FINAL

Omnibus Essential Fish Habitat Amendment 2

Volume 4:
Environmental impacts of spatial management alternatives on habitat, human community, and protected resources

Amendment 14 to the Northeast Multispecies FMP
Amendment 14 to the Atlantic Sea Scallop FMP
Amendment 4 to the Monkfish FMP
Amendment 3 to the Atlantic Herring FMP
Amendment 2 to the Red Crab FMP
Amendment 2 to the Skate FMP
Amendment 3 to the Atlantic Salmon FMP

Including a
Final Environmental Impact Statement

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2 Introduction

This volume analyzes the impacts of the spatial management alternatives described in Volume 3 on the following valued ecosystem components (VECs):

- Physical and biological environment, with a focus on seabed habitats in particular.
- Human communities and the fishery. In this section, the impacts are described by gear type because this is how the management area regulations are applied. Impacts on specific managed resources and their fisheries are described in Volume 5.
- Protected resources. This includes impacts to large and small cetaceans, pinnipeds, sea turtles, Atlantic sturgeon, and Atlantic salmon occurring in the New England Region.

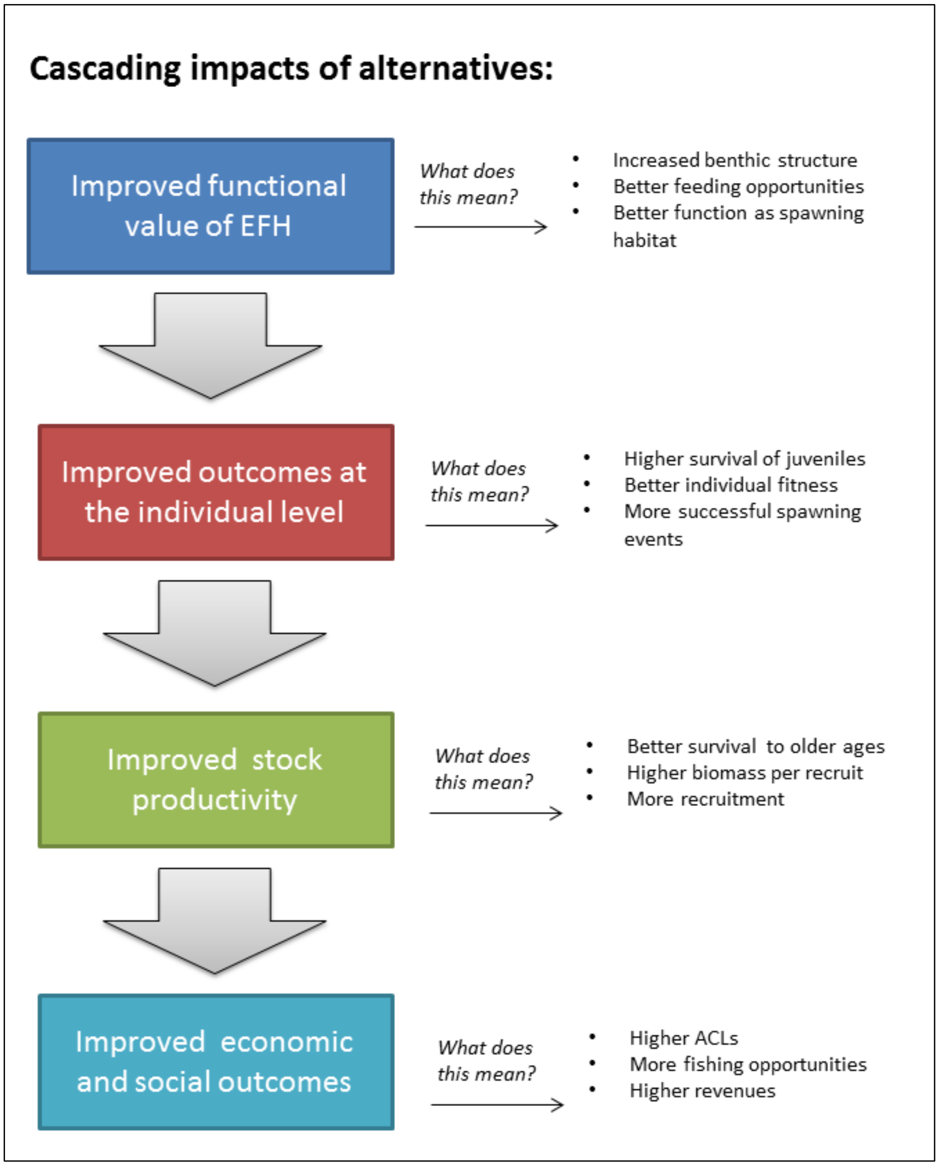
While the analytical approach and assumptions vary according to alternative type and VEC, there are some general issues and assumptions common to all alternative type/VEC combinations. The overall approach for the impacts analysis is to identify the attributes of the various areas that make up each alternative, and then use these attributes, or metrics, to evaluate the impacts of each alternative on the valued ecosystem component in question. Metrics include seabed habitat type and vulnerability, overlap with designated EFH, species diversity, revenue by gear type, spatial overlap with protected species management areas, etc. In some cases, the analyses describe these metrics at the alternative level, and in other cases, the analyses describe these metrics at the area level. To be clear, most of the alternatives consist of combinations of individual management areas.

The analyses in this volume are presented by valued ecosystem component and then type of management alternative (habitat, spawning, research). Impacts of the framework and monitoring alternatives are described in a separate section. Within the sub-region (habitat alternatives) or region (spawning alternatives), impacts are compared between each alternative and the no action alternative, and between action alternatives. Comparisons are made at the sub-regional or regional level in this volume because the very large number of alternatives in the amendment means that matrix of direct comparisons is sizable. Presenting all of these comparisons in text format would likely detract from the readability and clarity of the analysis, which is already extremely dense. Tables provided in the cumulative effects analysis in Volume 6 summarize the conclusions of the impacts analysis and allow for a comparison of alternatives across sub-regions. In addition, the cumulative effects analysis describes the additive impacts of the No Action, preferred, and other suites of alternatives on the VECs. In this volume, qualifiers such as slightly, moderately, or highly positive or negative are comparable across sub-regions. For example, if Alternative 3 in a sub-region A has highly positive impacts on EFH, and Alternative 4 in sub-region B has slightly positive impacts on EFH, it is appropriate to interpret these conclusions as Alternative 3 in sub-region A providing more positive habitat benefits relative to Alternative 4 in sub-region B. Of course, given that different stocks occupy different parts of the New England region, the alternatives in one sub-region may have greater positive or negative impacts on one species vs. another. But, as was noted in Volume 3, presenting the habitat management alternatives by sub-region is not intended to indicate that equal magnitudes of outcomes in all sub-regions is necessary for the conservation of regional EFH.

One overarching issue that complicates development of the impacts analyses is that the purposes for the action alternatives do not always map directly to the original rationale for the areas and measures that make up the no action alternatives. In particular, the year-round groundfish closed areas (Closed Areas I and II, Nantucket Lightship Closed Area, Western Gulf of Maine and Cashes Ledge Closure Areas) are included in the no action habitat management alternatives and the no action spawning alternatives, but they were primarily designated to meet mortality reduction objectives, which is not an objective of this amendment. Thus, the analyses will address how the action alternative areas and measures meet the purpose and need of this amendment relative to how well the no action areas and measures meet the purpose and need of this amendment. This is different than an evaluation of how well the no action areas perform relative to their original intended purpose.

These management alternatives were developed with the amendment’s goals and objectives in mind. These include minimizing the adverse effects of fishing on EFH to the extent practicable, and improving productivity of groundfish resources, among others (see Volume 1). While the analyses in this volume and in Volume 5 are presented by VEC, parsing impacts in this way is somewhat artificial, given the complex ecology of the natural environment, which is closely intertwined with the users of that environment. For example, minimizing the adverse effects of fishing on EFH to the extent practicable is important because it is a requirement of the Magnuson-Stevens Act, but the reason for doing so is that improving the functional value of a fish’s habitat should improve survival and fitness of individuals. Improving individual fitness across enough invididual fish should improve the stock overall, which should lead to positive economic and social outcomes over time (Figure 1).

Figure 1 - Linkages between VECs and impacts

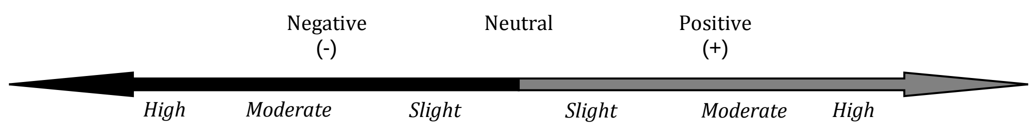


Throughout the following sections, the following terminology is used to describe the impacts of the alternatives on the valued ecosystem components (VECs).

Table 1 – Terms used in the impacts analysis for this amendment

Impact Definition			
	Direction		
VEC	**Positive (+)**	**Negative (-)**	**Neutral**
Managed fish and invertebrate species, and protected resources	Actions that increase stock/population size, improve stock structure, improve the fitness of individuals, etc.[1]	Actions that decrease stock/population size, negatively affect age or size structure, lead to lower individual fitness, etc.	Actions that have little or no positive or negative impacts to stocks/populations
Physical environment	Actions that improve the quality or reduce disturbance of habitat	Actions that degrade the quality or increase disturbance of habitat	Actions that have no positive or negative impact on habitat quality
Human community	Actions that increase revenue and social well-being of fishermen and/or associated businesses	Actions that decrease revenue and social well-being of fishermen and/or associated businesses	Actions that have no positive or negative impact on revenue and social well-being of fishermen and/or associated businesses

Impact Qualifiers	
Slight	To a lesser degree
Moderate	To an average degree (i.e., more than “low”, but not “high”). If the qualifiers ‘slight’ or high’ are not specified, this indicates moderate impacts.
High	To a substantial degree



Another overarching issue is that it is difficult to specify with any certainty how fishing effort will shift in response to alternative spatial management scenarios. However, the impacts of any alternative are directly related to the displacement of fishing effort that results from any particular management area or combination of areas. The analyses attempt to evaluate how fishing effort may shift under the various alternatives, and assess the costs and benefits of such shifts. These potential changes in fishing effort are challenging to evaluate for several reasons. First, some of the areas into which effort could shift as a result of the alternatives in this amendment have been closed for many years to certain types of fishing, in some cases for since 1994. Since fisheries characteristics and stock biomass have changed so much since these closures went into effect, data describing previous effort distributions in these areas may be of little use to predict future effort distributions. Effort distribution data available have changed since 1994 as well; at-sea observer data, vessel trip reports (VTR), and vessel monitoring system (VMS) data were first collected around 1989, 1994, and 2000, respectively, so historical spatial distributions are often lacking and may not be representative of the fishery under current

[1] See section 4.1for details.

circumstances. Nonetheless, these older data provide some insight into how fishing effort may change as existing closed areas become available to fishing and new areas close to fishing using mobile bottom-tending gear. For example, VTR and observer data clearly show an abundance of gillnet effort on Jeffreys Ledge prior to the implementation of the Western Gulf of Maine Closure Area in 1998. In other cases, the current distributions of a stock may provide better insight to potential shifts in fishing effort.

Regional fishing effort redistribution is expected to influence the magnitude and direction of impacts of the alternatives in this amendment. Although the total catches are limited via Annual Catch Limits, the spatial distribution of fishing effort is important. A few general assumptions are made in the analyses relative to how fishing effort will be redistributed, depending on the management option selected.

If habitat management Option 1 is selected for a habitat management area, all mobile bottom-tending gear use would be displaced from the area. For some existing fishery management areas, namely the existing habitat closures in the groundfish and scallop FMPs, this may represent a continuation of measures already in place, but for other areas, including HMAs newly developed in this amendment, these gears would be excluded for the first time. Mobile bottom-tending gears include bottom otter trawls used to target groundfish, scallops, and shrimp, including small mesh trawls. Mid-water trawls would not be excluded under Option 1. Mobile bottom-tending gear also includes all scallop dredges, regardless of size/width, and all clam dredges, both hydraulic and dry dredges. It is expected that displaced fishing effort will be redistributed surrounding the new habitat management area.

With this redistribution of effort, the catch composition will change, making it easier to catch some species and harder to catch others. In the groundfish fishery, where most vessels fish in sectors, the species-specific limits allocated to that sector may be easier or more difficult to achieve if fishermen are forced to shift their fishing location as the result of a new closure. To the extent that fishing effort will be lower in areas with more juvenile fish, fishing mortality (number of fish) may decline. Alternatively, if fishing effort increases where there is a greater amount of sub-legal fish that are retained by the trawls, fishing mortality could increase. Changes in bycatch of non-target stocks could occur as well.

In areas that are closed to fishing with trawls, but remain open to fishing with gillnets and longlines, fishermen may increase the use of non-mobile gears to target groundfish. This change in gear use is more likely occur in inshore, shallower areas where these fixed gears are typically deployed. Although removal of the Western Gulf of Maine Closure Area was not identified as a preferred alternative by the Council, this area provides a good example of the potential for fixed gear effort shifts. At present, most of the observed gillnet sets targeting groundfish and monkfish are located between the southern part of the Western Gulf of Maine and Massachusetts Bay, and other areas on southern Jeffreys Ledge, just inshore of the Western Gulf of Maine Area (Map 1, left), but gillnet fishing effort distribution has not always looked as it does now. Before 1998, there was considerable observed fishing effort with gillnets in what later became the Western Gulf of Maine Closure Area and the Western Gulf of Maine Habitat Closure Area (Map 1, right).

Because total catch is limited by ACLs for Council-managed species[2], the magnitude of catch is not expected to change significantly if fixed gears replace mobile gears within areas managed as mobile bottom-tending gear closures, but catch composition may. In terms of groundfish, gillnets usually select larger fish than trawls do, so groundfish fishing mortality (number of fish) could decline if a greater fraction of the ACLs by weight are caught with gillnets (Figure 2 shows the size distribution by gear for trawls and gillnets observed in the Gulf of Maine). If this occurs, in the longer term, assessments would re-estimate size selectivity and ACLs would be adjusted accordingly. Also over the longer term, better selectivity could increase yield-per-recruit and total yield from the fishery for stocks that have better size selectivity using gillnets. Increased gillnet use may increase gear conflicts with recreational fishing, interactions with marine mammals and other protected species, like sturgeon, and incidental catch of non-groundfish species.

Changes in patterns of fixed gear use are not limited to the reopening of existing groundfish closed areas. Some of the alternatives in this amendment would close or limit the use of mobile bottom-tending gears in new areas. Those areas that are closer inshore could attract new or additional gillnet fishing by groundfish vessels because the potential for gear loss would be reduced and gillnet catch rates could increase. This might occur in the Large and Small Bigelow Bight and Platts Bank HMAs, although none of these areas are part of the Council's preferred management approach. Although less frequent since 2010, previously there were substantial amounts gillnetting in the Scantum Basin off New Hampshire and around Platts Bank (Map 1, right).

It is most likely that shifts in effort would be the result of vessels that already use gillnets fishing in different locations. Another possibility is that vessels could switch to using fixed gears to catch the same species. However, this is likely very expensive, and might require acquisition of a new fishing vessel, so these types of gear switches are unlikely.

If Option 2 is selected, fishing with hydraulic clam dredges would be permitted, but other types of mobile bottom-tending gear would be prohibited, including dry clam dredges. Fishing effort by any bottom trawls or non-hydraulic dredges (scallop dredges, dry clam dredges) would be displaced. It is unlikely that hydraulic dredging would increase in an area if they are the only mobile bottom-tending gear type operating there. Effort distribution in the clam fishery is more closely related to the density of clams (surfclams or ocean quahogs) and operational costs (e.g. distance from port).

If Option 3 or 4 (trawl ground cable modifications) is selected, a few different outcomes are possible. One possibility is that trawl vessel operators would choose to fish in an area using the modified gear type if the trawl gear restriction is enacted, with similar numbers and distributions of trips and tows as in previous years, subject of course to changing catch limits and other

[2] Exceptions: Offshore hake, which is included in the southern silver hake catch limits, does not have an annual catch limit. The seven skate species managed under the Northeast Skate Complex have a single annual catch limit for the complex as a whole. For the Mid-Atlantic Council-managed species, the two squid species are exempt from the annual catch limit requirement because of their life history characteristics, as provided for in the National Standard 1 guidelines.

restrictions. Because the raised ground cables are less efficient at capturing some species of fish, this could lead to increased tow times thus increased bottom contact to achieve equivalent catches. Another possibility is that vessel operators will fish less in the area after the gear modification is required, because the modified gear requirements compromise operations in some way (e.g., efficiency is reduced). Another possibility is that trawl operators will outfit themselves with the modified ground cables and use them in all areas they fish, to avoid the need to switch back and forth, such that the impacts of the modified gears would extend to other areas of the region.

It is very difficult to assess which outcome is most likely, and an individual operator’s choice may depend on the characteristics of their vessel, as well as the amount of fishing they normally do within any areas currently open to them. Also, note that Maine and Massachusetts shrimp trawl vessels are likely already compliant with Options 3 and 4 based on current regulations:

- Maine – The maximum length of the bottom legs of the bridle of any shrimp trawl net shall not exceed 15 fathoms of uncovered bare wire.
- Massachusetts – It is unlawful for any vessel to fish for shrimp with a net having: (A) more than 90 feet between the trawl doors and trawl wings, including the ground cables, bridles, and legs. (B) bottom legs of other than bare or uncovered wire or chain.

Each sub-region also includes a no habitat management area alternative (generally Alternative 2, except in the Eastern Gulf of Maine, where it is the No Action alternative). This would mean that mobile bottom-tending gears would not be restricted on the basis of benthic habitat conservation in that sub-region, although they might be restricted as part of a spawning management area restriction, seasonally or year-round, depending on the spawning alternative selected. The question is whether and how much mobile bottom-tending gear effort will shift into currently closed areas if they reopen.

Even if existing habitat management areas are removed, some locations may be only lightly fished by mobile bottom-tending gears because they are difficult to fish with these gears. However, it is difficult to estimate to what extent complex seabed habitats are self-protecting because they are not fishable. The assumption under this no-closure alternative is that mobile bottom tending gear vessels would fish within a sub-region in a way that balances available fishing quota for species found in the area, operating costs, and responds to market factors including prices.

Beyond the distribution of mobile bottom tending gear effort, another consideration for Options 2, 3, and 4 that allow some types of mobile bottom-tending gear use is that the use of these gears may influence the distribution of commercial fixed gear effort, or recreational fishing effort. Patterns of effort by fixed vs. mobile gear types are likely to vary in an open area or area where some mobile bottom tending gear can be used vs. within an area where mobile bottom tending gear are completely prohibited, but fixed gears and/or recreational fishing are allowed. Specifically, fixed commercial and recreational gear use could increase in areas where mobile bottom-tending gear use is prohibited (Option 1), or limited to hydraulic dredges only (Option 2).

Map 1 – Current gillnet effort distribution (left, 2010-2013) compared to historic gillnet effort distribution (right, 1994-1998) before the Western Gulf of Maine closure. Lines represent the set and haul locations for fishing events observed at sea.

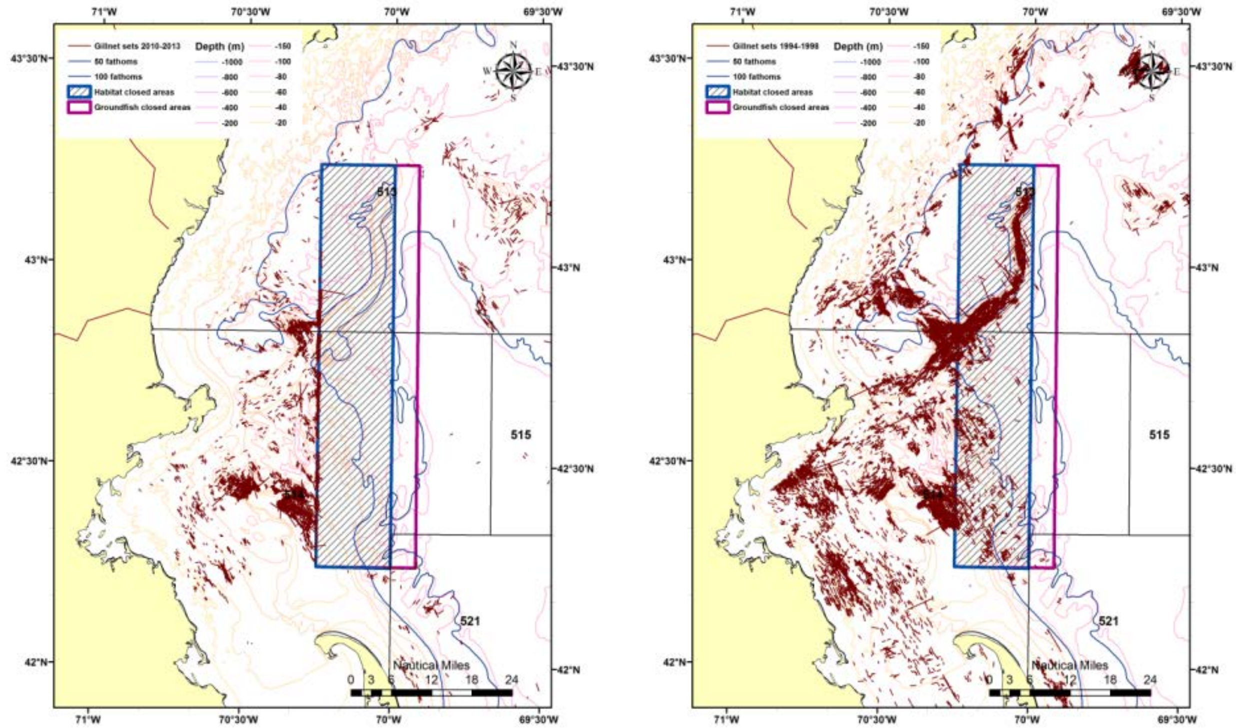
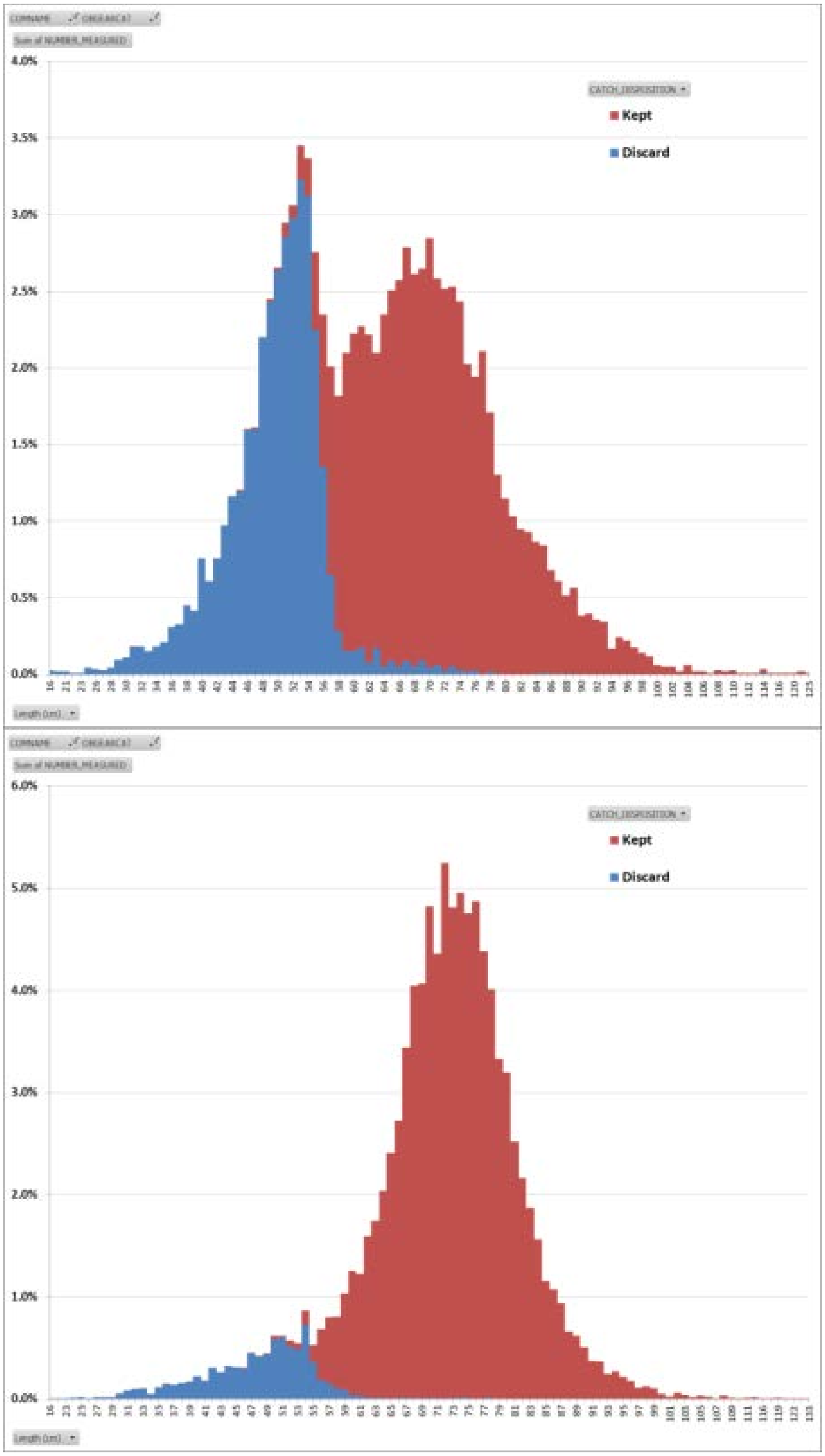


Figure 2 – Length frequency of observed cod catches in the Gulf of Maine (Statistical Areas 511-515) by trawls (top) and gillnets (bottom) during 2010-2013 using both ASM and NEFOP data. These are for observed tows only, and are not expanded to represent the fishery as a whole.



3 Physical and biological habitats

This section evaluates the impacts of the habitat, spawning, and research areas on physical and biological habitats. This section does not evaluate impacts of the management alternatives on protected resources (see Section 5 of this volume) or provide a detailed evaluation of impacts on specific managed resources (these are described in Volume 5, by fishery management plan).

3.1 Approach to analysis

The focus of the physical and biological habitats impacts analysis is on estimating the direction and magnitude of the impacts of management alternatives on seabed habitats, and assessing how that may translate into benefits for fishery resources. A detailed list of metrics evaluated is provided below in Section 3.1.1. General assumptions and considerations associated with the analysis of different fishing restriction options are described in Section 3.1.2. To streamline the discussion, direct comparisons and characterizations are made by sub-region only, but the magnitudes of impacts can be compared across any alternative. Tables summarizing the conclusions of this analysis are provided in the cumulative effects section of Volume 6.

3.1.1 Metrics evaluated

Various metrics are used to evaluate the impacts of the spatial management alternatives considered in this amendment on the physical and biological environment. Management areas are characterized according to sediment type, sediment stability, and natural disturbance. The relative vulnerability of the seabed habitats in each management area is also evaluated. Any particularly unique habitat feature in each sub-region are described. The relationship between the management alternatives and the preferred EFH and HAPC designations are described. These overlaps, combined with aggregate measures of biological diversity and species persistence are used to evaluate which species and lifestages might benefit from a particular management action. Another metric is the area's current closure status and any habitat recovery that may have occurred as a result of existing measures. In addition, the current distribution of realized adverse effects is considered, including an assessment of the extent to which habitat management areas may be causing effort displacement. Size in square kilometers is also provided for each area. These metrics are considered collectively in estimating the overall impacts of an alternative on EFH, and it is not appropriate to rely on a single metric for evaluating the benefits of habitat management actions. As noted previously in this EIS, the groundfish closure areas evaluated under the No Action alternatives were not explicitly designed for adverse effects minimization, but may provide some benefits in this regard.

Finally, the introduction to each sub-region lists benthic prey species frequently consumed by managed species with a high degree of EFH overlap with one or more sub-regional HMAs. This emphasizes the importance of prey as a component of EFH. Essential fish habitat by definition includes those areas necessary for spawning, breeding, feeding, and growth to maturity, and the EFH regulations require that fishery management plans include a description of major prey items for managed species and the distribution of those prey types. Appendix B lists the major prey types consumed by each species managed by the Council, and Appendix H summarizes information about the vulnerability of major invertebrate prey types to fishing impacts and provides maps of the general distribution of fish and invertebrate prey species. While none of the adverse effects minimization measures were designed solely to minimize adverse effects on specific prey species, the adverse effects minimization measures in this amendment are expected to support the ability of a habitat area to provide prey resources for managed stocks.

3.1.1.1 *Seabed geology*

One way in which habitat management areas are characterized is according to benthic substrate composition and water flow/natural disturbance. Both substrate composition and natural disturbance influence the habitat's vulnerability to impact. The following information is provided in each sub-regional section:

- Coverage of each dominant substrate (mud, sand, granule-pebble, cobble, and boulder) in both square kilometers and as a percentage of each management area, according to the unstructured SASI substrate grid. A grid was considered overlapping if its center point (centroid) fell inside the management area. Coverage is grouped by high and low energy (the SASI model uses different parameters for high vs. low energy habitats). See Volume 1 and Appendix D for details on how the substrate map was developed.
- Level of data support/data quality associated with those substrate grids, summarized as area in square kilometers and percentage of each management area (see Volume 1 and Appendix D for details on how the data support values were assigned). Higher data support values (5-7) indicate full sampling of all substrate types and progressively smaller grid sizes. Lower data support values (1-4) indicate sampling of only mud, sand, and granule-pebble size classes, with values of 1 indicating the largest cell size (lowest sampling resolution).

At the bottom of each table, substrate and data support information is also summarized by region to indicate where the management areas fall generally relative to average conditions on a broader spatial scale. This perspective is important because while a primary purpose of the analysis is to compare the management areas to one another, in general the management areas proposed in this amendment represent on average coarse substrate areas that are more vulnerable to fishing impacts relative to the region overall. Regional boundaries are the ecological production units identified by the Northeast Fisheries Science Center (Ecosystem Assessment Program 2012), with their Scotian Shelf[3] and Gulf of Maine units combined for this analysis.

Additional seabed characterization for the Georges Bank and Great South Channel sub-regions was developed by Harris and Stokesbury (2010) and Harris et al. (2012). These data sets include dominant sediment, largest sediment, sediment coarseness, benthic boundary shear stress, and sediment stability. The substrate classification in Harris and Stokesbury (2010) and Harris et al. (2012) is based on a video survey with four quadrats (views of the seafloor) per station. Dominant sediment classification in this survey is the same as what was used for the SASI model grid, except that these publications use video data only, vs. the combination of video and grab sample data used to support the SASI model. **Dominant** refers to the most frequently occurring, largest sediment size. Additional seabed characterization metrics are as follows:

[3] Note that most of the Scotian Shelf, including major banks such as Emerald, Western, and Banquereau, lies beyond the boundaries of the Scotian Shelf EPU, and is not part of the NEFSC analysis.

- **Largest or maximum** sediment size is simply the largest type of sediment at each station. For example, at a station where mud is not observed, sand is found in four quadrats, granule-pebble in four quadrats, cobble in two quadrats, and boulder in one quadrat, the station would be mapped as granule-pebble dominated, and boulder would be the largest sediment size.
- Harris and Stokebury (2010) assigned each grain size a number from 0 (mud) to 5 (boulder). Summing the values for all grain sizes present across all four quadrats, **sediment coarseness** refers to the mean score for each station, where values less than or equal to 2 are considered "smooth" substrate, and values greater than 2 but less than 4 are considered "intermediate" substrate, and values greater than 4 are considered "coarse" substrate. In the example above, the coarseness score would be ((2*4) + (3*4) + (4*2) + (5*1)/11 = 3, indicating intermediate coarseness at that station.
- **Sediment heterogeneity** refers to the variability among the sediment types found in each area. Where there is little to no variability in sediment type, the area is considered homogenous. The standard deviation associated with the coarseness calculation described above generates the heterogeneity score. A value of less than 0.48 is considered "homogeneous", lacking variability in substrate type across the local area. A value greater than 0.48 but less than 0.96 is characterized as "mixed". A value greater than 0.96 is considered a "heterogeneous" mixture of sediment type. In the example above, the standard deviation, or heterogeneity, is 1.0, so the station is considered heterogeneous.
- **Benthic boundary shear stress** (Newtons m^{-2}) refers to the force per unit area exerted on the seabed by flowing water. **Critical shear stress** is the force needed to move a particular particle size. The ratio of shear stress and critical shear stress was used by Harris et al. (2012) to map stable benthic sediments on Georges Bank. Their sediment stability index is the ratio of predicted shear stress (from modelling and direct observation) to the estimated critical shear stress level for that sediment type. An index less than 1 would indicate that the sediment is stable because the shear stress in the environment (numerator) would be less than the critical sheer stress (denominator). This creates stable points for the attachment of structure forming organisms. If the shear stress exceeds the sediment's critical shear stress threshold, the sediment type is unstable in that location and particle movement is likely to occur. This may cause mortality to those organisms that end up buried under the sediment. A similar analysis of bottom shear stress in the Great South Channel/Southern New England region was developed by Dalyander et al. 2013. Dalyander et al. did not estimate sediment stability.

3.1.1.2 *Seabed habitat vulnerability*

The Swept Area Seabed Impact (SASI) approach is one framework used to evaluate the impacts of the various habitat management alternatives on the physical and biological environment. Additional background on habitat vulnerability is provided in the Affected Environment section of this EIS (Volume 1) and in Appendix D. Observed spatial patterns in the SASI vulnerability estimates are directly related to the distribution of various substrate types within and outside the management areas, and natural disturbance at the seabed. The vulnerability assessment and literature review concluded that cobble and boulder dominated seafloors are most vulnerable to the adverse effects associated with fishing due to the occurrence of biota that is susceptible to injury and has long recovery times (Grabowski et al 2014). A major premise of the SASI approach is that the overall magnitude of the adverse effects of fishing on habitat is related to the total amount of contact between fishing gear and the seabed. Thus, if fishing can be done in such a way as to minimize seabed contact, it will help to reduce the magnitude of adverse effects.

The SASI analysis concluded that: (1) Mobile bottom-tending gears have a greater per unit area impact than fixed bottom-tending gears, and (2) they have a greater overall magnitude of impacts, since individual mobile gear fishing events contact more of the seabed than individual fixed gear fishing events and there is more overall fishing effort by mobile gears than fixed gears. Due to the much greater magnitude of mobile vs. fixed bottom-tending gear impacts, eliminating mobile bottom-tending gear use in an area should reduce the adverse effects of fishing on seabed habitats significantly within that area.

- A table in each section shows the minimum and maximum mobile bottom-tending gear vulnerability scores for each habitat management area, and the number of structured (10km x 10km) grids overlapping each area. Similar to the substrate analysis, a grid was considered overlapping if its center point (centroid) fell inside the management area. Regional values are provided for comparison. The numeric scores result from running the SASI model with an input of 100 km^2 of area swept in each grid during each year. Magnitudes can be compared across gear types. The approach used to calculate these scores is described in Volume 1, section 4.2.2.
- The four panel map figure in each section shows the spatial distribution of (1) dominant substrate, (2) data support, and (3) trawl vulnerability scores and LISA clusters, overlaid by the various alternative areas. The meaning of the LISA clusters is described in Volume 1, Section 4.2.2.1, and also in Appendix D. Briefly, these clusters represent 100 km^2 SASI model grid cells that meet two conditions: (1) they have vulnerability scores that are well above average, and (2) they are in a neighborhood of above-average vulnerability grids. The LISA clusters were used as a starting point for identifying some of the management areas proposed in this amendment.

The spatial resolution of the model outputs (100 km^2) relative to the size the various management areas (<100 km^2 to over 7000 km^2), as well as the high degree of spatial overlap between some of the management areas, and the underlying data support, influences how these results are interpreted.

