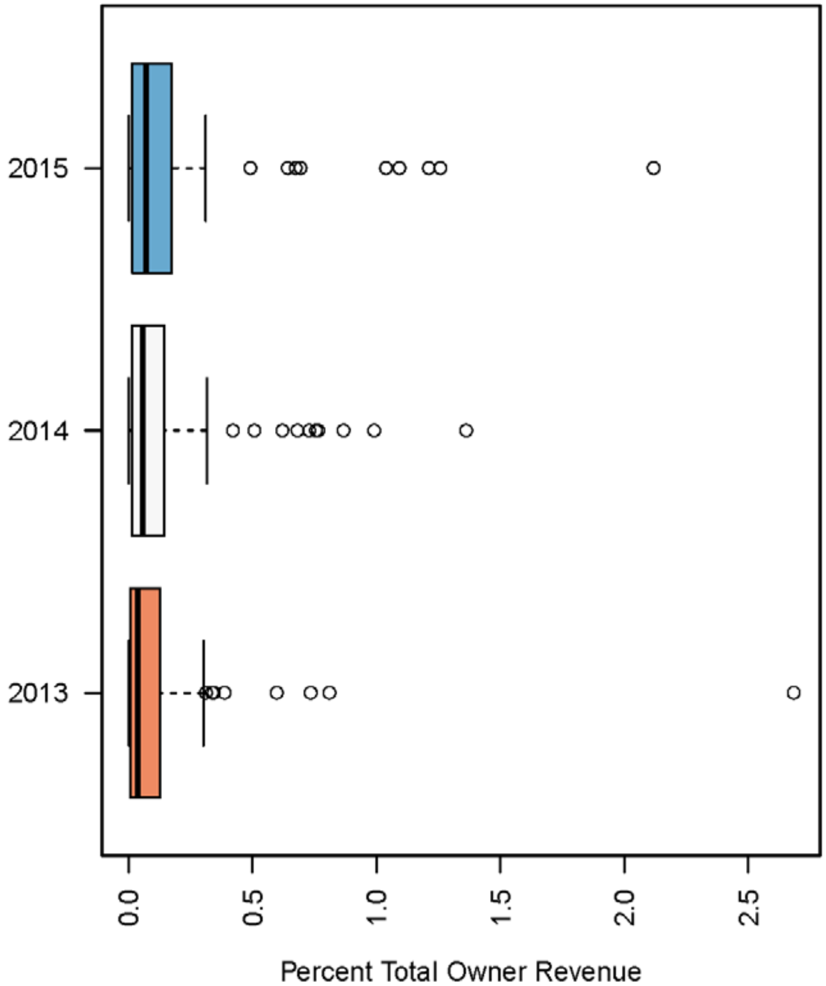
Source: **VTR analysis.**

Figure 97 – Revenue by species (top 10) attributed to the Lindenkohl Knoll coral zone Option 2, 2010-2015.



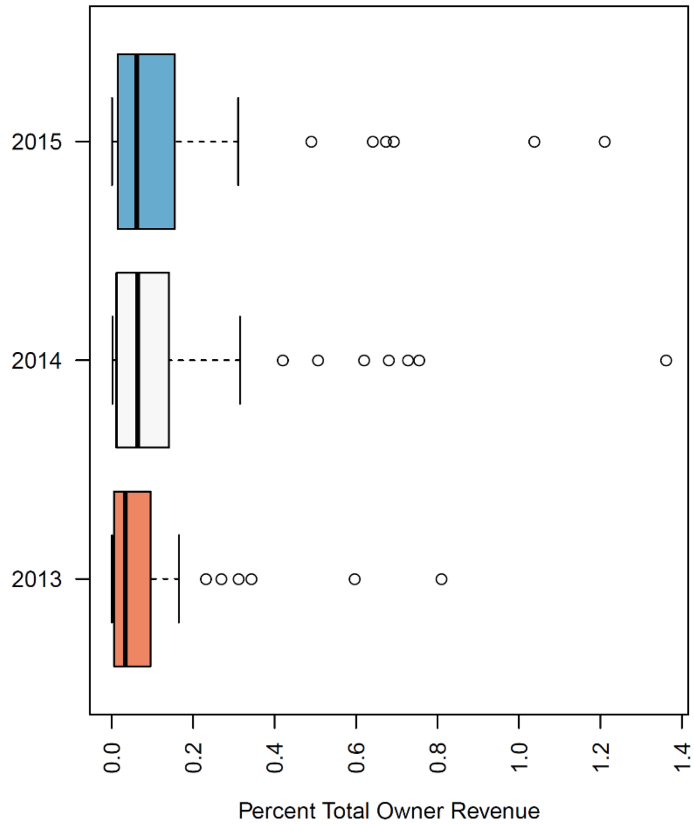
Source: **VTR analysis.**

Figure 98 – Percent of vessel owner revenue attributed to the Lindenkohl Knoll coral zone Option 1, 2013-2015.



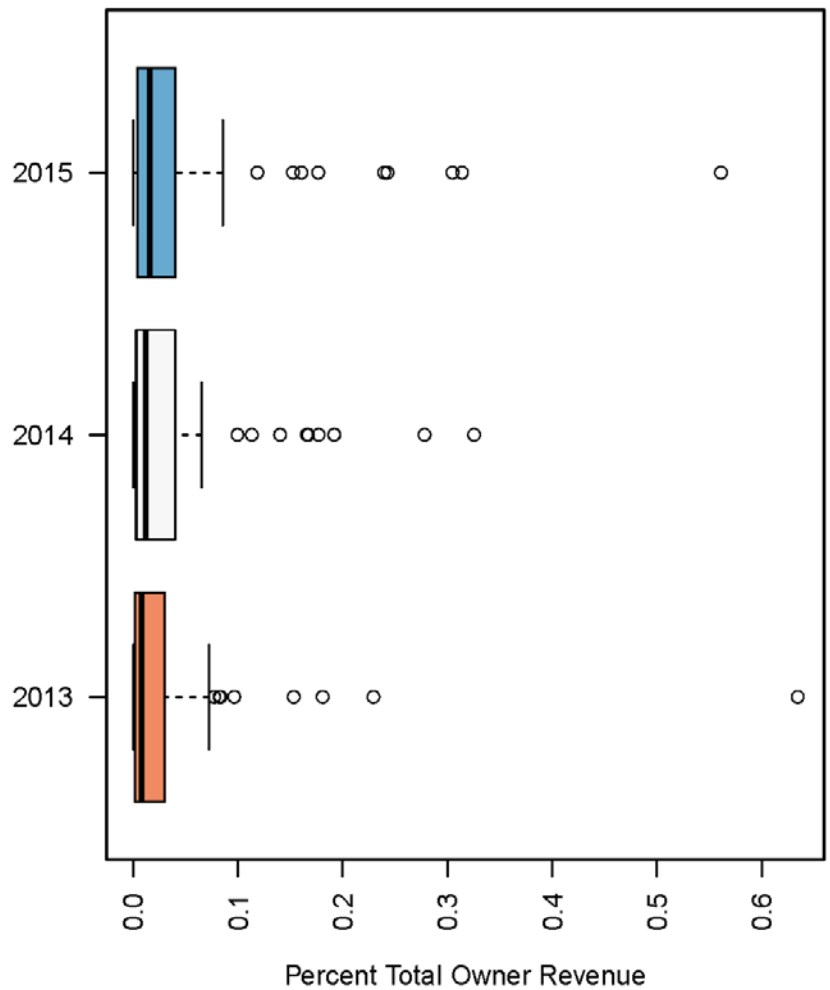
Source: VTR analysis.

Figure 99 – Percent of vessel owner revenue attributed to MBTG within the Lindenkohl Knoll coral zone Option 1, 2013-2015.



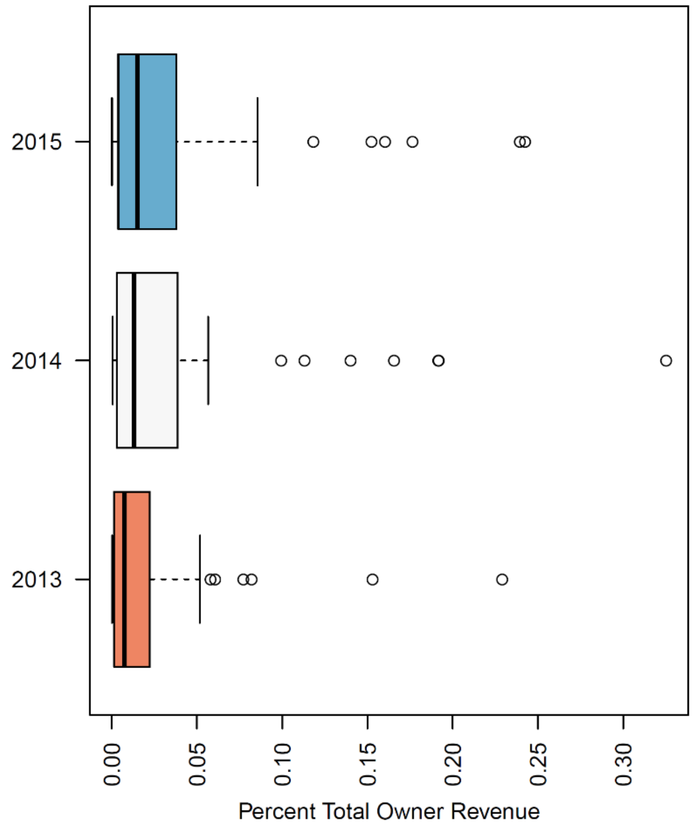
Source: VTR analysis.

Figure 100 – Percent of vessel owner revenue attributed to the Lindenkohl Knoll coral zone Option 2, 2013-2015.



Source: VTR analysis.

Figure 101 – Percent of vessel owner revenue attributed to MBTG within the Lindenkohl Knoll coral zone Option 2, 2013-2015.



Source: VTR analysis.

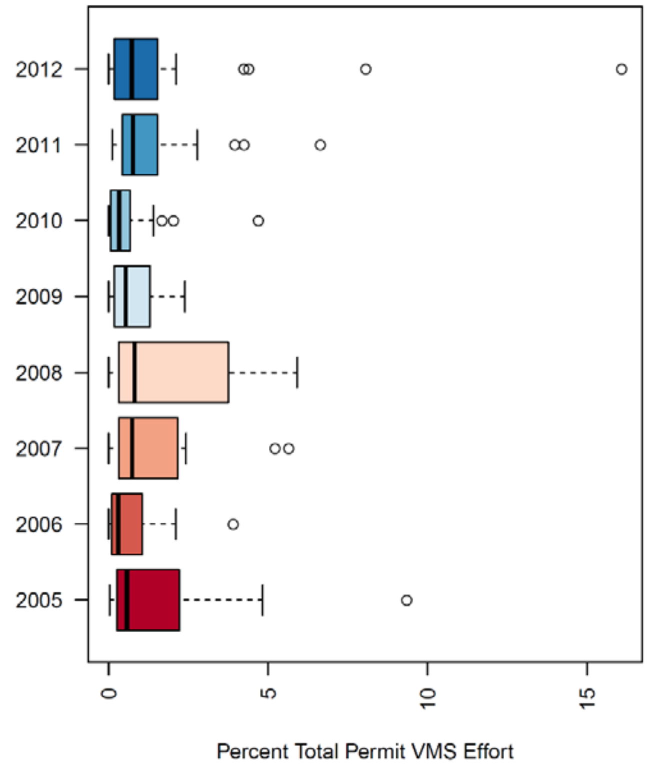
Table 84 – VMS coverage of VTR trips in the vicinity of Lindenkohl Knoll coral zone Options 1 & 2.

		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 85 – VMS derived effort within the two Lindenkohl Knoll coral zone options.

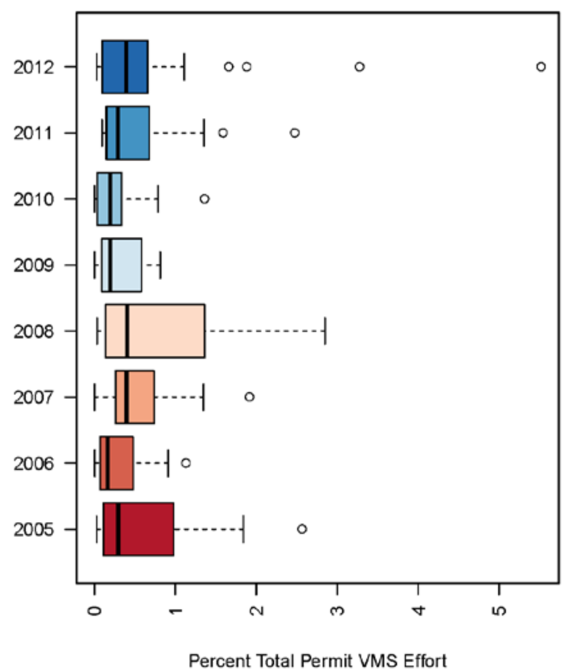
		Lindenkohl Knoll Option 1			Lindenkohl Knoll Option 2		
Gear	Year	Hours Fished	Trips	Permits	Hours Fished	Trips	Permits
Bottom Trawl	2005	845	116	31	321	99	27
Bottom Trawl	2006	340	73	31	129	54	25
Bottom Trawl	2007	533	57	18	171	49	15
Bottom Trawl	2008	473	54	17	182	47	16
Bottom Trawl	2009	403	70	24	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 102 – Percent of permit-level effort attributed to the Lindenkohl Knoll coral zone Option 1, 2013-2015.



Source: VMS analysis.

Figure 103 – Percent of permit-level effort attributed to the Lindenkohl Knoll coral zone Option 2, 2013-2015.



Source: VMS analysis.

7.9.3.2 Fishing community impacts

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 86, 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 28). 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.

Lindenkohl Knoll zone Option 1: Although the VTR analysis has some degree of error, it 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 86). 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 98, p. 398).

Table 86 – 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	$1.5K	$0.3K	15
Other (n=2)	$0.1K	$0.0K	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.

Lindenkohl Knoll zone Option 2: **Although the VTR analysis has some degree of error, it 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 86). 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 98, p. 398).

Table 87 - 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	$93K	$15K	50
New Bedford	$65K	$11K	100
Boston	$17K	$3K	20
Other (n=4)	$1	$0K	16
Rhode Island	$2K	$0.4K	19
Newport	$2K	$0.3K	3
Point Judith	$0.4K	$0.1K	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.

7.9.3.3 Sociocultural impacts

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. 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.

7.9.4 Impacts on protected resources

To be completed.

7.10 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:

- **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.

7.10.1 Impacts on deep-sea corals

Alternative 1/No Action is expected to have negative to no 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 negative to no impacts on deep-sea corals relative to baseline environmental conditions. If these alternatives are selected, the programs would be carefully designed so as to minimize negative impacts on coral communities. 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.

Alternative 4 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.

7.10.2 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. The specific impacts of Alternative 1/No Action can be discussed more fully once the preferred coral zone alternatives are known.

Alternatives 2 and 3 are expected to have neutral impacts on managed species and their 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. Alternative 3 is also expected to have neutral 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. The specific impacts of Alternatives 2 and 3 can be discussed more fully once the preferred coral zone alternatives are known.

Alternative 4 is expected to have no impactto 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.

7.10.3 Impacts on human communities

Alternative 1/No Action is expected to have slightly negative to no impacts on human communities.

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. The specific impacts of Alternative 2 can be discussed more fully once the preferred coral zone alternatives are known.

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. The specific impacts of Alternative 3 can be discussed more fully once the preferred coral zone alternatives are known.

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 fishery management programs are expected to have indirect positive impacts on human communities overall.

7.10.4 Impacts on protected resources

To be completed.

7.11 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.

7.11.1 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, as amendments require additional Council resources to complete and might not be as high a priority in any particular year.

Indirect 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.

7.11.2 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.

7.11.3 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.

7.11.4 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.

8 Cumulative effects analysis

To be completed.

9 Compliance with the Magnuson Stevens Fishery Conservation and Management Act

To be completed.

10 Compliance with the National Environmental Policy Act

To be completed.

11 Relationship to other applicable laws

To be completed.