3.1.1.3 *Unique habitat features found in the sub-region*

The SASI vulnerability analysis infers which biological habitat features such as sponges or anemones are likely to occur in a location on the basis of dominant substrate classification and energy regime. Actual seabed features will vary from these assumptions, and in some cases unusual or unique features may be present in a management area that contribute to its vulnerability. This includes features like deep-sea coral habitats in the eastern Gulf of Maine and kelp habitats on Cashes Ledge.

3.1.1.4 *Overlap with designated EFH*

EFH designations (detailed in Volume 2) include both a map representation (spatial coverage) and qualitative text description of preferred habitat attributes. The preferred alternative EFH designations reflect the distribution of essential habitats occupied by a particular species and lifestage, and can be used to indicate which areas and management alternatives are most likely to provide the most habitat protection for the greatest number of species and life stages. This may be especially important for those species that occupy habitats types that are more vulnerable to fishing impacts.

The egg and larval EFH map representations follow a few general approaches (see Appendix A). Some are egg and larval data binned by ten minute square, some are egg and larval data plus relative abundance trawl survey data from another lifestage (typically juveniles), and some use trawl survey data from another lifestage only. The egg and larval only maps have fairly patchy coverage, and while the focus of the habitat management areas is seabed conservation, the lifestages shown in these maps are pelagic. These pelagic lifestages are not summarized in the tables for reasons discussed below. The maps that use a proxy lifestage or a proxy lifestage plus egg and larval data are one step removed from the distribution of the lifestage in question. In these cases, the overlap between the egg and larval EFH designations and the management areas may be a less useful metric than overlaps between the juvenile and adult designations and the management areas.

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 were used to make the maps (see Appendix A), 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. There are some cases where data from more than one lifestage were combined to develop a single juvenile/adult designation, so these will be a less reliable predictor of the lifestage for which data were deemed insufficient to develop a map representation on their own.

Some of the juvenile and adult designations do not follow this method (again, see details in Appendix A) and cannot really be compared to 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.

Some Council-managed species have no designated EFH within the No Action and proposed habitat management areas, so they are not shown in the tables described below. The details of the No Action and alternative designations for these can be found in Volume 2. The map coverages for offshore hake and deep-sea red crab, which occur off the continental shelf on the slope, are too deep overlap the various habitat management areas under review in this amendment. Rosette and clearnose skate occur south of the proposed management areas. 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 habitat management areas, which are in federal waters only. However, the oceanic extent of the salmon designation abuts some of the HMAs in the eastern and western Gulf of Maine sub-regions.

The habitat management measures focus on mobile bottom-tending gear restrictions, so this analysis is restricted to species and lifestages that are benthic versus pelagic (Table 2). 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.

Table 2 – 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.	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	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
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	Atlantic herring, white hake prior to settlement	Atlantic herring, Atlantic salmon

Some habitat types, including cobble and boulder-dominated seabed types, particularly in low-energy locations, are more vulnerable to fishing impacts than others (see Volume 1, section 4.2.2). The habitat management areas are generally designed to encompass these habitat types, so species associated with more vulnerable marine and estuarine habitat types are expected to derive greater benefits from the habitat management alternatives proposed in this amendment. Juvenile fishes may benefit especially from the benefits these types of habitat provide in terms of shelter. Table 3 summarizes the habitat types used by benthic lifestages of Council-managed species. Species and lifestages that may occur on gravel sediment types are shown in bold, italicized text. Juvenile groundfish that were positively weighted in the hotspot analysis because they have an affinity for coarse substrates are also shaded grey.

Table 3 – Habitat types used by each benthic species and lifestage. Species and lifestages more closely associated with structured seabeds are shown in bold italicized type. Juvenile groundfish that are shaded grey were weighted positively in the juvenile groundfish hotspot analysis.

Species	Life Stage	Substrate features of EFH
Acadian redfish	***Juveniles***	Complex rocky reef substrates with associated structure-forming epifauna (e.g., sponges, corals), and soft sediments with cerianthid anemones; occupy adjacent gravel habitats when local abundance on reefs is high
Acadian redfish	***Adults***	Finer grained bottom sediments and variable deposits of gravel, silts, clays, and boulders; do not occupy boulder reef habitats.
American plaice	Juveniles and adults	Soft bottom substrates (mud and sand), but also found on gravel and sandy substrates bordering bedrock
Atlantic cod	***YOY juveniles***	Inshore, prefer gravel and cobble habitats and eelgrass beds after settlement, but also utilize adjacent un-vegetated sandy habitats for feeding; also settle on sand and gravel on Georges Bank (see haddock).
Atlantic cod	***Older Juveniles***	Structurally-complex habitats, including eelgrass, mixed sand and gravel, and rocky habitats (gravel pavements, cobble, and boulder) with and without attached macroalgae and emergent epifauna
Atlantic cod	***Adults***	Structurally complex hard bottom habitats composed of gravel, cobble, and boulder substrates with and without emergent epifauna and macroalgae
Atlantic halibut	***Juveniles and adults***	Sand, gravel, or clay substrates
Atlantic wolffish	***Eggs***	Wolffish egg masses are hidden under rocks and boulders in nests
Atlantic wolffish	Juveniles	Occur over various substrates but no strong substrate preferences
Atlantic wolffish	***Adults***	Spawn in rocky habitats; occupy a wider variety of sand and gravel substrates once they leave spawning habitats, but are not caught over muddy bottom
Haddock	***YOY juveniles***	Settle on sand and gravel on Georges Bank, but are found predominantly on gravel pavement areas within a few months after settlement, then disperse over a greater variety of substrate types
Haddock	***Juveniles***	Hard sand (particularly smooth patches between rocks), mixed sand and shell, gravelly sand, and gravel
Haddock	***Adults***	Hard sand (particularly smooth patches between rocks), mixed sand and shell, gravelly sand, and gravel substrates
Ocean pout	***Eggs***	Rocky habitats, eggs are laid in gelatinous masses, generally in sheltered nests, holes, or rocky crevices
Ocean pout	***Juveniles***	Wide variety of substrates, including shells, rocks, algae, soft sediments, sand, and gravel.

Species	Life Stage	Substrate features of EFH
Ocean pout	***Adults***	Mud and sand, particularly in association with structure forming habitat types; i.e. shells, gravel, or bouders; congregate in rocky areas prior to spawning and frequently occupy nesting holes under rocks or in crevices
Pollock	***Juveniles***	Rocky bottom habitats with attached macroalgae (rockweed and kelp); YOY also use eelgrass. Older juveniles occupy same habitats as adults
Pollock	***Adults***	Tops and edges of offshore banks and shoals (e.g., Cashes Ledge) with mixed rocky substrates, often with attached macro algae.
Red hake	YOY juveniles	Settle in depressions on the seabed
Red hake	Older juveniles	Bottom habitats providing shelter, including biogenic depressions in mud, eelgrass, macroalgae, shells, live bivalves, anemone and polychaete tubes, and artificial reefs
Red hake	Adults	Shell beds, soft sediments (mud and sand), and artificial reefs
Silver hake	YOY juveniles	Settle on muddy sand substrates, find refuge in amphipod tube mats
Silver hake	Juveniles	Found in association with sand-waves, flat sand with amphipod tubes, and shells, and in biogenic depressions in the Mid-Atlantic
Silver hake	Adults	In bottom depressions or in association with sand waves and shell fragments; also in mud habitats bordering deep boulder reefs, and on boulder surfaces in the Gulf of Maine.
White hake	Juveniles	Fine-grained, sandy substrates in eelgrass, macroalgae, and un-vegetated habitats
White hake	Adults	Fine-grained, muddy substrates and in mixed soft and rocky habitats
Windowpane flounder	Juveniles and adults	Mud and sand substrates
Winter flounder	***Eggs***	Eggs are adhesive and deposited in clusters on mud, sand, muddy sand, gravel, and submerged aquatic vegetation, especially in areas with reduced bottom current where they are not buried by suspended sediment settling to the bottom
Winter flounder	***YOY juveniles***	Inshore, tend to settle to the bottom on muddy and sandy sediments in and adjacent to eelgrass and macroalgae, in bottom debris, and in marsh creeks and disperse into coarser-grained substrates as they get older.
Winter flounder	***Juveniles***	Variety of bottom types, such as mud, sand, rocky substrates with attached macro algae, tidal wetlands, and eelgrass
Winter flounder	***Adults***	Muddy and sandy substrates, and on hard bottom on offshore banks; for spawning, also see eggs.
Witch flounder	Juveniles and adults	Mud and muddy sand substrates
Yellowtail flounder	Juveniles	Sand and muddy sand
Yellowtail flounder	Adults	Sand, shell hash, muddy sand, and sand with gravel
Monkfish	***Juveniles***	A variety of habitats, including hard sand, pebbles, gravel, broken shells, and soft mud, seek shelter among rocks with attached algae, feed along edges of rock ledges and boulder fields
Monkfish	***Adults***	Hard sand, pebbles, gravel, broken shells, and soft mud; seem to prefer soft sediments over sand and gravel, and, like juveniles, utilize the edges of rocky areas for feeding.

Species	Life Stage	Substrate features of EFH
Smooth skate	***Juveniles and adults***	Soft mud in deeper areas, but also on sand, broken shells, gravel, and pebbles on offshore banks in the Gulf of Maine.
Thorny skate	***Juveniles and adults***	Sand and gravel, also found on mud
Barndoor skate	***Juveniles and adults***	Mud, sand, and gravel substrates
Little skate	***Juveniles and adults***	Sand and gravel, also found on mud
Winter skate	***Juveniles and adults***	Sand and gravel, also found on mud
Clearnose skate*	Juveniles and adults	Primarily mud and sand, but also on gravelly and rocky bottom.
Rosette skate*	Juveniles and adults	Mud and sand substrates
Atlantic sea scallop	***Larvae***	Pelagic larvae settle on any hard surface, including shells, pebbles, and gravel; they also attach to macroalgae and other benthic organisms such as hydroids, but do not survive on shifting sand.
Atlantic sea scallop	***Juveniles***	When very small, attach to shells, gravel, and small rocks (pebble, cobble), preferring gravel; older juveniles not attached, occupy same habitats as adults.
Atlantic sea scallop	***Adults***	Often aggregate in beds on sand and gravel substrates
Atlantic herring	***Eggs***	Deposited on the bottom in beds, stick to coarse sand, pebbles, cobbles, and boulders and/or on macroalgae
Deep-sea red crab*	Juveniles and adults	Unconsolidated and consolidated silt-clay sediments

*No overlap between these species and the habitat management areas proposed in this amendment

The tables in each sub-regional habitat impacts section identify various levels of spatial overlap between the map representations for each species and lifestage and the corresponding habitat management area boundaries. Overlaps were assessed visually using Geographic Information System software and are coded as follows. The numeric scores were used to generate a comparison metric across areas. 'High' and 'full' were given the same numeric score because the differences between these two categories were typically minor, and in many cases the difference between high and full resulted from small areas eliminated from the map based on a depth contour-based clipping of the spatial coverage.

Overlap	Score	Definition
None	0	No spatial overlap
Slight	1	Overlap of less than 25% of the HMA
Moderate	2	Overlap of greater than 25% but less than 75% of the HMA
High	3	Overlap of greater than 75% of the HMA
Full	3	The entire HMA is mapped as EFH

Given the wide variety of species managed and the various locations, depths, and habitat types encompassed by the management areas, each is unique in terms of its EFH overlap. While the tables are arranged by management area, they identify the management alternative or alternatives associated with each, and the discussions accompanying the tables provide some comparison across alternatives.

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 provide a metric representing both the number of designations represented and the degree of overlap for those designations. This “total score” metric ranges from a low value of 39 to a high value of 108, with a mean of 73.0, out of a possible score of 129, which would represent a score of 3 for all 43 benthic species and lifestages. In addition to the total score, the sums of the numeric scores for gravel-associated species, juveniles positively weighted in the hotspot analysis, and overfished species are also provided. The gravel-associated designation totals ranged from 23 to 67 out of 84, with a mean score of 47.2. The hotspot species totals ranged from 5 to 17 out of 18, with a mean score of 11.7. Although overfished status is determined at the stock level, for the purpose of this analysis if one or more stocks is currently considered overfished, the scores for all benethic lifestages of this species were included in this sum. Overfished species include Atlantic cod, Atlantic halibut, Atlantic wolffish, ocean pout, winter flounder, windowpane flounder, witch flounder, yellowtail flounder, and thorny skate.

Next, a “species count” metric is provided, which indicates the number of species that have at least one benthic lifestage designated in the HMA. Twenty three species total are included on the tables, since those stocks with no overlap with any HMAs are not shown. Some areas have all 23 species represented, while other areas are as low as only 13 species represented. The mean value is 19.2 species. Finally, a “designation count” metric is also included, which indicates the number of individual designations overlapping the area, out of the 43 benthic species/lifestage combinations included in the tables. The range of values was a high of all 43 designations represented, with a low of 19 designations represented. The mean value was 32.7 designations. As the tables indicate, some designations cover 2, 3, or all 4 lifestages.

Metric	Minimum value	Maximum value	Mean value
Total score	39	107	72.7
Count of species	11	23	19.0
Count of designations	19	43	32.9

Note that this analysis complements but is different from the groundfish hotspot analysis presented in the affected environment section of this amendment (Volume 1) and in the managed species impacts analysis in Volume 5 for a few reasons:

- The EFH designations include all species managed by the Council, not just groundfish.
- The EFH designations include egg and larval distributions where available, whereas the hotspot analyses do not evaluate these lifestages. Only some eggs and larvae are benthic, however, as noted above.
- The EFH designations are typically based on a long time series of data (up to 37 years) whereas the hotspot analysis was conducted using ten years of recent data.
- The EFH designations classify all fish caught in the various trawl surveys as either juveniles or adults, while the hotspot analysis focuses on young (age-0 and age-1) juveniles and the largest adults (top 20% of biomass), leaving out animals of intermediate size.

- The EFH designations are generally broader, covering much of the distribution of the species/lifestage, as compared to the hotspot analysis, which focuses on the highest catch areas only.

3.1.1.5 *Relationship to designated HAPCs*

Habitat Area of Particular Concern (HAPC) designations themselves do not restrict fishing activity or fishing methods. However, evaluation of adverse effects of fishing on habitat areas of particular concern should be given special attention, particularly for EFH that is vulnerable to fishing activities. Some of the Council's preferred HAPCs overlap with the habitat management areas analyzed in this section, which do carry restrictions on fishing activities, particularly for mobile bottom-tending gears. The impacts analyses below list the HAPCs that occur in each sub-region, and assess the extent to which the various management alternatives proposed within the sub-region minimize the adverse impacts of fishing within the preferred alternative HAPCs.

3.1.1.6 *Biological diversity*

Species diversity indices described in Volume 1 were summarized by alternative to determine which areas are most diverse with respect to groundfish, regulated species and all species caught in the NEFSC bottom trawl surveys. Areas and alternative combinations of areas with the higher diversity indices may provide positive benefits to more species.

3.1.1.7 *Weighted persistence*

The Nature Conservancy's North Atlantic Marine Ecoregional Assessment includes an analysis of weighted fish persistence (Anderson et al. 2010). For a given species, the weighted persistence score in a grid/area measures the number of decades in which the species was present in fishery-independent surveys (out of 4), and the relative abundance of the species in that ten minute square as compared to other ten minute squares (0.0-0.9). For example, a weighted persistence score of 3.8 indicates that in that ten minute square, the species was present in three of four decades, and that the grid was in the top 20% of abundance. Weighted persistence was calculated separately for the fall and spring surveys. Additional details about the fish persistence analysis are provided in Volume 1, Section 4.2.4.

Weighted persistence of managed species was evaluated with respect to alternatives under consideration in the amendment. Specifically, the analysis included cod, haddock, halibut, little skate, monkfish, ocean pout, American plaice, pollock, red hake, redfish, silver hake, spiny dogfish, thorny skate, white hake, windowpane flounder, winter flounder, witch flounder, yellowtail flounder, and Atlantic herring. Weighted persistence scores for species present in at least three of four decades were carried forward in the analysis. "Notable areas" were identified as ten minute squares that had above average persistence (0.5 standard deviations) and 9-19 of the species present, far above average persistence (1.0 standard deviations) and 11-19 of the species present, or very far above average persistence (2.0 standard deviations) and 15-19 of the species present. Maps depicting these notable areas were generated. Rather than mapping the results by ten minute square, a density analysis of the tows within the three categories of ten minute squares were mapped instead to better reflect actual sampling locations within notable ten minute squares. Ten minute squares with relatively low sampling effort of 1-10 tows were identified on the maps. Sea scallops were analyzed separately from fish, and high and very high overlap areas were identified. These results complement the EFH overlap and biological diversity metrics described above.

3.1.1.8 *Distribution of fishing effort and realized adverse effects*

A fundamental premise of the SASI approach is that the overall magnitude of habitat impacts in a fishery is related to both the underlying vulnerability of the areas being fished and the total amount of bottom contact that occurs. As fishing effort shifts due to changes in spatial management, both of these factors will change simultaneously, as both habitat vulnerability and catch rates are spatially heterogeneous.

In addition to estimating spatial patterns in habitat vulnerability, another output of the SASI model is the spatial distribution of past fishing impacts, by gear type. These 'realized' adverse effects estimates were developed by adding fishing effort into the model at each annual timestep, with fishing effort measured in term of swept area in units of square kilometers. Over time, the model assumes some rate of habitat recovery, depending on the habitat type. Thus, for each year the model is run, impacts associated with prior years' fishing effort decay as recovery occurs, and new fishing effort contributes new impacts. If fishing ceases in an area, the model predicts that eventually the habitats in that location will recover their functional value. SASI assumes that full recovery may take up to ten years, depending on the habitat type.

The realized adverse effects estimates are calculated using the same 100 km^2 grid as the vulnerability estimates, and can be mapped to show spatial patterns. In a very general way, these realized adverse effects maps can be used to understand the benefits that might be realized from a habitat management area designation. However, there are a number of caveats associated with this evaluation. First, the distribution of realized adverse effects is heavily influenced by the regulatory environment, which has shaped the distribution of past effort through year-round, seasonal, and rotational closures, catch limits, and other measures. In addition, past distributions of fishing effort may not be a good predictor of future patterns. Displacement of fishing effort is also an important consideration. If a particular fishing gear type is not allowed to operate within a management area, that effort will be redirected elsewhere. The area into which the effort is redirected may have higher, lower, or similar vulnerability to impact, and may have higher, lower, or similar catch rates of the target stock(s). In general it is very challenging to predict where displaced effort will redirect to. Another consideration related to the redistribution of fishing effort is that not all areas are equally fishable. Thus, even if an area is open to a particular gear type, and the target species is present there, the bottom characteristics may make fishing with a specific gear difficult, inefficient, or expensive.

Despite these caveats, observed patterns of fishing effort and habitat impacts should not be ignored in the context of habitat impacts analysis. The realized adverse effects estimates are available for the time period 1996-2009, and the revenue analysis through 2014 can be used to supplement this information and understand patterns of fishing effort for more recent years, although revenue and area swept are not the same. Some general types of conclusions are as follows:

- If a potential new habitat management area is in a location that appears to be lightly fished and has a relatively small magnitude of adverse impacts currently, designating the

HMA and closing it to fishing is likely to have a relatively small magnitude of potential benefits because effort displacement will be small and therefore the potential for habitat recovery is likely less.

- If a potential new habitat management area is in a location that appears to be heavily fished and has a relatively large magnitude of adverse effects currently, designating the HMA and closing it to fishing should lead to larger improvements in habitat functional value within the HMA. However, fishing effort within the area will be displaced to other locations and the relative vulnerability of those other areas should be considered.
- If an HMA is currently closed to fishing, historic estimates of adverse effects and revenue will likely be small in magnitude. If the area opens to fishing activity, the amount of effort that will move into the area is unknown, but can be predicted based on activity in adjacent open areas, and based on the distribution and abundance of target stocks within the HMA. Opening a previously closed HMA will most likely result in at least some shifts of impacts from currently fished areas into the HMA. If the reopened HMA is not highly vulnerable to impact, this may have a net benefit if effort is redirected off of more vulnerable habitats. If the reopened HMA is relatively vulnerable to impact, then net benefits may be negative, if other nearby fishing grounds are less vulnerable, and/or if recovered functional value in the reopened HMA is lost.

3.1.1.9 *Area size*

The size of a particular management area is another contributing factor in terms of the positive benefits it may provide for seabed habitat protection. Larger areas may provide more habitat protection, but also may contribute to more displacement of fishing effort.

3.1.2 Analysis of specific gear restriction options

3.1.2.1 *Option 1 – Closure to all mobile bottom-tending gears*

Closure to all mobile bottom-tending gears (Option 1) is one type of measure that can be used to reduce the impacts of fishing on habitat. This is the measure employed in all of the existing habitat closure areas. Compared to management approachs that restrict only <u>some</u> mobile bottom-tending gear types, a prohibition on <u>all</u> types of mobile bottom-tending fishing will have a larger positive impact on habitats within the management area. The magnitude of that positive impact will depend on two main factors, as discussed in the previous section: the underlying vulnerability of the management area to impact, and the the distribution and magnitude of mobile bottom-tending gear fishing both inside and outside the management area. Because fishing effort shifts and relative vulnerability are difficult to quantify with any degree of precision, impacts are necessarily qualitative and often expressed as a range and/or relative to other management options.

3.1.2.2 *Option 2 – Exemption for hydraulic clam dredges*

Option 2 would enact a complete closure to all mobile bottom-tending gears, but allow an exemption for hydraulic clam dredges.

The SASI vulnerability assessment evaluated the impacts of hydraulic clam dredges in sand- and granule-pebble-dominated habitats, but not in other habitat types including mud-, cobble-, or boulder-dominated. Over these sand- and granule-pebble-dominated seabed types, the per unit area impact of hydraulic clam dredges is high relative to scallop dredges and otter trawls. However, in general, across multiple gear types, the SASI vulnerability assessment indicates that sand and fine gravel habitats are less vulnerable to accumulating fishing gear impacts than cobble- and boulder-dominated habitats. In addition, the vulnerability assessment indicated that hydraulic dredge impacts were estimated to be greater in low energy areas than in high energy areas, due to longer estimated recovery times for geological and biological features in low energy environments. Thus, the seabed impacts associated with a hydraulic dredge exemption would be higher in low energy HMAs as compared to high energy HMAs, given similar levels of fishing effort. Generally, known clam grounds are classified as high energy so the distinction between high and low energy areas is not a major issue in terms of impacts analysis.

Hydraulic dredges generally target clams living in sand- and fine gravel-dominated high energy habitats. The SASI model assumes that hydraulic clam dredges are only used in sand and fine gravel habitats, not in cobble or boulder habitats. However, tow by tow information provided by the clam industry subsequent to the development of SASI indicated that the gear is also used in cobble-dominated habitats. It is not known whether these tow locations are representative of all vessels in the fishery. This tow by tow information also suggested that clam dredges do not operate on top of the highly dynamic sandy shoals, but rather in mixed sediment troughs. Presumably fishing occurs where the number of cobbles and boulders is low enough that damage to the gear is not excessive. The incentive to avoid or fish in coarser sediment areas is likely linked to known or expected catch rates of clams, such that vessel operators are more likely to fish in coarse sediment areas if catch rates are known to be high relative to surrounding areas. Fishing in coarser sediments may add operational costs, such as increased crew time spent discarding cobble, or repairing the dredge. There is likely a degree of sediment coarseness beyond which fishing in an area might be avoided entirely.

In the areas of Georges Bank and the Great South Channel sub-regions currently fished with clam dredges, including Georges, Cultivator, and Nantucket Shoals, cobble- and boulder-dominated habitats are patchily distributed amongst sand- and granule-pebble-dominated habitats. The way in which hydraulic clam dredges operate within these mixed habitat types will influence the direction and magnitude of the impacts associated with an exemption for this gear. Just because clam dredges operate in cobble-dominated areas doesn’t mean that vessels are unable to minimize contact with cobble features on a fine scale.

Two scenarios are possible. If hydraulic dredging is allowed within a HMA that is closed to other types of mobile, bottom-tending gear, and is confined to sand and fine gravel habitats, the benefits of habitat protection under Option 2 would only be somewhat reduced as compared to a complete closure to mobile bottom-tending gears (Option 1). However, if dredging extends into areas dominated by cobble and boulder substrates, it is likely that adverse impacts would increase and the overall benefits of habitat protection within the HMA would be reduced, perhaps substantially so, relative to a full mobile bottom-tending gear closure. Extending the results of the clam dredge vulnerability assessment beyond sand and granule-pebble-dominated substrates, the biological and geological features present in cobble and boulder habitat types are likely to be highly susceptible to clam dredge impacts.

In some of the proposed HMAs, a hydraulic clam dredge exemption would make no difference in terms of habitat impacts because there are few clams and no clam fishing effort. This is true generally in most areas in the Gulf of Maine where there is currently no hydraulic clam dredging (only 'dry' dredging in eastern Maine), and in some of the other HMAs in the Georges Bank and Great South Channel/Southern New England sub-regions. For each sub-region and alternative, the occurrence or likelihood of occurrence of clam dredging is discussed, and this influences the conclusions about impacts of Option 1 vs. Option 2. For example, lifting the Northern Temporary PSP Closed Area has allowed some vessels to use hydraulic dredges to target unmanaged arctic surfclams in the vicinity of Stellwagen Bank in the western Gulf of Maine, but this recent change is not reflected in historical effort data presented throughout this document.

While the local impacts of hydraulic clam dredging may be significant, region-wide impacts are low relative to other gear types that contact a larger amount of bottom area. Specifically, the per-trip area swept for hydraulic clam dredges is low as compared to the per trip area swept for scallop dredges and otter trawls. Figures in the affected environment section provide a comparison across all ten gears evaluated in SASI. Hydraulic clam dredge area swept per trip values ranged from 0.07 km2 to 0.20 km2 from 2000-2009. Over that same time period, generic otter trawl values ranged between 5.64 km2 and 8.98 km2 per trip, while limited access scallop dredge values ranged from 2.01 km2 to 5.85 km2 per trip. These lower per trip values contribute to lower overall area swept by hydraulic dredges relative to other mobile bottom-tending gears. Annual totals for hydraulic dredges between 2000-2010 ranged from 371 km2 to 860 km2, while totals for generic otter trawls and limited access scallop dredges ranged from 125,694-297,954 km2 and 19,523-26,525 km2, respectively, over that same period. Annual values are provided in the affected environment section for all gears.

3.1.2.3 *Options 3 and 4 – Ground cable modifications*

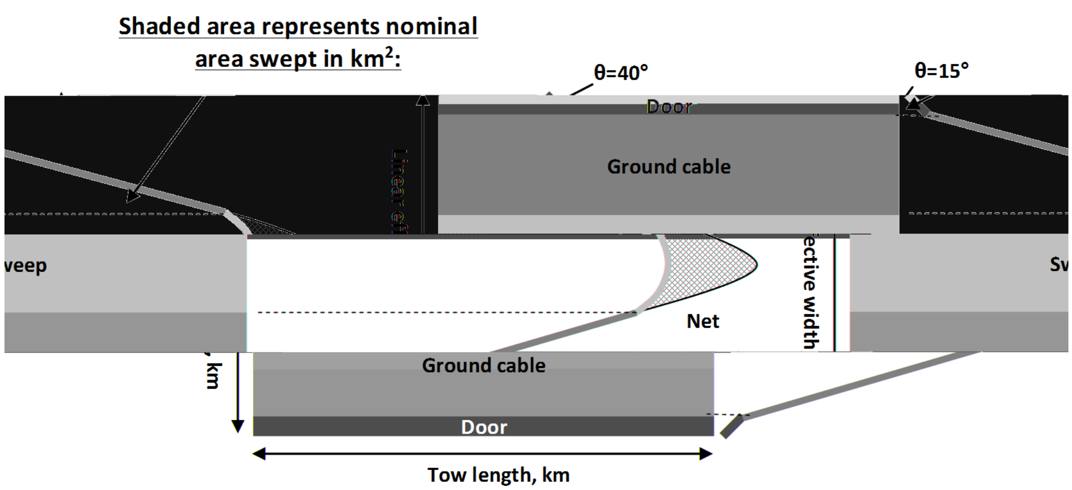
Options 3 and 4 would allow mobile bottom-tending gear use, but restrict ground cable configuration and length (Option 3) or prohibit ground cable use (Option 4). Because trawls and other mobile bottom-tending gears would be allowed, these options are expected to have negative impacts on habitat relative to Option 2, and especially relative to Option 1, although concerns related to effort displacement within the region and the resulting influence on impacts are reduced with gear modification options because mobile bottom-tending gears would still be allowed in the areas and would not have to redirect their efforts to other locations. Allowing vs. prohibiting mobile bottom-tending gears has the largest influence on the impacts associated with Options 3 and 4 vs. Options 1 and 2. However, the potential for swept area reduction associated with Options 3 and 4 was a motivating factor behind including these alternatives in the amendment, and the state of knowledge about how these gear modification options might work merits further discussion. Thus, the rest of this section focuses on the challenges and caveats associated with comparing Options 3 and 4 to scenarios where no habitat management areas are proposed.

Ground cables connect the trawl doors to the bridles, which in turn attach to the wing ends of the net; they run along the seabed during trawl operation and serve to herd fish and increase the area of seabed fished (swept) by the trawl. Ground cable diameter can be increased be passing the wires through rubber disks (cookies) or rollers; this modification is designed to assist passage of the ground cables over the seabed. Ground cables are typically constructed from twisted steel wire rope, often with small diameter rubber disks (cookies) compressed together along the entire cable length. There are some reports that a few fishermen use chain as an alternative to wire rope. Cable diameter ranges from $^{9}/_{16}$ inch to ¾ inch, with 1¾ to 3 inch diameter cookies (2 inch to 2 $^{3}/_{8}$ inch cookies are most commonly used).

Ground cable length varies between boats and typically is 30-80 ftm (55-146 m) although some larger boats may use up to 120 ftm (219 m). Generally, longer lengths are used on smooth seabeds, when the risk of hooking up on obstacles is small, and/or when targeting flatfish. Inshore boats (which also tend to be smaller) tend to use shorter ground cables (30–50 ftm, 55-91 m) so they can maneuver the trawl gear around rocky outcrops and other obstructions that can catch or damage the gear. Some fishermen do not vary ground cable length much under different circumstances as changes in cable length may affect the herding angle of the cables and catch rates. Others have been known to add or remove substantial lengths to their ground cables; however, it is not known if this is a regular or infrequent activity, nor is it known under which circumstances fishermen make such a change.

In comparison with the sweep and the doors, ground cables are the longest element of bottom trawl gear and thus they contribute the greatest proportion of area swept for a given fishing event (The figure below shows the relative contribution of each gear element to the effective width of the gear). Thus, shortening their length and/or reducing their contact with the seabed provides a mechanism to reduce gear width, <u>assuming that the total length of the tow does not change</u>.

Figure 3 – Schematic of trawl gear (top down view) showing the relative contribution of doors vs. ground cables vs. sweep to gear width/area swept. Not to scale.



Given some straightforward assumptions about angle of attack, and holding all else constant, it is possible to estimate the reductions in linear effective gear width that could result from shortened cable lengths. In addition, gear contact with the seabed may be reduced if ground cables are raised above the seabed with elevating disks. This also provides a mechanism to reduce area swept. However, in order to understand if there is a <u>net benefit</u> for use of these types of gear modifications to minimize total area swept, other information is needed:

- What is the cable length/configuration/catchability trade-off for target species?
    - If catchability is reduced with shortened cables, how does tow length/duration increase to compensate to achieve the same total catch? Would gear modifications lead to a net increase in area swept, and thus EFH adverse effects, within restricted areas because modified ground cables catch fewer fish?
    - How does this relationship vary by species?
    - What other changes might be made to the way the gear is rigged or fished to allow fishermen to compensate for reduced ground cable lengths?
- What will the distribution of effort look like after the ground cable restrictions are implemented?
    - Will reduced catchability cause vessels to fish elsewhere, thereby minimizing adverse effects within the area?
    - Can target species within the ground cable area be captured using other gear types instead of trawls, e.g. gillnets or longlines?
    - Is the target species readily available in other locations?
- What is the effect of area size on the enforceability of ground cable length limit measures?
- Does the ground cable length cap represent a significant reduction?
    - 45 fathom limit is close to the current maximum size (generally there are no regulatory limits on ground cable length, although shrimp trawls are an exception to this)
    - No ground cables represents a much greater % reduction
    - These changes may be easier to make on some vessels as compared to others.

In terms of enforceability, there may be lessons in the way that the multispecies exemption areas are regulated. For example, exemption areas that allow the use of small mesh have strict stowage requirements for small mesh nets when transiting other areas, and some of the areas require vessels to carry letters of authorization. There are also strict possession and landings limits for non-target species.

Past changes to fishing gears have been authorized following extensive field trials of the new gear type to determine how target and non-target species catches are affected. There is one good example of ground cable changes made in the North Pacific where habitat protection was one of the primary management objectives. Scientists and fishermen in the Bering Sea have examined the habitat and bycatch related benefits and costs to industry of ground cable changes (Rose et al. 2009, Rose et al. 2010). The wire ground cables (called sweeps in the North Pacific literature) were raised off the seabed by adding cookies of various sizes at various spacing intervals. They examined changes in the catch of target and incidental species and found that seafloor contact could be reduced with relatively low associated losses in catch. As of 2011, Bering Sea flatfish trawlers must use the reduced contact gear.

While there are some lessons that can be taken from the Bering Sea work, there are limits in terms of applying this work to our situation in the Northeast. Specifically, the Bering Sea flatfish trawl fishery operates primarily on mud and sand substrates, and prior to the new regulations, most vessels used cables made of coated wire. Here, the habitat management areas include a mix of sand, granule-pebble, cobble, and boulder-dominated areas, and cable construction appears to be about 50/50 bare wire vs. cookies, according to the observer data examined for Georges Shoal and the Great South Channel. Chains, rollers, and rockhoppers are also reported as ground cable materials.

Also, it is not clear whether widely spaced elevating disks would allow the gear to pass over the types of geological and biological structures found in the proposed habitat management areas. The Bering Sea study (Rose et al 2009) found that the sweeps with disks only contacted the seabed at the disk positions, whereas the bare wire sweeps raised sediments clouds along their length, but they note that the structure-forming seafloor organisms of the eastern Bering Sea are generally 'small and flexible' and that elevating the cables by a few centimeters would not prevent contact with larger organisms. Similar experiments in the Northeast would be required to provide the knowledge necessary to fully gauge the net effect of gear modifications on EFH.

Two pilot studies have been conducted in the Northeast region and the results of one of the studies were provided to the PDT. A 6-day, May 2013 paired vessel study in Ipswich Bay compared standard ground cables with ground cables of the same length that used the elevating disks, as proposed by Option 3. Five one-hour tows were made each day, and the modified ground cables were moved from vessel to vessel on a daily basis. Six species were caught in sufficient numbers to statistically analyze differences in catch rates between the two nets. Three species, witch flounder, American plaice, and yellowtail flounder, were caught at significantly lower rates with the modified (disk elevated) ground cables. Three other species, silver hake, winter skate, and winter flounder, showed no significant difference in catchability between the two nets. Total catch was significantly higher with the standard net. Given the observed catch rates, the preliminary study report estimated that total fishing time would need to be about 18% higher to maintain the same catch with the modified ground cables as compared to the standard cables. While it appears that the modified cables raise the gear off the seabed somewhat, it is not clear that this reduction in contact would compensate for the necessary increase in tow length. It is important to note that this study should be regarded as a pilot project, and the results should not be extrapolated to other areas, vessel sizes, habitat types, or species. It is also important to note that the results of this study have not been reviewed by the Council's Research Steering Committee or peer-reviewed by an independent group.

In summary, the size and direction of changes in adverse effect estimates as a result of ground cable adjustments could be calculated using applications of the SASI model, but only if effort distribution is well understood and changes in area swept can be estimated pre- and post- gear modification. Because the effect of ground cable modifications on species catchability, and therefore on area swept, is not well understood, it is very difficult to say with any certainty that there would be a net habitat benefit of requiring ground cables with elevating disks in habitat management areas. However, the pilot study does indicate that the modified ground cables can at least be used by regional fishing vessels, and the 45 fathom length limit per side is not expected to be particularly constraining, given that many vessels already use shorter cables. Overall, Option 3 will have negative impacts on seabed habitats as compared to Options 1 and 2. However, the magnitude of the difference in impacts is uncertain.

The impacts of the option to eliminate ground cables entirely (Option 4) may be somewhat different. Comments made during informational interviews indicated that this requirement would be less constraining for smaller vessels than larger ones, because smaller vessels already use relatively short cables. Shrimp vessels in particular already appear to comply with this restriction, based on their gear requirements. It is possible that under a no-ground cable requirement, some effort would simply be displaced into other areas. Overall, it is not possible to determine the effect of a no ground cable measure on catchability, and therefore on overall swept area and adverse effects. Option 4 will have negative impacts on seabed habitats as compared to Options 1 and 2, but it is not possible to quantify the magnitude of the difference between the Options.

3.1.2.4 *Option 5 – Closure to gears capable of catching groundfish*

This option was considered for Alternative 2 in the eastern Gulf of Maine sub-region, and many of the spawning management areas would be managed as closures to gears that capture groundfish. While bottom otter trawls and scallop dredges are considered capable of catching groundfish, hydraulic dredges are not. Thus, from a habitat impacts perspective, this option is similar to Option 2. Additional benefits associated with restricting the use of fixed gears capable of catching groundfish within an HMA, are likely minimal. As described in Volume 1, sink gillnets and demersal longlines have substantially reduced impacts per unit area compared to mobile bottom-tending gears.

3.2 Habitat management alternatives

3.2.1 Eastern Gulf of Maine

There are three habitat management alternatives for the Eastern Gulf of Maine sub-region: (1) no action/no HMAs, (2) Machias and Eastern Maine Large areas with Options 1-5, and (3) Machias, Eastern Maine Small, and Toothaker Ridge areas with Options 1-4. The preferred alternative is a variation of Alternative 3, with the Small Eastern Maine HMA only as a closure to mobile bottom-tending gears (Option 1), and is discussed in Section 3.2.1.3.

In general, the habitat management areas in this subregion contain mud and sand sediments and some areas of hard bottom, and tend to be low energy, except for the Machias HMA, which, by area, is over 70% high energy (Table 4 Map 2). Data support for the substrate maps and, therefore, the associated SASI model vulnerability outputs is low to moderate, and is particularly low for the Toothaker Ridge HMA (Table 5, Map 2). The substrate sampling is this sub-region is based entirely on grab samples, and may therefore be under sampling hard bottom and more vulnerable habitat types. While the Maine Bottom Type substrate map better characterizes the seabed in these areas (see section 4.2.1 in Volume 1), there is limited overlap between the sampling region for that anlaysis and the management areas (Map 3). The Maine Bottom Type sediment map indicates that the coastal areas of the Large and Small Eastern Maine HMAs consist of bedrock habitats interspersed with mud. The Machias HMA also contains rocky habitats, intermixed with sands and gravels (Map 3). The lack of mud habitats indicated by the Maine Bottom Type data in the Machias HMA, relative to other areas mapped with that data set, may be due to the strong currents present in the area.

Additional rock habitats, including some high relief areas with attached epifauna, are known to occur in portions of the Large Eastern Maine HMA around Mt. Desert Rock, based on remotely operated vehicle sampling (Peter Auster, personal communication). Recent survey work has documented the presence of deep-sea coral habitats in this sub-region (see Auster et al. 2013 for a brief summary of the 2013 cruise; additional data from 2014 and 2015 are also available). These cruises indicate presence of deep-sea coral habitats near Mt. Desert Rock, within the Large Eastern Maine HMA, as well as along the Outer Schoodic Ridges and within Western Jordan Basin, neither of which are encompassed by the HMAs analyzed in this amendment. The Small Eastern Maine, Machias, and Toothaker Ridge HMAs are not known to contain deep-sea coral habitats.

In general the Large and Small Eastern Maine HMAs have higher vulnerability scores than the Gulf of Maine region overall and the Machias and Toothaker Ridge HMAs seem to have more typical scores for the Gulf of Maine (Table 6, Figure 4, Map 2). However, these results are of somewhat limited utility for discriminating between areas given uncertainties in the habitat maps underlying the SASI analysis.

The eastern Gulf of Maine HMAs are fairly close to shore in relatively shallow waters, which influences their overlap with preferred alternative EFH designations for particular species and lifestages (Table 7). For example, juvenile redfish and witch flounder EFH designations generally have high overlap with the areas, but adult redfish and witch flounder EFH is generally in deeper waters and has less overlap. The areas correspond well with cod, haddock, and halibut EFH, and also with EFH for red, white, and silver hake. The deeper Large Eastern Maine and Toothaker areas have high overlap with monkfish EFH. There is some overlap with herring egg EFH, especially in the Machias HMA. The areas also overlap with EFH for various skate species, particularly thorny skate.

There is more limited overlap with the EFH for some other stocks, including American plaice, ocean pout, pollock, windowpane flounder, winter flounder, and yellowtail flounder. The exception is that there is high or full overlap between designated pollock EFH and the Toothaker Ridge HMA. There is a high degree of overlap between wolffish EFH and the management areas in this sub-region, but the designation is very general as the entire Gulf of Maine is mapped as EFH for wolffish. Per the proposed text description, wolffish preferred depth ranges are 70-184 meters (juveniles) and up to 173 meters (adults), and occupy a diverse range of seafloor types, such that these HMAs likely provide suitable habitat for the species. Because they are poorly sampled in the trawl survey, it is not possible to assess the suitability of individual eastern Gulf of Maine HMAs as wolffish habitat. The exception to the general bottom type requirements for the species are that the eggs are hidden during incubation among rock and boulder habitats, generally in areas shallower than 100 meters. The shallower Machias and Small Eastern Maine HMAs have a greater degree of overlap with scallop EFH as compared to the deeper Toothaker Ridge and Large Eastern Maine HMAs. Across all benthic designations, relative to other sub-regions, the numeric EFH overlap metrics for the eastern Gulf of Maine areas are relatively high.

Across the species that have the highest degree of overlap with the eastern Gulf of Maine HMAs, i.e. redfish, cod, halibut, haddock, monkfish, pollock, red hake, silver hake, thorny skate, white hake, and witch flounder, a diverse array of benthic prey types are consumed (Table 8). Decapod shrimp constitute over 5% by weight of the diet of eight of these species, decapod crabs are important to four species, and polychaetes to three species. Amphipods and echinoderms are consumed in large quantities by haddock, and cod eat bivalve mollusks. As shown in the maps prepared for Appendix H, all of these prey types are found in the eastern Gulf of Maine. However, based on a review of the scientific literature on gear effects, there is little evidence for long-term impacts of fishing on these types of benthic prey (see Appendix H, section 4.0 for details). Therefore, substantial positive or negative impacts of the HMAs on the benthic invertebrate prey base in this sub-region appear unlikely to result from this amendment, regardless of which alternative is selected.

Two preferred alternative HAPCs are located within the eastern Gulf of Maine sub-region, the Atlantic salmon HAPC and the Inshore Juvenile Cod HAPC. Both of these areas are limited to state waters and therefore are inshore of the proposed HMAs. Thus, the HMAs in this sub-region are not expected to affect, positively or negatively, the habitats within any HAPCs.

Table 9 shows groundfish diversity, regulated species diversity, and all species diversity for the eastern Gulf of Maine habitat management alternatives. Alternatives with the highest diversity values (75th percentile of each season) for each diversity index across all alternatives in all sub-regions are shaded (red=groundfish, yellow=regulated species, green=all species). These diversity index values can be compared to the diversity indices for areas in other sub-regions by reviewing the species diversity summary (Section 4.2.3 in Volume 1). The red, yellow, and green highlighted values for each index are above the 75th percentile for that index across all habitat management alternatives in all sub-regions. Thus, the large number of highlighted values indicates a relatively high species diversity within the eastern Gulf of Maine sub-region management alternatives relative to other alternatives proposed in this amendment.

The weighted persistence analysis identified notable areas within the Toothaker Ridge, Small Eastern Maine, and Large Eastern Maine HMAs, but not within the Machias HMA (Map 4). In particular, very far above average persistence/highest diversity areas overlapped the Large and Small Eastern Maine HMAs. However, sampling effort in the Machias HMA was generally sparse.

The distribution of fishing effort by gear type and resultant expected adverse impacts through 2009 are described and mapped in Volume 1, Section 4.2.2.2. Fishing activity by gear type and fishery through 2012 is also described and mapped in Volume 1, Section 4.3. This volume, Section 4.2, summarizes revenue by gear type within each proposed HMA, through 2014. Fish and shrimp trawl activity occurs in the eastern Gulf of Maine, although at lower rates compared to other areas including the western Gulf of Maine. Area swept and adverse effects associated with fish trawls declined in the sub-region from 1996 through 2009. Shrimp trawl area swept fluctuated without any particular trend over the same period, but has declined to zero recently given a moratorium in the fishery. Revenue from the sub-regional HMAs for both gears combined has been relatively flat since 2005. From 1996-2009, adverse effects due to scallop and clam dredging were consistent but relatively lowin the sub-region, generally within the Machias HMAs, although none of the proposed HMAs including Machias appear to be a major center of activity for either gear. Purse seines, which are a mid-water gear used in the herring fishery and could be regulated under Alternative 2, Option 5 (not a preferred alternative) are a relatively important gear type in this sub-region. Gillnets and longlines are not commonly employed. Trap gear used to target lobster is by far the most important revenue generator in the sub-region, constituting the majority of revenue in all HMAs between 2005-2014, with the exemption of the Toothaker Ridge HMA where purse seines generate a similar amount of revenue. Trap effort is generally focused inshore, both inside and outside the state waters boundary, and this aligns with the generally inshore HMAs. None of the proposed measures in the amendment would restrict lobster trap gear. Charter/party recreational activity is very limited.

The HMAs in this sub-region range from 334-1692 km^2, and are generally within the size range of the seven existing habitat closure areas, which have an average size 1,395 km^2 (Figure 5).

Table 4 – EGOM: dominant substrate coverage within each management area. Values are provided in square kilometers and as a percentage of the total.

Area name and type (Alternative #)	Substrate										Total area, km²
	Low energy					High energy					
	M	S	G	C	B	M	S	G	C	B	
Habitat management areas											
Large Eastern Maine (#2)	1,447 85%	0 -	131 8%	113 7%	0 -	2 <1%	0 -	1 <1%	0 -	0 -	1,697
Small Eastern Maine (#3)	310 59%	0 -	103 19%	113 21%	0 -	2 <1%	0 -	1 <1%	0 -	0 -	529
Machias (#2, #3)	0 -	1 <1%	86 27%	0 -	0 -	111 34%	110 34%	10 3%	5 1%	0 -	322
Toothaker Ridge (#3)	590 79%	0 -	158 21%	0 -	0 -	0 -	0 -	0 -	0 -	0 -	748
GOM Region	**38,255 66%**	**11,618 20%**	**3,969 7%**	**510, 1%**	**294 1%**	**587 1%**	**1,689 3%**	**861 1%**	**211 <1%**	**41 <1%**	**58,036**

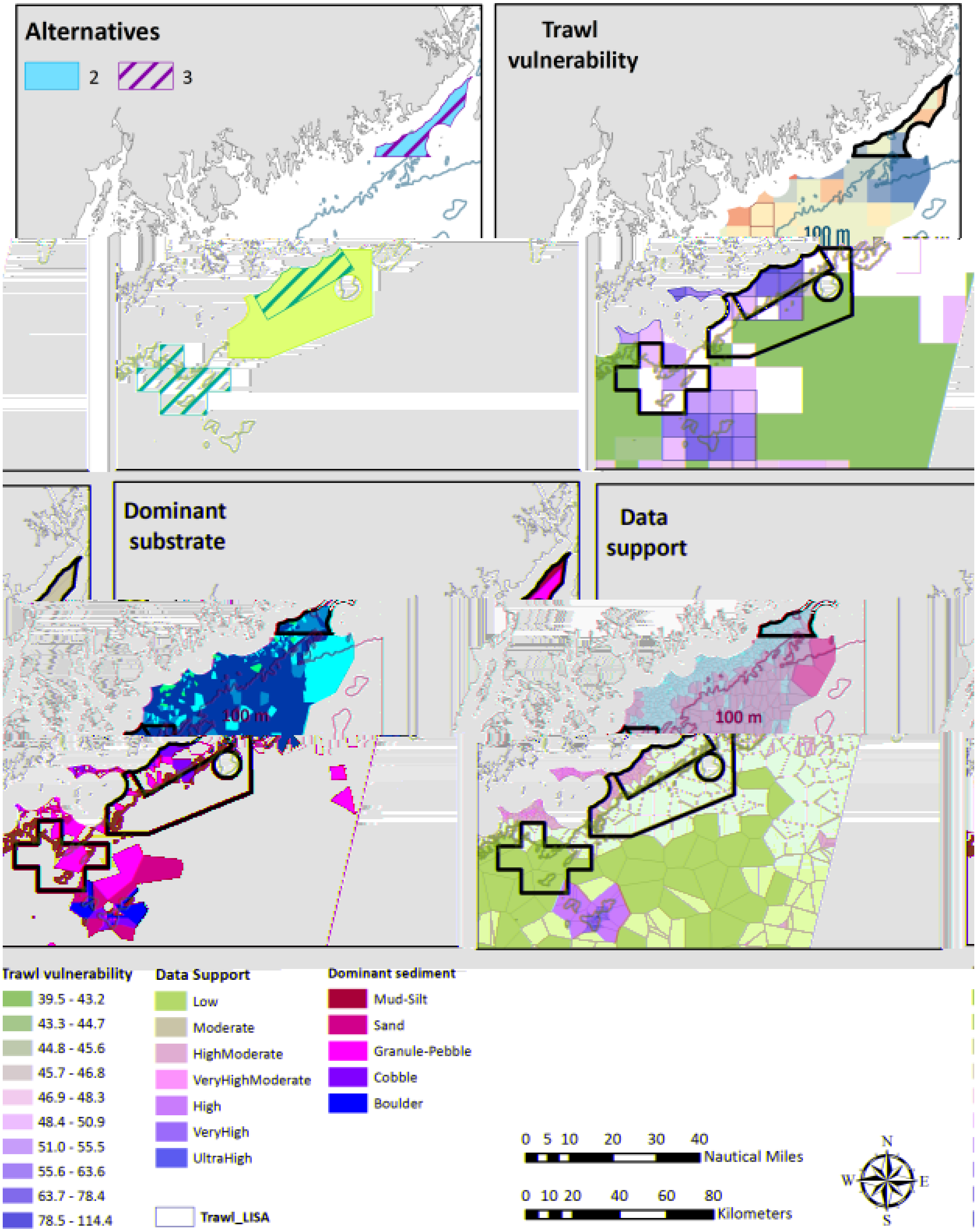
Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

Table 5 – EGOM: data support within each management area. Values are provided in square kilometers and as a percentage of the total.

Area name and type (number of overlapping unstructured grids, Alternative #)	Data support							Area, km²
	Low	Moderate			High			
	1	2	3	4	5	6	7	
Habitat management areas								
Large Eastern Maine (112, #2)	0 -	1,508 89%	184 11%	5 <1%	-	-	-	1,697
Small Eastern Maine (50, #3)	0 -	852 81%	199 19%	7 1%	-	-	-	529
Machias (48, #2, #3)	0 -	182 57%	137 42%	4 1%	-	-	-	322
Toothaker Ridge (8, #3)	580 78%	168 23%	0 -	0 -	-	-	-	748
GOM Region (5,772)	**21,134 38%**	**26,511 45%**	**7,125 11%**	**698 1%**	**1,126 2%**	**1,061 2%**	**381 <1%**	**54,640**

Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

Map 2 – EGOM: SASI dominant substrate, data support, and vulnerability outputs (trawl gear). Red outlined cells on the trawl vulnerability panel are LISA clusters.



Map 3 – Overlap between Eastern Gulf of Maine HMAs and Maine Bottom Type sediment maps. Toothaker Ridge has no overlap and is not shown. Compare this figure to the dominant substrate panel on the map above.

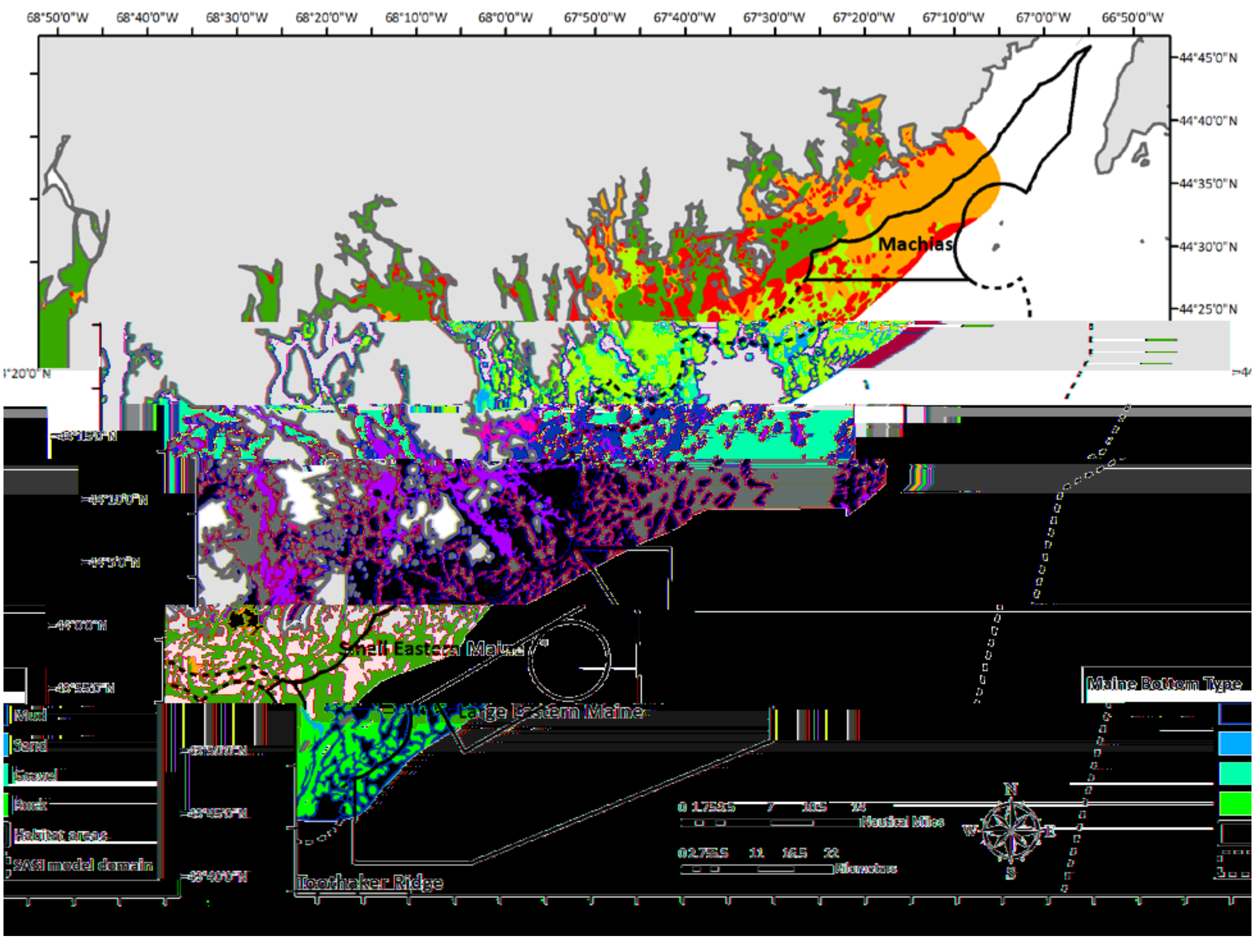


Table 6 – EGOM: minimum and maximum mobile bottom-tending gear vulnerability scores for each habitat management area, and the number of structured (10km x 10km) grids overlapping each area (*N*). Blanks indicate that the scallop dredge model domain did not cover the area, because it was beyond the maximum depth fished by that gear (83m).

	Otter trawl			Scallop dredge			Hydraulic dredge		
	Min	Max	*N*	Min	Max	*N*	Min	Max	*N*
Habitat Management Area (Alternative #)									
Small Eastern Maine (#3)	48.1	114.4	*7*	48.0	115.6	*5*	147.9	156.1	*6*
Large Eastern Maine (#2)	41.8	114.4	*21*	48.0	115.6	*5*	147.9	156.1	*11*
Machias (#2 and 3)	44.5	53.6	*9*	46.0	56.0	*8*	108.1	157.3	*9*
Toothaker Ridge (#3)	41.9	52.3	*7*	-	-	-	142.6	156.5	*6*
GOM region	**39.5**	**100.4**	***617***	**44.3**	**91.7**	***73***	**108.0**	**159.9**	***174***

Figure 4 – EGOM: Mean vulnerability scores for trawl, scallop dredge, and clam dredge gear. The region-wide means for the Gulf of Maine are 47.5 (otter trawl), 52.7 (scallop dredge), and 136.6 (clam dredge).

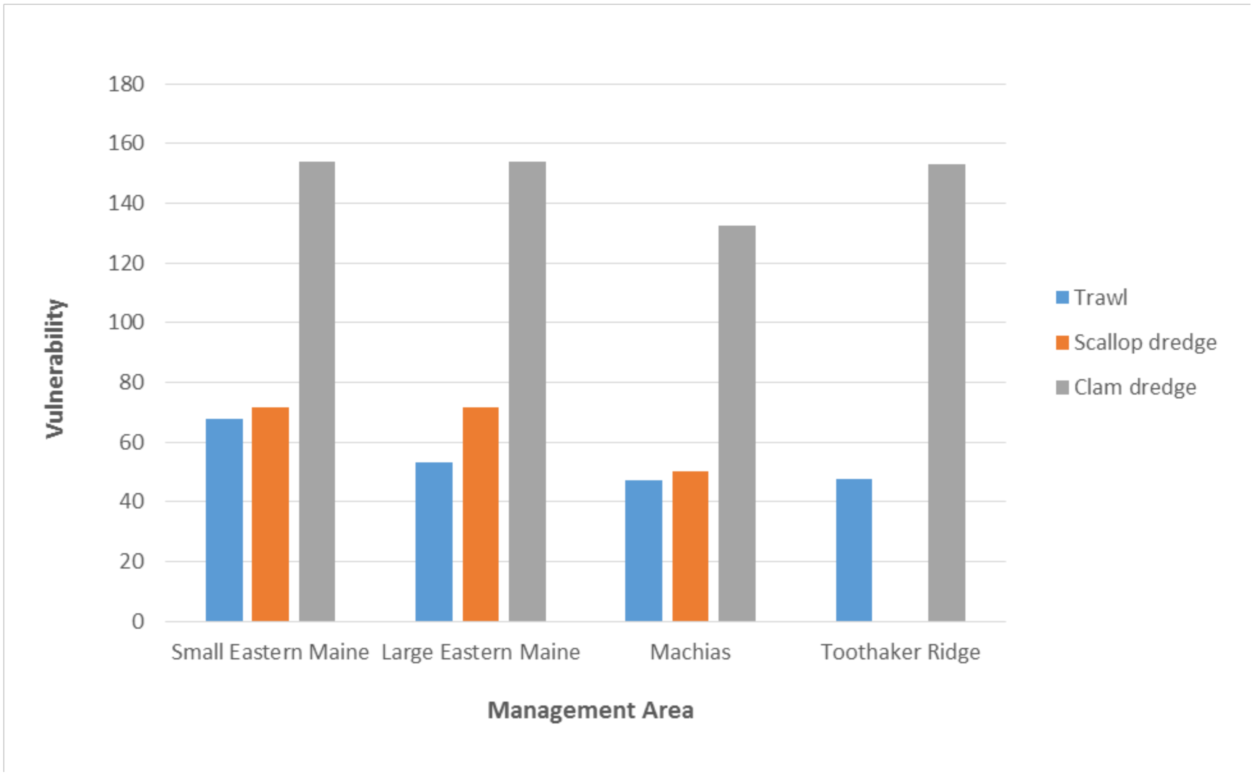


Table 7 – Overlap between Eastern GOM HMAs and preferred alternative EFH designations. Species and lifestages in bold italicized type are associated with complex substrate. Juveniles shaded grey were positively weighted in the hotspot analysis. Overfished species are indicated with an asterisk (*). After each management area the alternatives it is a part of are listed in parentheses. Scores correspond to full/high=3, moderate=2, slight=1, none=0.

Species and lifestage	Machias (2, 3)	Small Eastern Maine (3)	Large Eastern Maine (2)	Toothaker Ridge (3)
Acadian redfish juvenile	High	High	High	High
Acadian redfish adult	Slight	Slight	Slight	Slight
American plaice juvenile	Moderate	**Full**	Moderate	High
American plaice adult	Slight	**Full**	High	**Full**
Atlantic cod juvenile*	High	**Full**	Moderate	Moderate
Atlantic cod adult*	High	**Full**	High	High
Atlantic halibut - all stages*	High	High	Moderate	High
Atlantic wolffish - all stages*	**Full**	**Full**	**Full**	**Full**
Haddock juvenile	High	**Full**	Moderate	High
Haddock adult	Slight	Moderate	Moderate	High
Ocean pout egg*	High	Moderate	Slight	Slight
Ocean pout juvenile*	High	Moderate	Slight	Moderate
Ocean pout adult*	Slight	Slight	Slight	Moderate
Pollock juvenile	Moderate	**Full**	High	**Full**
Pollock adult	Slight	*None*	Slight	High
Red hake egg, larvae, and juvenile	High	**Full**	High	High
Red hake adult	Slight	High	High	**Full**
Silver hake juvenile	High	**Full**	**Full**	**Full**
Silver hake adult	High	**Full**	**Full**	**Full**
White hake juvenile	High	**Full**	**Full**	**Full**
White hake adult	High	High	High	High
Windowpane flounder juvenile*	Moderate	High	Moderate	Slight
Windowpane flounder adult*	Slight	Moderate	Slight	Slight
Winter flounder egg*	Moderate	Slight	Slight	Slight
Winter flounder larvae and adult*	High	High	Moderate	Slight
Winter flounder juvenile*	High	High	Moderate	Slight
Witch flounder juvenile*	Slight	**Full**	**Full**	**Full**
Witch flounder adult*	Slight	Moderate	Moderate	High
Yellowtail flounder juvenile*	Slight	Slight	Slight	Slight
Yellowtail flounder adult*	Moderate	Moderate	Moderate	Moderate
Monkfish juvenile	High	**Full**	High	**Full**
Monkfish adult	Slight	Moderate	High	**Full**
Smooth skate juvenile	High	Slight	Moderate	High
Smooth skate adult	Slight	Slight	Slight	Slight
Thorny skate juvenile*	High	Moderate	High	High
Thorny skate adult*	Slight	High	High	High
Barndoor skate – juv/adu	*None*	Slight	Slight	Slight
Little skate juvenile	High	Moderate	Moderate	Moderate
Little skate adult	High	High	Moderate	Moderate
Winter skate juvenile	High	Moderate	Moderate	Slight
Winter skate adult	*None*	Slight	Slight	Slight
Atlantic sea scallop - all	High	High	Moderate	Moderate
Atlantic herring egg	Moderate	Slight	Slight	Slight
Total score (out of 129)	**91**	**98**	**90**	**96**
Score for s/l asso/w complex substrate (out of 84)	**61**	**58**	**54**	**60**
Score for juvs positively weighted in hotspot analysis (out of 18)	**17**	**17**	**14**	**16**
Score for overfished species (out of 54)	**39**	**42**	**35**	**36**
Count of species (out of 23)	**22**	**22**	**23**	**22**
Count of designations (out of 43)	**41**	**42**	**43**	**43**

Table 8 – Prey types consumed by species with a relatively high degree of overlap with Eastern GOM HMAs. Values represent the percentage of stomach contents, by weight, in the NEMFC food habitats database, 1973-2005. Totals do not equal 100% as some stomach contents could not be identified.

Species	Amphi-pods	Decapod crabs	Decapod shrimp	Bivalves	Poly-chaetes	Echino-derms	Total benthic inverts	Benthic fish	Total benthic	Total pelagic	Total
Acadian redfish	1	0	45	0	0	0	46	0	46	38	84
Atlantic cod	0	14	5	7	1	1	28	6	34	25	59
Atlantic halibut	0	15	8	0	0	0	23	40	63	21	84
Haddock	13	2	3	2	9	23	52	1	53	4	57
Monkfish	0	0	0	0	0	0	0	19	19	30	49
Pollock	1	0	21	0	0	0	22	9	31	47	78
Red hake	4	7	24	1	2	0	38	2	40	23	63
Silver hake	1	0	15	0	0	0	16	5	21	50	71
Thorny skate	1	7	8	0	24	0	40	11	51	16	67
White hake	0	0	8	0	0	0	8	3	11	44	55
Witch flounder	2	0	0	1	71	0	74	0	74	1	75

Table 9 – Average diversity indices within the eastern Gulf of Maine sub-region habitat management alternatives. Indices exceeding the 75th percentile for each species group across all habitat management areas in all sub-regions are highlighted (red, large mesh; yellow, regulated species; green, all species). There are no areas associated with Alternative 1.

		Lg. Eastern Maine, Machias (2)	Sm. Eastern Maine, Toothaker Ridge, Machias (3)	Sm. Eastern Maine (3, as preferred by Council)
Spring	*Tows*	*44*	*26*	*20*
	Lg mesh groundfish ISI	0.609	0.633	0.629
	Regulated spp. ISI	0.626	0.651	0.654
	All spp. SDI	1.611	1.632	1.660
Summer	*Tows*	*9*	*17*	*0*
	Lg mesh groundfish ISI	0.682	0.616	n/a
	Regulated spp. ISI	0.405	0.521	n/a
	All spp. SDI	1.462	1.537	n/a
Fall	*Tows*	*17*	*11*	*6*
	Lg mesh groundfish ISI	0.510	0.538	0.564
	Regulated spp. ISI	0.593	0.591	0.603
	All spp. SDI	1.519	1.522	1.649
Winter	*Tows*	*4*	*2*	*2*
	Lg mesh groundfish ISI	0.637	0.716	0.716
	Regulated spp. ISI	0.756	0.814	0.814
	All spp. SDI	2.063	1.952	1.952

Map 4 – EGOM weighted fish persistence. Source: TNC.

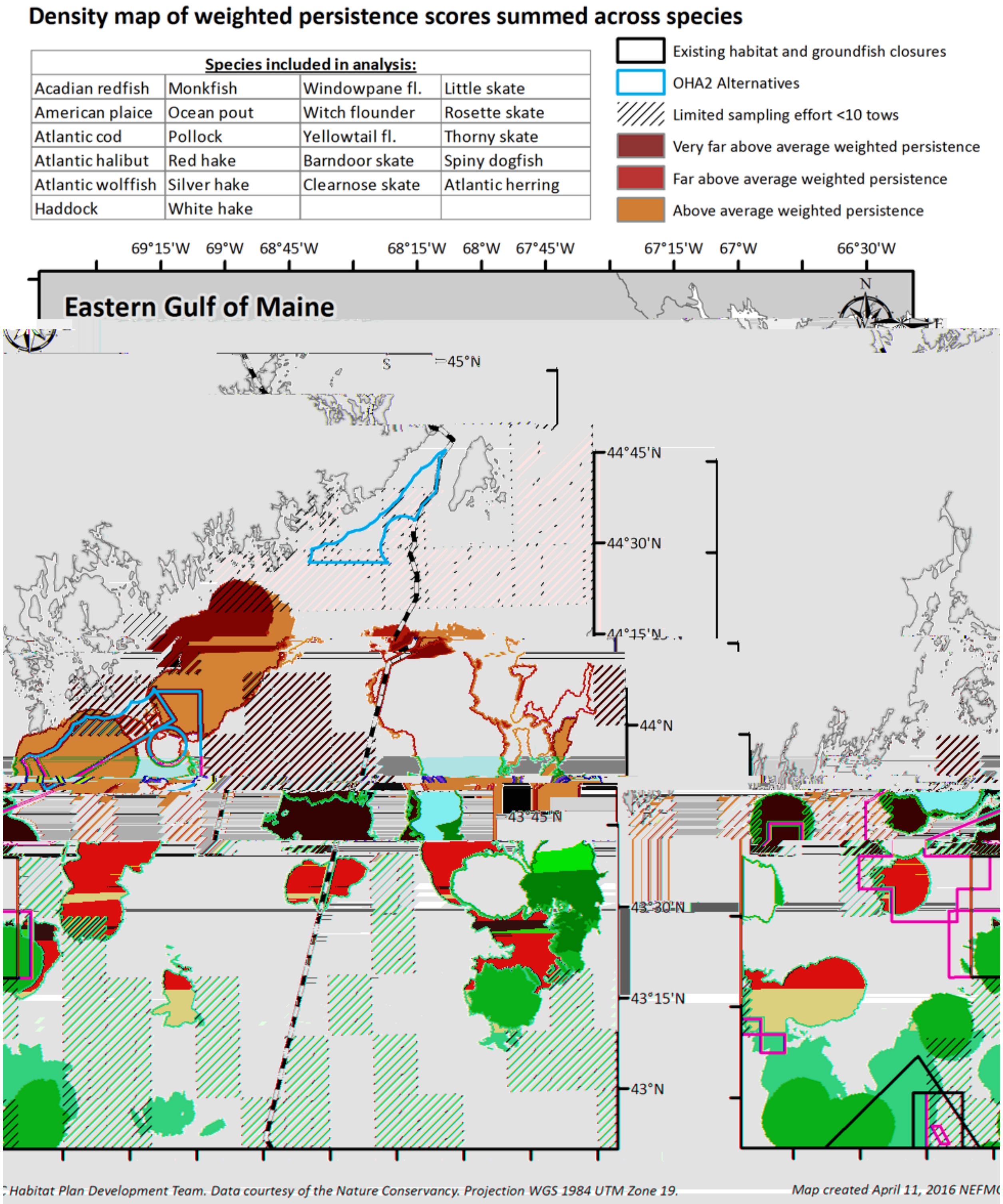
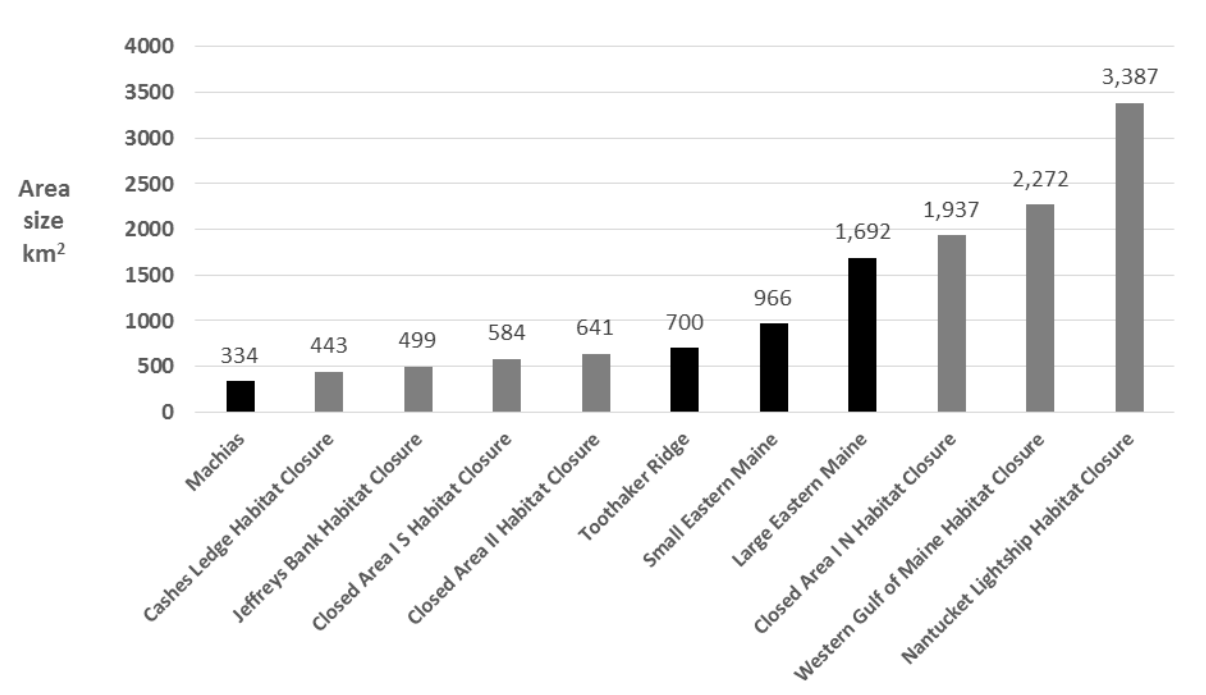


Figure 5 – Size comparison between eastern GOM HMAs (black bars) and no action habitat closure areas (grey bars).