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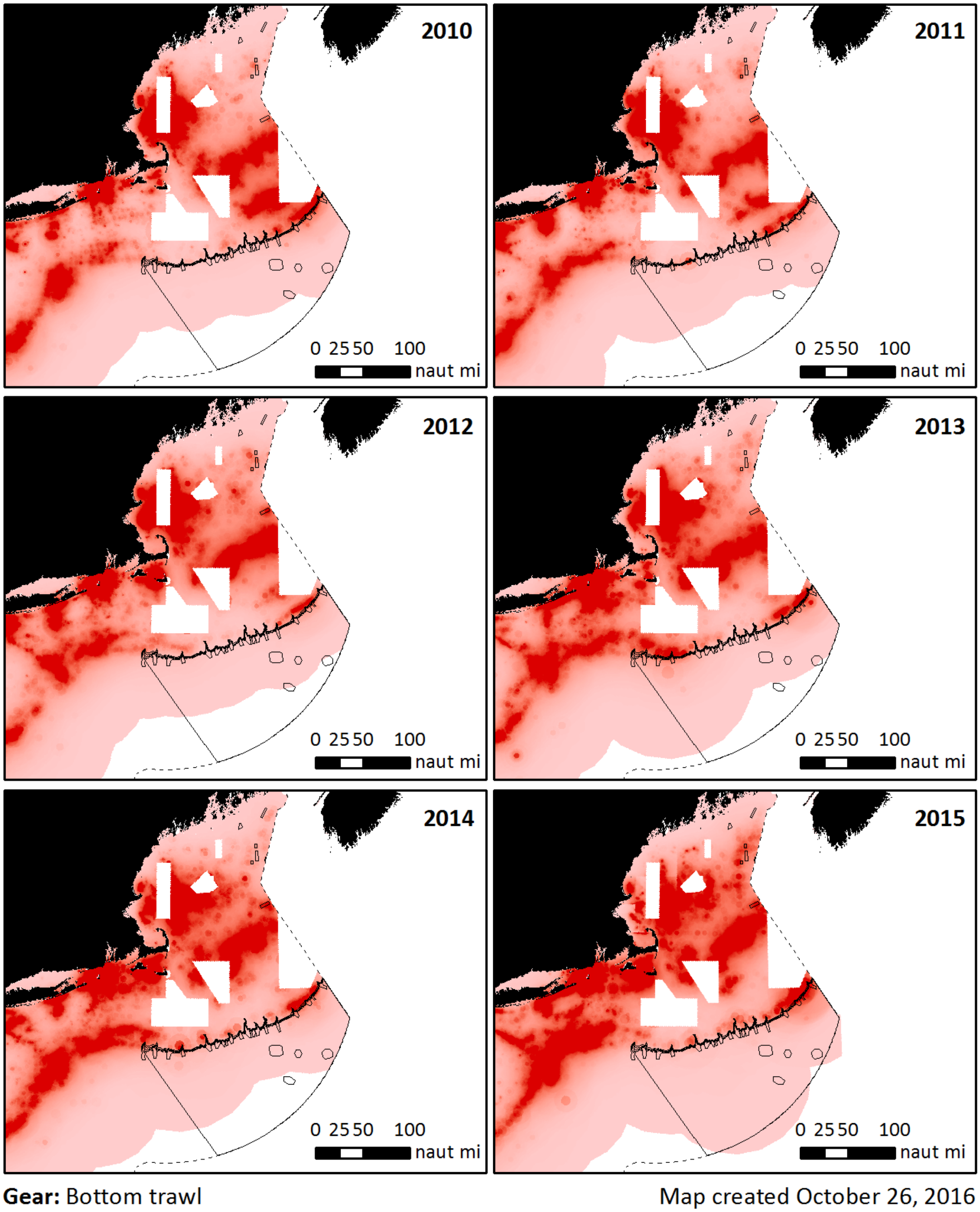
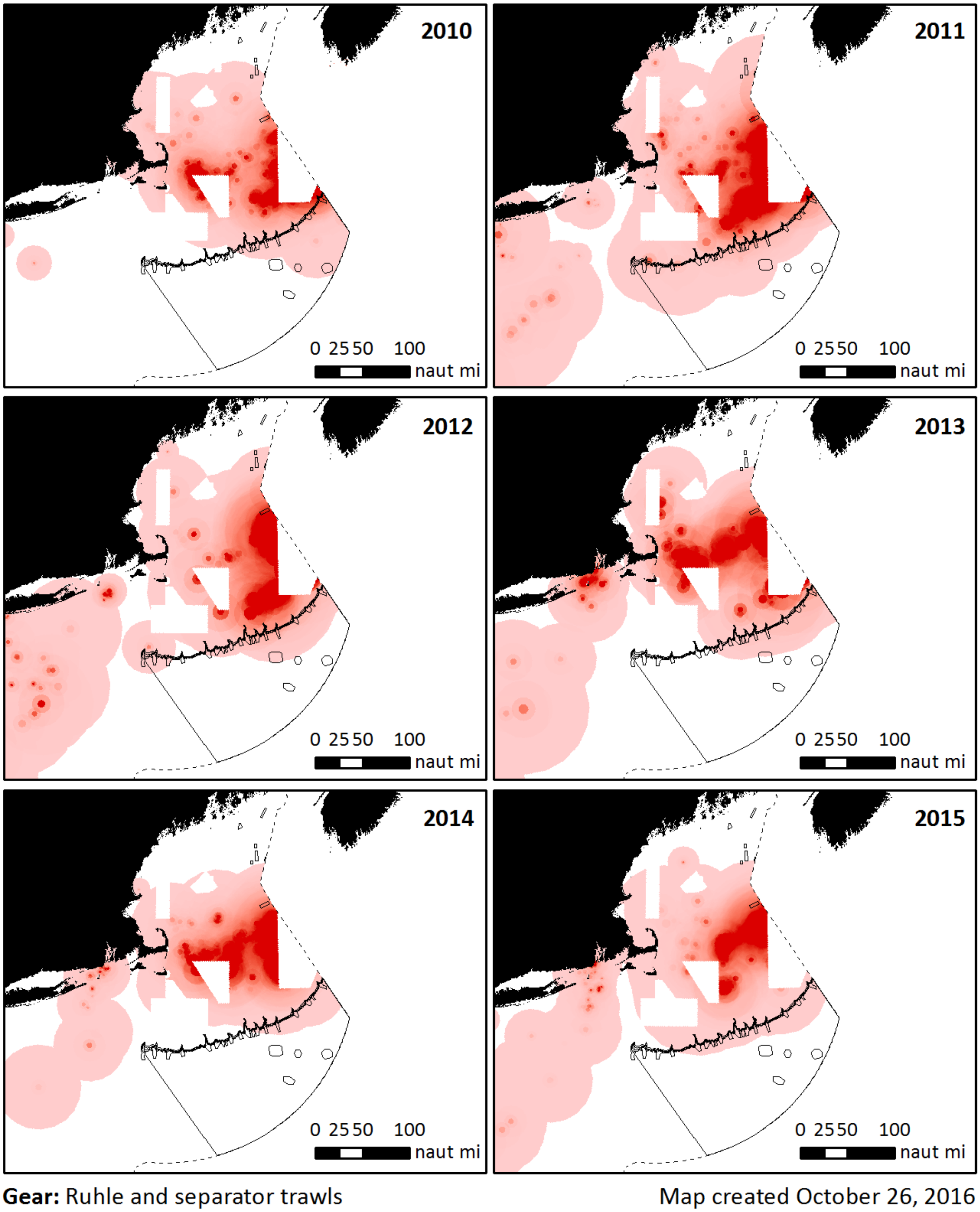
13 VTR-based revenue maps

Map 54 – Bottom trawl gear revenue distribution, 2010-2015.



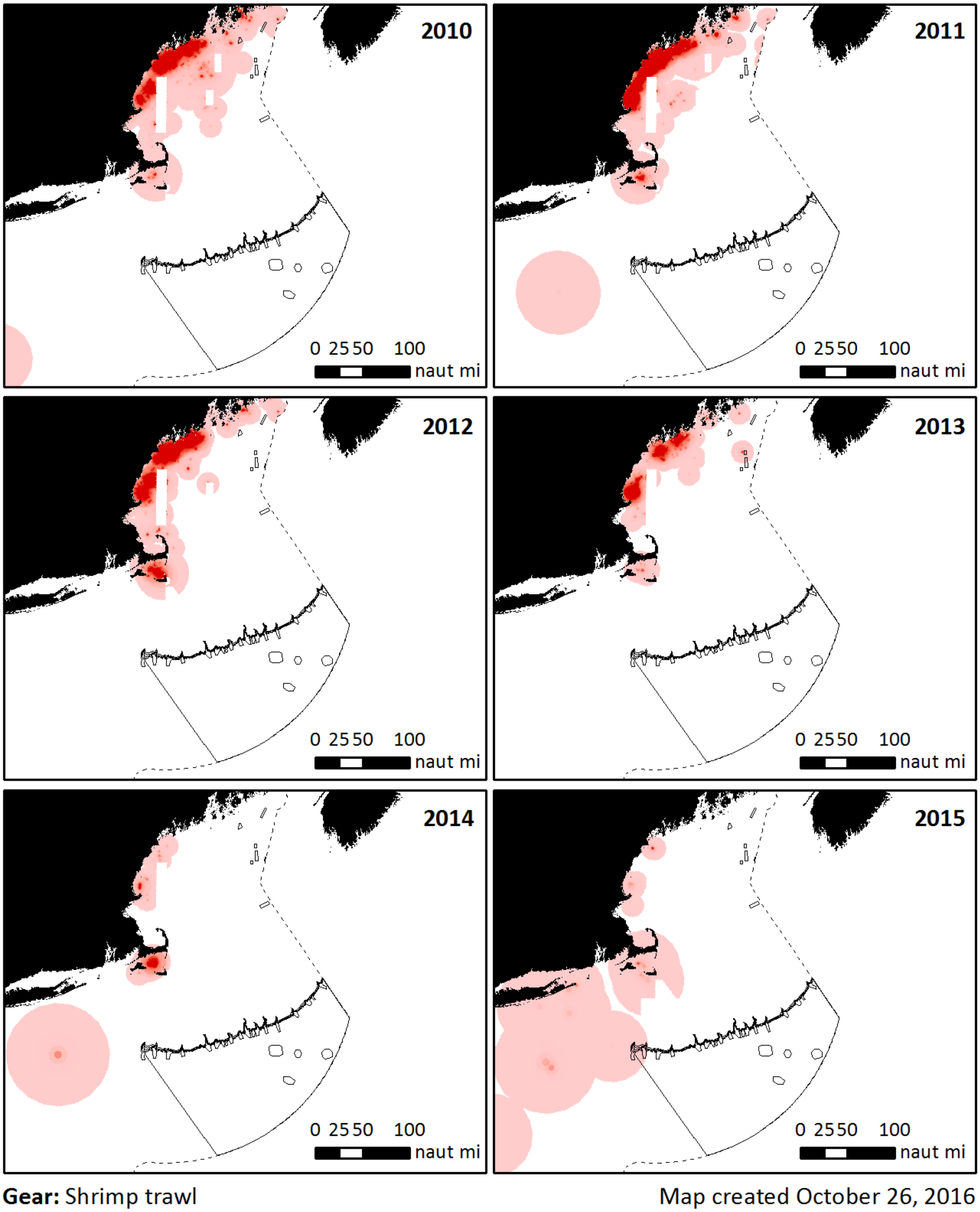
Note: Zero values excluded.
Source: VTR analysis.

Map 55 – Ruhle and separator trawl gear revenue distribution, 2010-2015.



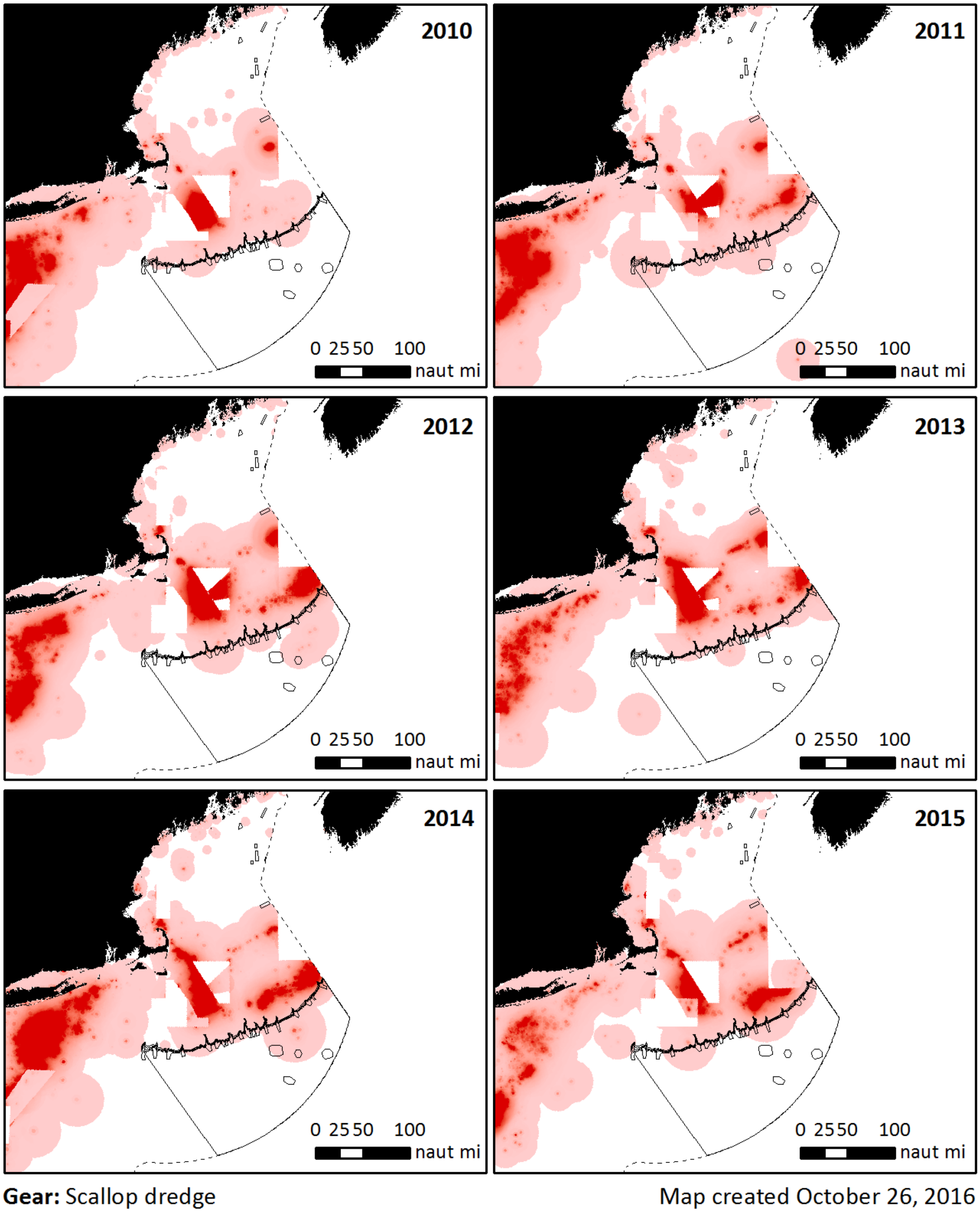
Note: Zero values excluded.
Source: VTR analysis.

Map 56 – Shrimp trawl gear revenue distribution, 2010-2015.