3.2.1.1 *Alternative 1 (No Action/No Habitat Management Areas)*

Under Alternative 1/No Action, fishing with mobile bottom-tending gears would continue in the region without any restrictions related to adverse effects minimization. In contrast to Alternatives 2 and 3, which propose specific habitat management areas and gear restrictions, under Alternative 1/No Action there would be no specific protection provided for benthic habitats in particular locations in the eastern Gulf of Maine through limits on the use of these gears. As described above, the magnitude of mobile bottom-tending gear fishing in the eastern Gulf of Maine is small. Assuming patterns of effort do not change, any negative impacts associated with this alternative are going to be small in magnitude. Although not particularly well mapped, there are known areas of vulnerable habitats in the eastern Gulf of Maine. In addition, the HMAs considered under other alternatives have a high degree of overlap with designated EFH for a variety of species, and the Small and Large Eastern Maine HMAs in particular overlap with areas showing far above average weighted persistence for managed species. Combining these factors, there are missed opportunities for proactive conservation measures under No Action, but given the limited magnitude of existing fishing with gears to which vulnerable habitats are most susceptible, i.e. mobile bottom-tending gears, the magnitude of future impacts associated with this alternative are minor. Thus, Alternative 1/No Action has slightly negative impacts. This could change if the use of mobile, bottom-tending gear increases at some point in the future, perhaps due to improvement in conditions of the groundfish resource, or increased activity in the scallop or clam fisheries. Alternative 1/No Action has negative impacts relative to Alternative 2 with Options 1, 2, and 5, and relative to Alternative 3 with Options 1 and 2, all of which do provide specific protections to vulnerable habitat types from mobile bottom-tending gear impacts. Alternative 1/No Action also has negative impacts relative to the preferred Alternative, which is a subset of Alternative 3. Alternative 1/No Action has uncertain but likely neutral impacts relative to Alternatives 2 and 3 with gear modification Options 3 and 4, which have uncertain impacts that are likely small in magnitude but could be positive or negative.

3.2.1.2 *Alternative 2*

Alternative 2 includes the Large Eastern Maine and Machias HMAs. Both the Large Eastern Maine HMA in this alternative and the Small Eastern Maine Area in Alternative 3 cover areas of complex benthic habitat with rocky substrates (see substrate panel in Map 2 as well as Map 3). The Large Eastern Maine HMA extends further offshore, and encompasses steep, rocky habitats colonized by deep-sea corals surrounding Mt. Desert Rock. The other deep-water portions of the Large Eastern Maine HMA are poorly characterized (data support panel in Map 2). The SASI vulnerability results indicate that the HMA contains vulnerable habitat types relative to the reigon as a whole (Table 6, trawl vulnerability panel in Map 2). While these results are difficult to interpret given the uncertainty in the underlying substrate map, the nearshore habitats in the HMA and especially the coral habitats near Mt. Desert Rock are likely more vulnerable to accumulating fishing impacts than deep mud basin habitats found in other parts of the Gulf of Maine.

The Machias HMA also contains rocky substrates, but currents along the seabed in this area are high, and the area is classified as high energy (Table 4). According to the SASI vulnerability assessment, this means habitats in the Machias area are likely somewhat less vulnerable to accumulating adverse effects of fishing due to more rapid recovery times associated with high energy habitats vs. low energy habitats. Data support values in the Machias HMA are low, so dominant substrate maps and therefore vulnerability estimates are uncertain. Another consideration is that the Machias HMA overlaps the Machias Seal Island Grey Zone, which is the result of competing exclusive economic zone boundary claims between the U.S. and Canada. Thus, even if the Machias HMA is designated as a mobile bottom-tending gear closure that applies to U.S. vessels, Canadian trawl and dredge vessels could still operate in the area, which would undermine the effectiveness of the mobile bottom-tending gear closure and compromise habitat recovery.

Combining the two HMAs, Alternative 2 overlaps with designated EFH for all 23 species and 43 lifestages with benthic lifestages assessed in the EFH overlap analysis (Table 7). The total scores indicating the degree of spatial overlap with these designations are generally high, whether all species in the analysis, overfished species, gravel-associated species, or hotspot weighted juveniles are considered. The latter two scores indicate that minimizing impacts to structured seabed habitats occurring in these management areas should benefit a relatively large number of species that occur in or are strongly associated with these substrate types.

Because the Machias HMA is included in both Alternatives 2 and 3, and the Small and Large Eastern Maine areas overlap, the relevant question when comparing Alternatives 2 and 3 is what additional protections may be afforded by enacting gear restrictions in the deeper water section of the Large Eastern Maine HMA in this alternative vs. the Toothaker Ridge HMA in Alternative 3. In general, the mix of species is similar between these two locations and either alternative would afford protections for the same array of species. Because the Large Eastern Maine HMA encompasses the Small Eastern Maine HMA, the areas overlap a very similar array of EFH designations, but the Large Eastern Maine HMA is expected to afford more protection for deeper water species and lifestages, such as adult monkfish (Table 7).

Alternative 2 has relatively high species diversity for all three categories (all species, regulated species, and groundfish species only) compared to other alternatives in other sub-regions. The indices are similar to those calculated for Alternative 3, so this metric has limited utility for comparing between EGOM Alternatives 2 and 3, but does indicate that the EGOM areas in general encompass a relatively diverse array of species. Sampling effort in the Machias HMA in the diversity analysis was very low (one tow, in the spring). This low sampling effort also influences the species persistence analysis, which did not identify any notable areas within the Machias HMA. However, the Large Eastern Maine HMA did have notable areas in the species persistence analysis.

Alternative 2 with Option 1 or 2 is expected to reduce the adverse effects of fishing on the seabed in the identified areas, and improve habitat protection for groundfish and other resources that occur in and around these HMAs. Options 1 and 2 are equivalent in this sub-region because there is currently no hydraulic clam dredging. Although there is dredging with toothed clam dredges in this part of the Gulf of Maine, this gear would not be exempted under Option 2. In terms of mobile bottom-tending gear activity, there is relatively limited use of generic otter trawls, shrimp trawls, scallop dredges, and clam dredges in this sub-region as compared to other sub-regions (see the realized adverse effects maps section 4.2.2.2 of Volume 1, and section 4.2.1 below). The high degree of overlap with designated EFH and high species diversity indices both indicate that a large number of stocks could derive benefits from these areas. However, because the current magnitude of adverse impacts is small, the positive impacts are likely to be small as well. In addition, the portions of the Machias HMA in the grey zone could continue to be fished with mobile bottom-tending gears by Canadian vessels. Overall, Alternative 2 Options 1 and 2 are expected to have slightly positive impacts on habitat. Larger positive impacts could be generated over the long term, if the HMAs, when combined with other resource management measures, aid in groundfish stock recovery, fishing effort with bottom trawls targeting these groundfish increases, and the HMAs serve to displace adverse effects associated with that activity off of these important habitat areas.

Alternative 2 Options 1 and 2 and Alternative 3 Options 1 and 2 are expected to have similar, slightly positive impacts on seabed habitats. Although the Eastern Maine area in Alternative 2 is larger and incorporates deep-sea coral habitats, the alternative provides no protection for the habitats and species within the Toothaker Ridge area. Both alternatives cover approximately the same total area, approximately 2000 km^2. Alternative 2 Options 1 and 2 are expected to have positive impacts relative to Alternative 3 as preferred.

The impacts of Alternative 2 with gear modification Options 3 or 4 are uncertain. They could be slightly negative relative to Alternative 1/No Action if catch efficiency declines with the modified gear, which is expected to be offset with an overall increase in effort. Alternately, impacts could be slightly positive if some trawl effort is displaced from the areas because vessels choose not to adopt the modified gear, or if the ground cables with rollers effectively reduce contact of the gear with the seabed. Because it is difficult to estimate the impacts of Alternative 2 Option 3 or 4, it is difficult to compare these impacts with Alternative 3, Options 3 or 4.

The addition of Option 5 (closure to all gear capable of catching groundfish) would make little difference in terms of reduction of fishing impacts on the seabed relative to selection of Option 1 alone. As described below in the economic impacts section (4.2.1.2), the vast majority of additional effort that would be restricted under this option is from purse seine gear, which is not considered to be bottom-tending and therefore is not expected to cause adverse impacts on seabed habitats.

3.2.1.3 *Alternative 3 (Preferred Alternative, with Small Eastern Maine HMA only)*

Alternative 3, as originally developed, included the Small Eastern Maine, Machias, and Toothaker Ridge HMAs. All three areas cover areas of complex benthic habitat with rocky substrates (see substrate panel in Map 2, Map 3) and include a large number of EFH designations. The alternative as a package has relatively high species diversity indices and the Small Eastern Maine and Toothaker Ridge areas overlap with notable areas in the species persistence analysis (Map 4). Similar to Alternative 2, Alternative 3 Options 1 or 2 would be expected to reduce the adverse effects of fishing on the seabed in the identified areas, and improve habitat protection, resulting in slightly positive impacts relative to Alternative 1/No Action. The impacts of Options 3 and 4 are uncertain, but are likely similar to Alternative 1/No Action. Inclusion of the Toothaker Ridge area with Option 1 or 2 fishing restrictions would improve seabed habitat protection in the sub-region, although it appears that the habitat type within the Toothaker Ridge area is relatively less vulnerable and consists mainly of mud-dominated areas. However, data quality for Toothaker is relatively low, and does not include sampling that could detect cobble and boulder substrates, so our understanding of seabed characteristics in this area is very uncertain. Statements in the Alternative 2 section regarding the limited magnitude of adverse effects tempering the positive benefits of habitat conservation measures apply to this alternative as well, as do statements regarding increased benefits over the long term.

The Council's preferred action includes the Small Eastern Maine area only, implemented as a closure to all mobile bottom-tending gears. Although overall impacts of the Council's preferred are still expected be slightly positive, the benefits would not not be as great as the benefits associated with either Alternative 2 or 3 with all HMAs included. However, comparing the attributes of the three areas, the Small Eastern Maine HMA appears to potentially provide the most habitat protection. While the Small Eastern Maine HMA does encompass vulnerable habitat types, there is likely some reduction in conservation value for deeper-water species including pollock and smooth skate, which are better represented in other HMAs in this sub-region. However, species diversity indices for the Small Eastern Maine HMA alone are still relatively high (Table 9), and compare favorably with those for the three areas combined. In addition, the very far above average weighted persistence areas are included within this HMA, and do not overlap the Toothaker Ridge or Machias HMAs (Map 4), although as previously noted trawl survey data for Machias are extremely limited. Finally, the Small Eastern Maine HMA is the largest of the three areas in this alternative (Figure 5), covering approximately half the area covered by the full alternative with all three areas (966 km^2 vs. 2100 km^2).

3.2.2 Central Gulf of Maine

There are four habitat management alternatives for the Central Gulf of Maine sub-region: (1) no action Cashes Ledge and Jeffreys Bank Habitat Closure Areas and no action Cashes Ledge Groundfish Closed Area, (2) no HMAs, (3) modified Cashes Ledge, Ammen Rock, modified Jeffreys Bank, Fippennies Ledge, and Platts Bank and (4) Modified Cashes Ledge, Ammen Rock, and Modified Jeffreys Bank. For alternatives 3 and 4, each area except Ammen Rock, which would be closed to all fishing except lobster trapping, could have any one of the four gear restriction options. The Council's preferred alternative combines elements of Alternative 1 and Alternative 3, specifically including the existing Cashes Ledge Groundfish Closure Area, Modified Jeffreys Bank and Cashes Ledge HMAs, and new HMAs on Ammen Rock and Fippennies Ledge. When reviewing the summary metrics below, it is important to bear in mind that some of the areas overlap spatially (see panel showing management areas in Map 5). Specifically, all of the features associated with the Cashes Ledge HMA (both existing and modified) and Fippennies Ledge HMA are encompassed by the larger Cashes Ledge Groundfish Closure Area.

In this sub-region, the management areas tend to have coarser substrates (Table 10, Map 5), higher levels of data support (Table 11, Map 5, Map 5), and higher vulnerability indices (Table 12) than the Gulf of Maine region as a whole. The management areas are generally shallower, hardbottom banks and ledges while much of the central Gulf of Maine consists of deeper mud basin habitats. The exception to this is the Cashes Ledge Groundfish Closure Area, where the substrate composition and minimum vulnerability index are more consistent with the regional totals because the area includes a mix of shallow coarse sediment areas around a central mud basin. Because some areas within the groundfish closure are better sampled, specifically Cashes and Fippennies Ledges, the overall data support in the area is higher than the regional average. In general, the central GOM management areas are considered low energy (Table 10), with the exception of the Ammen Rock HMA and the Platts Bank HMA. While all of the areas have very low benthic boundary shear stress values, the Ammen Rock and Platts Bank HMAs include a relatively large amount of area shallower than 60 meters.

The Ammen Rock HMA contains a deep-water offshore kelp habitat, which is not found elsewhere in the Gulf of Maine. With the exception of Alternative 2, all of the alternatives in this sub-region afford protection for Ammen Rock. Under Alternative 1, Ammen Rock is closed to gear capable of catching groundfish and mobile bottom-tending gears. Under Alternatives 3 and 4, the area would be closed to all fishing except lobster trapping; this is the preferred management approach for Ammen Rock.

In terms of overlap with the preferred alternative EFH designations (Table 13), species that are not common in the offshore Gulf of Maine have little overlap with the central Gulf of Maine habitat areas generally. These species include ocean pout, offshore hake, windowpane, winter, and yellowtail flounders, and skates other than smooth and thorny skate.

Across the species that have the highest degree of overlap with the central Gulf of Maine HMAs, i.e. redfish, plaice, cod, halibut, haddock, monkfish, pollock, red hake, silver hake, smooth skate, thorny skate, white hake, and witch flounder, a diverse array of benthic prey types are consumed (Table 14). Decapod shrimp constitute over 5% by weight of the diet of nine of these species, decapod crabs are important to four species, and polychaetes to three species. Amphipods are consumed in large quantities by haddock, haddock and plaice eat large amounts of echinoderms, and cod eat bivalve mollusks. As shown in the maps prepared for Appendix H, all of these prey types are found in the central Gulf of Maine. However, based on a review of the scientific literature on gear effects, there is little evidence for long-term impacts of fishing on these types of benthic prey (see Appendix H, section 4.0 for details). Further, all of the managed fishes consume multiple prey types. Therefore, substantial positive or negative impacts of the HMAs on the benthic invertebrate prey base in this sub-region appear unlikely to result from this amendment, regardless of which alternative is selected.

The Cashes Ledge HAPC occurs in this sub-region, and has the same boundaries as the No Action Cashes Ledge Habitat Closure. With the exception of Alternative 2, all of the alternatives in this sub-region maintain at minimum a mobile-bottom tending gear closure in most of the HAPC, including the shallower portion of the HAPC containing the ledge feature.

Table 15 shows groundfish diversity, regulated species diversity, and all species diversity for the central Gulf of Maine habitat management alternatives. Alternatives with the highest diversity values (75th percentile of each season) for each diversity index across all alternatives in all sub-regions are shaded (red=groundfish, yellow=regulated species, green=all species). These diversity index values can be compared to the diversity indices for areas in other sub-regions by reviewing the species diversity summary (Section 4.2.3) in Volume 1. The red, yellow, and green highlighted values for each index are above the 75th percentile for that index across all habitat management alternatives in all sub-regions. Thus, the number of red highlighted values indicates that large mesh groundfish diversity is high in the central Gulf of Maine sub-region management alternatives, relative to other alternatives proposed in this amendment. For example, the Cashes Ledge Groundfish Closure Area has high diversity across all species in the summer and fall surveys, which indicates that it would protect a relatively broad array of biological resources.

The weighted persistence analysis identified notable areas within the Cashes Ledge Closure Area, Cashes Ledge Habitat Area (current and modified), Jeffreys Bank Habitat Area (current and modified), Fippennies Ledge HMA, and Platts Bank HMA, but not within the Ammen Rock HMA (Map 6). None of the areas included 'very far above average persistence/highest diversity' areas. Sampling effort in Cashes Ledge Habitat Closure, including the portion overlapping Ammen Rock, was generally sparse.

The distribution of fishing effort by gear type and resultant expected adverse impacts through 2009 are described and mapped in Volume 1, Section 4.2.2.2. Fishing activity by gear type and fishery through 2012 is also described and mapped in Volume 1, Section 4.3. This volume, Section 4.2, summarizes revenue by gear type within each proposed HMA, through 2014. Groundfish trawl effort has occurred in the sub-region historically, although it is difficult to use the distribution of fishing effort or realized adverse effects as a metric for evaluating the alternatives in this subregion because in general, many of the areas have been closed to fishing since 2002 when the Cashes Ledge Groundfish Closure Area was implemented year round. An interesting hypothetical question is whether or not mobile bottom-tending gears could be used on the shallow, steep, and rocky portions of the Cashes Ledge HMA, particularly on Ammen Rock pinnacle, should the habitat and groundfish closures overlapping the ledge reopen. Observer data from the period shortly prior to year-round closure in 2002 were examined to evaluate this question. Based on the spatial distribution of observed hauls, it seems that trawls avoided the Ammen Rock pinnacle, but that there was some fishing activity on other parts of Cashes Ledge, and on Fippennies Ledge, with cod, monkfish, and pollock as the main target species. Those species, plus deeper-water stocks including white hake, witch flounder, and American plaice were targeted in the larger Cashes Ledge Groundfish Closure Area. Comparing the relative intensity of fishing on the ledges vs. in adjacent basin areas, it does not appear that trawl effort was heavily concentrated on the ledges themselves.

This spatial pattern of trawl activity contrasts sharply with historical spatial patterns in sink gillnet fishing. Gillnetting was concentrated on both Cashes and Fippennies Ledges prior to closure, with fewer observed sets on the soft-bottom habitats in Cashes Basin and in other off-ledge areas. Pre-closure, gillnets were used to target cod, pollock, white hake, and monkfish during observed hauls on the ledges.

Conditions in the groundfish fishery are different now than they were in 2002 when the Cashes Ledge Groundfish Closure Area was implemented year-round, and there is less effort in the fishery overall. However, if the closure was reopened, these general patterns of activity by gear type would likely still hold, i.e., opening existing areas would lead to an influx of sink gillnet activity on Cashes and Fippennies Ledges, but would not lead to large amounts of bottom trawling on the ledges, especially on Ammen Rock pinnacle. Likely target species and the overall magnitude of effort are discussed in the economic analysis using recent at-sea observer data collected in waters adjacent to the current closures (see section 4.2.2.2).

Scallop dredging is not especially important in the central Gulf of Maine, as scallops only occupy shallower ledges and banks in commercial abundance, and the resource has fluctuated over time. Howeve, there was a recent increase in scallop dredging activity on Platts Bank, which is describe more fully in section 4.2.2. Clam dredging is not known to occur in the sub-region. Mid-water gears targeting herring, i.e. purse seines and mid-water trawls, are used in the sub-region, but effort is less than in the eastern Gulf of Maine sub-region (purse seines) and western Gulf of Maine and Georges Bank sub-regions (mid-water trawls). Lobster trapping occurs in the central Gulf of Maine, but there is substantially lower effort than in the nearshore areas of the Gulf. There is some charter/party recreational fishing activity, but much less than in areas closer to shore, i.e. the western Gulf of Maine.

The action alternative HMAs in this sub-region range from 15-494 km^2, and are generally smaller than the seven existing habitat closure areas[4], which have an average size 1,395 km^2 (Figure 7). The modified version of the Cashes Ledge HMA is approximately 73% of the size of the existing HMA, while the existing and modified Jeffreys Bank habitat areas are nearly identical in size. The Cashes Ledge Closure Area is larger than all of the habitat closures, at 1.373 km^2. The two Platts Bank HMAs are stand-alone areas, but the Fippennies Ledge and Ammen Rock HMAs are nested within other management areas as part of the preferred alternative.

[4] Existing habitat closures include Jeffreys Bank, Cashes Ledge, Western Gulf of Maine, Closed Area II, Closed Area I N, Closed Area I S, and Nantucket Lightship. Not all of the habitat closures are in the central Gulf of Maine.

Table 10 – CGOM: dominant substrate coverage within each management area. Values are provided in square kilometers and as a percentage of the total.

Area name and type (Alternative #)	Substrate										Area, km²
	Low energy					High energy					
	M	S	G	C	B	M	S	G	C	B	
No action EFH											
Cashes Ledge EFH (#1)	142 36%	113 29%	84 22%	1 <1%	35 9%	0 -	1 <1%	0 -	1 <1%	14 4%	392
Jeffreys Bank EFH (#1)	205 41%	100 20%	105 21%	69 14%	25 5%	0 -	0 -	0 -	0 -	0 -	504
No action groundfish											
Cashes Ledge GF (#1)	926 65%	290 20%	144 10%	6 <1%	46 3%	0 -	1 <1%	0 -	1 <1%	14 1%	1,428
Habitat management areas											
Ammen Rock (#3 and #4)	0 -	1 7%	0 -	1 7%	1 7%	0 -	1 8%	0 -	1 7%	9 65%	14
Modified Cashes Ledge (#3 and #4)	124 37%	74 22%	84 25%	1 <1%	35 11%	0 -	1 <1%	0 -	1 <1%	14 4%	335
Fippennies Ledge (#3)	0 -	16 40%	13 32%	5 11%	7 16%	0 -	0 -	0 -	0 -	0 -	41
Modified Jeffreys Bank (#3 and 4)	47 9%	188 36%	105 20%	69 13%	112 22%	0 -	0 -	0 -	0 -	0 -	521
Platts Bank (#3)	0 -	21 34%	9 15%	6 9%	9 14%	0 -	7 11%	3 5%	3 5%	5 8%	63
GOM Region	**38,255 66%**	**11,618 20%**	**3,969 7%**	**510, 1%**	**294 1%**	**587 1%**	**1,689 3%**	**861 1%**	**211 <1%**	**41 <1%**	**58,036**

Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

Table 11 – CGOM: data support within each management area. Values are provided in square kilometers and as a percentage of the total.

Area name and type (number of overlapping unstructured grids, Alternative #)	Data support							Area, km^2
	Low	Moderate			High			
	1	2	3	4	5	6	7	
No action EFH								
Cashes Ledge EFH (90, #1)	0 -	206 53%	44 11%	4 1%	30 8%	88 23%	19 5%	392
Jeffreys Bank EFH (35, #1)	135 27%	143 28%	0 -	0 -	160 32%	63 12%	3 1%	504
No action groundfish								
Cashes Ledge GF (188, #1)	216 15%	759 53%	69 5%	6 <1%	152 11%	181 13%	47 3%	1,428
Habitat management areas								
Ammen Rock (14, #3 and 4)	0 -	0 -	0 -	0 -	0 -	4 30%	10 70%	14
Modified Cashes Ledge EFH (86, #3 and 4)	0 -	189 56%	44 13%	4 1%	0 -	79 24%	19 6%	335
Fippennies Ledge (41, #3)	0 -	0 -	0 -	1 3%	0 -	18 44%	22 54%	41
Modified Jeffreys Bank EFH (39, #3 and 4)	0 -	96 18%	0 -	0 -	360 69%	63 12%	3 1%	521
Platts Bank (54, #3)	0 -	0 -	0 -	0 -	0 -	43 65%	23 35%	63
GOM Region (5,772, n/a)	**21,134** **38%**	**26,511** **45%**	**7,125** **11%**	**698** **1%**	**1,126** **2%**	**1,061** **2%**	**381** **<1%**	**54,640**

Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

Map 5 – CGOM: SASI dominant substrate, data support, and vulnerability outputs (trawl gear). Red outlined cells on the trawl vulnerability panel are LISA clusters.

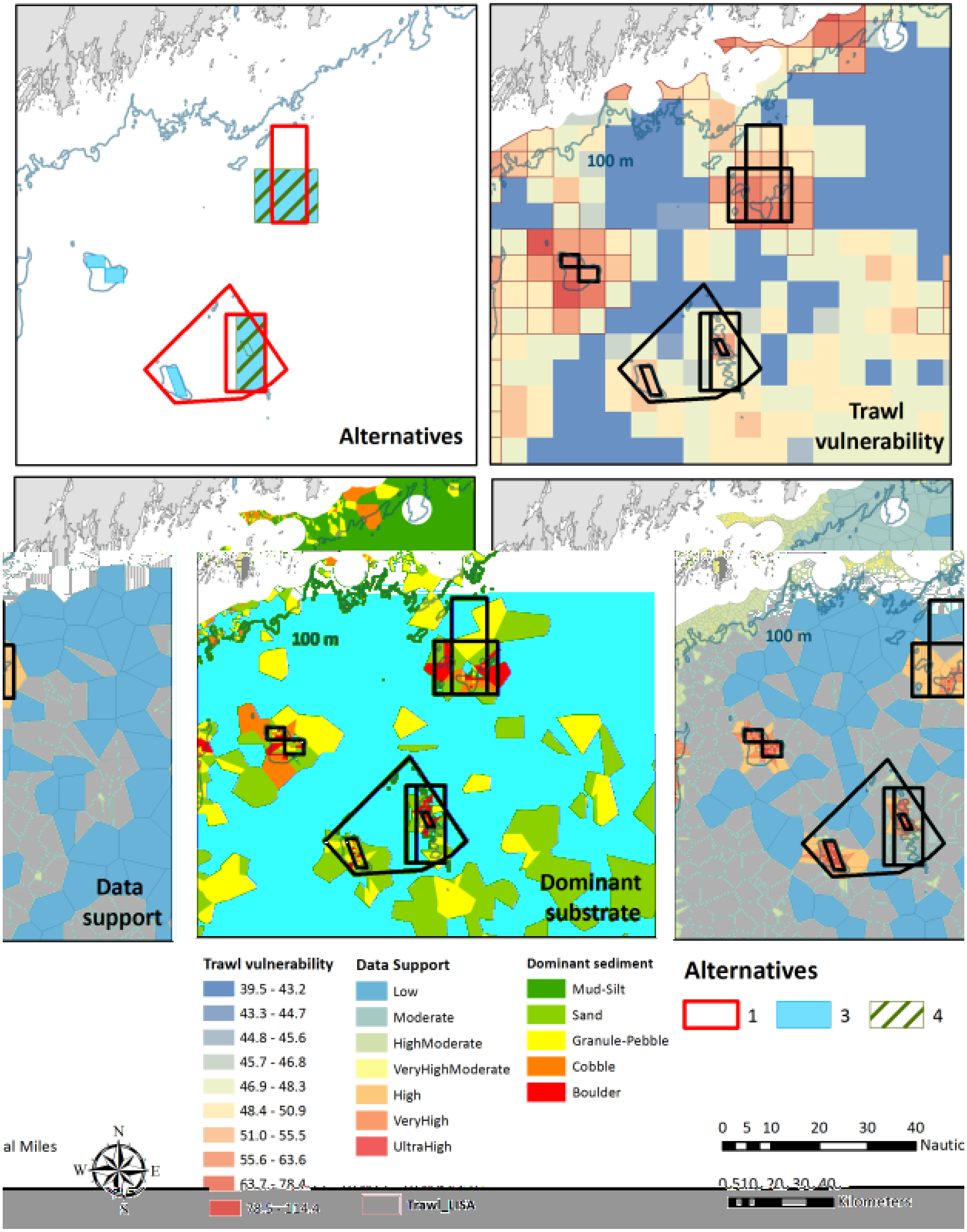


Table 12 – CGOM: minimum and maximum mobile bottom-tending gear vulnerability scores for each management area, and the number of structured (10km x 10km) grids overlapping each area (*N*). Blanks indicate that the scallop dredge model domain did not cover the area, because it was beyond the maximum depth fished by that gear.

	Otter trawl			Scallop dredge			Hydraulic dredge		
	Min	Max	*N*	Min	Max	*N*	Min	Max	*N*
Management area									
Cashes Ledge EFH (#1)	49.7	61.2	*3*	-	-	-	133.5	148.1	*3*
Jeffreys Bank EFH (#1)	47.9	75.3	*8*	-	-	-	134.5	155.3	*7*
Cashes Ledge GF (#1)	42.1	61.2	*15*	-	-	-	132.6	148.1	*7*
Ammen Rock (#3 and 4)	61.2	61.2	*1*	-	-	-	145.2	145.2	*1*
Modified Cashes Ledge EFH (#3 and 4)	49.7	61.2	*3*	-	-	-	133.5	148.1	*3*
Fippennies Ledge (#3)	52.9	52.9	*1*	-	-	-	139.1	139.1	*1*
Modified Jeffreys Bank EFH (#3 and 4)	59.1	75.3	*4*	-	-	-	134.5	140.4	*4*
Platts Bank (#3)	63.0	63.0	*1*	65.2	65.2	*1*	142.0	142.0	*1*
GOM region	**39.6**	**100.4**	***617***	**44.3**	**91.7**	***73***	**108.0**	**159.9**	***174***

Figure 6 – CGOM: Mean vulnerability scores in the habitat management areas for bottom trawl, scallop dredge, and clam dredge gears. Blanks indicate that the scallop dredge model domain did not cover the area, because it was beyond the maximum depth typically fished by that gear. The region-wide means for the Gulf of Maine are 47.5 (otter trawl), 52.7 (scallop dredge), and 136.6 (clam dredge).

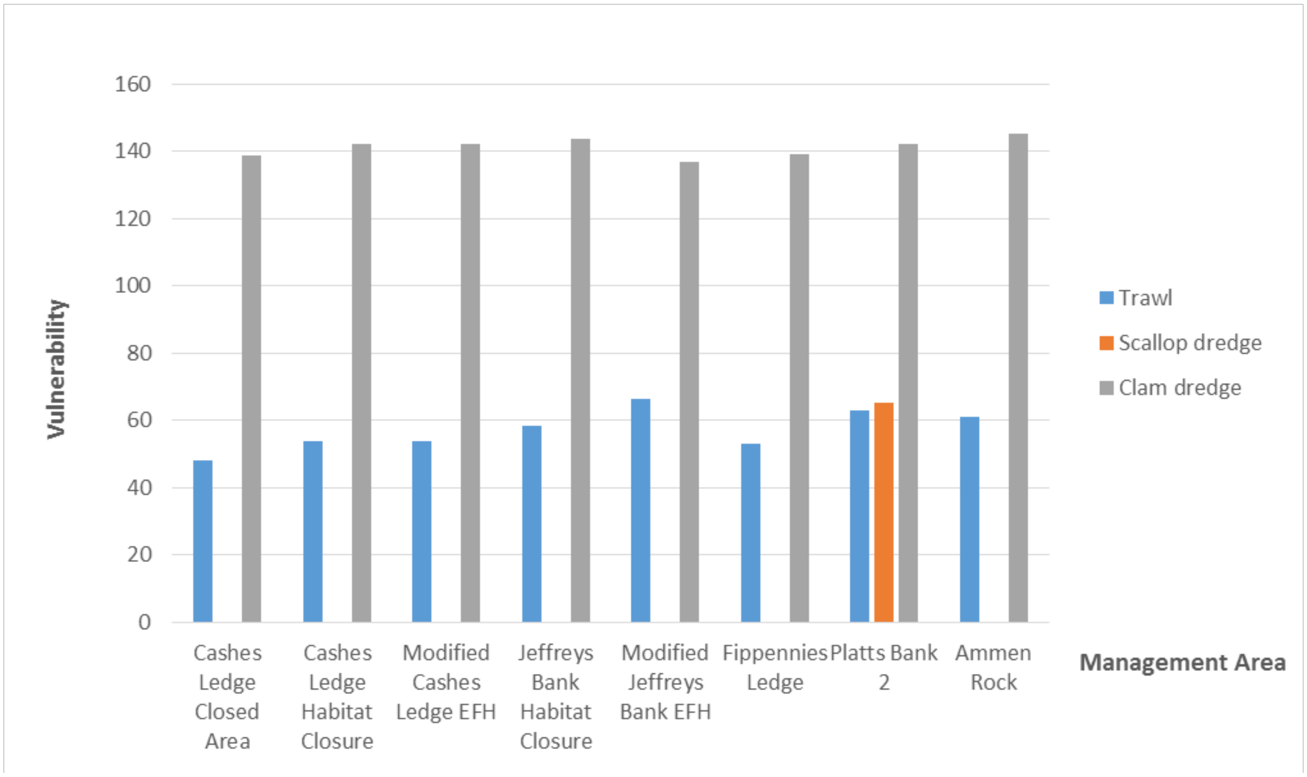


Table 13 – Overlap between Central GOM HMAs and preferred alternative EFH designations. Species and lifestages in bold italicized type are associated with complex substrate. Juveniles shaded grey were positively weighted in the hotspot analysis. Overfished species are indicated with an asterisk (*). After each management area the alternatives it is a part of are listed in parentheses. Scores correspond to full/high=3, moderate=2, slight=1, none=0.

Species and lifestage	Cashes Ledge Closure Area (1)	Cashes Ledge Habitat Closure Area (1)	Cashes Ledge Modified (3, 4)	Ammen Rock HMA (3, 4)	Fippennies Ledge HMA (4)	Platts Bank HMA (4)	Jeffreys Bank Habitat Closure Area (1)	Jeffreys Bank Modified (3, 4)
Acadian redfish juvenile	High	Moderate	Moderate	*None*	Slight	Slight	High	High
Acadian redfish adult	Moderate	Slight	Slight	*None*	*None*	*None*	Moderate	Slight
American plaice juvenile	High	High	High	Moderate	**Full**	**Full**	Moderate	High
American plaice adult	High	High	High	Slight	Moderate	Moderate	**Full**	**Full**
Atlantic cod juvenile*	Slight	Slight	Slight	*None*	**Full**	**Full**	Moderate	Moderate
Atlantic cod adult*	Moderate	High	High	High	**Full**	**Full**	**Full**	**Full**
Atlantic halibut - all stages*	Moderate	Moderate	High	Slight	**Full**	Moderate	Moderate	High
Atlantic wolffish - all stages*	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**
Haddock juvenile	Moderate	High	High	High	**Full**	**Full**	High	High
Haddock adult	Moderate	High	High	Moderate	**Full**	**Full**	**Full**	**Full**
Ocean pout egg*	*None*	*None*	*None*	*None*	*None*	*None*	Slight	Slight
Ocean pout juvenile*	Slight	*None*	*None*	*None*	**Full**	High	Moderate	Moderate

Species and lifestage	Cashes Ledge Closure Area (1)	Cashes Ledge Habitat Closure Area (1)	Cashes Ledge Modified (3, 4)	Ammen Rock HMA (3, 4)	Fippennies Ledge HMA (4)	Platts Bank HMA (4)	Jeffreys Bank Habitat Closure Area (1)	Jeffreys Bank Modified (3, 4)
Ocean pout adult*	Slight	*None*	*None*	*None*	*None*	High	*None*	Slight
Pollock juvenile	Moderate	Moderate	Moderate	Moderate	*None*	High	**Full**	**Full**
Pollock adult	High	High	High	Slight	Slight	Slight	**Full**	**Full**
Red hake egg, larvae, and juvenile	Moderate	Moderate	High	**Full**	**Full**	*None*	**Full**	**Full**
Red hake adult	High	High	High	Moderate	**Full**	**Full**	**Full**	**Full**
Silver hake juvenile	High	High	High	Moderate	**Full**	**Full**	**Full**	**Full**
Silver hake adult	High	High	High	Slight	Moderate	Moderate	**Full**	**Full**
White hake juvenile	High	High	High	High	**Full**	**Full**	**Full**	**Full**
White hake adult	High	Moderate	Moderate	*None*	*None*	Slight	High	High
Windowpane flounder juvenile*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Windowpane flounder adult*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Winter flounder egg*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Winter flounder larvae and adult*	*None*	*None*	*None*	*None*	Slight	*None*	*None*	*None*
Winter flounder juvenile*	*None*	*None*	*None*	*None*	Slight	*None*	*None*	*None*
Witch flounder juvenile*	High	High	High	Slight	Slight	Slight	**Full**	**Full**
Witch flounder adult*	High	High	High	Slight	Slight	Slight	High	High
Yellowtail flounder juvenile*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Yellowtail flounder adult*	Slight	*None*	*None*	*None*	High	High	*None*	Slight
Monkfish juvenile	High	High	High	Moderate	**Full**	Moderate	**Full**	**Full**
Monkfish adult	High	High	High	Slight	**Full**	*None*	**Full**	**Full**
Smooth skate juvenile	High	High	Moderate	*None*	*None*	Slight	High	Moderate
Smooth skate adult	High	High	Moderate	*None*	*None*	Slight	Moderate	Slight
Thorny skate juvenile*	High	High	High	Slight	Moderate	Moderate	**Full**	**Full**
Thorny skate adult*	High	High	High	Slight	Slight	Slight	**Full**	**Full**
Barndoor skate – juv/adu	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Little skate juvenile	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Little skate adult	*None*	*None*	*None*	*None*	*None*	*None*	*None*	Slight
Winter skate juvenile	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Winter skate adult	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Atlantic sea scallop - all	Slight	Moderate	Moderate	**Full**	**Full**	**Full**	Moderate	Moderate
Atlantic herring egg	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Total score (out of 129)	**73**	**71**	**71**	**39**	**61**	**60**	**78**	**80**
Score for s/l asso/w complex substrate (out of 84)	**43**	**43**	**42**	**23**	**36**	**38**	**49**	**49**
Score for juvs positively weighted in hotspot analysis (out of 18)	**12**	**11**	**11**	**8**	**13**	**16**	**16**	**16**
Scores for overfished species (out of 54)	**23**	**21**	**22**	**11**	**25**	**25**	**25**	**28**
Count of species (out of 23)	**17**	**15**	**15**	**14**	**18**	**17**	**16**	**18**
Count of designations (out of 43)	**30**	**27**	**27**	**21**	**26**	**27**	**29**	**32**

Table 14 – Prey types consumed by species with a relatively high degree of overlap with central GOM HMAs. Values represent the percentage of stomach contents, by weight, in the NEMFC food habitats database, 1973-2005. Totals do not equal 100% as some stomach contents could not be identified.

Species	Amphi-pods	Decapod crabs	Decapod shrimp	Bivalves	Poly-chaetes	Echino-derms	Total benthic inverts	Benthic fish	Total Benthic	Total pelagic	Total
Acadian redfish	1	0	45	0	0	0	46	0	46	38	84
American plaice	0	0	3	3	4	70	80	0	80	1	81
Atlantic cod	0	14	5	7	1	1	28	6	34	25	59
Atlantic halibut	0	15	8	0	0	0	23	40	63	21	84
Haddock	13	2	3	2	9	23	52	1	53	4	57
Monkfish	0	0	0	0	0	0	0	19	19	30	49
Pollock	1	0	21	0	0	0	22	9	31	47	78
Red hake	4	7	24	1	2	0	38	2	40	23	63
Silver hake	1	0	15	0	0	0	16	5	21	50	71
Smooth skate	1	7	45	0	1	0	54	2	56	19	75
Thorny skate	1	7	8	0	24	0	40	11	51	16	67
White hake	0	0	8	0	0	0	8	3	11	44	55
Witch flounder	2	0	0	1	71	0	74	0	74	1	75

Table 15 – Average diversity indices within the central Gulf of Maine sub-region habitat management alternatives. Indices exceeding the 75th percentile for each species group across all habitat management areas in all sub-regions are highlighted (red, large mesh; yellow, regulated species; green, all species).

		Cashes Ledge and Jeffreys Bank Habitat Closure Areas (1)	Cashes Ledge Groundfish Closure Area (1)	Modified Cashes HMA, Modfied Jeffreys Bank HMA, Fippennies HMA, Platts HMA, Ammen Rock HMA (3)	Modified Cashes HMA, Modfied Jeffreys Bank HMA, Ammen Rock HMA(4)
Spring	*Tows*	*28*	*18*	*39*	*34*
	Lg mesh groundfish ISI	0.547	0.351	0.523	0.538
	Regulated spp. ISI	0.626	0.437	0.602	0.626
	All spp. SDI	1.454	1.109	1.386	1.446
Summer	*Tows*	*22*	*26*	*10*	*10*
	Lg mesh groundfish ISI	0.532	0.271	0.373	0.373
	Regulated spp. ISI	0.495	0.518	0.474	0.474
	All spp. SDI	1.460	1.538	1.376	1.376
Fall	*Tows*	*24*	*12*	*29*	*26*
	Lg mesh groundfish ISI	0.528	0.220	0.488	0.505
	Regulated spp. ISI	0.594	0.636	0.571	0.586
	All spp. SDI	1.323	1.513	1.252	1.278
Winter	*Tows*	*16*	*7*	*29*	*28*
	Lg mesh groundfish ISI	0.511	0.161	0.546	0.553
	Regulated spp. ISI	0.568	0.167	0.593	0.601
	All spp. SDI	1.281	0.389	1.340	1.361

Map 6 – CGOM weighted fish persistence. Source: TNC.

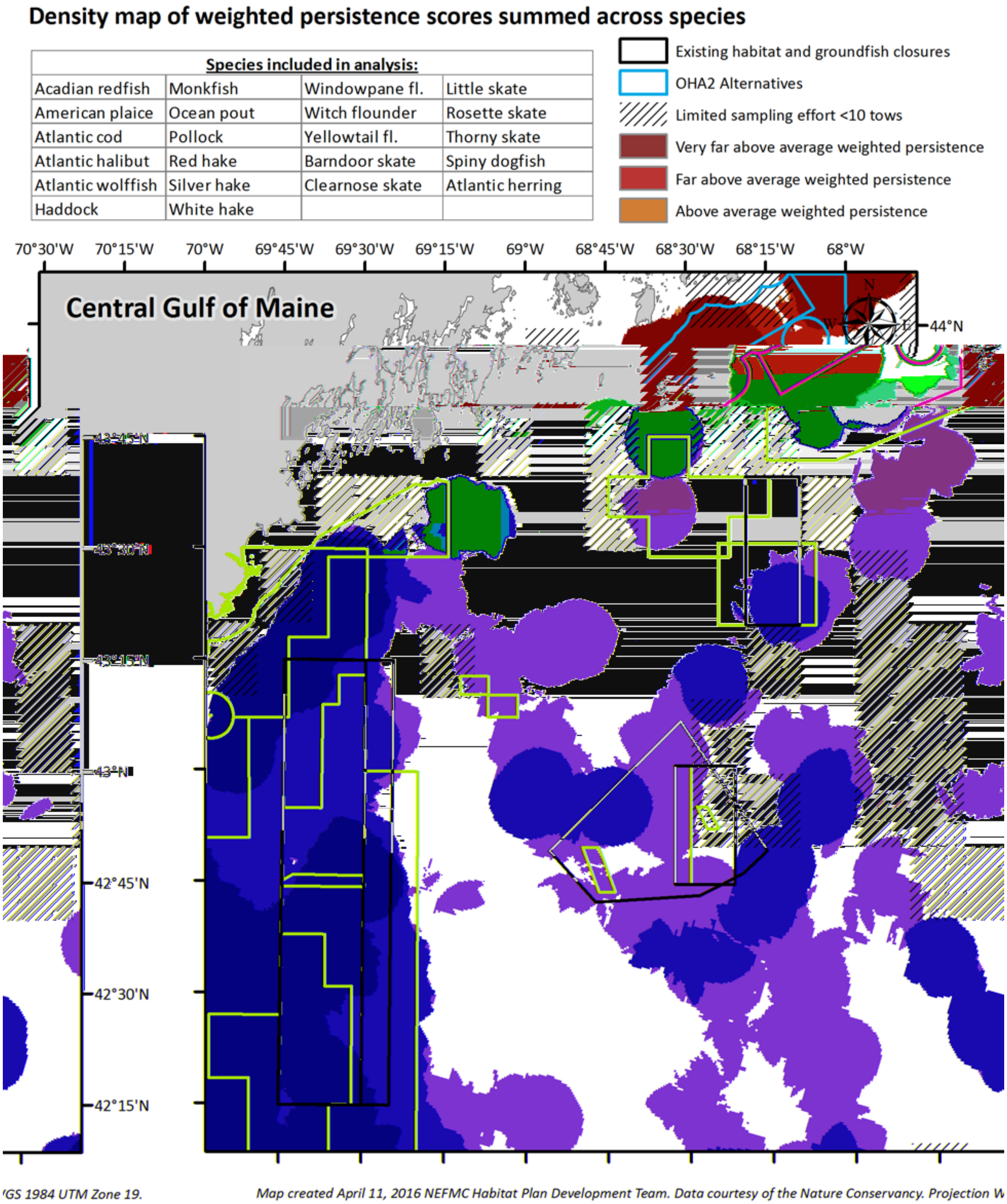
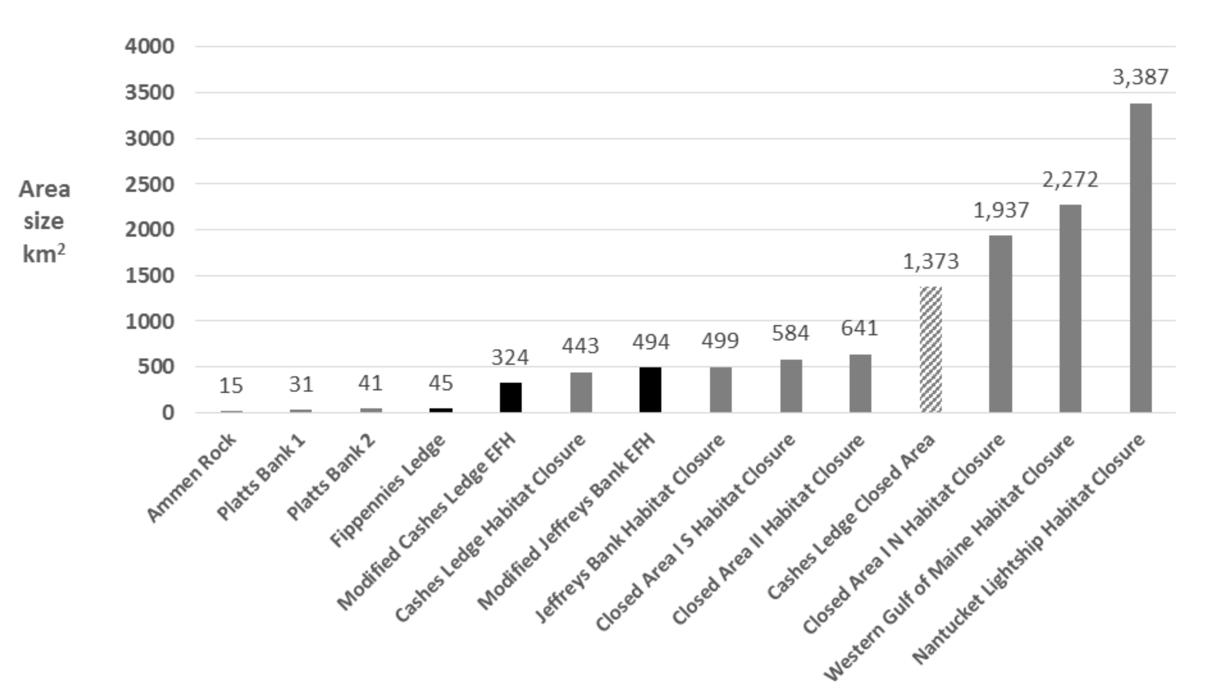


Figure 7 – Size comparison between central GOM HMAs (black bars) and no action habitat closure areas (grey bars). The Cashes Ledge Groundfish Closure Area is also shown (hatched).



3.2.2.1 *Alternative 1 (No Action, Preferred Alternative, Cashes Ledge Closure Area only)*

Alternative 1/No Action includes two habitat closure areas on Cashes Ledge and Jeffreys Bank plus the Cashes Ledge [Groundfish] Closure Area; the groundfish closure combined with most elements of Alternative 3 is the Council's preferred approach in the central Gulf of Maine. Combined, the three No Action areas encompass a mix of shallower hard substrate areas containing granule-pebble, cobble, and boulder-dominated habitats on top of Cashes Ledge, Fippennies Ledge, and Jeffreys Bank, as well as deeper muddy habitats in Cashes Basin (between Cashes and Fippennies Ledges) and north of Jeffreys Bank (Map 5). In the shallow, relatively hard bottomed areas where sampling of all substrate types was possible with video, data support is high, at least relative to other areas in this sub-region (lower right panel of Map 5). However, the deep mud habitats have been sampled at a relatively low rate, and data support is classified as low or moderate (Map 5). Based on general descriptions of the seabed in the Gulf, classification of deeper areas around the shallow ledge and bank features in the Gulf of Maine as predominantly muddy is probably accurate. However, due to low sampling rates outside the shallow areas, the sediment map (see lower left panel of Map 5) may be somewhat misleading, particularly at the margins of shallower features, and depth is probably a better predictor of the dominance of mud vs. gravel substrates along the edges of the shallow features. Specifically, the difference in density of sampling between shallow and immediately adjacent deepwater areas can cause some of the edge grid cells to be very large, thereby overemphasizing the coverage of granule-pebble, cobble, and boulder habitats along the edges of shallow features.

The ledge and bank features included in Alternative 1/No Action areas contain habitat types highly vulnerable to fishing (upper right panel Map 5, Table 12). However, some of the large granule-pebble and boulder grids at the edges of Jeffreys Bank described in the previous paragraph have an influence on the vulnerability results, such that the vulnerability scores for this area are probably biased high, and the size and shape of the highly vulnerable area around Jeffreys Bank is somewhat exaggerated (upper right panel Map 5). The deeper mud habitats around the ledges and banks are estimated to be less vulnerable to fishing gears than the cobble- and boulder-dominated habitats on the banks and ledges (i.e., see the lower vulnerability scores for the Cashes Ledge Groundfish Closure Area (Table 12), which includes a greater proportion of mud than the Cashes Ledge Habitat Closure Area (Table 10). That being said, some of the biological features that occur in deep mud habitats, such as burrowing anemones and sea pens, may have lengthy recovery times.

The most important difference between Alternative 1 and Alternatives 3 and 4 is that Alternative 1 restricts groundfish fishing within Cashes Basin via the Cashes Ledge [Groundfish] Closure Area. Benefits of the Cashes Ledge Closure Area are two-fold. First, the area provides habitat protection for species that typically occupy deeper areas, such as Acadian redfish. In addition, some additional conservation benefits may result from the more expansive gear restrictions associated with the No Action groundfish closure area, which restricts gillnet and bottom longline activity in addition to trawls and scallop dredges. While the fixed gears are expected to have minimal impacts on seabed structures, including attached epifauna, they could be used to remove cod and other groundfish, and it is reasonable to expect that some gillnetting would occur on Cashes Ledge were it to reopen to fixed gear fishing under Alternatives 2, 3, or 4. However, it seems unlikely that effort would return quickly to pre-closure levels under current conditions, given lower levels of groundfishing effort region-wide. Alternatives 1, 3, and 4 overlap a diversity of designated EFH and include notable areas in the species persistence analysis (above average and far above average weighted persistence).

Overall, Alternative 1/No Action reduces the adverse effects of fishing and generates a highly positive impact on seabed habitats because the existing habitat and groundfish areas cover vulnerable seafloor and are currently closed to fishing with mobile bottom tending gears. In addition, groundfish resources are protected from harvest via broader gear restrictions, and the No Action management areas appear to be relatively important to these species, based on the EFH overlap, species diversity, and weighted persistence analyses. Although it is difficult to assess the extent to which they displace the fishing effort to other vulnerable habitats because they have been closed for nearly fifteen years, the ledge and bank features encompassed by these management areas are estimated to be among the most highly vulnerable in the sub-region. Historically, there was a greater magnitude of generic otter trawl fishing effort and adverse effects in the central Gulf of Maine region, including within these areas (see realized adverse effects maps in Volume 1). Although the habitat closure areas are off limits to all mobile-bottom tending gears, sea scallops, and by extension, scallop dredge adverse effects are limited in their distribution in the Central Gulf of Maine given the distribution of the scallop resource. However, existing management areas are likely precluding adverse effects due to what would most likely be periodic scallop dredging on Fippennies Ledge, when resource conditions allow. At present, clam dredging is allowed within the Cashes Ledge Closure Area because the gear does not catch groundfish, and there does not appear to be any activity in or around the closure area, presumably due to lack of clam resource. Therefore, Alternative 1/No Action is most likely not preventing clam dredges from adversely impacting habitats in the central Gulf of Maine.

The preferred management approach in the central Gulf of Maine includes the Cashes Ledge Closure Area, plus elements of Alternative 3, including modified habitat management areas on Jeffreys Bank and Cashes Ledge, additional gear restrictions on Ammen Rock, and a new habitat management area on Fippennies Ledge. Given existing fishing restrictions and the overlaps between the various management areas, the material difference between Alternative 1/No Action and the preferred approach is the new boundary proposed for Jeffreys Bank. The preferred Jeffreys Bank HMA is approximately the same overall size, but is on average shallower and rockier than the existing closure. A comparison between the existing and preferred HMAs will be discussed further in the Alternative 3 section, below. Overall, the preferred approach is expected to have very similar, i.e. highly positive, impacts on seabed habitats, as compared to Alternative 1/No Action.

Alternative 1/No Action is expected to generate positive impacts on seabed habitats relative to Alternative 2 and relative to Alternatives 3 and 4, Options 3 and 4 (see discussion in the following sections). Alternative 1/No Action also has positive impacts relative to Alternatives 3 and 4, Options 1 and 2. While these action alternatives include less area under habitat management, the most vulnerable locations do remain protected under Alternatives 3 and 4.

Because it overlaps the Cashes Ledge HAPC, Alternative 1/No Action provides comprehensive protection for habitats within the HAPC. The entire HAPC is currently managed as a closure to mobile bottom-tending gears, and most of the HAPC, except for the northeast corner, overlaps the groundfish closure, such that gillnets are also restricted.

3.2.2.2 *Alternative 2 (No Habitat Management Areas)*

Under this alternative, there would be no specific protection provided for benthic habitats through limits on the use of mobile bottom-tending gears. If existing management areas in the central Gulf of Maine were removed under this alternative, it is expected that otter trawling and gillnetting would be the primary fishing activities that would resume within the formerly closed areas, since the scallop and clam fisheries are fairly limited in extent in the Central GOM as noted above. Although there was an increase in scallop effort on Platts Bank during 2013 and 2014, there is no habitat management area on Platts Bank at this time, so Alternative 2 would represent status quo fishing restrictions in that location.

Specific locations encompassed by the existing management areas are vulnerable to the effects of fishing, and the Ammen Rock pinnacle on Cashes Ledge is an offshore kelp forest habitat not replicated elsewhere in the Gulf of Maine. In general the existing managed areas are important to various species, based on the EFH overlap, species diversity, and weighted persistence analyses. Thus, Alternative 2 would be expected to increase adverse effects and therefore have negative to highly negative impacts on seafloor habitats relative to Alternative 1/No Action, and relative to the Council's preferred management approach, which combines elements of Alternatives 1 and 3. While the magnitude of potential fishing effort should these areas reopen is difficult to estimate, it is not likely that large amounts of groundfishing activity would flow into the area in the short term, given conditions in the fishery, which mitigates impacts somewhat; i.e. negative vs. highly negative. Alternative 2 would also have negative impacts relative to Alternatives 3 and 4, Options 1 and 2, which maintain protection from mobile bottom-tending gears for large portions of the existing Cashes Ledge and Jeffreys Bank habitat closures. Alternative 2 is also expected to have negative impacts relative to Alternatives 3 and 4 Options 3 and 4. While the impacts of these alternatives are generally uncertain, they would allow all gear types to fish in existing management areas, with the exception of the small Ammen Rock HMA, where all gears except lobster traps would be prohibited.

Alternative 2 eliminates existing habitat and groundfish conservation measures within the Cashes Ledge HAPC such that portions of the HAPC could be subject to adverse fishing impacts, likely with trawl gear, or to removal of groundfish resources with trawl or gillnet gear.

3.2.2.3 *Alternative 3 (Preferred, without Platts Bank HMA)*

The HMAs included in Alternative 3 were designed to encompass areas of vulnerable seabed while allowing fishery access to adjacent habitats. This alternative includes modified versions of the existing Cashes Ledge and Jeffreys Bank Habitat Closure Areas. This alternative also includes new habitat management areas on Ammen Rock (within Cashes Ledge HMA), Fippennies Ledge, and Platts Bank. The larger Cashes Ledge Closure Area is removed under Alternative 3. As a preferred approach, the Council selected this alternative, without the Platts Bank HMA, combined with the Cashes Ledge Closure Area, which is part of Alternative 1/No Action. Under the preferred approach, the habitat management areas would be managed as mobile bottom-tending gear closures, with the exception of Ammen Rock which would be closed to all gears except lobster traps. Cashes Ledge Closure Area restrictions are focused on gears capable of catching groundfish and would not change from the status quo. This section describes the attributes of the Alternative 3 HMAs in order to assess the impacts of Alternative 3 as compared with Alternative 1/No Action, the Council's preferred approach, and other alternatives considered for the central Gulf of Maine. The impacts of Alternative 3 with and without the Platts Bank HMA are discussed.

Because the sampling resolution around these bank and ledge features tends to drop off rapidly moving into deeper water, the extent of gravel habitats on the banks and ledges of the central Gulf of Maine are not well resolved on the sediment map. Knowing these limitations, the Habitat PDT identified 100 meters as the approximate depth at which the shallow gravel habitats transition to soft sediment types. This depth was used to define the modified Cashes Ledge and Jeffreys Bank HMAs. The focus was on delimiting gravel habitats because these were estimated to have the greatest vulnerability to fishing gear impacts. The Platts Bank and Fippennies Ledge HMAs are even more narrowly focused subsets of the gravel habitats shallower than 100 meters, focusing on just the shallowest parts of the features with cobble- and boulder-dominated grids. The Ammen Rock area was drawn using bathymetric data to encompass even shallower depths, with appropriate depths identified using on a survey of benthic macroalgae (kelp), which is the primary habitat featurs on Ammen Rock (McGonigle et al. 2011).

As compared to the existing Cashes Ledge Habitat Closure Area, the subset of the area included in the modified Cashes Ledge HMA contains all of the areas mapped as granule-pebble, cobble, and boulder substrate (Table 10, Map 5). The areas removed along the eastern edge of the modified HMA are mapped as mud and sand habitat. The modified Jeffreys Bank HMA includes some new areas that are not part of the existing closure, and contains additional gravel habitat compared to the current Jeffreys Bank area (Table 10, Map 5).

Generally, the portions of the ledge and bank features included in Alternative 3 have high data support values (Table 11). Specifically, the Ammen Rock, Fippennies Ledge, Modified Jeffreys Bank, and Platts Bank HMAs have 95-100% areal coverage of high data support grids. Data support values are lower for the Modified Cashes Ledge HMA, as the southern part of the ledge was not sampled with video gear. As described under the Alternative 1 discussion, the areal coverage of boulder and granule-pebble substrates (Table 10) is probably biased high on and around Jeffreys Bank due to low sampling rates in deeper areas (note large red and yellow polygons in the lower left panel of Map 5). Nonetheless, based on the bathmetry, it is likely that there is more gravel habitat in the modified Jeffreys Bank HMA as compared to the existing Jeffreys Bank Habitat Closure. Similar uncertainties in the sediment map exist in the area surrounding Platts Bank.

Model-based vulnerability estimates for the existing Cashes Ledge Habitat Closure (Alternative 1) and the Modified Cashes Ledge HMA (Alternatives 3 and 4) are equivalent because the same set of structured SASI grids overlap both areas. Values for the Cashes Ledge habitat areas are intermediate between those for the Cashes Ledge Closure Area and the Jeffreys Bank Habitat Closure Area (existing and modified versions). The large boulder substrate grids within the Jeffreys Bank areas results in somewhat inflated vulnerability scores for these areas, especially the modified area. There is no particular reason to think that seabed vulnerability is substantially different between the modified Cashes and Jeffreys areas, with the exception of the unique and highly vulnerable macroalgal habitats on Ammen Rock.

Given the resolution of the vulnerability maps (100 km^2 grids) compared with the size of the HMAs (Fippennies Ledge is 45 km^2 and the two Platts Bank areas combined are 72 km^2, Figure 7), it is difficult to draw conclusions about the Platts Bank and Fippennies Ledge areas based on the vulnerability results. The spatial extent of vulnerable habitats around Platts Bank is likely overly broad, driven by the large grids on the edges of the bank in the sediment map. Thus, the presence of cobble- and boulder-dominated unstructured grids is a better metric for inferring the presence of vulnerable benthic habitats in these areas. While the areas are fairly small, data support for these areas is very high (scores of 6 and 7 in Table 11), indicating that the habitat types are well sampled, and known to contain a mix of boulder, cobble, granule-pebble, and sand (Table 10).

All of these management areas are considered low energy, with the exception of the shallower portions of Platts Bank and Ammen Rock, which were identified as high energy on the basis of depth. Structure-forming organisms adapted to high energy habitats were estimated to have somewhat shorter recovery times, and therefore slightly lower vulnerability to fishing impacts. That being said, Ammen Rock is a unique feature, being the only offshore kelp habitat in the Gulf of Maine, which is why it was singled out for increased protection via closure to all types of fishing.

Shifting from the existing Cashes Ledge closures and the existing Jeffreys Bank closure in Alternative 1 to the modified areas in this alternative protects a similar range of designated EFH, and species diversity indices for the two alternatives are similar. Both sets of areas include locations identified as notable in the species persistence analysis. The major difference between Alternatives 1 and 3 is that Alternative 3 opens deeper mud-dominated habitats in Cashes Basin to fishing with gear capable fo catching groundfish. In addition, the removal of the groundfish closure would allow fixed gear use on Cashes and Fippennies Ledges. Fixed gear (in this area, gillnet) impacts are not a major concern in terms of effects on the seabed, but trawl impacts in deep mud habitats could generate adverse effects, even though these areas are expected to be less vulnerable than hard-bottom habitat types found on top of the banks and ledges. Deep mud habitats likely have less vertical structure that may be vulnerable to impact, but these areas are low energy and relatively undisturbed by current and wave action, such that recovery of the benthic features that do occur there (e.g. sea pens, burrowing anemones) could take many years. Given that the longevity of these benthic species is poorly understood, recovery timeframes are difficult to estimate. Recovery of these types of species may have occurred under Alternative 1/No Action, and any recovery could be compromised by re-opening Cashes Basin to fishing activity, even if Cashes and Fippennies Ledges remain closed to trawling. This contributes to the conclusion below that Alternative 3 as originally proposed has negative impacts relative to Alternative 1/No Action.

Changing from an existing to a new set of management areas will not directly increase effort in the groundfish fishery or other fisheries, but could displace effort from existing fishing grounds into reopened areas. Section 4.2.2.2 discusses that this is most likely if catch rates for target stocks are higher than catch rates in existing fishing grounds, which does not generally appear to be the case for the habitat management areas in the central Gulf of Maine. While there is scallop resource on Fippennies Ledge that could be targeted with scallop dredges (see Section 6.2.1 of Volume 5), most of the top of the ledge would be closed under this alternative such that scallop fishing opportunities would likely be very limited.

Overall, Alternative 3 as originally proposed is expected to have positive impacts on seabed habitats. Because the HMAs included in Alternative 3 encompass a large fraction of the highly structured, gravel habitats in the central Gulf of Maine sub-region, closing these areas to mobile-bottom tending gears (all gears except lobster traps in the Ammen Rock HMA) would minimize adverse effects on these habitat types. In addition, for Jeffreys Bank, the modified HMA has slightly higher numeric scores in the EFH overlap analysis (Table 13), and better overlap with the ares of above average weighted fish persistence (Map 6). While protection of deep water habitats in Cashes Basin and north of Jeffreys Bank would be eliminated, Platts Bank and additional portions of Jeffreys Bank would be protected with Alternative 3. Despite any positive benefits associated with the modified Jeffreys Bank HMA, given the relatively small size of the Platts Bank HMA, and the larger size and long term protections afforded by the Cashes Ledge Closure Area, on balance, Alternative 3 as originally proposed likely has negative impacts relative to Alternative 1/No Action. Alternative 3 as originally proposed is expected to have positive impacts relative to Alternative 4, because it includes additional habitat protection for Platts Bank and Fippennies Ledge while Alternative 4 does not. As noted above, the preferred approach that combines elements of Alternatives 1 and 3 likely has similar, highly positive impacts to Alternative 1/No Action, and positive impacts relative to Alternative 3 as originally proposed.

Options 1 and 2 are functionally equivalent in this region because there is no hydraulic clam dredging in this part of the Gulf of Maine, despite the fact that the gear is exempted from the Cashes Ledge Closure Area restrictions. Similar to the discussion under Alternative 2, Alternative 3 with Option 3 or 4 would have a negative impacts relative to Alternative 1/No Action because mobile bottom-tending gears would be allowed to operate in previously closed areas vulnerable to fishing, with the exception of Ammen Rock, which would be closed to all gears except lobster traps. Assuming that Ammen Rock is managed as a closure, Alternative 3 with Option 3 or 4 has a slight conservation advantage to Alternative 2 with no closures of any kind, given the unique and highly vulnerable habitats found on Ammen Rock. As discussed in Section 3.1.2.3, the potential for gear modification measures to result in benefits to seabed habitats are highly uncertain, but they are likely very similar to open fishing areas in their impact, and are expected to have a negative impact relative to the current management restrictions in these areas.

Alternative 3, both as originally proposed and as preferred without the Platts Bank HMA, protects the shallower eastern portion of the Cashes Ledge HAPC (73% of the area) from the adverse impacts of mobile bottom-tending gears. This assumes the area is implemented with Option 1, as is preferred, although Option 2 would likely afford similar protections as scallop and clam dredging on Cashes Ledge are unlikely. Alternative 3 with Option 3 or 4 (not preferred) would not exclude mobile bottom-tending gears from the HAPC and thus the area could be subject to the adverse effects of fishing from those gears.

3.2.2.4 *Alternative 4*

Alternative 4 would modify the Cashes Ledge and Jeffreys Bank habitat management areas, and designate the Ammen Rock HMA. The larger Cashes Ledge Groundfish Closure Area would be removed. Similar to Alternative 3, the Alternative 4 areas encompass vulnerable seabed types, but the alternative does not provide any protection for Fippennies Ledge or Platts Bank, or for the deeper basin habitats within the existing Cashes Ledge Groundfish Closure Area. Platts Bank is currently fished, but Fippennies Ledge is closed as part of the Cashes Ledge Groundfish Closure Area. Under Alternative 4, scallop dredging would probably occur on Fippennies Ledge, although the exact number of trips is difficult to predict, and might vary over time as scallop recruitment and therefore biomass in the Gulf of Maine is variable and episodic (see Volume 5, sections 6.1.1 and 6.2.1). Alternative 4 with Option 1 or 2 would have slightly positive impacts overall, and a negative impact relative to Alternative 1/No Action, relative to the Council's preferred approach for the sub-region, and relative to Alternative 3 with Option 1 or 2. Alternative 4 with Option 1 or 2 would have positive impacts relative to Alternative 2, and relative to Alternative 3 or 4 with Option 3 or 4.

Alternative 4 protects the shallower eastern portion of the Cashes Ledge HAPC (73% of the area) from the adverse impacts of mobile bottom-tending gears. This assumes the area is implemented with Option 1, as is preferred, although Option 2 would likely afford similar protections as scallop and clam dredging on Cashes Ledge are unlikely. Alternative 4 with Option 3 or 4 (not preferred) would not exclude mobile bottom-tending gears from the HAPC and thus the area could be subject to the adverse effects of fishing from those gears.

3.2.3 Western Gulf of Maine

There are eight habitat management alternatives for the western Gulf of Maine sub-region: (1) no action Western Gulf of Maine Habitat Closure Area and Western Gulf of Maine Closure Area, (2) no HMAs, (3) Large Stellwagen HMA and Large Bigelow Bight HMA, (4) Small Stellwagen HMA, Jeffreys Ledge HMA and Large Bigelow Bight HMA, (5) Small Stellwagen HMA, Jeffreys Ledge HMA and Small Bigelow Bight HMA, (6) Large Stellwagen HMA, (7A/7B) which would implement roller gear restrictions as a habitat management measure in the existing area (A) or a modified area (B), and could be combined with one of the other alternatives, and (8) which would exempt shrimp trawls from the northwestern corner of the WGOM Habitat Closure Area, if Alternative 1/No Action was selected. For Alternatives 3-6, each management area could be implemented with one of four gear restrictions measures (Option 1, 2, 3, or 4). The preferred approach combines a modified version of Alternative 1, with the Western Gulf of Maine Closure Area boundary shifted west by five degrees, with the existing roller gear restricted area as a habitat measure (Alt. 7A), and the shrimp gear access area in the northwestern corner of the WGOM (Alt. 8).

In this sub-region, the management areas tend to have coarser substrates, higher levels of data support, and higher vulnerability than the Gulf of Maine region as a whole (Table 16, Table 17, Map 7). Many of the management areas overlap Jeffreys Ledge and Stellwagen Bank, and the Large and Small Bigelow Bight HMAs are located inshore just outside state waters where rocky substrates are fairly common. The exception to the habitat areas being relatively rocky and complex seabed types is the shrimp trawl access area in Alternative 8, which is in deeper, generally muddy waters west of Jeffreys Ledge. Northern shrimp are generally caught in mud habitats. Also, the large inshore roller gear restricted area (Alternative 7a) covers a diverse range of habitat types in the western Gulf of Maine due to its size. Additional substrate maps show non-SASI data sources for the Bigelow Bight (Map 8), Stellwagen (Map 9), and Jeffreys Ledge (Map 10) management areas.

Because of the distribution of habitat types in the proposed management areas, their vulnerability indices are generally higher than the regional average (Table 18, Figure 8). However, many of the areas are spatially overlapping, and given the resolution of the vulnerability model outputs (100 km^2 grids), it is hard to use the vulernability scores to discriminate between management areas.

In terms of overlap with preferred EFH designations, relative to the central Gulf of Maine areas, the western Gulf of Maine No Action and alternative habitat management areas overlap with a greater number of species/lifestages, and are comparable in this regard to the eastern Gulf of Maine areas (Table 19). This likely reflects the fact that the sub-region includes both inshore and offshore habitats that cover a wide range of depths. The Bigelow Bight areas, which are furthest inshore, have the highest total scores in the western Gulf of Maine. These higher total scores are due not so much to having more species or designations overlapping the Bigelow Bight areas, but rather due to a higher rate of spatial overlap between the management areas and the EFH desginations (more scores of ‘high’ or ‘full’ overlap).