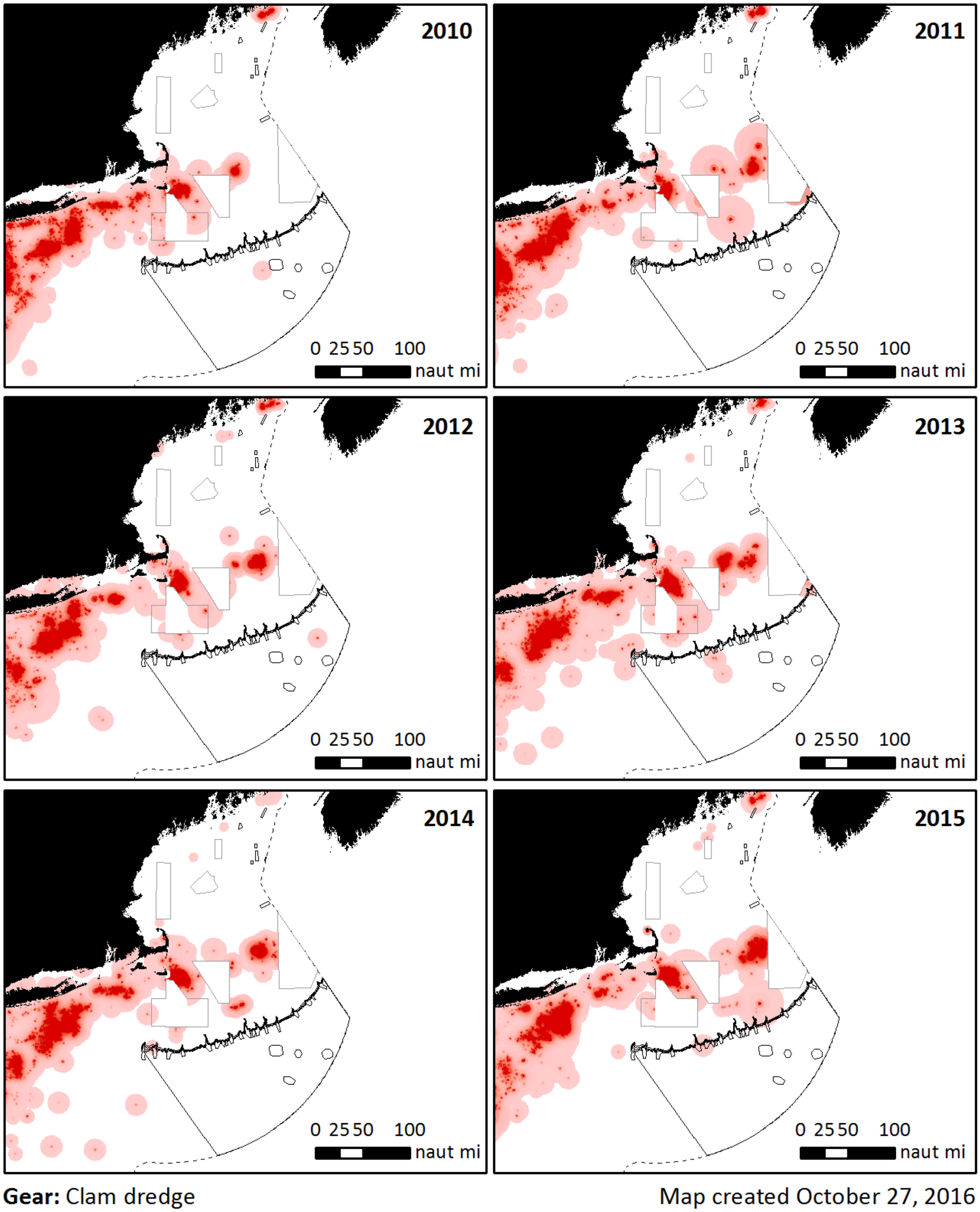
Note: Zero values excluded.
Source: VTR analysis.

Map 57 – Scallop dredge gear revenue distribution, 2010-2015.



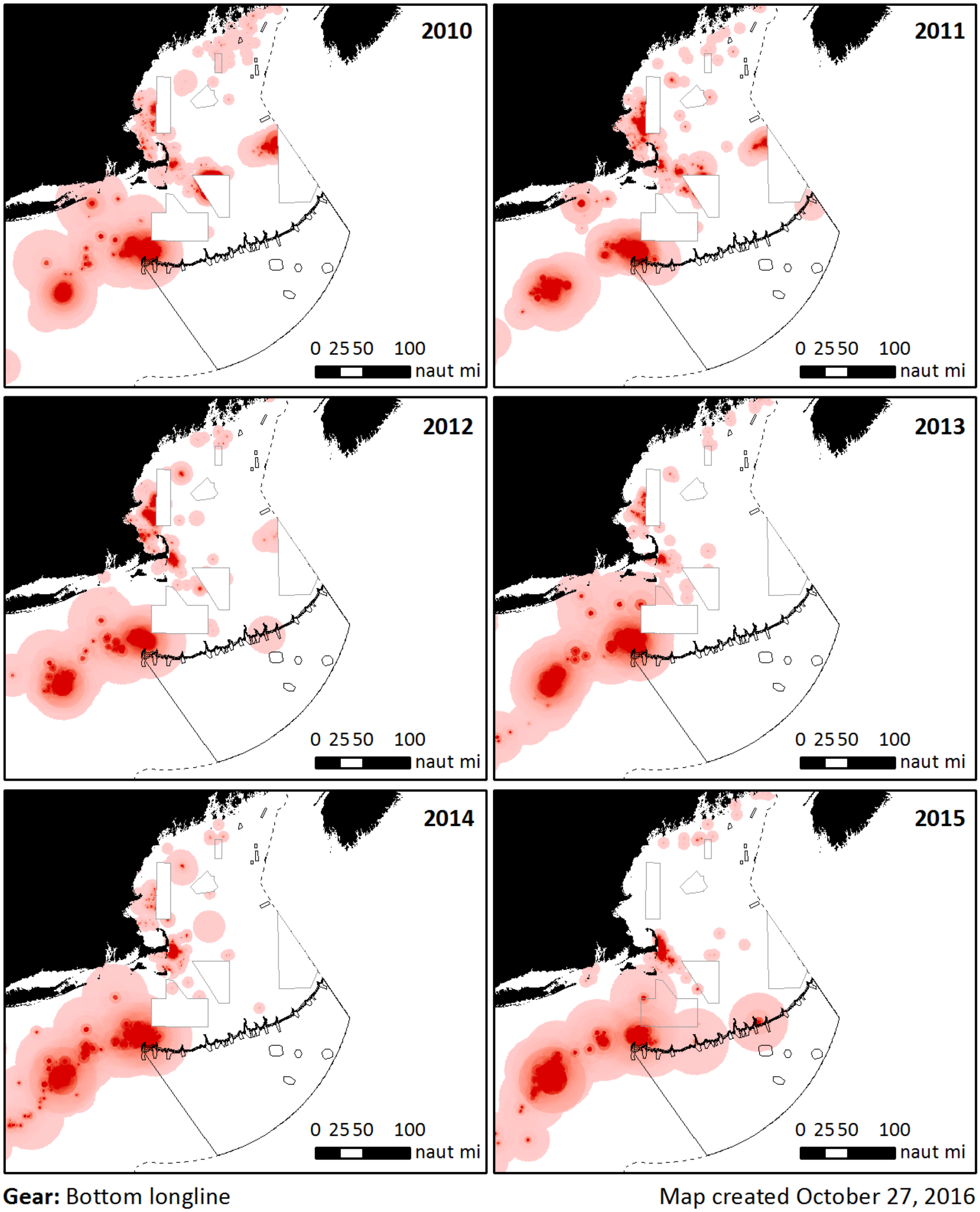
Note: Zero values excluded.
Source: VTR analysis.

Map 58 – Clam dredge gear revenue distribution, 2010-2015.



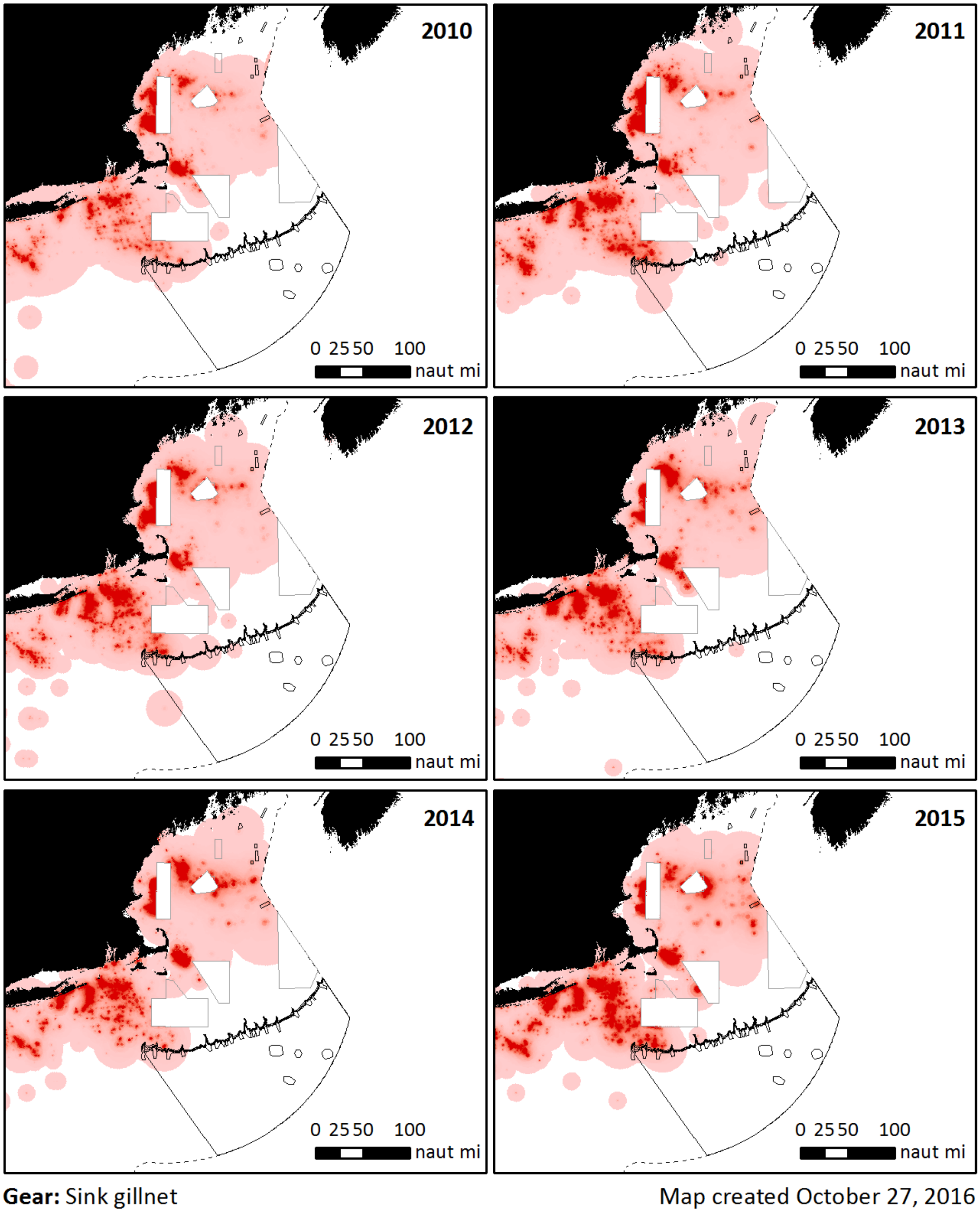
Note: Zero values excluded.
Source: VTR analysis.

Map 59 – Bottom longline gear revenue distribution, 2010-2015.



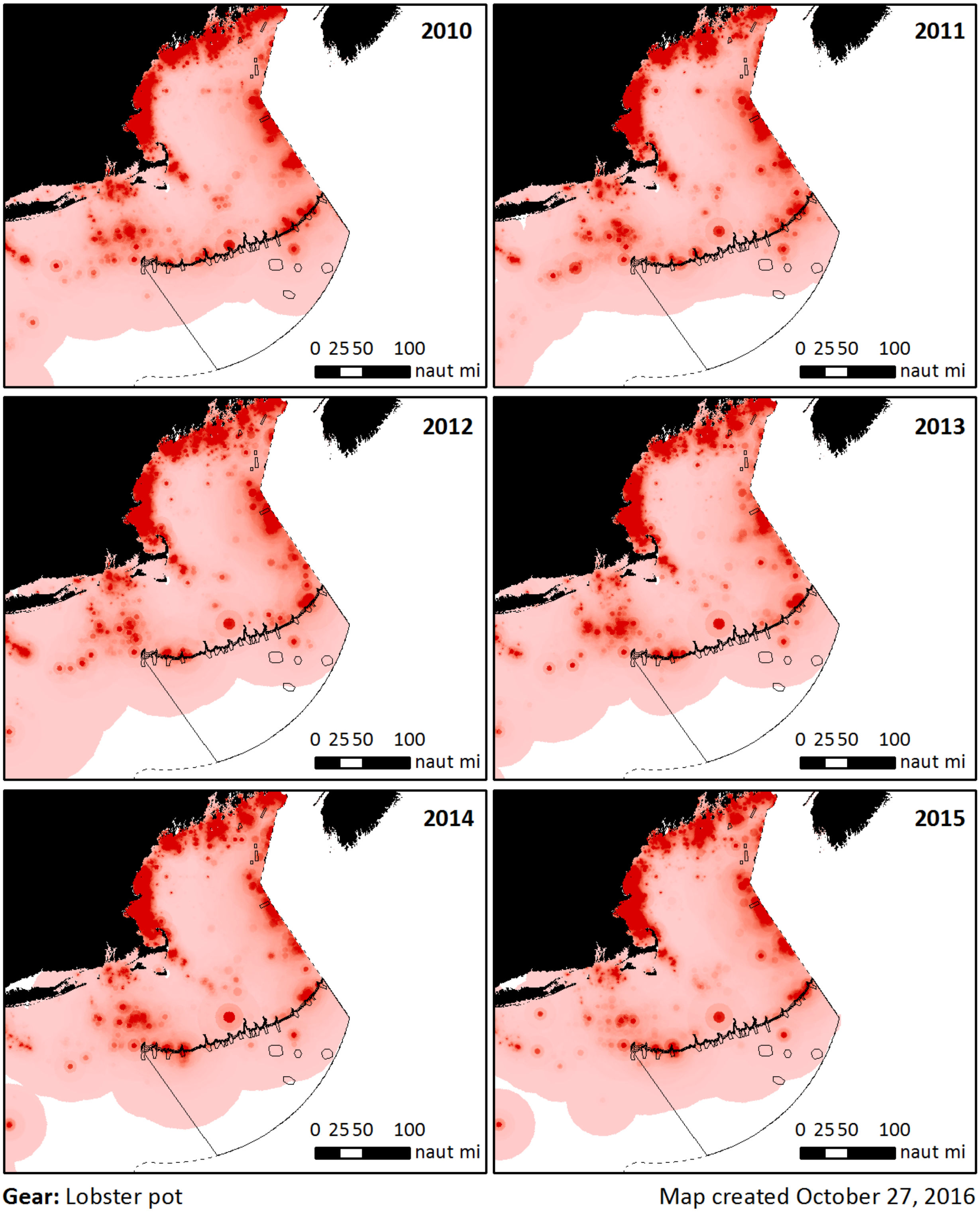
Note: Zero values excluded.
Source: VTR analysis.

Map 60 – Sink gillnet gear revenue distribution, 2010-2015.