Across the species that have the highest degree of overlap with the western Gulf of Maine HMAs, i.e. redfish, plaice, cod, halibut, haddock, monkfish, ocean pout, pollock, red hake, silver hake, smooth skate, thorny skate, white hake, winter flounder, winter skate, witch flounder, and yellowtail flouder, a diverse array of benthic prey types are consumed (Table 20). Decapod shrimp constitute over 5% by weight of the diet of ten of these species, decapod crabs are important to seven species, and polychaetes to six species. Amphipods are consumed in large quantities by haddock, winter flouder, winter skate, and yellowtail flounder; haddock, ocean pout, and plaice eat large amounts of echinoderms; and cod, ocean pout, and winter skate eat bivalve mollusks. As shown in the maps prepared for Appendix H, all of these prey types are found in the western Gulf of Maine. However, based on a review of the scientific literature on gear effects, there is little evidence for long-term impacts of fishing on these types of benthic prey (see Appendix H, section 4.0 for details). Further, all of the managed fishes consume multiple prey types. Therefore, substantial positive or negative impacts of the HMAs on the benthic invertebrate prey base in this sub-region appear unlikely to result from this amendment, regardless of which alternative is selected.

There are two HAPCs that overlap the western Gulf of Maine sub-region. The Inshore Juvenile Cod HAPC includes waters to a depth of 20 meters along the coasts of Maine, New Hampshire, Massachussetts, and Rhode Island, and lies inshore of the HMAs proposed in this sub-region. The Jeffreys Ledge/Stellwagen Bank HAPC has the same boundaries as the Western Gulf of Maine Habitat Closure Area (preferred alternative), and overlaps with most of the alternatives for this subregion.

Table 21 shows groundfish diversity, regulated species diversity, and all species diversity for the western Gulf of Maine habitat management alternatives. Alternatives with the highest diversity values (75th percentile of each season) for each diversity index across all alternatives in all sub-regions are shaded (red=groundfish, yellow=regulated species, green=all species). These diversity index values can be compared to the diversity indices for areas in other sub-regions by reviewing the species diversity summary (Section 4.2.3) in Volume 1. Alternatives 3, 4, and 5 that include both the Bigelow Bight HMAs and areas within the Western Gulf of Maine Habitat Closure are notable for their high diversity indices.

The weighted persistence analysis identified notable areas throughout all of the management areas in the western Gulf of Maine sub-region (Map 11). All of the management areas included ‘very far above average persistence/highest diversity’ areas. Only a few inshore locations indicated sparse sampling effort.

The distribution of fishing effort by gear type and resultant expected adverse impacts through 2009 are described and mapped in Volume 1, Section 4.2.2.2. Fishing activity by gear type and fishery through 2012 is also described and mapped in Volume 1, Section 4.3. This volume, Section 4.2, summarizes revenue by gear type within each proposed HMA, through 2014. Relative to the eastern and central Gulf of Maine sub-regions, fishing effort for many gear types is more concentrated in the western Gulf of Maine. Since 1996, and even now, despite declining effort in the groundfishery, the sub-region has been an important center of bottom trawl activity, both inshore and offshore of the Western Gulf of Maine Closure Area.Whiting and shrimp trawl fisheries also occur in the western Gulf of Maine, although the shrimp fishery has been under moratorium in recent years. Dogfish are also harvested with trawls inshore of the Western Gulf of Maine Closure Area.

Scallop dredging the western Gulf of Maine generally occurs west of the Western Gulf of Maine Closure Area, nearshore, and in the southern part of the sub-region, off Cape Cod. Similar to the central Gulf of Maine, activity has varied over time depending on local scallop resource conditions. Clam dredging has not occurred in this sub-region historically, however, Stimpson's surfclam (*Spisula polynyma* or *Mactromeris polynyma*), is known to occur in the Gulf of Maine. Lambert and Goudreau (1996) studied the performance of hydraulic dredges for capturing Stimpson's clams in the Gulf of St. Lawrence and found that the species could be captured with an efficiency of over 90%. Stimpson's clams are currently being harvested with hydraulic dredges in an area previously closed due to PSP (the Northern Temporary PSP Closure Area). The closure, which was lifted in 2015, encompassed much of the Western gulf of Maine, extending north to 43° N and east to 69° W. While currently there is limited activity in this fishery, effort could expand in the future (C. Gilbert, GARFO, personal communication). Stimpson's surfclam is found in medium to coarse, well-sorted, sandy sediments down to a depth of about 100 m. According to industry representatives, clam habitats are in sandy substrates on Stellwagen Bank and west of the bank north and south of Cape Ann in depths less than 100 meters. These locations do not overlap with the various HMAs evaluated for this sub-region.

Fixed gears, including gillnets, longlines, and traps, are all fished in the western Gulf of Maine. The longline fishery targets groundfish, while gillnets are used to harvest groundfish, monkfish, skates, and dogfish. Traps are used to target lobster, and traps represent the largest fraction of revenue from the overlapping Large and Small Bigelow Bight HMAs. Herring are targeted in the sub-region with both mid-water trawls and purse seines. Party/charter recreational fishing is concentrated in the western Gulf of Maine, relative to lower levels of effort in the eastern and central portions of the region.

It is somewhat difficult to use fishing effort as a metric by which to compare the relative benefits of the western Gulf of Maine habitat alternatives because, while many of the management areas are long term closures or a subset of the long term closures, the Large and Small Bigelow Bight are located in heavily fished inshore grounds that currently do not have year round habitat management restrictions. What is clear from the fishing effort data is that, unlike the Eastern and Central Gulf of Maine sub-regions, redistribution of effort from currently open areas in the western Gulf of Maine is of greater importance in terms of estimating the net benefits of these alternatives on seabed habitats and species.

The action alternative HMAs in this sub-region (Alternatives 3-6 and 8) range from 422-1,691 km^2, and are generally within the size range of the seven existing habitat closure areas, which have an average size 1,395 km^2 (Figure 9). The shrimp trawl exemption area is the smallest. The Western Gulf of Maine Habitat Closure Area, which was selected as preferred, is larger than the individual action alternative HMAs (Alternatives 3-6), although the areas that comprise Alternative 4 cover a larger area in combination (3,093 km^2). The roller gear restricted areas described in Alternatives 7A and 7B are larger than any of the areas closed to particular gears, at 11,327 km^2 and 4,147 km^2, respectively.

Table 16 – WGOM: dominant substrate coverage within each management area. Values are provided in square kilometers and as a percentage of the total.

Area name and type	Substrate										Area,
	Low energy					High energy					
(Alternative #)	M	S	G	C	B	M	S	G	C	B	km^2
No action EFH											
Western Gulf of Maine EFH (#1)	742 33%	969 43%	297 13%	27 1%	16 1%	25 1%	110 5%	31 1%	21 1%	17 1%	2,256
No action groundfish											
Western Gulf of Maine GF (#1)	1,145 39%	1,062 36%	477 16%	27 1%	26 1%	25 1%	110 4%	31 1%	21 1%	17 1%	2,941
Habitat management areas											
Large Bigelow Bight (#3, #4)	894 53%	143 8%	214 13%	64 4%	0 -	29 2%	113 7%	163 10%	73 4%	0 -	1,696
Large Stellwagen (#3, #6)	115 10%	830 70%	126 11%	10 1%	2 <1%	0 -	82 7%	16 1%	3 <1%	0 -	1,185
Small Bigelow Bight (#5)	314 56%	43 8%	92 16%	14 3%	0 -	7 1%	42 8%	35 6%	13 2%	0 -	560
Small Stellwagen (#4, #5)	14 2%	442 68%	89 14%	0 -	2 <1%	0 -	82 13%	16 3%	3 <1%	0 -	650
Jeffreys Ledge (#4, #5)	254 36%	188 26%	131 18%	24 3%	14 2%	25 4%	28 4%	14 2%	18 3%	17 2%	714
Inshore Roller Gear Area (#7a)	3,496 42%	2,126 25%	928 11%	85 1%	27 <1%	191 2%	992 12%	409 5%	113 1%	17 <1%	8,384
Alternate Roller Gear Area (#7b)	1,286 31%	1,179 29%	472 11%	88 2%	16 <1%	57 1%	682 17%	212 5%	97 2%	17 <1%	4,107
Shrimp Trawl Exemption Area (#8)	393 89%	0 -	45 10%	3 1%	0 -	0 -	0 -	0 -	0 -	0 -	441
GOM Region	**38,255 66%**	**11,618 20%**	**3,969 7%**	**510, 1%**	**294 1%**	**587 1%**	**1,689 3%**	**861 1%**	**211 <1%**	**41 <1%**	**58,036**

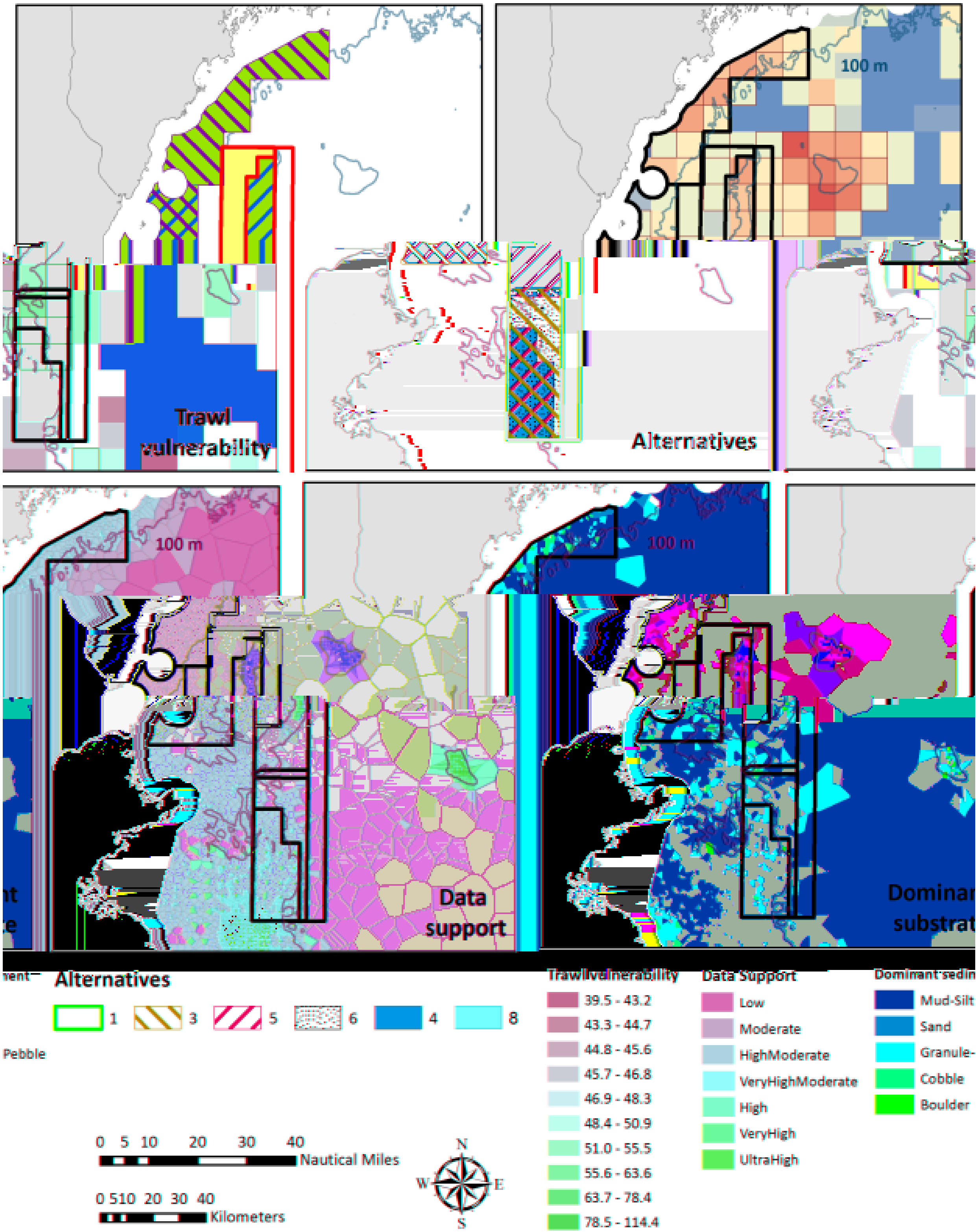
Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

Table 17 – WGOM: data support within each management area. Values are provided in square kilometers and as a percentage of the total.

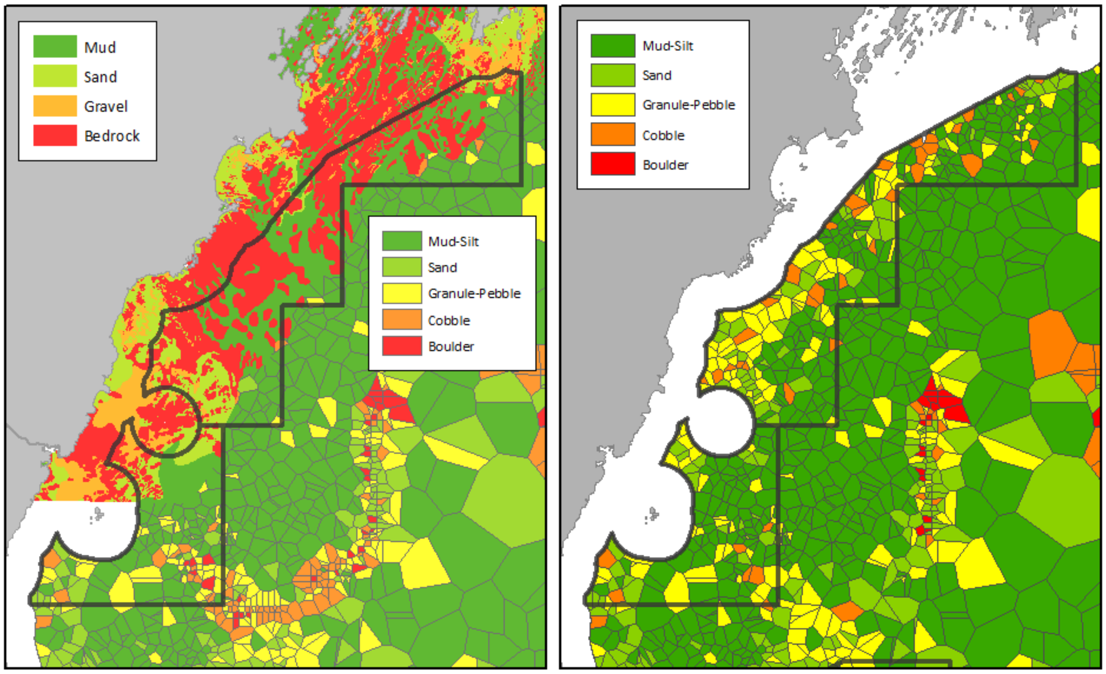
Area name, type, and region (number of overlapping unstructured grids, Alternative #)	Data support							Area, km²
	Low	Moderate			High			
	1	2	3	4	5	6	7	
No action EFH								
Western Gulf of Maine EFH (848, #1)	0	688	1,286	163	0	118	20	2,256
	-	29%	57%	7%	-	5%	1%	
No action groundfish								
Western Gulf of Maine GF (876, #1)	0	1,318	1,312	163	0	127	20	2,941
	-	45%	45%	6%	-	4%	1%	
Habitat management areas								
Large Bigelow Bight (471, #3 and 4)	0	202	1,472	22	0	0	0	1,696
	-	12%	90%	1%	-	-	-	
Large Stellwagen (639, #3 and 6)	0	218	794	156	0	13	4	1,185
	-	18%	67%	13%	-	1%	<1%	
Small Bigelow Bight (146, #5)	0	109	444	7	0	0	0	560
	-	19%	79%	1%	-	-	-	
Small Stellwagen (540, #4 and 5)	0	0	480	152	0	13	4	650
	-	-	74%	23%	-	2%	1%	
Jeffreys Ledge (158, #4 and 5)	0	320	265	8	0	104	17	714
	-	45%	37%	1%	-	15%	2%	
Inshore Roller Gear Area (3480, #7a)	109	2,316	4,871	663	0	285	66	8,384
	1%	28%	58%	8%	-	3%	1%	
Alternate Roller Gear Area (2376, #7b)	0	666	2,721	512	1%	138	60	4,107
	-	16%	66%	12%		3%	6%	
Shrimp Trawl Exemption Area (59, #8)	0	204	238	0	<1%	0	0	441
	-	46%	54%	-		-	-	
GOM Region (5,772)	**21,134**	**26,511**	**7,125**	**698**	**1,126**	**1,061**	**381**	**54,640**
	38%	**45%**	**11%**	**1%**	**2%**	**2%**	**<1%**	

Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

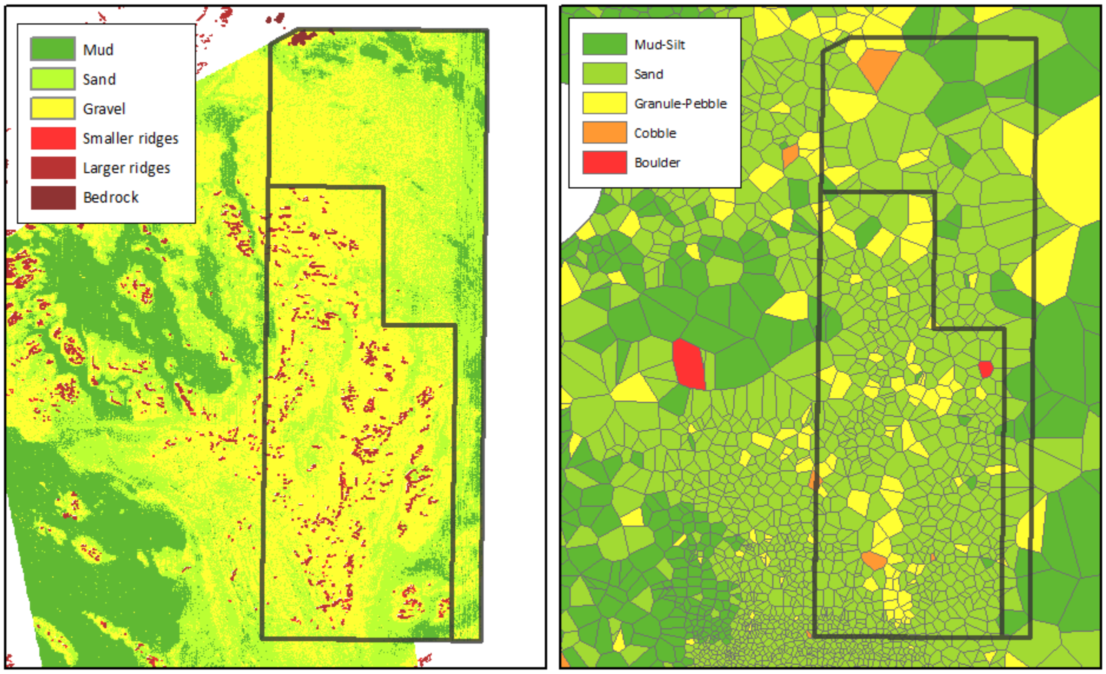
Map 7 – WGOM: SASI dominant substrate, data support, and vulnerability outputs (trawl gear). Alternatives 7a and 7b (roller gear restricted areas) are not shown on these figures. Red outlined cells on the trawl vulnerability panel are LISA clusters.



Map 8 – Bigelow Bight substrate distribution comparison. Left panel – Maine Bottom Type data along coast (legend in upper left) overlaid on updated SASI grid with additional Jeffreys Ledge data (legend at right). Right panel – SASI grid on which vulnerability model runs are based. The Large Bigelow Bight HMA is outlined in grey. The lower part of this area is the Small Bigelow Bight HMA.



Map 9 – Stellwagen substrate distribution comparison. Left panel – multibeam backscatter (mud, sand, and gravel) overlaid with boulder ridges and bedrock outcrops in red. Right panel – SASI grid on which vulnerability model runs are based. The larger outlined area is the Stellwagen Large HMA, and the smaller area to the southwest is the Stellwagen Small HMA.



Map 10 – Jeffreys Ledge substrate distribution comparison. Left panel – updated SASI grid. Data were collected using video and analyzed to match SASI methods. Right panel – SASI grid on which vulnerability model runs are based.

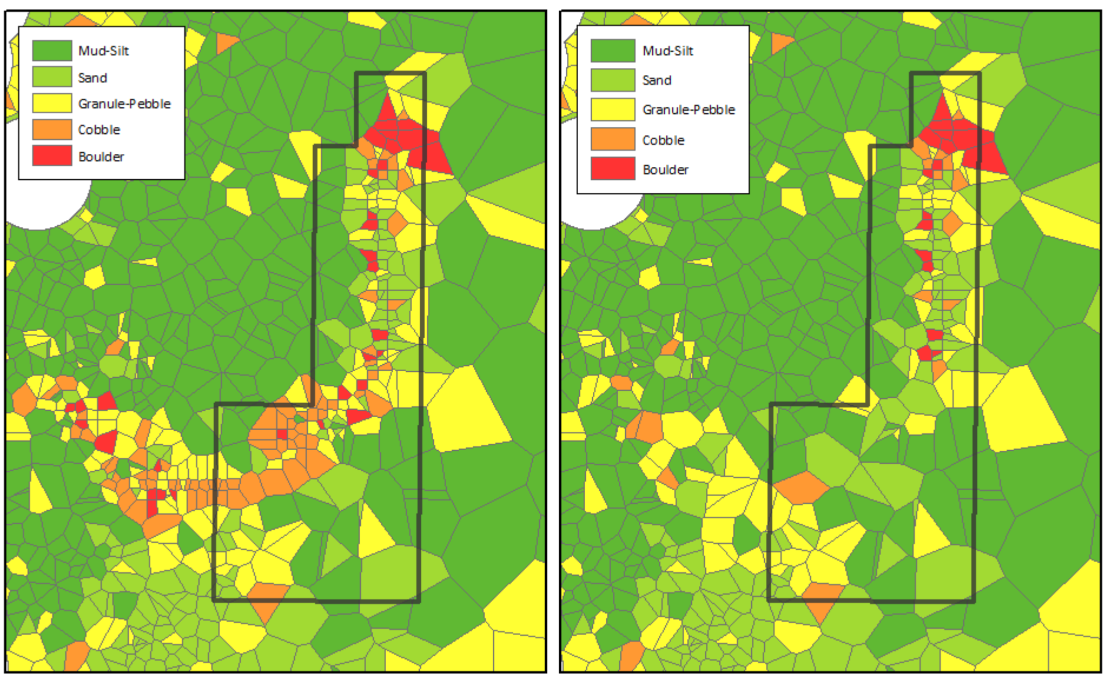


Table 18 – WGOM: minimum and maximum mobile bottom-tending gear vulnerability scores for each habitat management area, and the number of structured (10km x 10km) grids overlapping each area (*N*). Blanks indicate that the scallop or clam dredge model domain did not cover the area, because it was beyond the maximum depth fished by that gear.

	Otter trawl			Scallop dredge			Hydraulic dredge		
	Min	Max	*N*	Min	Max	*N*	Min	Max	*N*
Management area									
Western Gulf of Maine EFH (#1)	46.4	61.6	*22*	49.3	52.7	*3*	120.7	148.5	*18*
Western Gulf of Maine GF (#1)	46.4	61.6	*33*	49.3	52.7	*3*	120.7	148.5	*19*
Large Bigelow Bight (#3 and 4)	43.0	69.1	*27*	44.5	70.3	*18*	110.0	159.9	*27*
Large Stellwagen (#3 and 6)	46.4	55.8	*12*	49.3	52.7	*3*	120.7	140.7	*12*
Small Bigelow Bight (#5)	45.5	57.2	*9*	47.1	55.3	*5*	110.0	154.8	*9*
Small Stellwagen (#4 and 5)	46.4	50.8	*8*	49.3	52.7	*3*	120.7	140.7	*8*
Jeffreys Ledge (#4 and 5)	48.3	61.6	*7*	-	-	-	134.3	148.5	*6*
Inshore Roller Gear Restricted Area (#7a)	42.4	69.1	*100*	44.5	70.3	*48*	108.0	156.9	*83*
Alternate Roller Gear Restricted Area (#7b)	43.0	69.1	*55*	44.5	70.3	*30*	108.0	159.9	*54*
Shrimp Trawl Exemption Area (#8)	46.4	47.9	*3*	-	-	-	-	-	-
GOM region	**39.6**	**100.4**	***617***	**44.3**	**91.7**	***73***	**108.0**	**159.9**	***174***

Figure 8 – WGOM: Mean vulnerability scores for bottom trawl, scallop dredge, and clam dredge gears. Blanks indicate that the scallop and/or hydraulic dredge model domain did not cover the area, because it was beyond the maximum depth typically fished by that gear. The region-wide means for the Gulf of Maine are 47.5 (otter trawl), 52.7 (scallop dredge), and 136.6 (clam dredge).

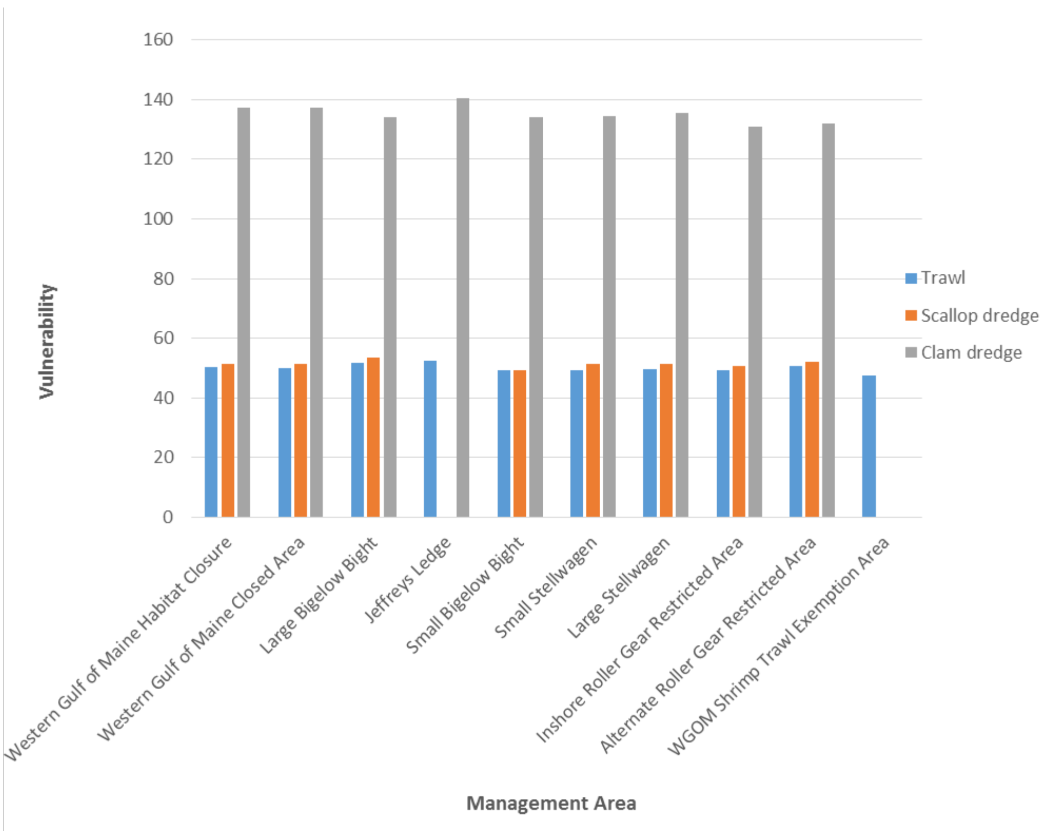


Table 19 – Overlap between western GOM HMAs and preferred alternative EFH designations. Species and lifestages in bold italicized type are associated with complex substrate. Juveniles shaded grey were positively weighted in the hotspot analysis. Overfished species are indicated with an asterisk (*). After each management area the alternatives it is a part of are listed in parentheses. Scores correspond to full/high=3, moderate=2, slight=1, none=0.

Species and lifestage	WGOM Closure Area (1)	WGOM Habitat Closure Area (1)	Jeffreys Ledge HMA (4, 5)	Large Stellwage n HMA (3, 6)	Small Stellwage n HMA (4, 5))	Large Bigelow Bight HMA (3, 4)	Small Bigelow Bight HMA (5)	Shrimp Trawl Access Area (8)
Acadian redfish juvenile	Moderate	Moderate	Moderate	Moderate	Slight	High	High	High
Acadian redfish adult	Moderate	Slight	Slight	Slight	Slight	Moderate	High	Moderate
American plaice juvenile	High	High	High	High	High	High	**Full**	High
American plaice adult	High	High	High	High	High	High	High	**Full**
Atlantic cod juvenile*	Moderate	Moderate	High	High	High	High	High	Slight
[redacted]	Moderate	High	High	High	High	**Full**	**Full**	Moderate
[redacted]	Moderate	Moderate	High	High	High	High	High	Moderate
[redacted]	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**
[redacted]	Moderate	High	High	High	High	High	High	Moderate
[redacted]	Moderate	High	High	High	High	High	High	Moderate
Ocean pout egg*	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	*None*
Ocean pout juvenile*	Moderate	Moderate	Moderate	High	High	Moderate	Moderate	Slight
Ocean pout adult*	Moderate	Moderate	Moderate	High	High	Moderate	High	Slight
Pollock juvenile	High	High	High	High	High	High	**Full**	High
Pollock adult	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	**Full**
Red hake egg, larvae, and juvenile	Moderate	Moderate	High	Slight	Slight	High	**Full**	**Full**
Red hake adult	High	High	High	High	High	High	High	**Full**
Silver hake juvenile	High	High	**Full**	Moderate	Moderate	High	High	**Full**
Silver hake adult	Moderate	Moderate	High	Slight	Slight	High	**Full**	**Full**
White hake juvenile	High	High	**Full**	High	High	High	**Full**	**Full**
White hake adult	Moderate	Moderate	Moderate	Moderate	Slight	High	High	High
Windowpane flounder juvenile*	Slight	Slight	*None*	Slight	Slight	Moderate	Slight	*None*
Windowpane flounder adult*	*None*	*None*	*None*	*None*	*None*	Slight	Slight	*None*
Winter flounder egg*	Slight	Slight	Slight	Slight	Slight	Moderate	Moderate	*None*
Winter flounder larvae and adult*	Slight	Slight	Slight	Slight	Slight	High	High	*None*
Winter flounder juvenile*	Slight	Slight	Slight	Slight	Slight	High	**Full**	*None*
Witch flounder juvenile*	High	High	Moderate	High	Moderate	High	High	**Full**
Witch flounder adult*	Moderate	Moderate	Moderate	Moderate	Slight	High	High	**Full**
Yellowtail flounder juvenile*	Slight	Slight	Slight	Slight	Moderate	High	**Full**	Slight
Yellowtail flounder adult*	Moderate	Moderate	Moderate	Moderate	High	High	**Full**	Slight
Monkfish juvenile	High	High	High	Moderate	Moderate	High	**Full**	**Full**
Monkfish adult	High	High	High	Moderate	Moderate	High	**Full**	High
Smooth skate juvenile	Moderate	Moderate	Moderate	Moderate	Slight	Moderate	High	High
Smooth skate adult	Moderate	Moderate	Moderate	Moderate	Slight	Moderate	Moderate	High
Thorny skate juvenile*	High	High	High	High	High	High	High	High
Thorny skate adult*	Moderate	Moderate	Slight	Moderate	Moderate	Moderate	Moderate	High
Barndoor skate – juv/adu	Slight	Slight	Slight	Slight	Slight	*None*	*None*	*None*
Little skate juvenile	*None*	*None*	*None*	*None*	*None*	Moderate	Slight	*None*
Little skate adult	Slight	Slight	*None*	Slight	Slight	Moderate	Slight	*None*
Winter skate juvenile	Slight	Slight	*None*	Moderate	High	Moderate	Moderate	*None*
Winter skate adult	Slight	Slight	*None*	Slight	Moderate	Slight	Slight	*None*
Atlantic sea scallop - al396 1472								

Species and lifestage	WGOM Closure Area (1)	WGOM Habitat Closure Area (1)	Jeffreys Ledge HMA (4, 5)	Large Stellwagen HMA (3, 6)	Small Stellwagen HMA (4, 5))	Large Bigelow Bight HMA (3, 4)	Small Bigelow Bight HMA (5)	Shrimp Trawl Access Area (8)
Score for juvs positively weighted in hotspot analysis (out of 18)	14	15	16	17	16	17	17	13
Score for overfished species (out of 54)	32	33	32	37	38	46	46	24
Count of species (out of 23)	23	23	20	23	23	23	23	18
Count of designations (out of 43)	41	41	37	41	41	42	42	32

Table 20 – Prey types consumed by species with a relatively high degree of overlap with western GOM HMAs. Values represent the percentage of stomach contents, by weight, in the NEMFC food habitats database, 1973-2005. Totals do not equal 100% as some stomach contents could not be identified.

Species	Amphi-pods	Decapod crabs	Decapod shrimp	Bivalves	Poly-chaetes	Echino-derms	Total benthic inverts	Fish	Total Benthic	Total pelagic	Total
Acadian redfish	1	0	45	0	0	0	46	0	46	38	84
American plaice	0	0	3	3	4	70	80	0	80	1	81
Atlantic cod	0	14	5	7	1	1	28	6	34	25	59
Atlantic halibut	0	15	8	0	0	0	23	40	63	21	84
Haddock	13	2	3	2	9	23	52	1	53	4	57
Monkfish	0	0	0	0	0	0	0	19	19	30	49
Ocean pout	4	12	0	8	3	67	94	0	94	0	94
Pollock	1	0	21	0	0	0	22	9	31	47	78
Red hake	4	7	24	1	2	0	38	2	40	23	63
Silver hake	1	0	15	0	0	0	16	5	21	50	71
Smooth skate	1	7	45	0	1	0	54	2	56	19	75
Thorny skate	1	7	8	0	24	0	40	11	51	16	67
White hake	0	0	8	0	0	0	8	3	11	44	55
Winter flounder	8	0	0	3	40	0	51	0	51	0	51
Winter skate	8	6	3	15	12	0	44	20	64	7	71
Witch flounder	2	0	0	1	71	0	74	0	74	1	75
Yellowtail flounder	25	1	0	3	38	0	69	0	69	0	69

Table 21 – Average diversity indices within the western Gulf of Maine sub-region habitat management alternatives. Indices exceeding the 75th percentile for each species group across all habitat management areas in all sub-regions are highlighted (red, large mesh; yellow, regulated species; green, all species). There are no areas associated with Alternative 2.

		WGOM Habitat Closure (1)	WGOM Groundfish Closure Area (1)	Lg. Bigelow Bight, Lg. Stwg. (3)	Lg. Bigelow Bight, Jeffreys Ledge, Sm. Stwg. (4)	Sm. Bigelow Bight, Jeffreys Ledge, Sm. Stwg.(5)	Lg. Stwg. 6	Shrimp trawl access area (8)
Spring	*Tows*	*109*	*120*	*146*	*140*	*90*	*59*	*18*
	Lg mesh groundfish ISI	0.478	0.475	0.508	0.509	0.521	0.484	0.455
	Regulated spp. ISI	0.522	0.530	0.575	0.578	0.578	0.535	0.436
	All spp. SDI	1.234	1.265	1.363	1.364	1.343	1.261	1.165
Summer	*Tows*	*43*	*64*	*39*	*40*	*29*	*10*	*26*
	Lg mesh groundfish ISI	0.285	0.279	0.448	0.410	0.399	0.508	0.199
	Regulated spp. ISI	0.514	0.539	0.643	0.614	0.607	0.697	0.450
	All spp. SDI	1.346	1.428	1.502	1.480	1.479	1.555	1.254
Fall	*Tows*	*51*	*66*	*56*	*77*	*56*	*17*	*5*
	Lg mesh groundfish ISI	0.451	0.408	0.465	0.470	0.471	0.501	0.298
	Regulated spp. ISI	0.667	0.673	0.613	0.611	0.630	0.729	0.631
	All spp. SDI	1.569	1.581	1.497	1.428	1.460	1.892	1.419
Winter	*Tows*	*44*	*46*	*51*	*59*	*43*	*23*	*0*
	Lg mesh groundfish ISI	0.499	0.499	0.562	0.511	0.466	0.521	n/a
	Regulated spp. ISI	0.537	0.540	0.642	0.594	0.534	0.554	n/a
	All spp. SDI	1.143	1.162	1.416	1.338	1.179	1.143	n/a

Map 11 – WGOM weighted fish persistence. Source: TNC.

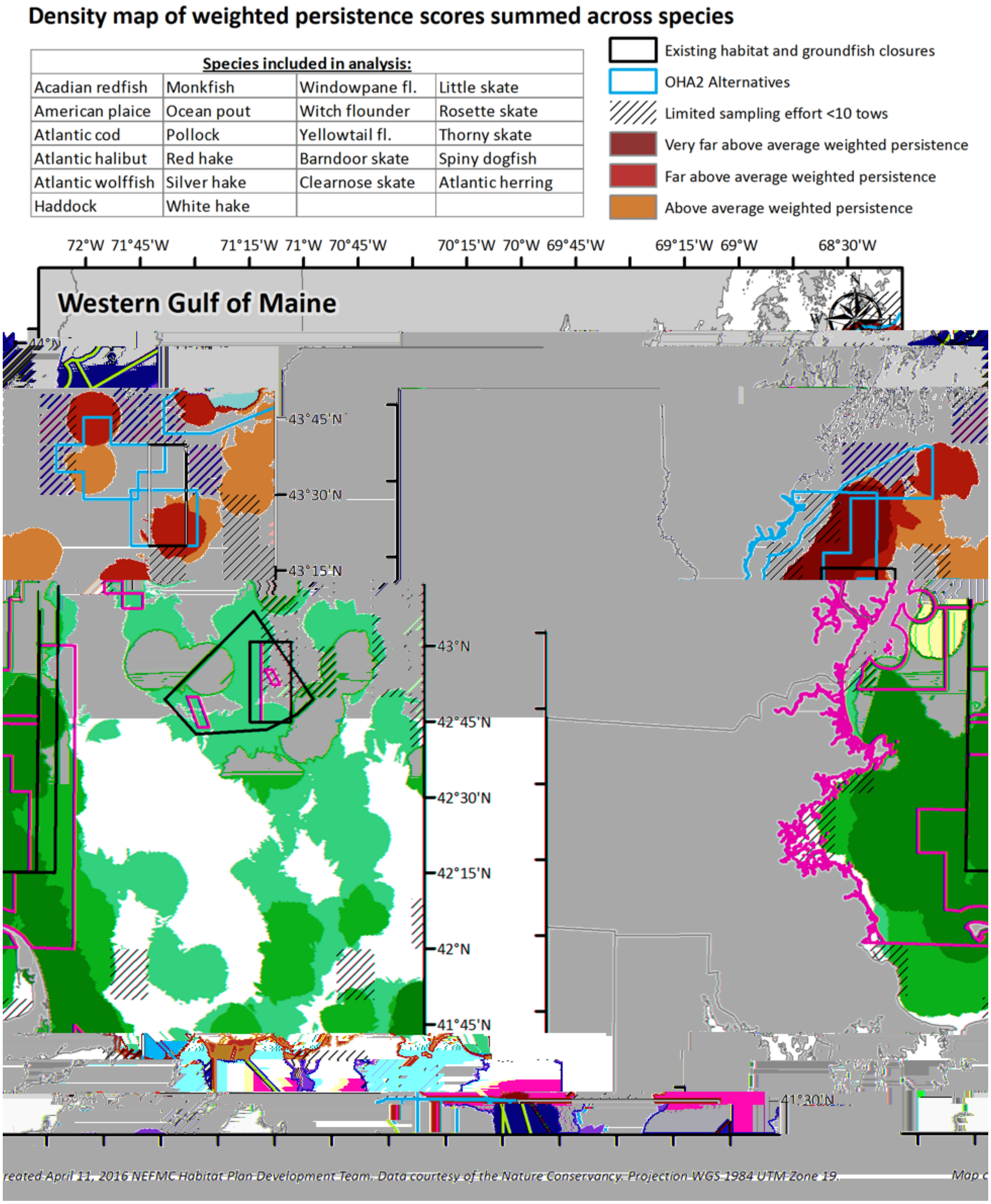
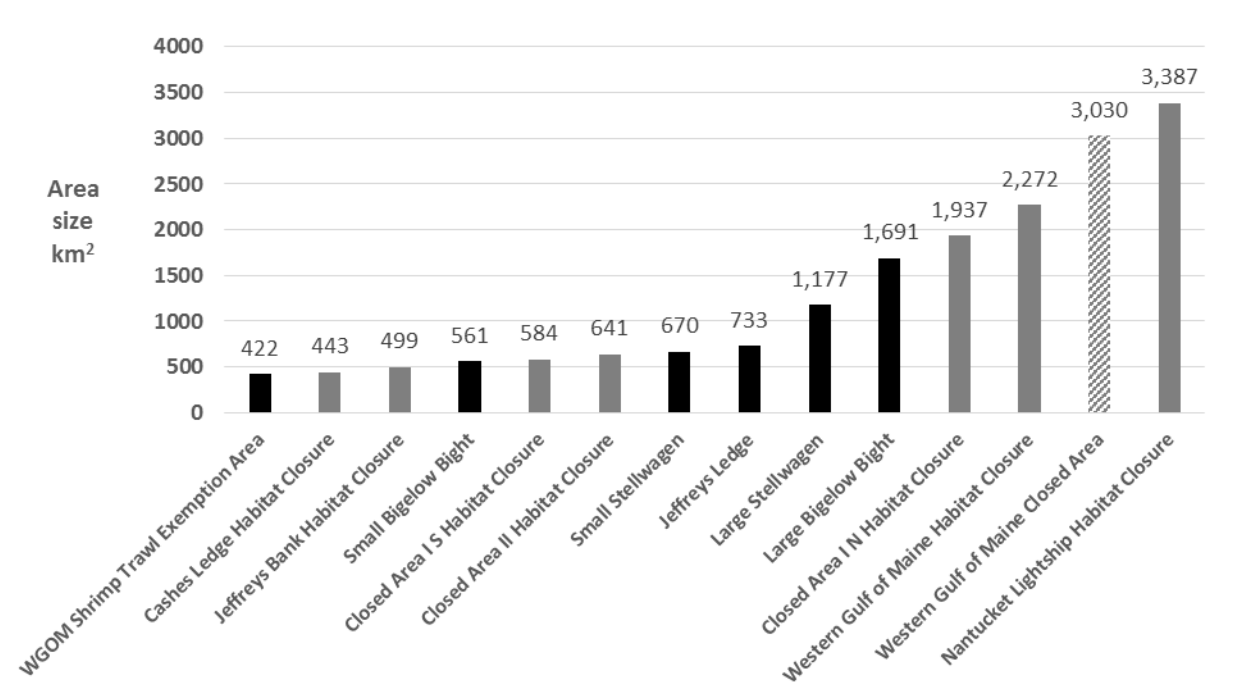


Figure 9 – Size comparison between western GOM HMAs (black bars) and no action habitat closure areas (grey bars). The Western Gulf of Maine Groundfish Closure Area is also shown (hatched).



3.2.3.1 *Alternative 1 (No Action); modified version is the Preferred Alternative)*

Alternative 1/No Action includes the Western Gulf of Maine Closure Area and overlapping Habitat Closure Area. The Habitat Closure Area overlaps the groundfish closure by 75%, and excludes the eastern portion. The Council's preferred alternative maintains both areas, including status quo gear restrictions, but modifies the eastern boundary of the groundfish closure to be coincident with the habitat closure. This section discusses both the No Action alternative and this modified, preferred approach.

The overlapping areas that comprise this alternative encompass the eastern part of Stellwagen Bank and most of Jeffreys Ledge, as well as smaller features including Tillies Bank and Wildcat Knoll. These areas are generally low energy, except for the tops of Stellwagen Bank and Jeffreys Ledge, and include a mix of sediment types, depths, and water masses. According to the SASI substrate map, the dominant substrate types of the habitat closure are mud and sand, with about 14% of the area dominated by granule-pebble, and small fractions of cobble- and boulder-dominated areas (2% each, Table 16, Map 7). Because the eastern sliver of the Western Gulf of Maine Closure Area that does not overlap with the Western Gulf of Maine Habitat Closure Area tends to be deeper muddier, the existing groundfish closure is 40% mud habitat vs. 34% mud habitat for the habitat closure. The preferred alternative removes this part of the groundfish closure, which includes one notable shallow feature, Wildcat Knoll. Data support values are moderate in this region, with only about 9% of the areas mapped with a sampling gear capable of detecting cobble and boulder sediments. Cobble and boulder habitat types are under-represented in these data sets, and sampling on Jeffreys Ledge subsequent to the development of SASI identified additional cobble- and boulder-dominated areas (Map 10). Multibeam data that could not be readily integrated with the SASI grid better resolve the substrate distribution in the southern part of the areas overlapping Stellwagen Bank (Map 9) and in the Bigelow Bight Area (Map 8). Given additional data indicating areas of coarse sediment on Stellwagen Bank (Map 9) and Jeffreys Ledge (Map 10) that are not part of the SASI grid, the habitat closure is likely to be even coarser than the values in Table 16 would indicate.

Vulnerability estimates are moderate to high for these and other management areas in this region relative to other locations not proposed for habitat management (Table 18). Average vulnerability scores for all areas are similar (Figure 8). Due to spatial overlaps between the various management areas in this sub-region, the relatively coarse 100 km^2 resolution of the vulnerability grid, and the overall moderate level of data support in the underlying substrate distribution, it is difficult to distinguish between the various management areas on the basis of vulnerability scores. As in the central Gulf of Maine, substrate distributions serve as a more reliable metric for identifying areas of vulnerable habitat. The Small Stellwagen HMA (Alternatives 4 and 5), Large Stellwagen HMA (Alternatives 3 and 6), and Jeffreys Ledge HMA (Alternatives 4 and 5) cannot be readily distinguished from the No Action areas of which they are subsets on the basis of vulnerability scores. It is likely that vulnerability is underestimated in these areas, given the discrepancy between the multibeam-based map (Stellwagen, Map 9), more recently updated map (Jeffreys, Map 10), and the SASI map (Map 7).

In terms of overlap with designated EFH, the No Action areas and the areas that are subsets of them (Small and Large Stellwagen, Jeffreys Ledge) have lower summary scores than the Large and Small Bigelow Bight areas, which are further inshore (Table 19). This is true for groupings of species associated with coarse substrates, species positively weighted in the hotspot analysis, and species where at least one stock is overfished. The Bigelow Bight HMAs have a higher degree of overlap with juvenile redfish and cod; multiple lifestages of halibut, haddock, red hake, winter flounder, and yellowtail flounder; and adult silver and white hake. Adult pollock EFH has a higher degree of overlap with the No Action areas, however. The higher overlap of certain groundfish with the Bigelow Bight HMAs is also reflected in the higher large mesh groundfish species diversity scores in the spring survey for the alternatives that contain those areas, i.e. Alternatives 3, 4, and 5 (Table 21). Despite these discrepancies between the areas currently under management and the proposed inshore areas that overlap the Bigelow Bight, the species persistence analysis indicates that the entire region considered for management has areas of far above average and very far above average fish persistence (Map 11). This analysis indicates that areas west of approximately 70° W longitude have persistent abundance of many stocks, relative to other portions of the Gulf of Maine, and that any of the Alternatives 1, 3, 4, 5, or 6 would include high persistence areas.

In addition to the high degree of EFH overlap with the No Action and other proposed areas, other important considerations in this sub-region are the total sizes of the areas that would be protected under each alternative, as well as any habitat recovery that has occurred within areas that are currently closed. Alternative 1/No Action covers 3,030 km^2, and Alternative 1 as preferred with the reduction in size of the Western Gulf of Maine Closure area covers 2,272 km^2. Alternatives 3 (2,868 km^2), 4 (3,094 km^2), 5 (1,964 km^2), and 6 (1,177 km^2) cover more or less area relative to the existing and preferred management approaches, depending on the alternative. Ecological changes within the Western Gulf of Maine Closure Area have been studied since it was established in 1998 (see section 3.4.3 for additional details). Tamsett et al. 2010 compared photographs of different habitat types inside and outside the closure taken between 1998 and 2005 to determine whether there were differences in community structure over time and between habitat types. They found that community structure over that time period was dynamic across habitat types, years, and closure status, with changes suggesting that the closure is having significant impacts on invertebrate community structure, but that community structure is dynamic and that recovery is not predictable or successional.

Overall, Alternative 1/No Action has moderately to highly positive impacts on seabed habitats. The Alternative 1/No Action areas include vulnerable seabed types, and overlap with numerous managed species, as reflected in the EFH designations and the species persistence analysis. The fishing restriction measures associated with the existing closures are sufficient for protecting these habitats from the impacts of the most damaging gear types, i.e. mobile bottom-tending gears. In addition, under No Action, fixed bottom tending gears capable of catching groundfish are also excluded because of the groundfish closure. Fixed gears have a much lower magnitude of impact on the seabed, so these restrictions provide a marginal benefit to seabed habitats as compared to the mobile bottom-tending gear restrictions associated with the habitat closure area. However, similar to the overlapping habitat and groundfish closures on Cashes Ledge, limiting groundfish removals with commercial fixed gear may provide ecological benefits. Alternative 1/No Action would not lead to shifts in fishing effort as it maintains existing area closures and fishing restrictions.

As preferred, the eastern portion of the Western Gulf of Maine Closure Area would be removed and the area would be subject to groundfish trawling. Because this area is not currently part of the Western Gulf of Maine Habitat Closure Area, hydraulic clam dredging and shrimp trawling with a properly configured fish excluder grate are already allowed, but fishing with either gear type is unlikely, given that clams tend to occur in sandy substrates and the fact that northern shrimp occur further inshore during the winter shrimp fishing season. Scallop dredges would also be allowed to fish in the eastern sliver under the preferred alternative, but the area east of Jeffreys Ledge and Stellwagen Bank is in general relatively deep and muddy, and while scallops have been caught during trawl survey tows in the area, catches are infrequent and small in magnitude. The most likely outcome of the preferred alternative is an influx of groundfish trawling into the area from adjacent fishing grounds east of the current closure, as observed hauls are concentrated along the existing closure area boundary. While the overall magnitude of effort in the groundfishery is unlikely to increase, fishing with trawls would likely be redistributed into the reopened portion of the closure to target deeper water species such as pollock. These deeper mud habitats are likely less vulnerable to impact than nearby structured habitats on Jeffreys Ledge or Stellwagen Bank. Overall, the preferred alternative likely has moderately positive impacts on habitat, with slightly fewer positive benefits than the No Action areas as currently configured.

Alternative 1/No Action has positive impacts on seabed habitats relative to Alternative 2, and relative to Alternatives 3-6, Options 3 and 4. These alternatives will be discussed further in subsequent sections. Alternative 1/No Action also has positive impacts relative to Alternative 6, Options 1 and 2. While Alternative 6/Large Stellwagen would still function effectively as a habitat closure, and includes a diversity of habitat types and managed species, it is much smaller than either Alternative 1/No Action or the Alternative 1 as preferred. It is more difficult to compare Alternative 1/No Action or Alternative 1 as preferred to Alternatives 3, 4, and 5 with Option 1 or 2. Alternatives 3, 4, and 5 include the Bigelow Bight HMAs, which have a greater degree of overlap with designated EFH. Alternative 4 covers a larger area than Alternative 1/No Action, and Alternatives 3 and 4 cover a larger area than Alternative 1 as preferred. Under Alternatives 3, 4, and 5, many areas where habitat recovery has occurred since implementation of the Western Gulf of Maine Closure would remain off limits to mobile bottom-tending gears, particularly alternatives 4 and 5 which protect both Stellwagen Bank and Jeffreys Ledge. Therefore, based on area size, protection of recovering habitats, overlap with EFH for managed resources, benefits associated with more extensive restrictions on groundfish gears, and the potential for effort shifts (Table 22), Alternative 1/No Action likely has negative impacts relative to Alternative 4, neutral impacts relative to Alternative 3, and positive impacts relative to Alternative 5. Alternative 1 as preferred likely has negative impacts relative to Alternative 4, negative to neutral impacts compared to Alternative 3, given loss of protection on Jeffreys ledge, and neutral impacts relative to Alternative 5. Alternatives 7 and 8 are analyzed as add-on alternatives only, so they are not directly comparable to Alternatives 1-6.

Table 22 – Comparison of key metrics across a subset of western Gulf of Maine habitat management alternatives with similar net impacts.

Alternative	**1 (No Action)**	**1 (As preferred)**	**3 (Lg. BB, Lg. Stellwagen)**	**4 (Lg. BB, Sm. SW, JL)**	**5 (Sm. BB, Sm. SW, JL)**
Size	3,030 km^2	2,272 km^2	2,868 km^2	3,094 km^2	1,964 km^2
Protects gravel habitats within existing closure	Yes	Yes, except for Wildcat Knoll	Partially, overlapping Stellwagen only	Yes, both Stellwagen and Jeffreys Ledge	Yes, both Stellwagen and Jeffreys Ledge
Overlap with designated EFH	Good	Good	Better	Better	Better
Excludes commercial gears capable of catching groundfish	Yes	Yes	No, only mobile bottom-tending gears	No, only mobile bottom-tending gears	No, only mobile bottom-tending gears

Alternative	1 (No Action)	1 (As preferred)	3 (Lg. BB, Lg. Stellwagen)	4 (Lg. BB, Sm. SW, JL)	5 (Sm. BB, Sm. SW, JL)
Fishing effort shifts	No	Minor, into eastern sliver	Possibly substantial; fixed gears into existing closures, mobile gears out of Lg. Bigelow Bight	Possibly substantial; fixed gears into existing closures, mobile gears out of Lg. Bigelow Bight	Possibly substantial, although less than Alternatives 3 and 4; fixed gears into existing closures, mobile gears out of Lg. Bigelow Bight

Both Alternative 1/No Action and Alternative 1 as preferred protect the habitats and species occurring in the Jeffreys Ledge/Stellwagen Bank HAPC. Neither alternative overlaps the Inshore Juvenile Cod HAPC.

3.2.3.2 *Alternative 2 (No Habitat Management Areas)*

Under this alternative, there would be no specific protection provided for benthic habitats through limits on the use of mobile bottom-tending gears. Under this alternative, there would be no specific protection provided for benthic habitats through limits on the use of mobile bottom-tending gears. Habitats within the Western Gulf of Maine Closure Area that are vulnerable to adverse effects would be fished by mobile bottom-tending gears for the first time since 1998 when the closure was enacted. If existing management areas in the western Gulf of Maine were removed under this alternative, it is expected that otter trawling and gillnetting would be the primary fishing activities within the formerly closed areas, although there could be some clam and scallop dredging in shallower sand/gravel habitats on Stellwagen Bank. Specific locations encompassed by the existing management areas are vulnerable to the effects of fishing, and the existing managed areas are important to various species, based on the EFH overlap, species diversity, and weighted persistence analyses. Thus, Alternative 2 would be expected to increase adverse effects and therefore have negative to highly negative impacts on seafloor habitats relative to Alternative 1/No Action, and relative to the Council's preferred management approach (modified version of Alternative 1). Given the relative proximity to shore compared to the existing central Gulf of Maine areas, it is likely that if reopened there could be a fairly substantial flow of fishing activity into the area in the short term. Alternative 2 would have a highly negative impact overall, relative to Alternative 1/No Action, relative to Alternative 1 as preferred, and relative to Alternatives 3-6, Options 1 and 2, on seabed habitats. Alternative 2 would have neutral impacts relative to Alternatives 3-6 with gear modification Options 3 and 4.

Alternative 2 eliminates existing habitat and groundfish conservation measures within the Jeffreys Ledge/Stellwagen Bank HAPC such that the HAPC could be subject to adverse fishing impacts from mobile bottom-tending gears, or to removal of groundfish resources with trawls or gillnets.

3.2.3.3 *Alternative 3*

Alternative 3 includes the Large Bigelow Bight and Large Stellwagen HMAs. Both of these areas include seabed types that are vulnerable to fishing relative to the region as a whole (Table 18). The distribution of rocky substrates including bedrock, boulder ridges, and cobble-dominated areas is more clearly identified in extra-SASI data sources (Map 8 and Map 9). In general, the SASI substrate grid under-represents gravel substrates in the coastal Gulf of Maine. Higher vulnerability scores relative to the regional average may have resulted if these additional data sets had been incorporated into the model.

It is difficult to estimate the net benefits of shifting habitat closures. There is an obvious tradeoff to be considered between maintaining the existing protection of benthic habitats on Jeffreys Ledge vs. opening Jeffreys to mobile bottom-tending gear and substituting new protections in the Bigelow Bight area. In combination, the Alternative 3 HMAs cover 2,868 km^2, which is similar to Alternative 1/No Action (3,030 km^2) and larger than Alternative 1 as preferred (2,272 km^2).The Alternative 3 HMAs combined have a high degree of overlap with designated EFH. The Large Bigelow Bight HMA in particular scores very well in terms of overlap with designated EFH and species diversity metrics. This relatively inshore area appears to overlap better with the distribution of young (age-0 and age-1) groundfish than the existing closures. The Alternative 3 HMAs cover an area nearly as large as Alternative 1/No Action, and larger than Alternative 1 as preferred.

The Large Bigelow Bight area is currently open to mobile-bottom tending gear fishing, and there are currently relatively high levels of fishing activity in the area. Thus, if Option 1 or 2 is selected for the Bigelow Bight HMA, this effort would be displaced and there would be highly positive impacts on seabed habitats within the HMA. However, it is possible that mobile bottom-tending gear effort currently occurring in the Large Bigelow Bight HMA would move up or down the coast onto other habitats used by juvenile groundfish and other species and lifestages, as well as onto Jeffreys Ledge, where some habitat recovery has already occurred. In addition, this alternative would allow commercial fixed gear use (likely gillnets) within the area that is now the Western Gulf of Maine Closure Area.

Combining the EFH attributes of Alternative 3 with the potential for effort displacement onto recovered habitats on Jeffreys Ledge, and considering the total area covered by each alternative, Alternative 3 with Option 1 or 2 likely has neutral impacts relative to Alternative 1/No Action (i.e. positive to highly positive impacts overall), and neutral to positive impacts relative to Alternative 1 as preferred, which covers a smaller area. Alternative 3 with Option 1 or 2 likely has negative impacts relative to Alternative 4 with Option 1 or 2, because Alternative 4 includes the conservation benefits of the Large Bigelow Bight HMA, but avoids concerns over compromising habitat recovery that has occurred on Jeffreys Ledge, because Jeffreys Ledge would continue as a habitat management area closed to mobile bottom-tending gear. Although Alternative 5 protects similar locations to Alternative 4, Alternative 3 would have positive impacts relative to Alternative 5 because the Alternative 5 areas combined are approximately 900 km^2 smaller, which represents a substantial reduction from the 2,868 km^2 that would be protected via Alternative 3. Alternative 3 would have positive impacts relative to Alternative 6 provided the same management Options are selected, because it include additional areas not protected by Alternative 6. If Option 1 or 2 is selected, Alternative 3 would have positive impacts relative to Alternative 2.

If Option 3 or 4 is selected, Alternative 3 would have negative impacts relative to Alternative 1/No Action, and relative to Alternative 1 as preferred. Alternative 3 with Option 3 or 4 would have negative impacts relative to other action alternative with Options 1 or 2, and would likely have neutral impacts compared to Alternative 2.

Alternative 3 would afford protection for approximately half of the Jeffreys Ledge/Stellwagen Bank HAPC.

3.2.3.4 *Alternative 4*

Alternative 4 includes the Large Bigelow Bight, Small Stellwagen, and Jeffreys Ledge HMAs. The Large Bigelow Bight area is discussed above. The Small Stellwagen and Jeffreys Ledge HMAs were each selected to efficiently encompass vulnerable seabed while allowing access to deeper water habitats between Stellwagen Bank and Jeffreys Ledge and on the eastern side of the Western Gulf of Maine Closure Area. Similar to the Bigelow Bight and Stellwagen HMAs, vulnerability of the Jeffreys Ledge HMA is probably underestimated, based on the discrepancy between the updated SASI grid and the grid used in modeling (Map 10). Because these two areas cover the majority of vulnerable seabed areas in the existing Western Gulf of Maine Habitat Closure Area, redefining these areas into the Small Stellwagen and Jeffreys Ledge HMAs probably has neutral impacts to the seabed relative to the current Western Gulf of Maine Habitat Closure Area, assuming they remain closed to mobile bottom-tending gears (Option 1 or 2). The addition of habitat management measures in the Large Bigelow Bight Area would result in positive habitat impacts of this alternative overall relative to Alternative 1/No Action, if Option 1 or 2 is selected. Alternative 4 would also have positive impacts relative to Alternative 1 as preferred. If Options 3 or 4 are selected for all three areas, highly negative impacts are expected relative to Alternative 1/No Action, because less protection would be afforded to currently closed areas and no particular improvement in habitat functional value in the Bigelow Bight HMA is expected to result from the gear modification options.

Alternative 4 would likely have positive impacts relative to Alternatives 3 and 5, and positive impacts relative to Alternative 6. Alternative 4 would also have a positive impact relative to Alternative 2 if Options 1 or 2 are selected, and a neutral impact relative to Alternative 2 if Options 3 or 4 are selected.

Alternative 4 would afford protection for the majority of the Jeffreys/Ledge Stellwagen Bank HAPC from the adverse effects of mobile bottom-tending gears.

3.2.3.5 *Alternative 5*

Alternative 5 includes the Small Bigelow Bight, Small Stellwagen, and Jeffreys Ledge HMAs. The Small Bigelow Bight HMA is not as well mapped as the larger area because the Maine Bottom Type coverage does not overlap the area very well, and SASI data support is moderate. However, the area definitely contains complex and vulnerable substrate types closer to the coast/state waters boundary, and on Old Scantum, in the southeastern corner (Map 8). However, the Alternative 5 areas in combination are smaller than Alternative 1/No Action by approximately 1000 km^2, which reduces the benefits expected from the alternative. Overall, habitat impacts would likely be moderately positive, negative relative to Alternative 1/No Action if all areas are managed as mobile bottom-tending gear closures (Option 1 or 2), and more highly negative relative to Alternative 1/No Action if Option 3 or 4 is selected. Alternative 5 with Option 1 or 2 would likely have neutral impacts relative to Alternative 1 as preferred, because the areas are only slightly smaller, and the Small Bigelow Bight HMA is expected to benefit a variety of species. While there would be effort displacement associated with the closure of the Small Bigelow Bight HMA, this effort would not be displaced onto recovering habitats on Jeffreys Ledge or Stellwagen Bank.

Alternative 5 would likely have negative impacts relative to Alternative 4, neutral to positive impacts relative to Alternative 3, and positive impacts relative to Alternative 6, provided the same management options are selected. Alternative 5 would have a positive impact relative to Alternative 2 if Options 1 or 2 are selected, and a neutral impact if Options 3 or 4 are selected.

Alternative 4 would afford protection for the majority of the Jeffreys/Ledge Stellwagen Bank HAPC from the adverse effects of mobile bottom-tending gears.

3.2.3.6 *Alternative 6*

Alternative 6 includes the Large Stellwagen HMA only. Given the attributes of the Large Stellwagen HMA, protecting this area as a mobile bottom-tending gear closure would have positive impacts on the habitats within the HMA. However, because this alternative removes habitat protections on Jeffreys Ledge, and does not add any protections in the Bigelow Bight region, the alternative is expected to have slightly positive impacts; negative impacts on habitat relative to Alternative 1/No Action, and relative to Alternative 1 as preferred. Alternative 6 would also have negative impacts relative to Alternative 3, Alternative 4, or Alternative 5 if comparable management options are selected. Alternative 6 would have a positive impact relative to Alternative 2 if Option 1 or 2 is selected, and a neutral impact of Option 3 or 4 is selected.

Alternative 3 would afford protection for approximately half of the Jeffreys Ledge/Stellwagen Bank HAPC.

3.2.3.7 *Alternatives 7A and 7B (7A preferred)*

This alternative would designate the existing inshore roller gear restriction as a habitat management measure (7A), or implement this restriction in an alternate area as a habitat management measure (7B). In theory, limiting roller size to 12 inches is expected to limit the seabed types in which bottom trawl vessels can fish to areas dominated by smaller substrates and less complex attached biota, and thus this type of restriction can be viewed as a habitat conservation measure.

Unfortunately given the spatial resolution of seabed data and fishing effort data, it is challenging to evaluate conclusively whether or not limiting roller size to 12 inches has affected the distribution of fishing effort with respect to habitat type. The multi-beam backscatter and boulder ridge data in the vicinity of Stellwagen Bank is of sufficient resolution for comparison with observed hauls, but there is not a comparable substrate distribution data set outside the Inshore

Roller Gear Restricted Area. Nonetheless, patterns of trawl effort can be examined relative to these data (Map 12). Tow paths shown use the start and end locations as reported in the observer database with locations between these points taken from VMS data. It appears that trawls avoid boulder ridge areas. Given the lack of high resolution substrate data to compare outside the roller gear area, it isn't clear that the roller size limit itself is responsible for this avoidance, although it is a possible contributing factor. It could be that these same spatial patterns (i.e., avoidance of the most complex seabed habitats) would be observed even in areas where roller size is not restricted.

Given the caveats above, assuming that the roller gear size limit does contribute to habitat conservation, Alternative 7A (current roller gear area footprint) would improve habitat protection slightly relative to the existing conditions because the requirement would apply to all bottom trawl vessels. Currently, the inshore roller gear restriction only applies to Northeast Multispecies vessels, and not to vessels fishing under other permits (for example, shrimp trawl vessels). The increase in habitat conservation would likely be small in magnitude, because many shrimp trawl vessels already use roller gear sizes of 12 inches or less (Figure 10). Alternative 7B would probably have neutral impacts to slightly positive impacts when combined with the No Action roller gear area as it is currently implemented. The Alternative 7B area covers additional areas of complex seabed in the Bigelow Bight region, and might be expected to improve habitat conservation in this location. Alternative 7B would apply to all trawl vessels, including shrimp vessels, and the additional area covered by Option B as compared to Option A is a relatively important fishing area for the shrimp trawl fishery. Other types of bottom trawls would also need to use 12 inch rollers in this location. Simply trading off this area for other locations not covered by the Option B areas might have neutral impacts, but given that the current roller gear restriction would continue, Option B should have slightly positive impacts for habitat protection.

Map 12 – Observed bottom fish trawl (NEGEAR 50) effort 2010-2014 (semi-transparent blue lines) overlaid on substrate type (light grey to darker grey indictes mud-sand-gravel, while reds indicate boulder ridges and bedrock). Blue-green outline indicates the roller gear restricted area and black outline indicates the WGOM Closure Area boundaries where bottom trawling is prohibited.

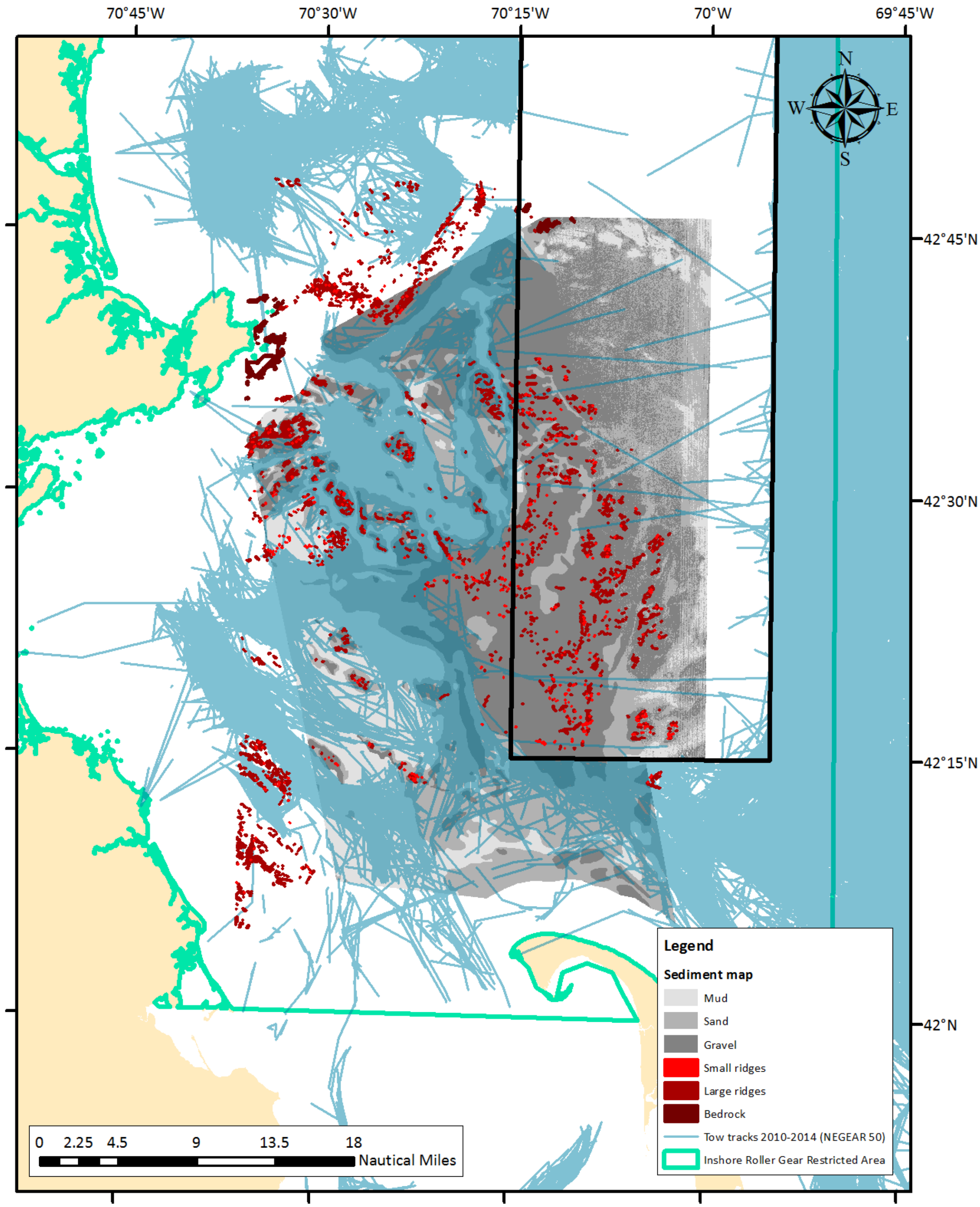
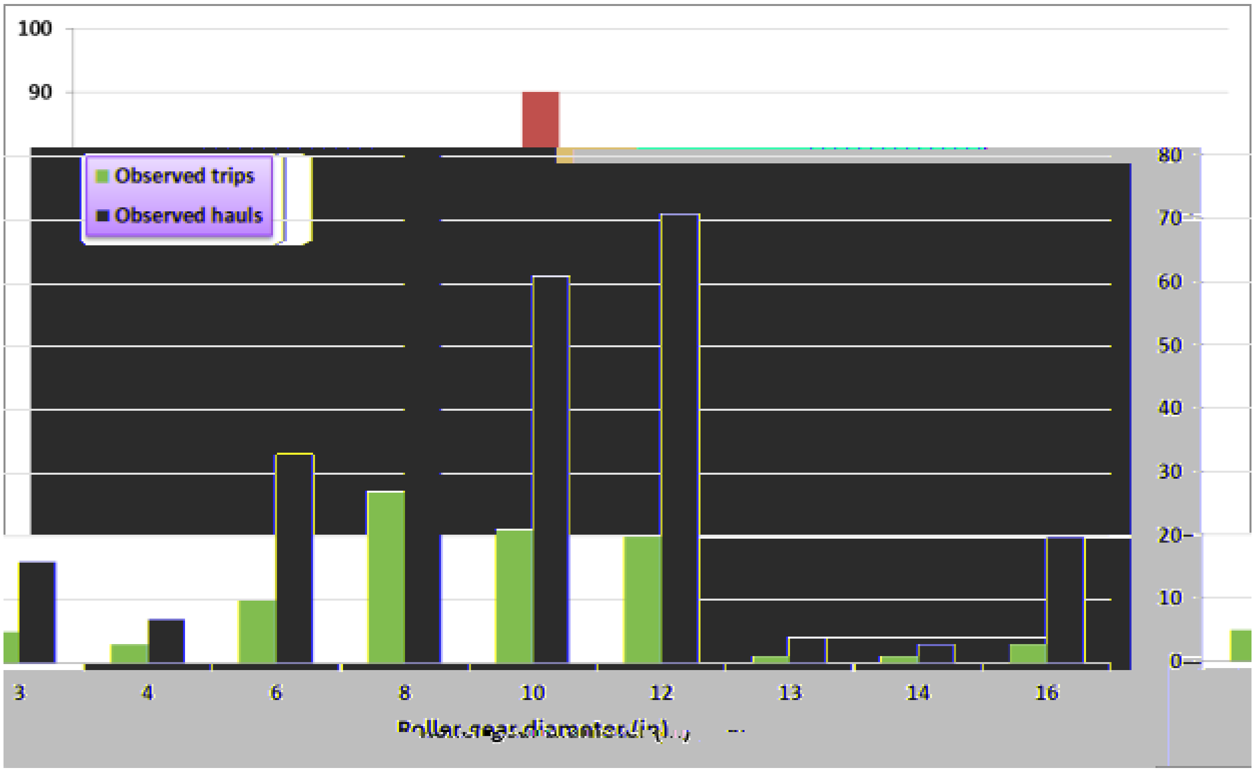


Figure 10 – Number of observed trips and hauls during 2008-2013 on vessels using shrimp trawls within the Inshore Roller Gear Restricted Area. Five percent of trips and nine percent of observed hauls used a roller size greater than 12 inches.