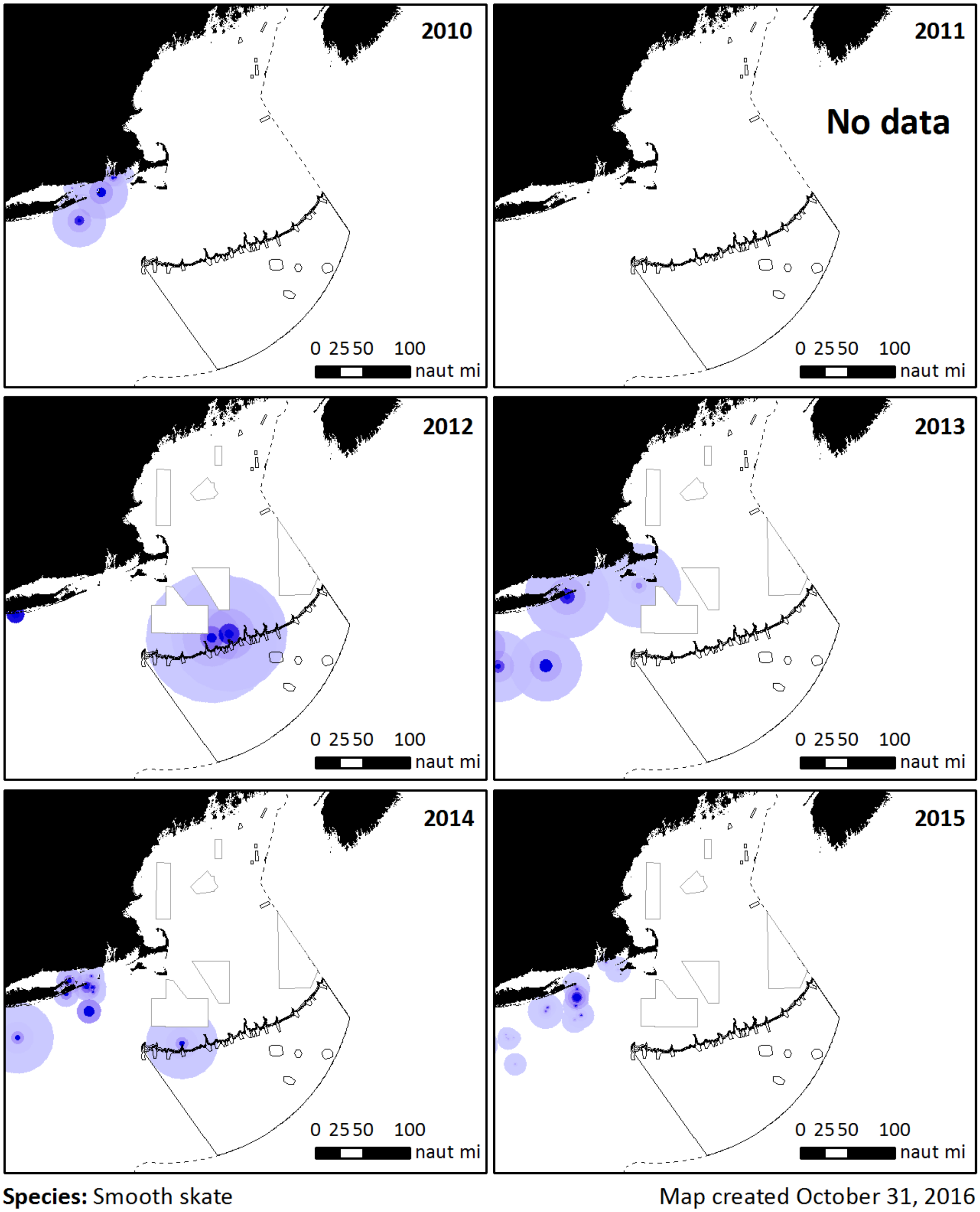
Note: Zero values excluded.
Source: VTR analysis.

Map 61 – Lobster pot gear revenue distribution, 2010-2015.



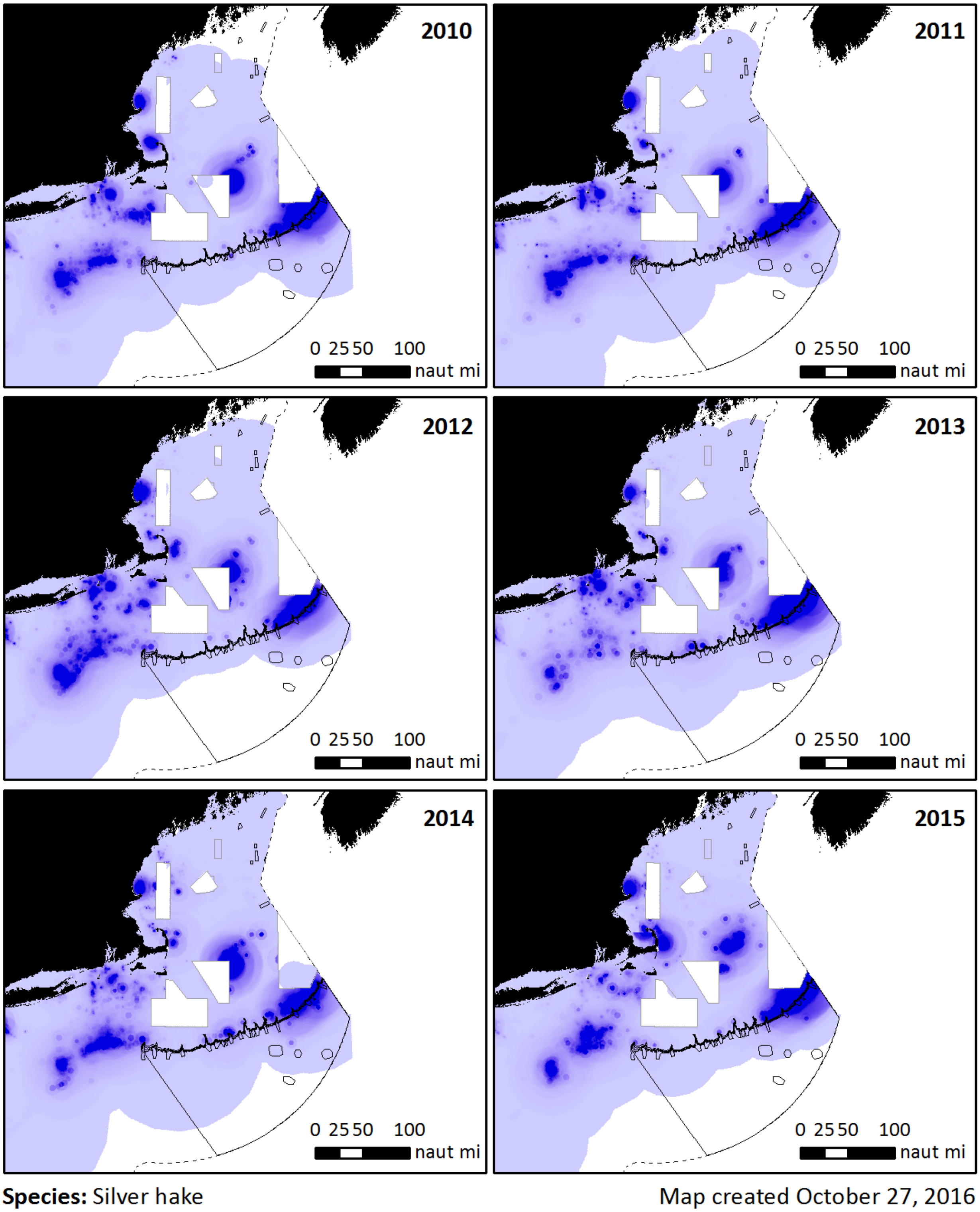
Note: Zero values excluded. Lobster data are not scaled, unlike as reported in the VTR analysis of the offshore coral zones.
Source: VTR analysis.

Map 62 – Smooth skate revenue distribution, 2010-2015.



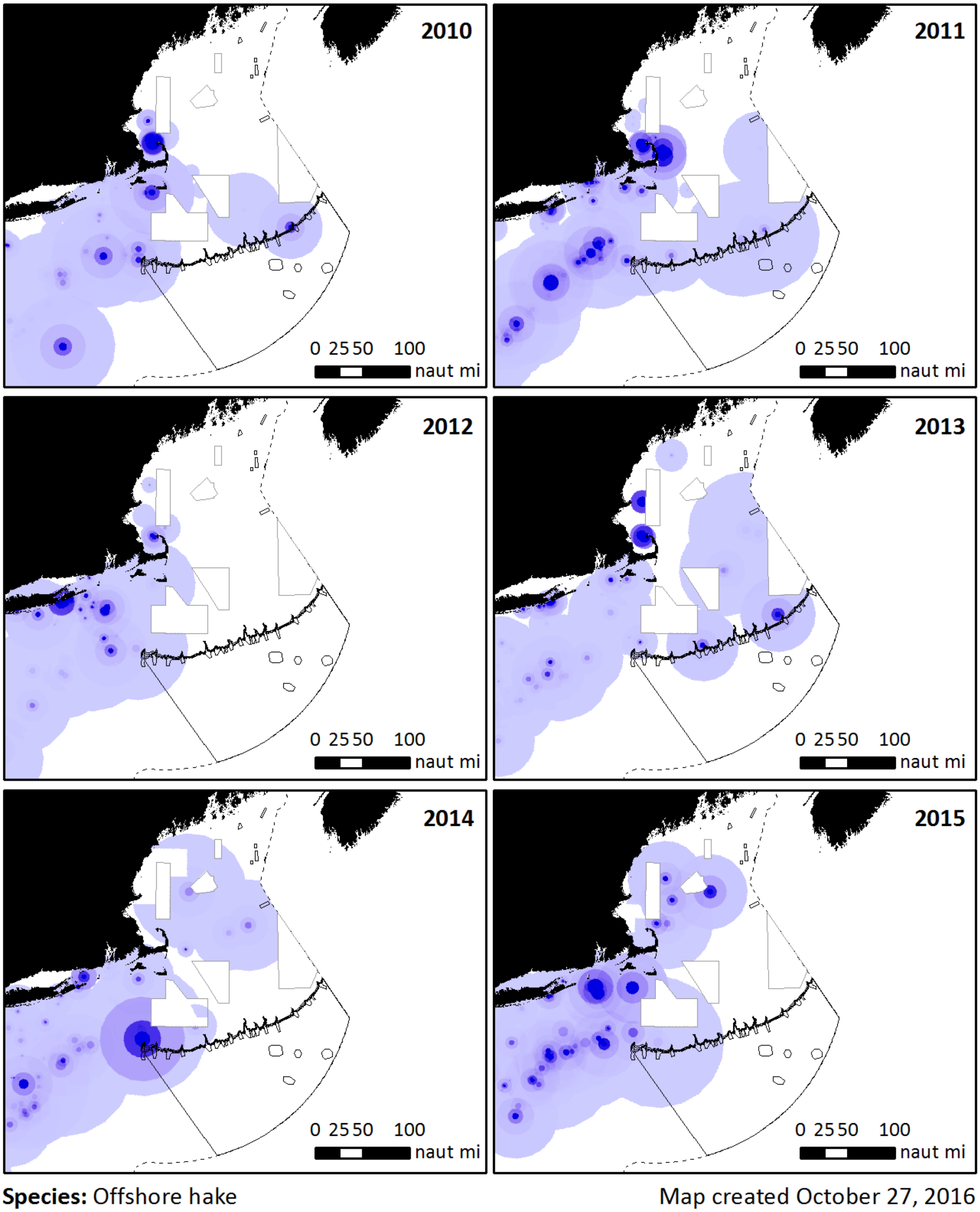
Note: Zero values excluded.
Source: VTR analysis.

Map 63 – Silver hake revenue distribution, 2010-2015.



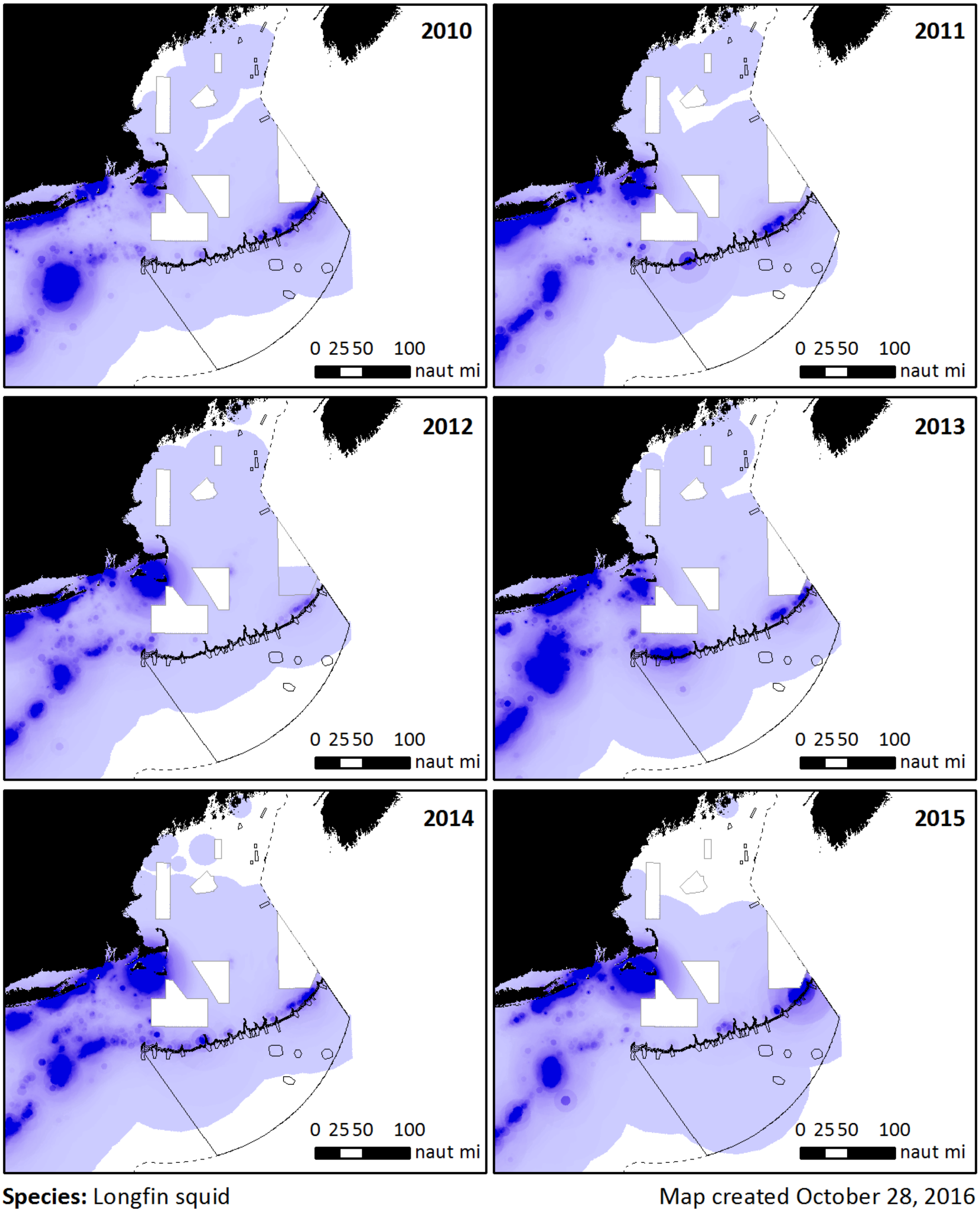
Note: Zero values excluded.
Source: VTR analysis.

Map 64 – Offshore hake revenue distribution, 2010-2015.



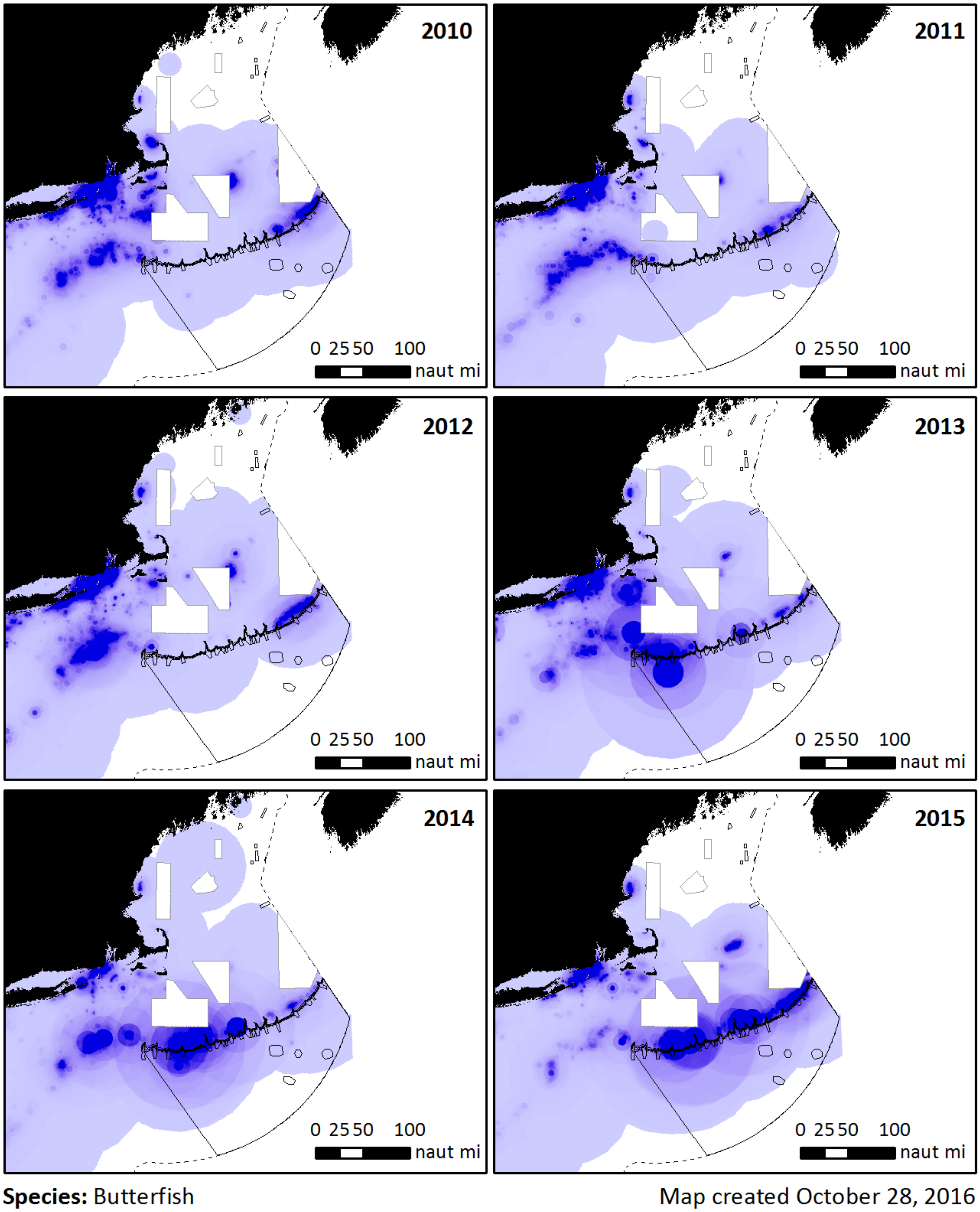
Note: Zero values excluded.
Source: VTR analysis.

Map 65 – Longfin squid revenue distribution, 2010-2015.



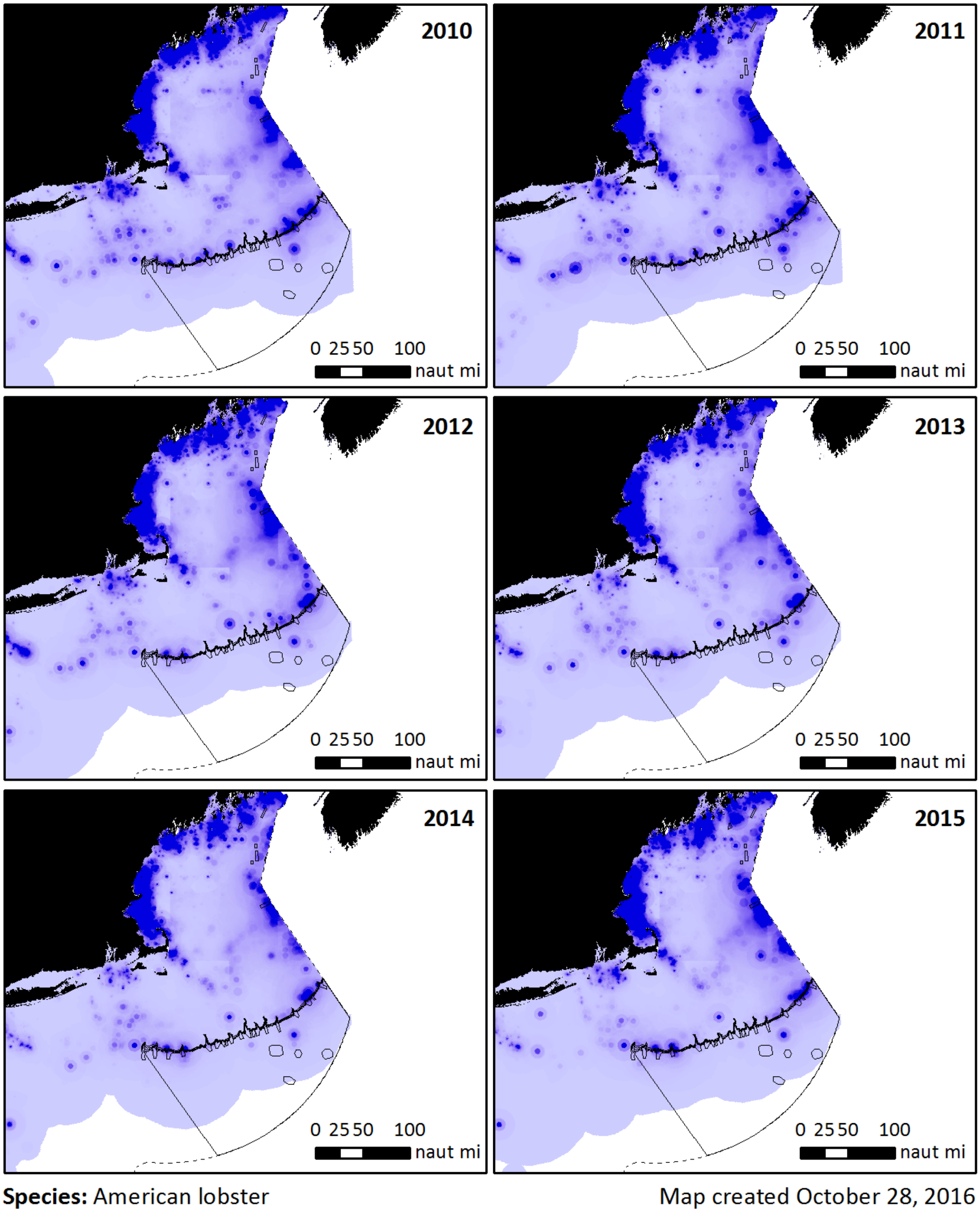
Note: Zero values excluded.
Source: VTR analysis.

Map 66 – Butterfish revenue distribution, 2010-2015.



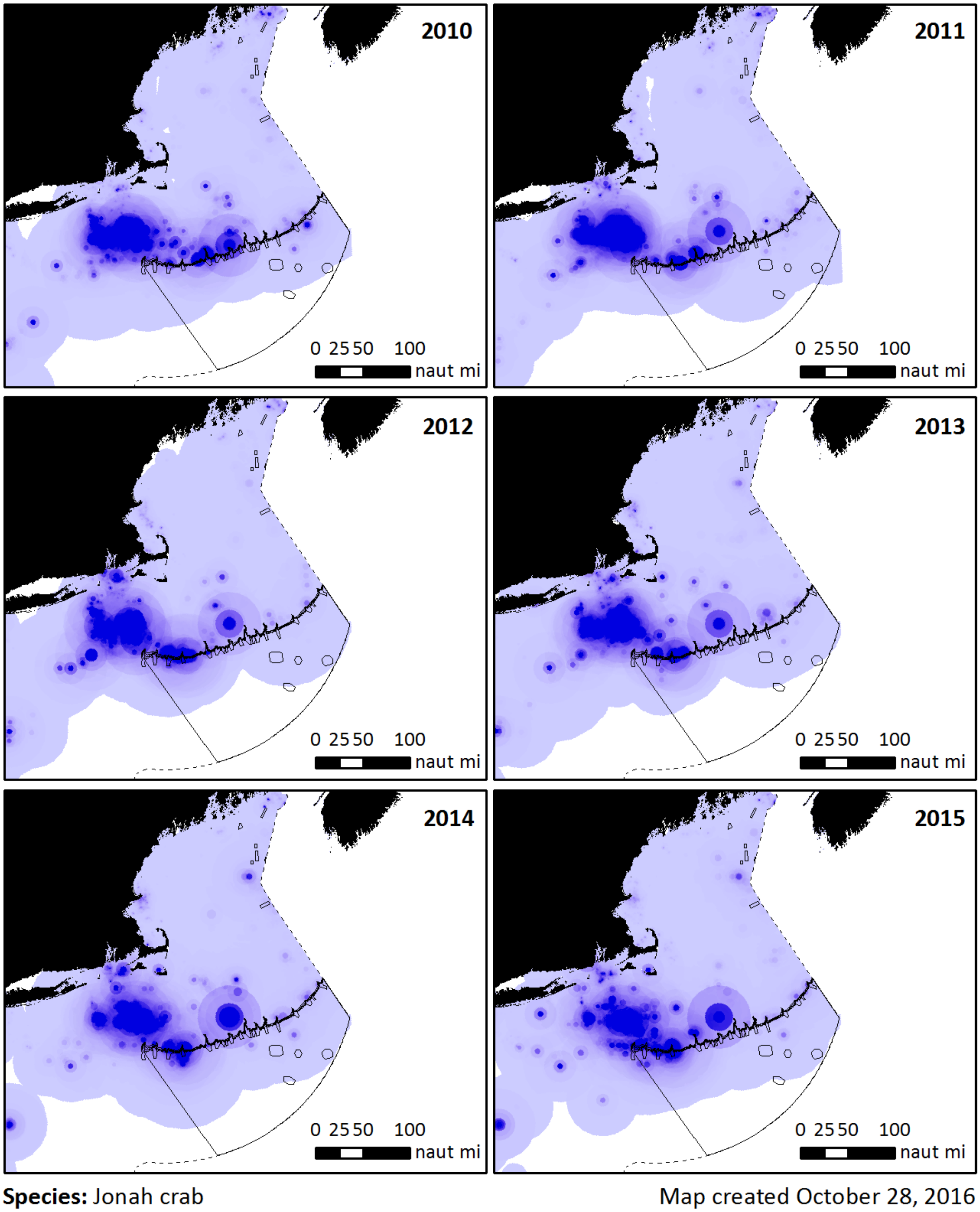
Note: Zero values excluded.
Source: VTR analysis.

Map 67 – Lobster revenue distribution, 2010-2015.



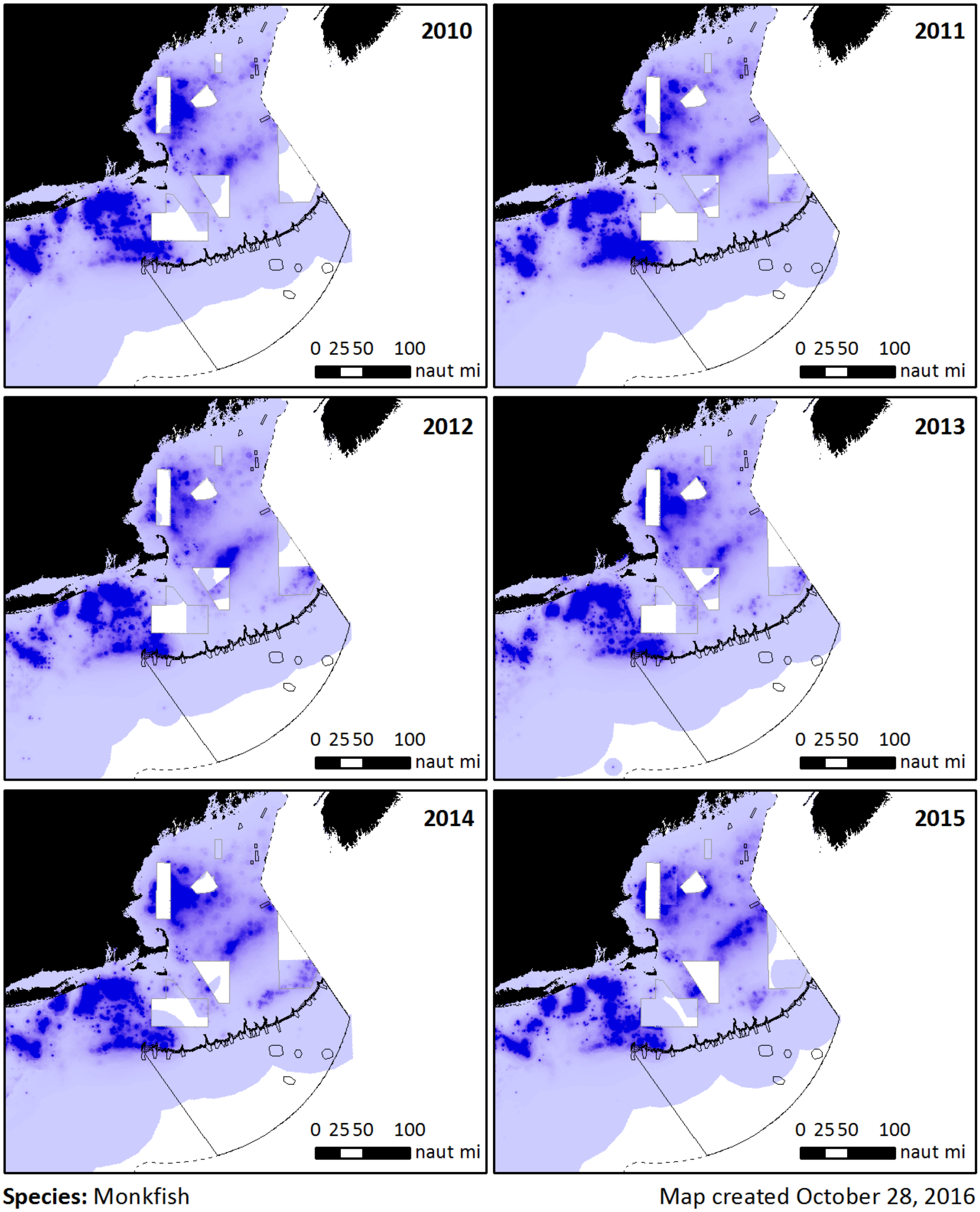
Note: Zero values excluded. Lobster data are not scaled, unlike as reported in the VTR analysis of the offshore coral zones.
Source: VTR analysis.

Map 68 – Jonah crab revenue distribution, 2010-2015.



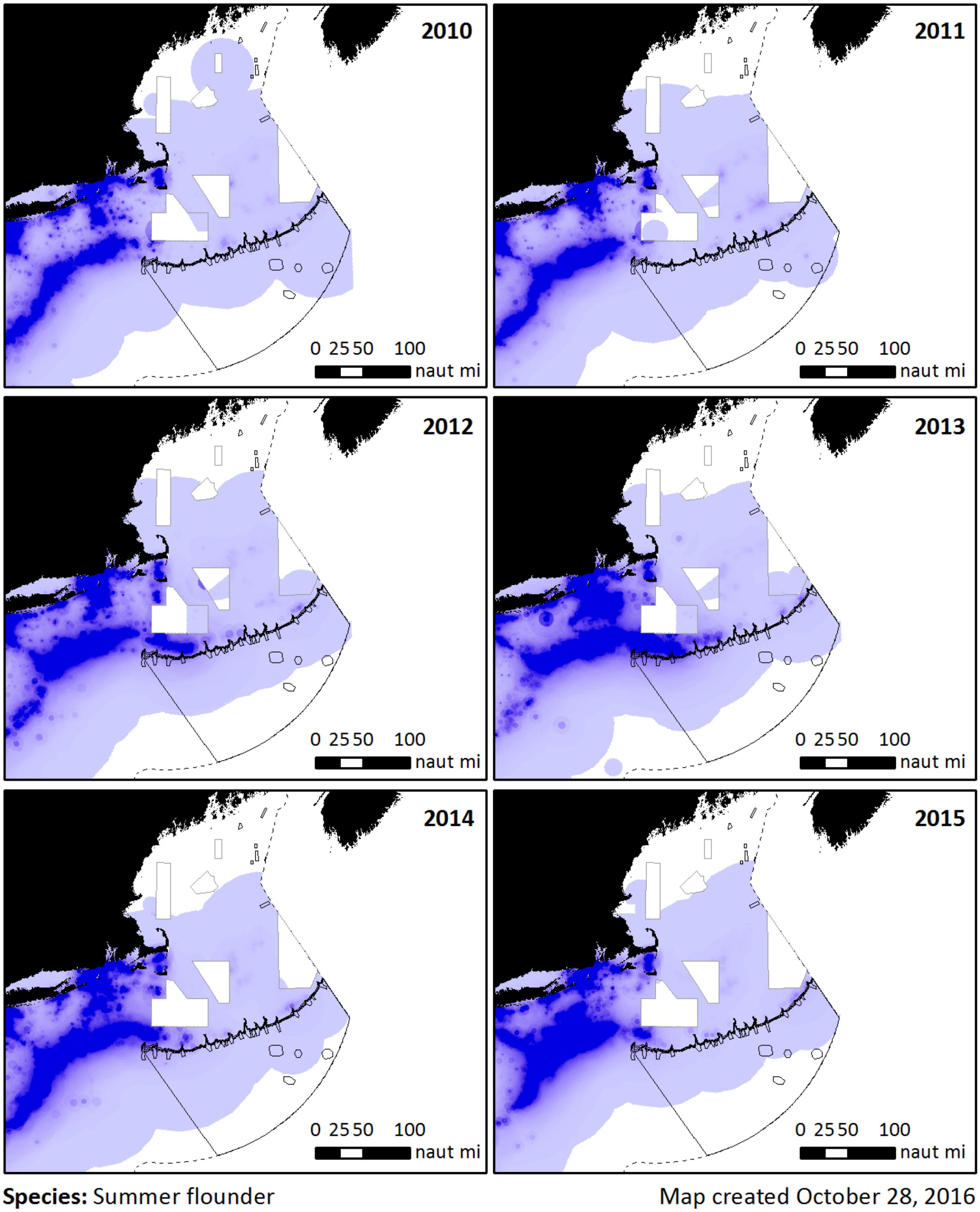
Note: Zero values excluded.
Source: VTR analysis.

Map 69 – Monkfish revenue distribution, 2010-2015.



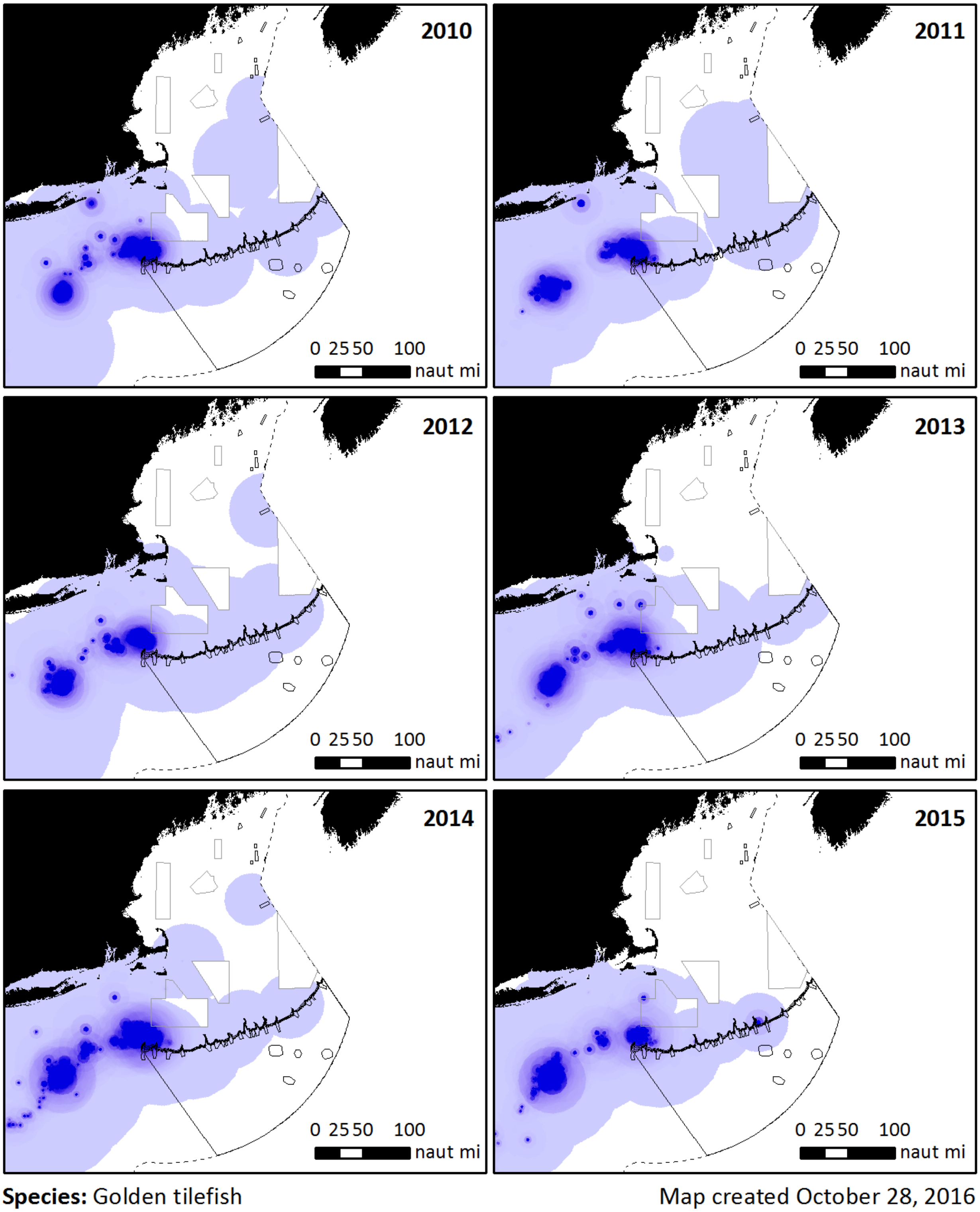
Note: Zero values excluded.
Source: VTR analysis.

Map 70 – Summer flounder revenue distribution, 2010-2015.



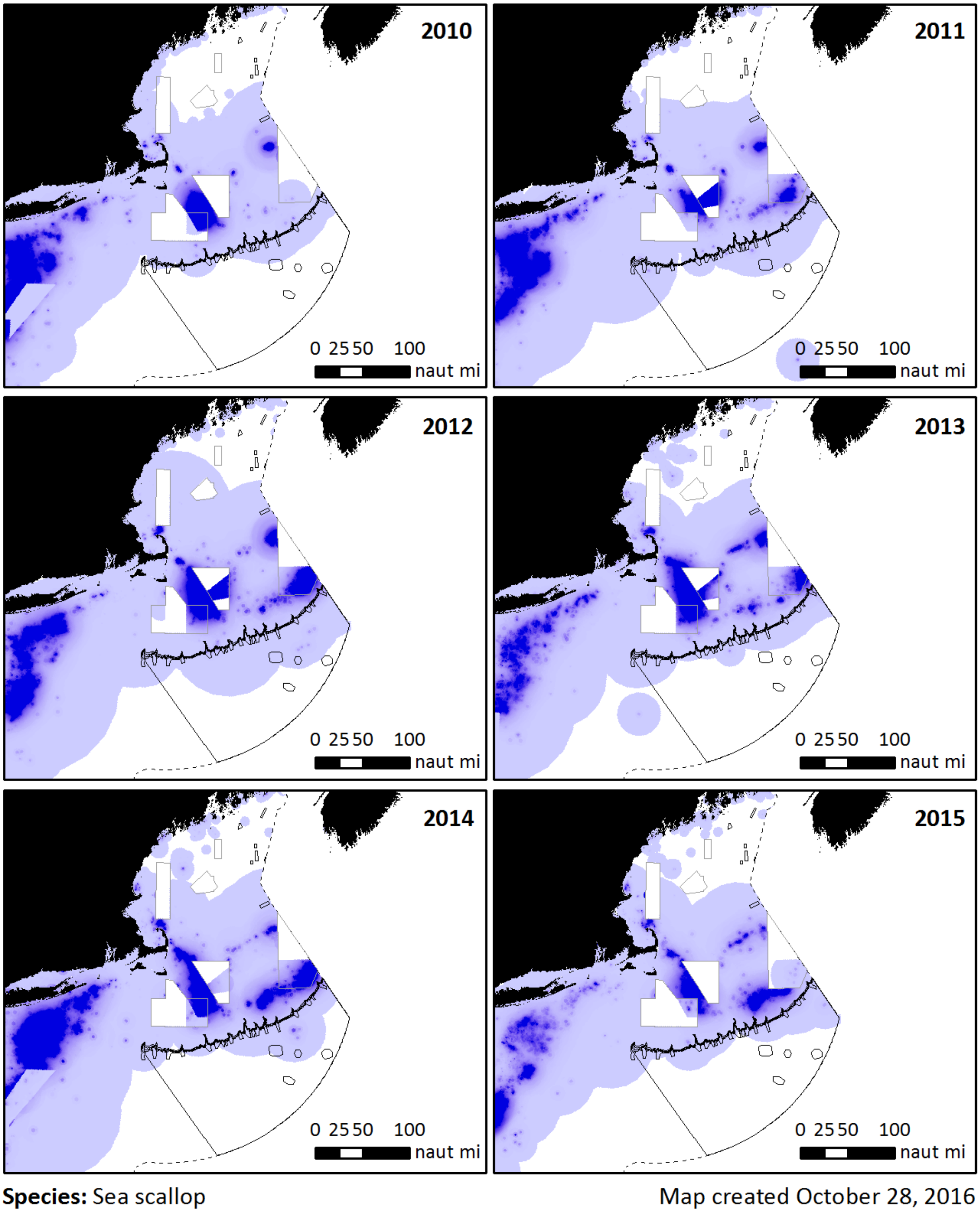
Note: Zero values excluded.
Source: VTR analysis.

Map 71 – Golden tilefish revenue distribution, 2010-2015.



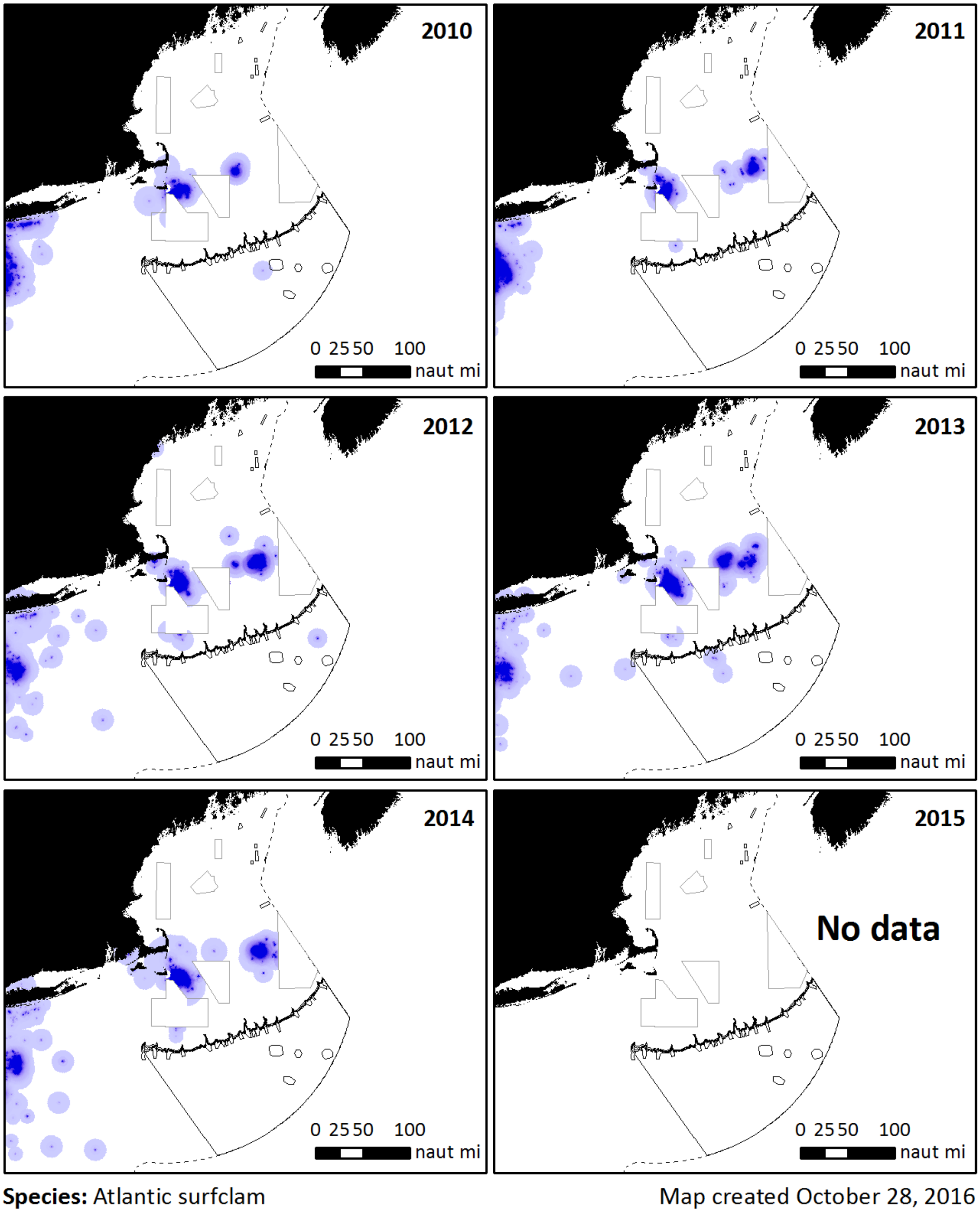
Note: Zero values excluded.
Source: VTR analysis.

Map 72 – Sea scallop revenue distribution, 2010-2015.



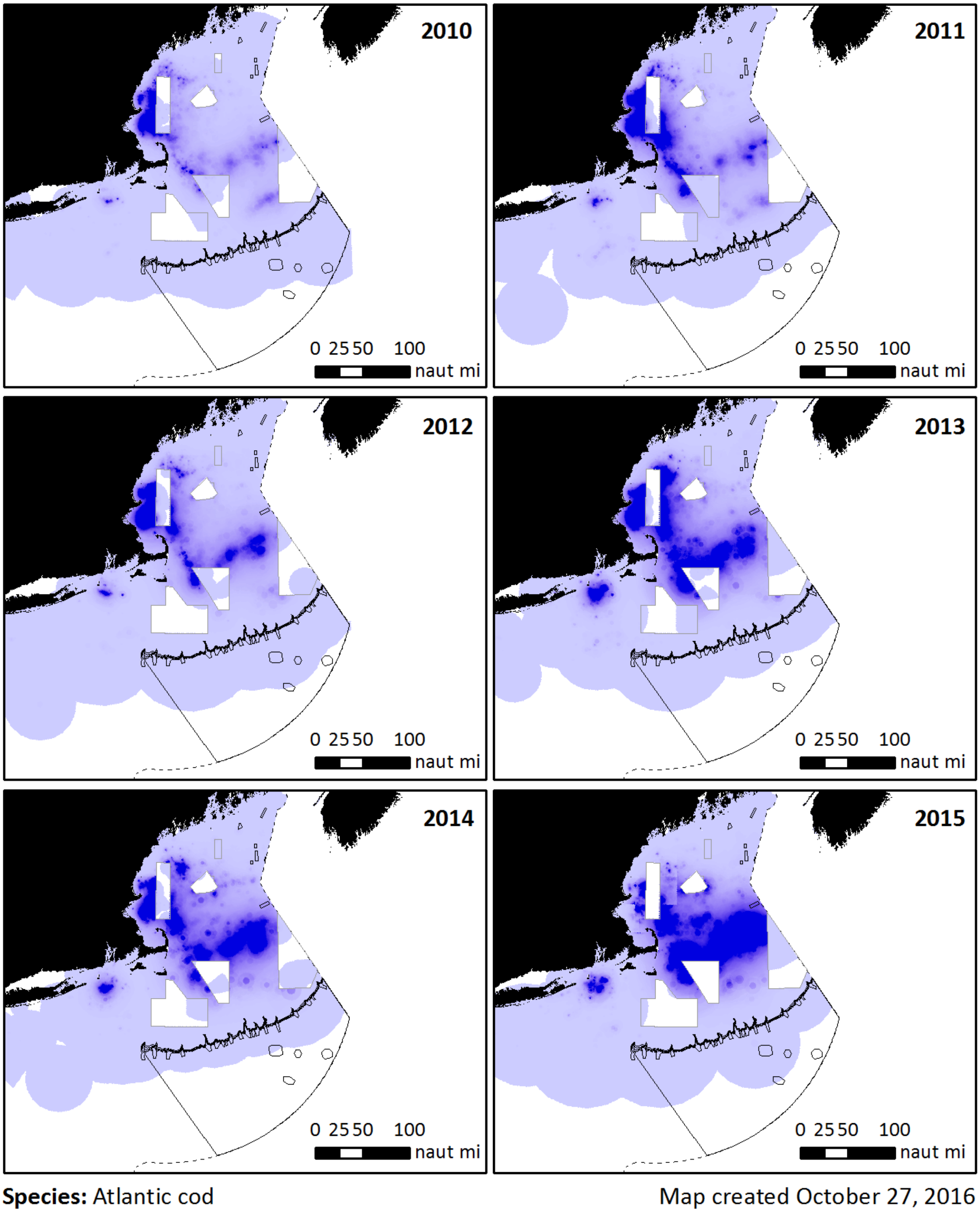
Note: Zero values excluded.
Source: VTR analysis.

Map 73 – Atlantic surfclam revenue distribution, 2010-2015.



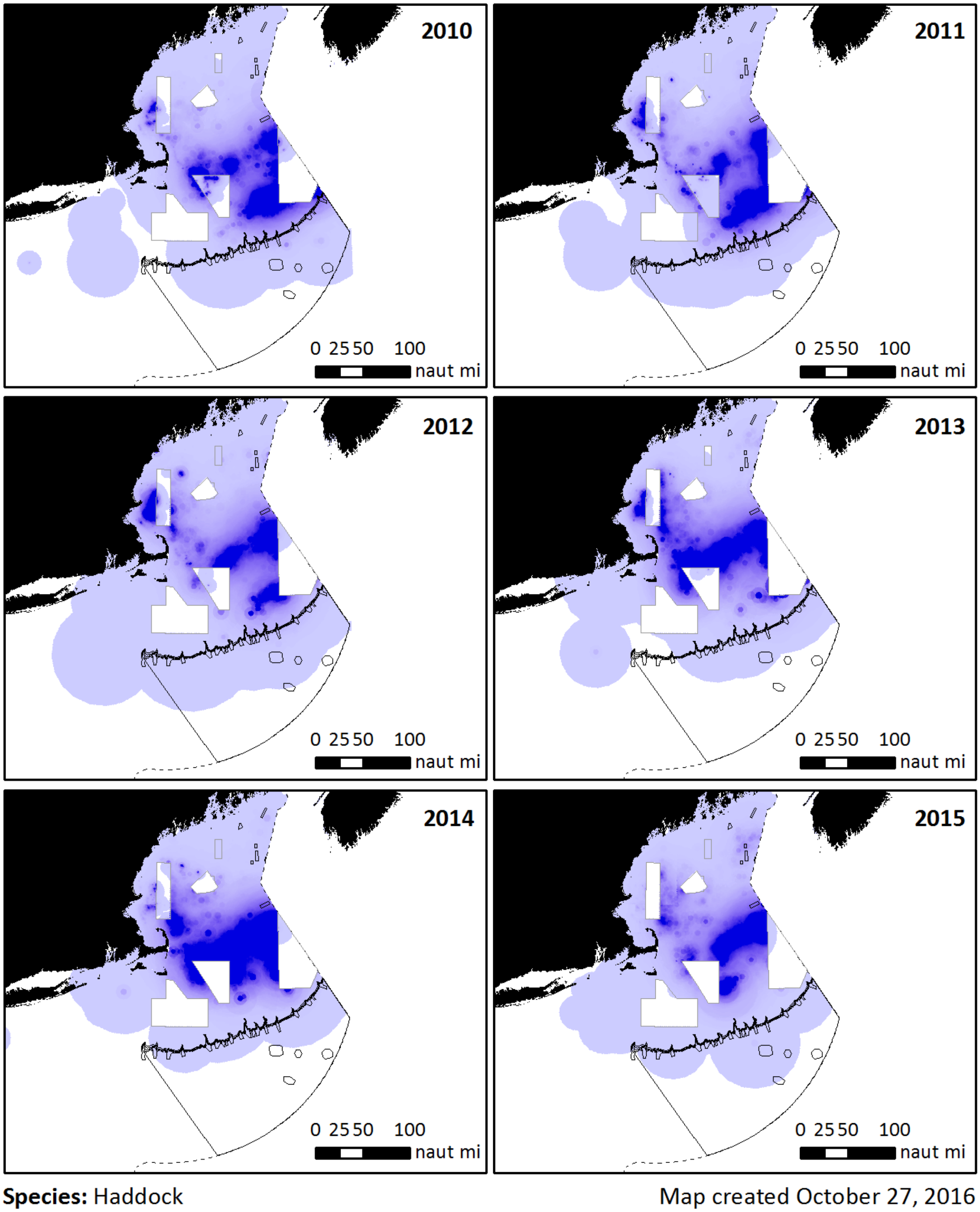
Note: Zero values excluded.
Source: VTR analysis.

Map 74 – Atlantic cod revenue distribution, 2010-2015.



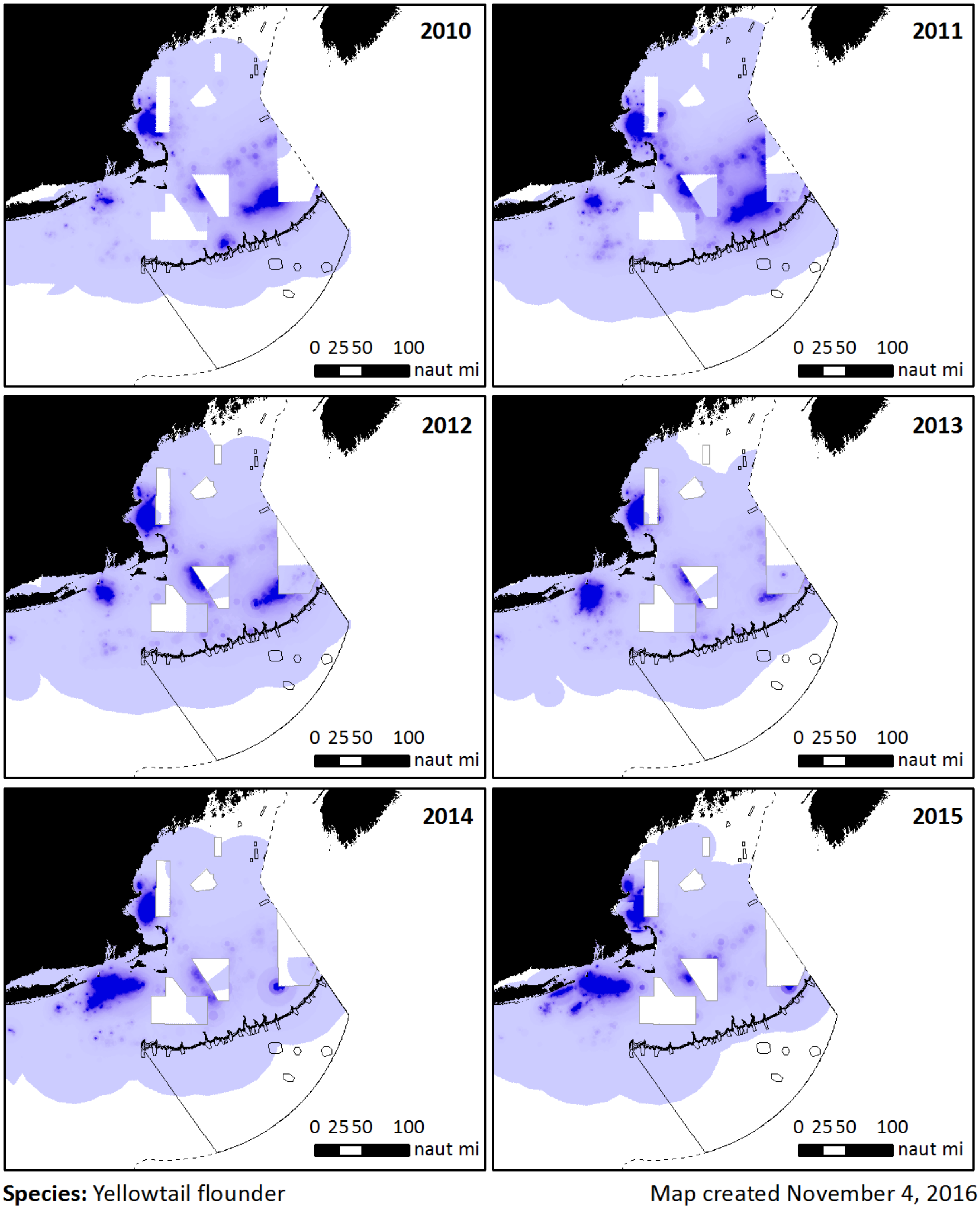
Note: Zero values excluded.
Source: VTR analysis.

Map 75 – Haddock revenue distribution, 2010-2015.



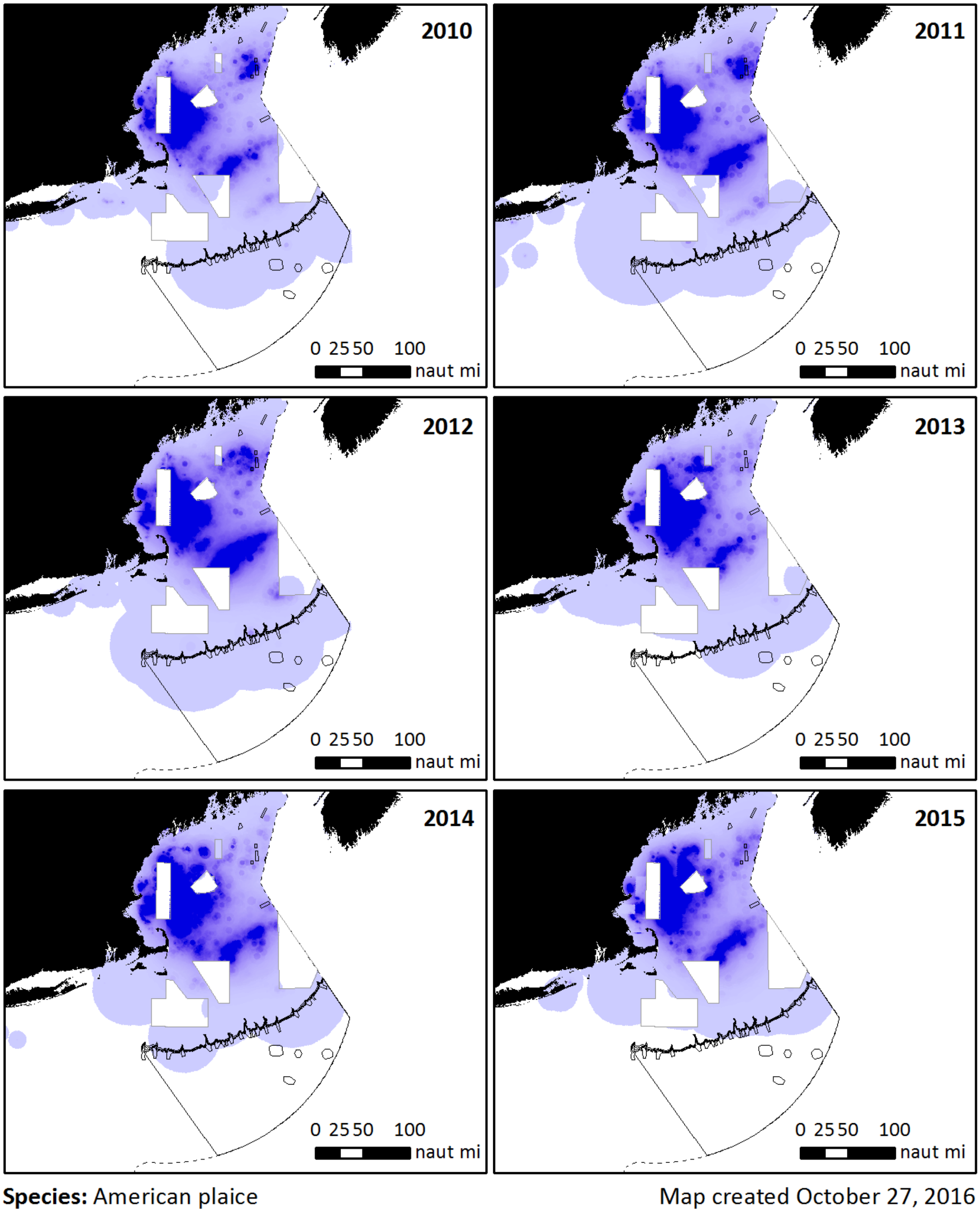
Note: Zero values excluded.
Source: VTR analysis.

Map 76 – Yellowtail flounder revenue distribution, 2010-2015.



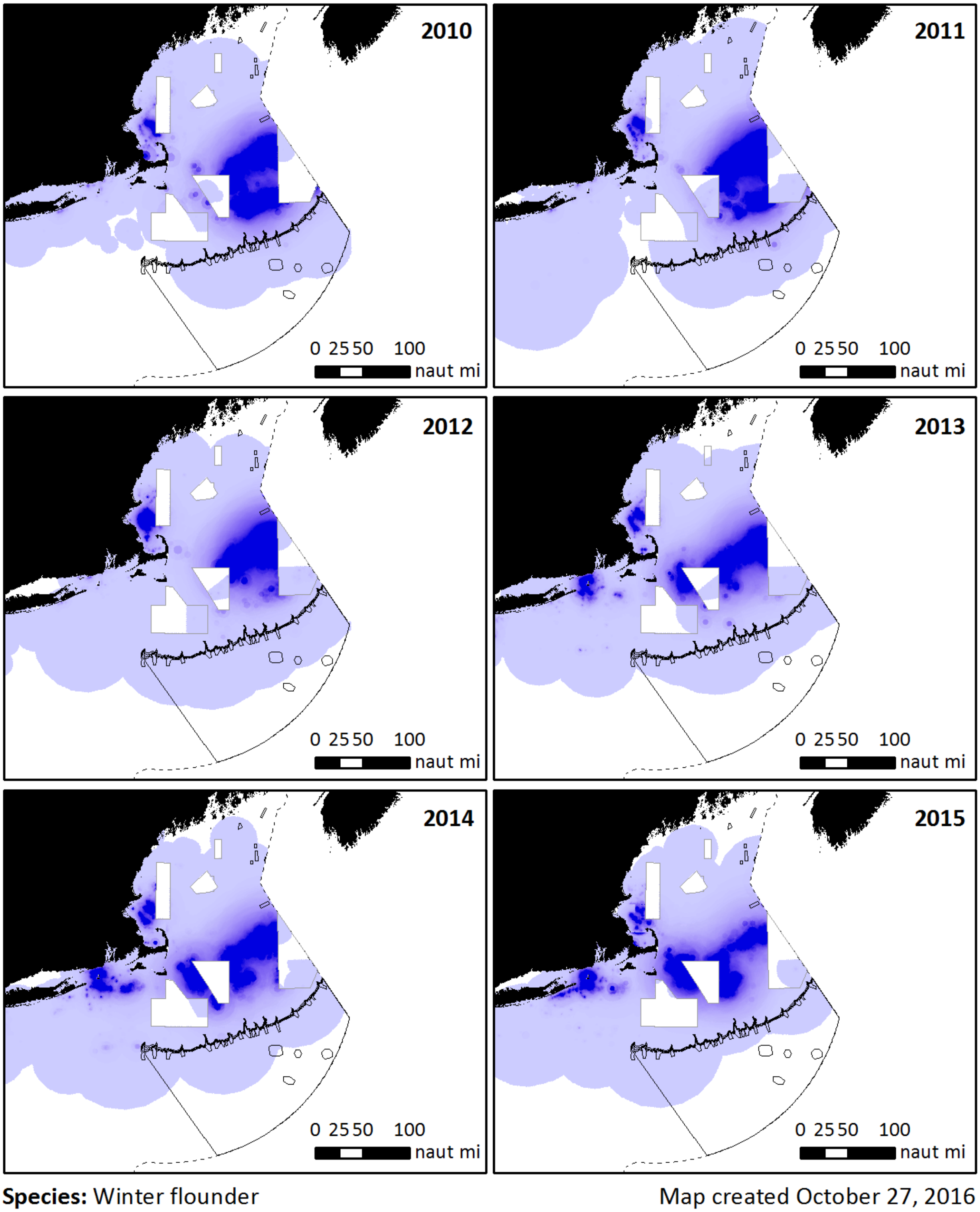
Note: Zero values excluded.
Source: VTR analysis.

Map 77 – American plaice revenue distribution, 2010-2015.



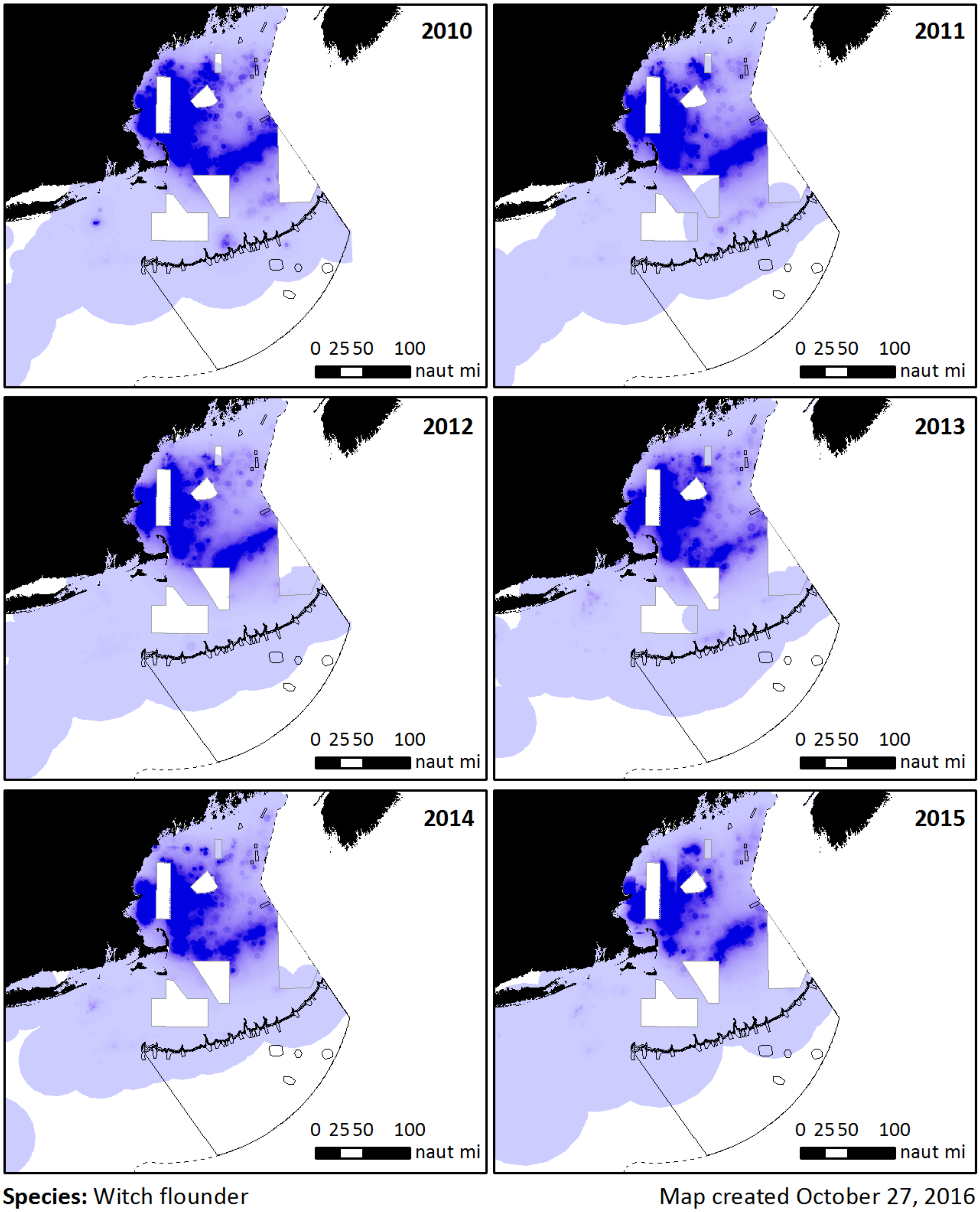
Note: Zero values excluded.
Source: VTR analysis.

Map 78 – Winter flounder revenue distribution, 2010-2015.



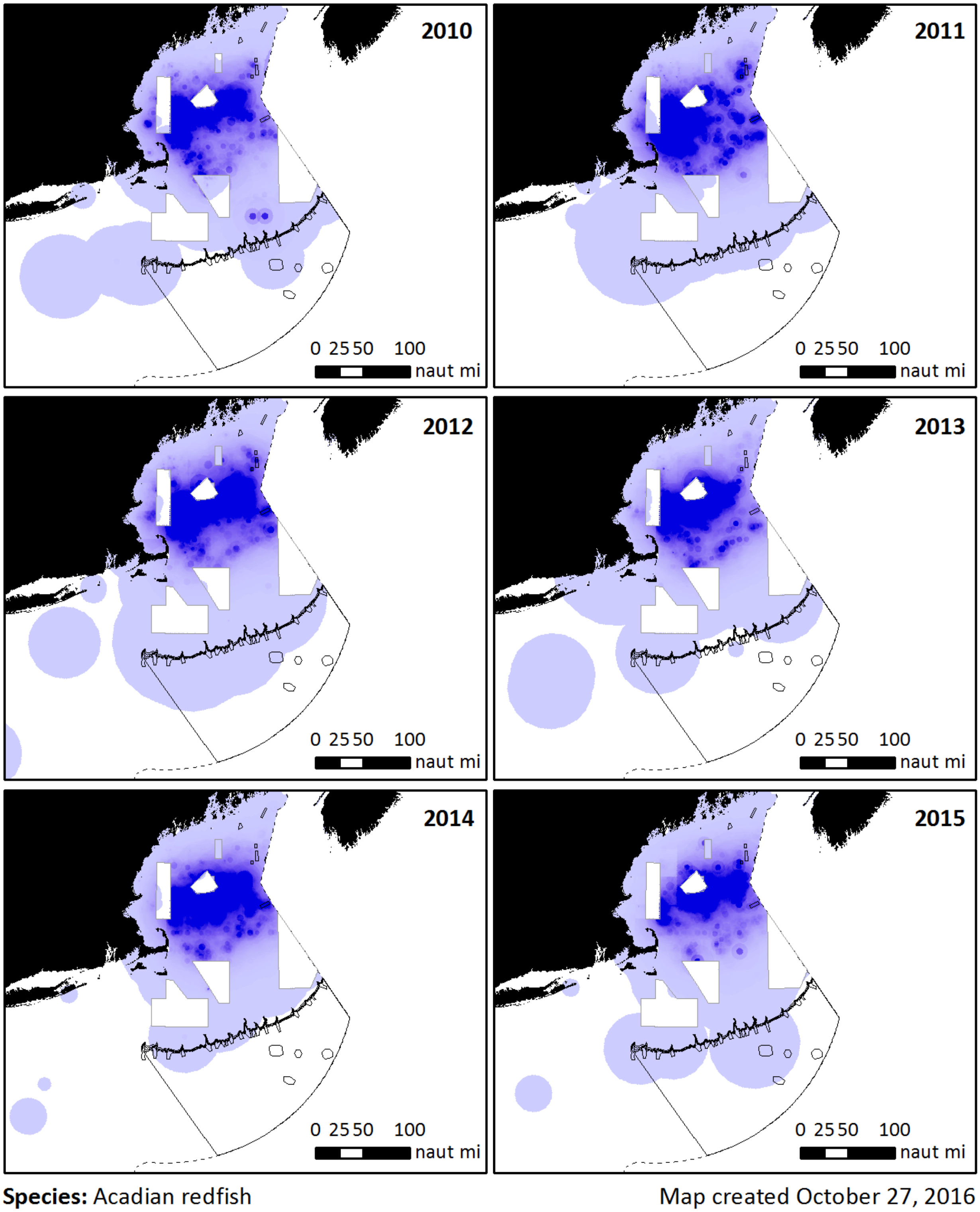
Note: Zero values excluded.
Source: VTR analysis.

Map 79 – Witch flounder revenue distribution, 2010-2015.



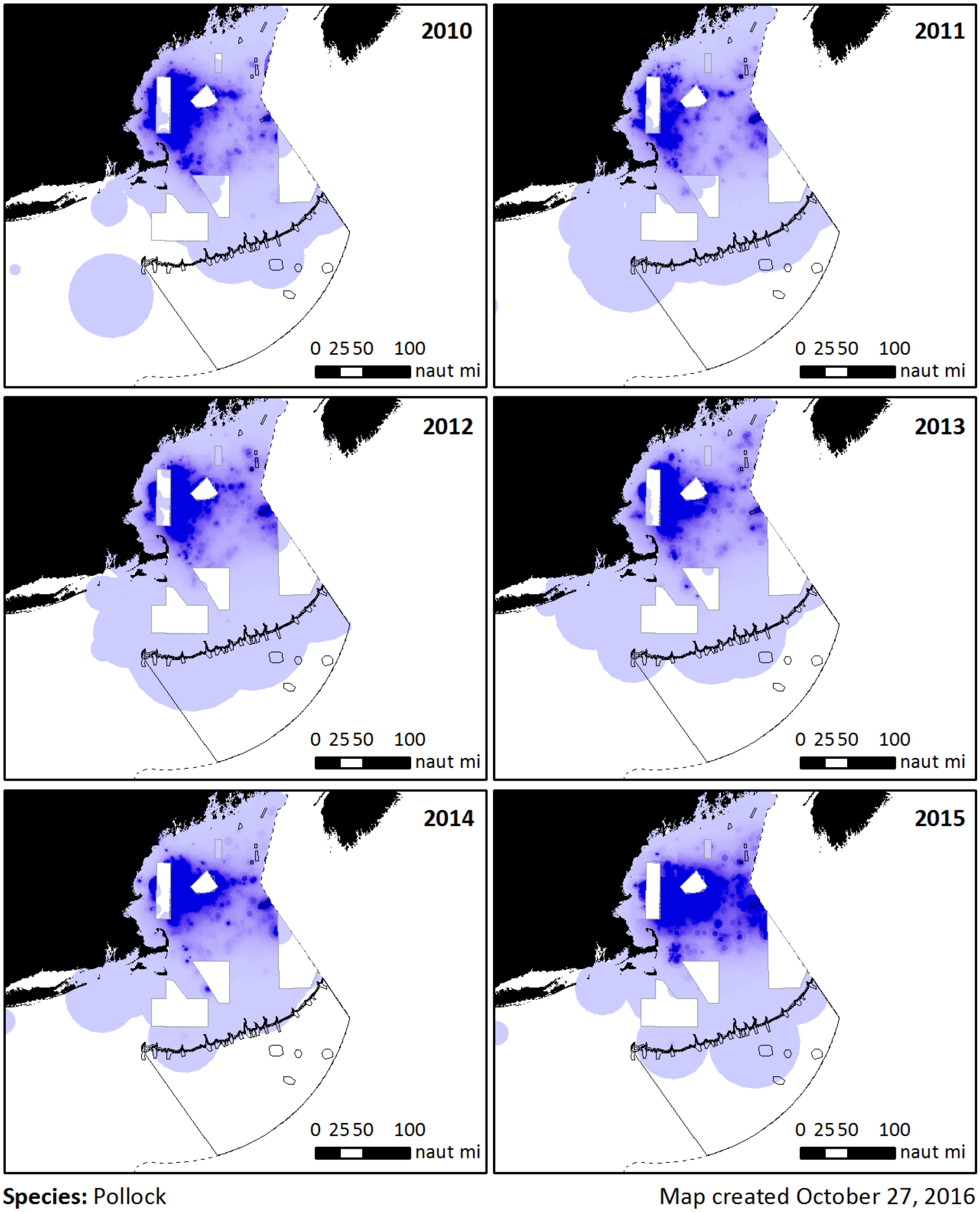
Note: Zero values excluded.
Source: VTR analysis.

Map 80 – Redfish revenue distribution, 2010-2015.



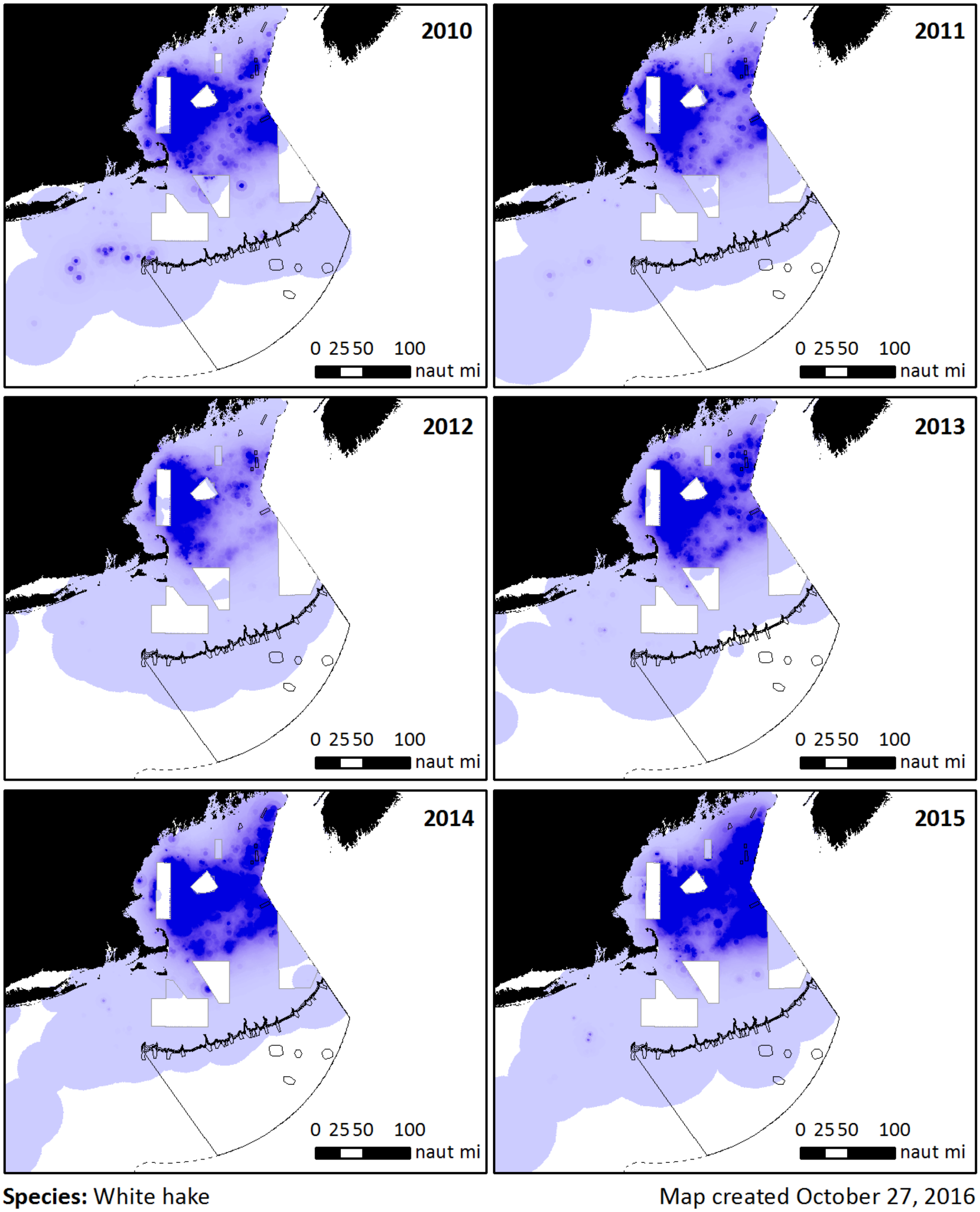
Note: Zero values excluded.
Source: VTR analysis.

Map 81 – Pollock revenue distribution, 2010-2015.



Note: Zero values excluded.
Source: VTR analysis.

Map 82 – White hake revenue distribution, 2010-2015.



Note: Zero values excluded.
Source: VTR analysis.