3.2.3.8 *Alternative 8 (Preferred)*

Alternative 8 would exempt shrimp trawl vessels from the northwestern part of the Western Gulf of Maine Habitat Closure Area, and only makes sense as an add-on to Alternative 1/No Action because Alternatives 2-6 eliminate the exemption area entirely. This alternative probably does not have a negative impact on the positive conservation benefits of Alternative 1 (i.e. the alternative has neutral impacts) for two reasons. First, the exemption area contains soft sediments, which are somewhat less vulnerable to fishing than the more complex seabed types on the adjacent banks and ledges. A study of shrimp trawling impacts in moderate depths in the Gulf of Maine indicated that there were short-term (less than three months) alterations to the macrofaunal community, but no long-term (longer than one year) impacts were identified (Simpson and Watling 2006). Second, shrimp trawling does not generally occur this far offshore. The shrimp are further inshore when the shrimp season begins in December, gradually moving offshore as the season progresses. Given the status of the shrimp stock, shrimp fishing seasons have been fairly short in recent years (there was no season in 2014 or 2015), so significant fishing effort within this area has not occurred in the recent past, and is unlikely to occur in the near future.

3.2.4 Georges Bank

The habitat management alternatives for the Georges Bank sub-region include various combinations of 19 areas (Table 23). For Alternatives 3-10, the fishing restriction options available for each area are listed below. Some areas could be managed as closures to all mobile bottom-tending gears (Option 1), some could be managed as closures to bottom trawls and scallop dredges but allow hydraulic clam dredges (Option 2), and some are proposed as gear modification areas only (Options 3 and 4). Alternative 10, which is preferred, also includes a seasonal closure for scallop dredges in Closed Area II north of 41° 30' N.

Table 23 – Habitat management alternatives for the Georges Bank sub-region. MBTG denotes a closure to mobile bottom-tending gears, with a possible exemption for hydraulic dredges.

Alternative	Areas	Possible fishing restrictions
1 (No Action)	Closed Area II Habitat Closure Area, Closed Area I N Habitat Closure Area, Closed Area I S Habitat Closure Area, Closed Area II, Closed Area I	Current measures; habitat areas closed to mobile bottom-tending gear; groundfish closures have exemptions for scallop dredging in two access areas, exemptions for trawling in northernmost triangle of Closed Area II and Closed Area II south of 41° 30' N
2	None	No habitat-related fishing restrictions
3	Northern Edge HMA	Options 1-4
4	Northern Edge HMA and Georges Shoal Gear Modified Area 1	NE: Options 1-4, GS1: Options 3-4
5	Georges Shoal 1 MBTG HMA and Northern Georges Gear Modified Area	GS: Options 1-2, NG: Options 3-4
6A	EFH Expanded 1 HMA	Options 1-4
6B	EFH Expanded 2 HMA	Options 1-4
7	Georges Shoal 2 MBTG HMA and EFH South MBTG HMA	Options 1-2
8	Northern Georges MBTG HMA	Options 1-2
9	Mortality Closure, Eastern and Western MBTG HMA	Eastern and Western Areas - Options 1-2; mortality closure managed like CAII.
10	Northern Edge MBTG HMA, Northern Edge Reduced Impact HMA, Georges Shoal 2 MBTG HMA	Northern Edge MBTG HMA and Georges Shoal 2 MBTG HMA - Options 1-2. Reduced Impact HMA closed to hydraulic dredges, most trawling; scallop dredging allowed rotationally.

Because the Georges Bank and Great South Channel/Southern New England sub-regions have been heavily sampled with video survey, benthic habitats are well-characterized relative to the Gulf of Maine sub-regions. Available data products include dominant substrate (Table 24, Map 13, Map 14), largest grain size (Map 15), sediment coarseness (Map 16), sediment heterogeneity (Map 17), and sediment stability (Map 19), which is based on sediment type combined with benthic boundary shear stress (Map 18), and sediment composition. Georges Bank is mostly dominated by sand and considered smooth, with coarse, granule-pebble and cobble-dominated areas along the northern part of the bank (Map 14, Map 16). Mud habitats are rare. Most of the bank contains mixed sediments, except for the shallow center of the bank, which is sandy with few gravels (Map 17). In general, the bank is highly dynamic (Map 18), with fast flowing currents that render fine-grained sand habitats unstable (Map 19). Coarse sediments are considered stable despite high flow (Harris et al. 2012).

While the resolution of the unstructured grid does influence vulnerability scores in this sub-region (this is further discussed below), all of the areas in this region are relatively well sampled in terms of their substrate type, especially relative to some areas in the Gulf of Maine (Table 25). In the worst case, only 11% of the Closed Area I North Habitat Closure was sampled with gears not capable of detecting cobble and boulder substrates. In other candidate HMAs on Georges Bank, the percentage drops to 3-5%. Thus, there is high certainty that the habitat types described for each area do occur there, and that the substrate maps are identifying geologic features with relative accuracy. Despite certainty about the occurrence of particular sediment types, sampling resolution is somewhat lower in the center of the bank (Map 13, data support panel), and these differences in resolution make it challenging to directly compare both vulnerability and coverage of particular substrate types between areas of different sampling resolution. Notably, this area of lower resolution sampling overlaps the Georges Shoal 2 HMA, which is part of the preferred Alternative 10, as well as Alternative 7.There is a small cluster of higher vulnerability habitat east of Closed Area I, but for the most part higher vulnerability habitats tend to occur along the northern margin of the bank where coarse sediment types are more abundant (Map 13). With the exception of the Closed Area II Habitat Closure Area, the No Action areas tend to be lower vulnerability (Figure 11).

Closed Area II and its associated habitat closure (Alternative 1/No Action) have good correspondence with EFH for cod, haddock, red hake, windowpane flounder, winter flounder, yellowtail flounder, barndoor skate, little skate, and winter skate. In general, these same species also have substantial overlap with Closed Area I and its habitat closures (also included in Alternative 1/No Action), particularly the central and southern part of Closed Area I and the southern habitat closure. In Closed Area I, the northern habitat closure tends to overlap with a different and smaller set of species, since much of it is off the edge of the bank in deeper waters. This northern area has high overlap with pollock, silver hake, white hake, monkfish, smooth skate, and thorny skate. Some of these species are more common in the Gulf of Maine than on Georges Bank.

The action alternative areas are concentrated on the northern half of the bank and many of them are spatially overlapping, so there are many similarities in terms of the EFH designations they encompass. Generally juvenile and adult cod EFH is well-represented, with high or full juvenile EFH coverage in the eastern areas (Northern Edge, EFH Expanded 1 and 2, EFH South, the eastern and mortality closure areas of Alternative 9) and slight or moderate coverage in those further west on Georges Shoals (Georges Shoal gear modification area, Georges Shoal MBTG 1 and 2). The eastern areas also have better coverage for juvenile and adult haddock EFH and adult ocean pout EFH. Windowpane flounder, winter flounder, and yellowtail flounder EFH designations tend to be well represented in the management areas as well, as are little and winter skate. The western area of Alternative 9 has good coverage of Atlantic cod EFH for both juveniles and adults, but only moderate coverage for haddock juveniles and adults and adult ocean pout. In general, the Alternative 9 area has slightly better EFH coverage across all benthic species and lifestages listed below as compared to the Georges Shoal 2 MBTG closure in Alternative 7. Comparing the EFH South HMA in Alternative 7 and the Eastern HMA in

Alternative 9, the two are very similar, which makes sense because of their degree of spatial overlap. The two mobile bottom-tending gear closures on Georges Shoal (Alternative 5 and 7) overlap the fewest number of species (13 out of 23) and designations (22 and 19 out of 43) of any of the Georges Bank areas. All Georges Bank areas have substantial overlap with wolffish, herring, and scallop EFH, noting the caveats associated with these fairly general designations.

Because both the Northern Georges gear modification area (Alternative 5) and mobile-bottom tending gear closure (Alternative 8) are very large and overlap a greater range of seabed types and depths relative to other management areas, their overlap with designated EFH is somewhat patchier, consisting of areas of lower and higher importance for various species, which translates into lower total scores of 70 and 71 as compared to the areas that focus more closely on gravel habitats within a narrower depth range. Although these areas are much larger, they only encompass a slightly higher diversity of species and number of designations as compared to many of the smaller areas. Nonetheless, because of its size and geographic scope, Alternative 8 has the best overall coverage of benthic EFH designations of any of the alternatives, with the exception of Alternative 1/No Action, which in aggregate covers all 23 species/43 designations, but is larger and broader in its geographic scope.

Because Alternatives 7, 9, and 10 include two and three areas each, it is worth discussing how these areas in combination cover the benthic EFH designations. Combined, the Alternative 7 areas, Georges Shoal 2 and EFH South, do not have any coverage for seven out of 23 species and 18 out of 43 designations. Most of these species, including Acadian redfish, American place, witch flounder, monkfish, smooth skate, and thorny skate, have limited EFH within any of the action alternative areas, and only have moderate or high EFH coverage in the northern part of Closed Area I, which contains deeper water than any other areas and has a somewhat different mix of species overall. The Alternative 7 areas include no pollock EFH, and this species' juvenile and adult designations are represented in various other Georges Bank HMAs. The three areas in Alternative 9, in combination, perform slightly better than Alternative 7 in terms of coverage of benthic EFH designations across various species and lifestages. Much of this can be attributed to the mortality closure element of Alternative 9, which includes deeper water areas along the edge of the bank. In combination, Alternative 9 includes EFH for all benthic species except monkfish and American plaice, and compares favorably with Alternative 8 (Northern Georges HMA) in terms of EFH designations encompassed. The two eastern areas in Alternatives 9 and 10 have the same overall footprint, and there is generally less overlap between the Georges Shoal 2 HMA in Alternative 10 and designated EFH, compared to the Western HMA in Alternative 9. Thus, Alternative 10 performs better than Alternative 7 but worse than Alternatives 1, 8, and 9 in terms of overlap with designated EFH.

Across the species that have the highest degree of overlap with the Georges Bank HMAs, i.e. cod, halibut, barndoor skate, haddock, little skate, monkfish, ocean pout, pollock, red hake, silver hake, smooth skate, thorny skate, white hake, windowpane flounder, winter flounder, winter skate, and yellowtail flouder, a diverse array of benthic prey types are consumed (Table 28). Decapod shrimp constitute over 5% by weight of the diet of nine of these species, decapod crabs are important to ten species, and polychaetes to six species. Amphipods are consumed in large quantities by haddock, little skate, windowpane, winter flouder, winter skate, and yellowtail flounder; haddock and ocean pout eat large amounts of echinoderms; and cod, little skate, ocean pout, and winter skate eat bivalve mollusks. As shown in the maps prepared for Appendix H, all of these prey types are found on Georges Bank. However, based on a review of the scientific literature on gear effects, there is little evidence for long-term impacts of fishing on these types of benthic prey (see Appendix H, section 4.0 for details). Further, all of the managed fishes consume multiple prey types. Therefore, substantial positive or negative impacts of the HMAs on the benthic invertebrate prey base in this sub-region appear unlikely to result from this amendment, regardless of which alternative is selected.

There is one HAPC in this sub-region. The No Action Northern Edge juvenile cod HAPC, which is a preferred alternative, has the same boundaries as the existing Closed Area II Habitat Closure Area, and overlaps many of the other HMAs proposed, to varying degrees.

Table 29 shows groundfish diversity, regulated species diversity, and all species diversity for the Georges Bank habitat management alternatives, excepting Alternatives 9 and 10, which were not updated for the FEIS. Alternatives with the highest diversity values (75^{th} percentile of each season) for each diversity index across all alternatives in all sub-regions are shaded (red=groundfish, yellow=regulated species, green=all species). In general, during the fall survey, all of the action alternative areas evaluated have high species diversity, and many have high diversity of regulated species.

The weighted persistence analysis identified notable areas within the existing habitat and groundfish closures, and within many of the proposed HMAs (Map 20). A small portion of Closed Area I and areas overlapping the northern margin of the bank between approximately Cultivator Shoal and the EEZ boundary were identified as ‘very far above average persistence/highest diversity’. Shallower areas towards the center of the bank were generally not identified as notable. These shallower areas include some of the HMAs: Georges Shoal Gear Modification Area (Alternative 5), Georges Shoal 1 MBTG HMA (Alternative 5), EFH South HMA (Alternative 7), Georges Shoal 2 HMA (Alternative 7), and the very similar Eastern HMA (Alternative 9) and Northern Edge MBTG HMA (Alternative 10).

The distribution of fishing effort by gear type and resultant expected adverse impacts through 2009 are described and mapped in Volume 1, Section 4.2.2.2. Fishing activity by gear type and fishery through 2012 is also described and mapped in Volume 1, Section 4.3. This volume, Section 4.2, summarizes revenue by gear type within each proposed HMA, through 2014. Fishing effort including predominant gear types used and the primary target species varies among the management areas under consideration and potential effort redistribution is considered in evaluating the relative impacts of alternatives.

Limited fishing effort of any type occurs in the shallow center of Georges Bank. Bottom trawling for groundfish, monkfish, skates, and to a lesser extent, summer flounder, occurs mostly along the northern margin of the bank, as well as in the southeastern portion around Closed Area II. The distribution of scallop dredging is similar. Squid trawling occurs on the southern margin of the bank only and therefore is not a major consideration relative to the proposed management areas. Unlike in the Gulf of Maine habitat management areas, clam dredging is a significant activity in some of the Georges Bank HMAs, and the amount of effort is expected to increase in the future given the recent removal of the PSP closure and declining catch rates in some Mid-

Atlantic clam beds. Clam dredge activity is currently concentrated on the shoals east of Closed Area I, i.e. Cultivator Shoal and Georges Shoal, and overlaps some of the proposed HMAs, particularly the Georges Shoal 2 HMA (Alternatives 7 and 10), the Northern Georges MBTG HMA (Alternative 8), and the Western HMA (Alternative 9). Gillnets are not an important gear on Georges Bank, but are used west of Closed Area I in the Great South Channel/Southern New England sub-region. Longlines are used along the northern margin of the bank to target groundfish. Lobster trapping is a seasonally important activity on eastern Georges Bank, particularly within Closed Area II, although the offshore fishery is much smaller than the inshore Gulf of Maine fishery. Effort increases between late spring and early fall as the lobsters migrate onto the bank, and moves off the bank in the winter as the lobsters move into deeper waters.

The action alternative HMAs on Georges Bank vary widely in size, with some areas being smaller than the existing Closed Area I South and Closed Area II Habitat Closures, and the Northern Georges MBTG HMA being larger than all existing habitat closures in New England, by a large margin (Figure 12). In combination, the preferred alternative areas, Northern Edge Reduced Impact HMA, Northern Edge Mobile Bottom-Tending Gear Closure HMA, and Georges Shoal 2 HMA, are about two thirds the size of the three existing habitat closures on Georges Bank, i.e., 2,075 vs 3,162 km^2.

Each section below focuses on describing the particulars of the areas included in the alternative, relative to the metrics outlined above. A conclusion is then drawn regarding the overall impacts of the alternative on habitat. Given the large number of alternatives in this section, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11. The focus of the comparisons between alternatives in the individual sections is between the alternative and no action (Alternative 1), no habitat closures (Alternative 2), the preferred alternative (Alternative 10), and other alternatives that are very similar. Given the large number of overlapping areas in this sub-region, each section includes a small figure that compares that alternative with the existing Closed Area II Habitat Closure. Additional maps and area coordinates can be found in Volume 3.

Table 24 – Georges Bank: dominant substrate coverage within each management area. Values are provided in square kilometers and as a percentage of the total.

	Substrate										
Area name and type	Low energy					High energy					**Area, km²**
(Alternative #)	M	S	G	C	B	M	S	G	C	B	
No action EFH											
Closed Area I EFH N (#1)	0	80	0	0	0	41	1,665	236	8	0	2,028
	-	4%	-	-	-	2%	82%	12%	<1%	-	
Closed Area I EFH S (#1)	0	0	0	0	0	1	566	41	8	0	617
	-	-	-	-	-	<1%	92%	7%	1%	-	
Closed Area II EFH (#1)	9	8	<1	0	0	<1	211	344	76	2	650
	1%	1%	<1%	-	-	<1%	32%	53%	12%	<1%	
No action groundfish											
Closed Area I GF (#1)	0	80	0	0	0	49	3,286	570	78	<1	4,063
	-	2%	-	-	-	1%	81%	14%	2%	<1%	
Closed Area II GF (#1)	9	348	63	0	0	58	5,675	540	129	6	6,826
	<1%	5%	1%	-	-	1%	84%	8%	2%	<1%	
Habitat management areas											
Northern Edge (#3, #4)	9	36	<1	0	0	<1	114	222	52	2	435
	2%	8%	<1%	-	-	<1%	26%	51%	12%	<1%	
Georges Shoal Gear	0	0	0	0	0	1	519	272	256	2	1,050
Mod Area (#4)	-	-	-	-	-	<1%	49%	26%	24%	<1%	
Georges Shoal 1 MBTG	0	0	0	0	0	14	740	146	43	0	946
(#5)	-	-	-	-	-	1%	78%	16%	5%	-	
Northern Georges Gear	103	237	<1	0	0	45	4,517	1,348	656	23	6,930
Mod Area (#5)	1%	3%	<1%	-	-	1%	65%	19%	9%	<1%	
EFH Expanded 1 (#6A)	9	76	<1	0	0	1	353	530	166	3	1,138
	1%	7%	<1%	-	-	<1%	31%	47%	15%	<1%	
EFH Expanded 2 (#6B)	0	65	0	0	0	1	256	349	121	1	794
	-	8%	-	-	-	<1%	32%	44%	15%	<1%	
EFH South MBTG (#7)	0	0	0	0	0	1	146	106	22	2	277
	-	-	-	-	-	1%	53%	38%	8%	1%	
Georges Shoal 2 MBTG	0	0	0	0	0	0	689	179	171	0	1,039
(#7, #10)	-	-	-	-	-	-	66%	17%	16%	-	
Northern Georges	73	773	51	0	0	10	2,061	1,213	604	23	4,808
MBTG (#8)	2%	16%	1%	-	-	<1%	43%	25%	13%	<1%	
Western area (#9)	0	0	0	0	0	0	388	226	269	12	895
	-	-	-	-	-	-	43%	25%	30%	1%	
Eastern area (#9)	0	1	0	0	0	1	355	193	56	4	611
	-	<1%	-	-	-	<1%	58%	32%	9%	1%	
Mortality area (#9)	0	2	<1	0	0	1	82	265	84	2	435
	-	<1%	<1%	-	-	<1%	19%	61%	19%	1%	
Northern Edge MBTG	0	1	0	0	0	1	385	242	71	4	705
Closure (#10)	-	<1%	-	-	-	<1%	55%	34%	10%	1%	
Northern Edge Reduced	0	1	0	0	0	1	52	216	69	2	342
Impact (#10)	-	<1%	-	-	-	<1%	15%	63%	20%	1%	
Georges Bank/GSC	**1,145**	**10,104**	**342**	**60**	**0**	**487**	**31,219**	**3,952**	**1,567**	**115**	**48,992**
region (17,663, n/a)	**2%**	**21%**	**1%**	**<1%**	**0%**	**1%**	**64%**	**8%**	**3%**	**>1%**	

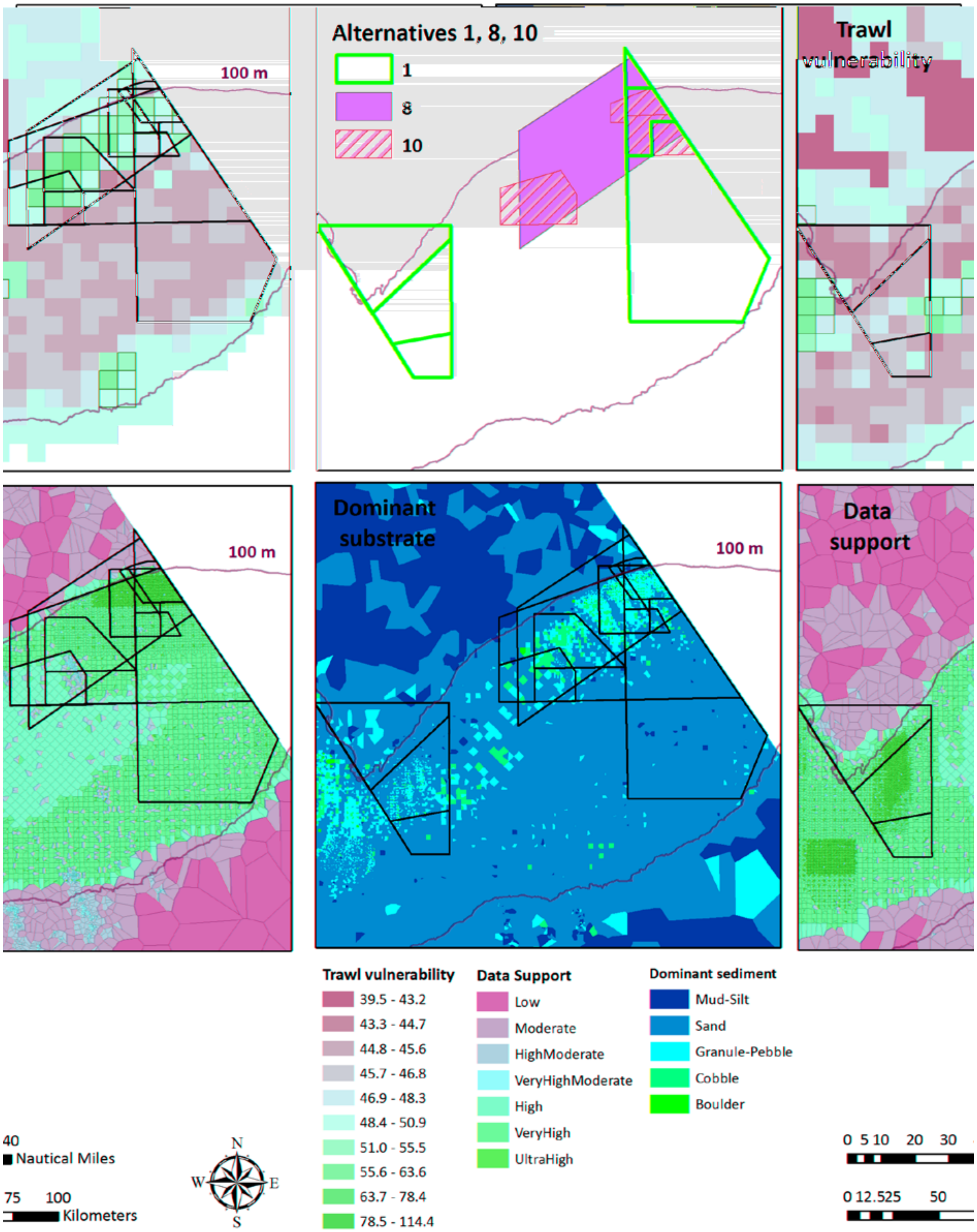
Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

Table 25 – Georges Bank: data support within each management area. Values are provided in square kilometers and as a percentage of the total.

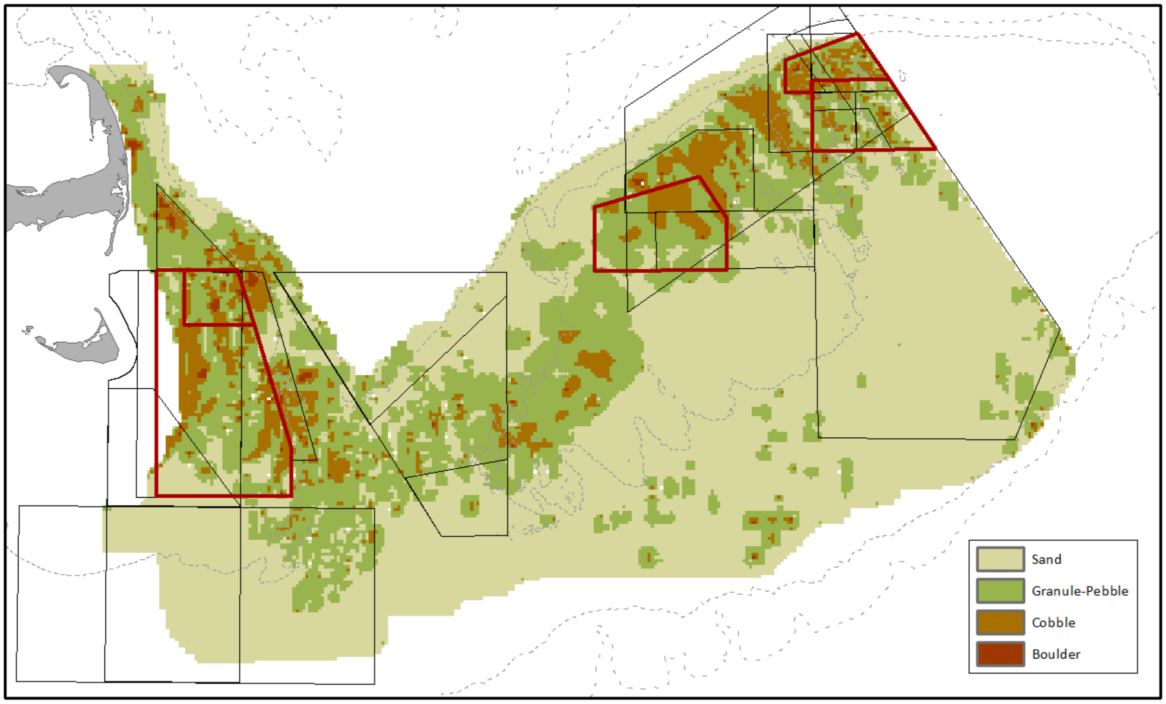
Area name and type (Number of overlapping unstructured grids, Alternative #)	Data support							Area, km^2
	Low	Moderate			High			
	1	2	3	4	5	6	7	
No action EFH								
Closed Area I EFH N (607, #1)	0	820	141	6	302	609	151	2,028
	-	40%	7%	<1%	15%	30%	8%	
Closed Area I EFH S (263, #1)	0	0	25	3	0	534	54	617
	-	-	4%	<1%	-	87%	9%	
Closed Area II EFH (1,175, #1)	0	0	12	11	0	247	379	650
	-	-	2%	2%	-	38%	58%	
No action groundfish								
Closed Area I GF (2,628, #1)	0	820	209	16	302	1,908	808	4,063
	-	20%	5%	<1%	7%	47%	20%	
Closed Area II GF (2,904, #1)	0	137	319	19	552	5,295	506	6,826
	-	2%	5%	<1%	8%	78%	7%	
Habitat management areas								
Northern Edge (949, #3, #4)	0	11	9	4	15	58	338	435
	-	3%	2%	1%	3%	13%	78%	
Georges Shoal Gear Mod Area (538,	0	0	87	39	48	846	31	1,050
#4)	-	-	8%	4%	5%	81%	3%	
Georges Shoal 1 MBTG (212, #5)	0	0	175	12	355	398	3	946
	-	-	19%	1%	38%	42%	<1%	
Northern Georges Gear Mod Area	103	65	408	77	1,188	4,296	794	6,930
(3876, #5)	1%	1%	6%	1%	17%	62%	11%	
EFH Expanded 1 (1,757, #6A)	0	0	28	19	15	495	582	1,138
	-	-	2%	2%	1%	44%	51%	
EFH Expanded 2 (963, #6B)	0-	0	19	16	15	444	301	794
		-	2%	2%	2%	56%	38%	
EFH South MBTG (195, #7)	0-	0	5	7	0	249	16	277
		-	2%	2%	-	90%	6%	
Georges Shoal 2 MBTG (277, #7)	0	0	219	45	646	128	<1	1,038
	-	-	21%	4%	62%	12%	<1%	
Northern Georges MBTG (3,229, #8)	0	565	311	76	743	2,344	769	4,807
	-	12%	6%	2%	16%	49%	16%	
Western area (429, #9)	0	0	90	38	83	665	19	895
	-	-	10%	4%	9%	74%	2%	
Eastern area (517, #9)	0	0	6	7	0	514	84	611
	-	-	1%	1%	-	84%	14%	
Mortality area (1,099, #9)	0	0	0	6	0	11	419	435
	-	-	-	1%	-	2%	96%	
Northern Edge MBTG Closure (#10)	0	0	6	8	0	514	177	705
	-	-	1%	1%	-	73%	25%	
Northern Edge Reduced Impact (#10)	0	0	0	8	0	11	326	342
	-	-	-	2%	-	3%	95%	
Georges Bank/GSC region (17,663,	**2,191**	**9,470**	**4,340**	**500**	**6,888**	**22,998**	**2,604**	**48,992**
n/a)	**4%**	**19%**	**9%**	**1%**	**14%**	**47%**	**5%**	

Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

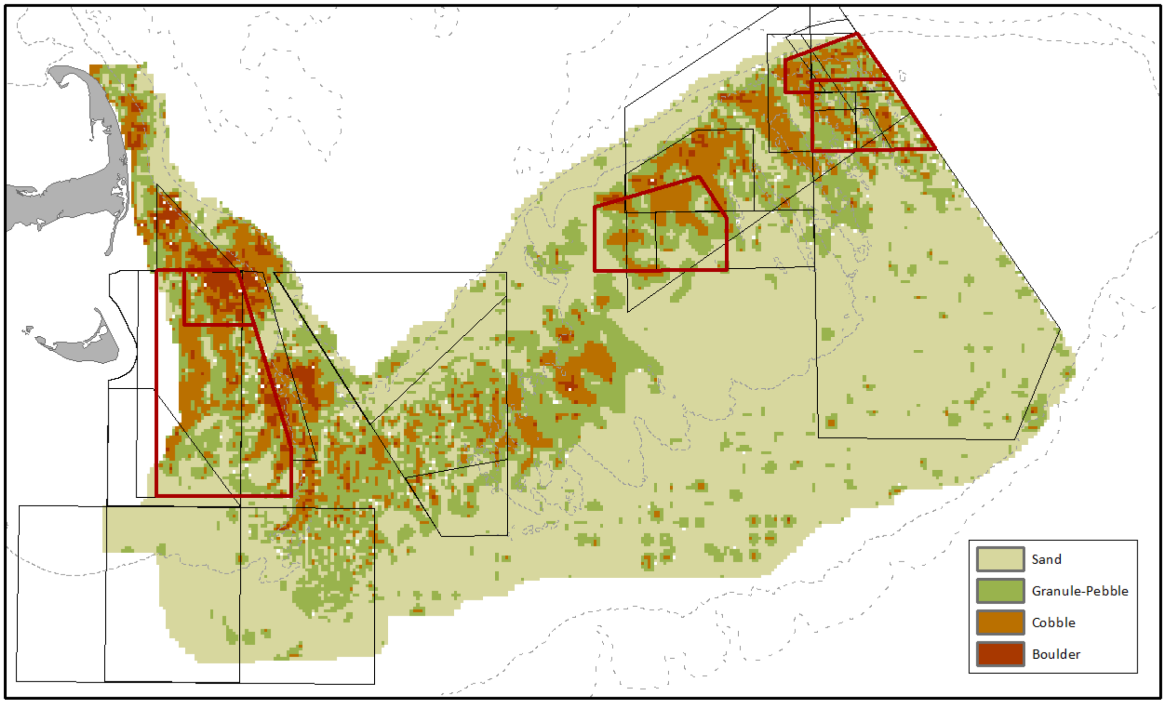
Map 13 – Georges Bank: SASI dominant substrate, data support, and vulnerability outputs (trawl gear). All management area boundaries are shown on the vulnerability, data support, and substrate panels, but only a subset of the management areas are higlighted on the upper left panel. Red outlined cells on the trawl vulnerability panel are LISA clusters.



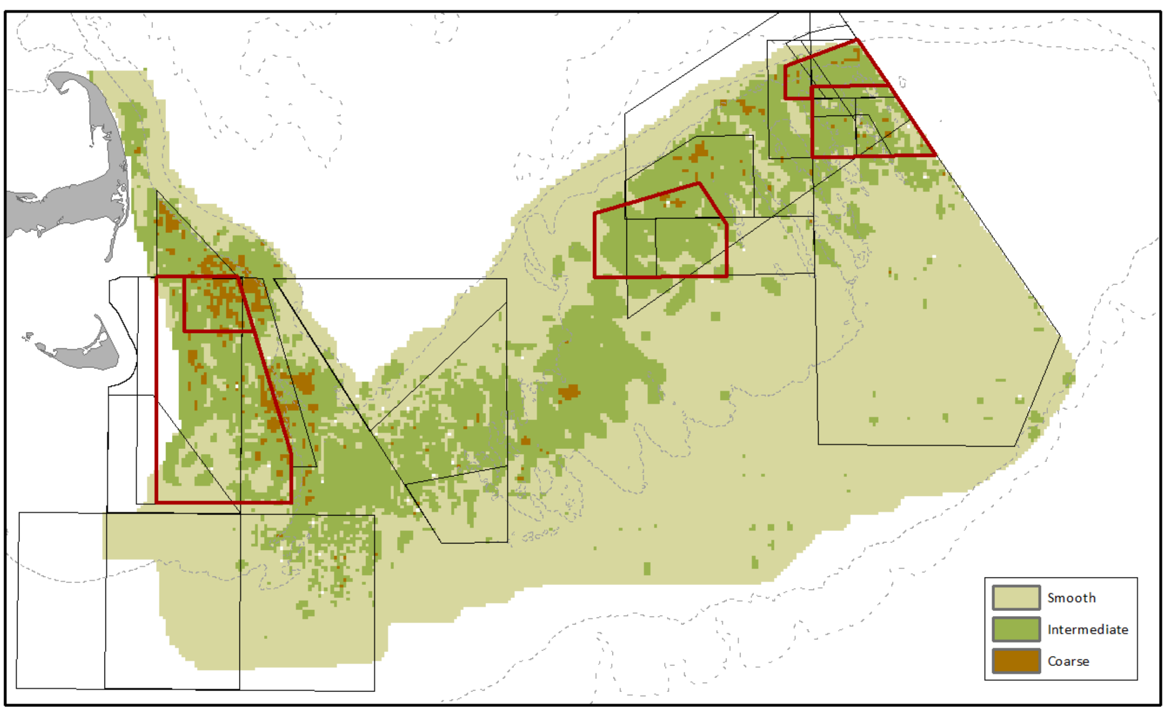
Map 14 – Dominant sediment type (Harris and Stokesbury 2010). Existing and new areas overlaid on dominant substrate. Red/brown indicates boulder, brown indicates cobble, green indicates granule-pebble, and beige indicates sand. The preferred alternatives are outlined in red.



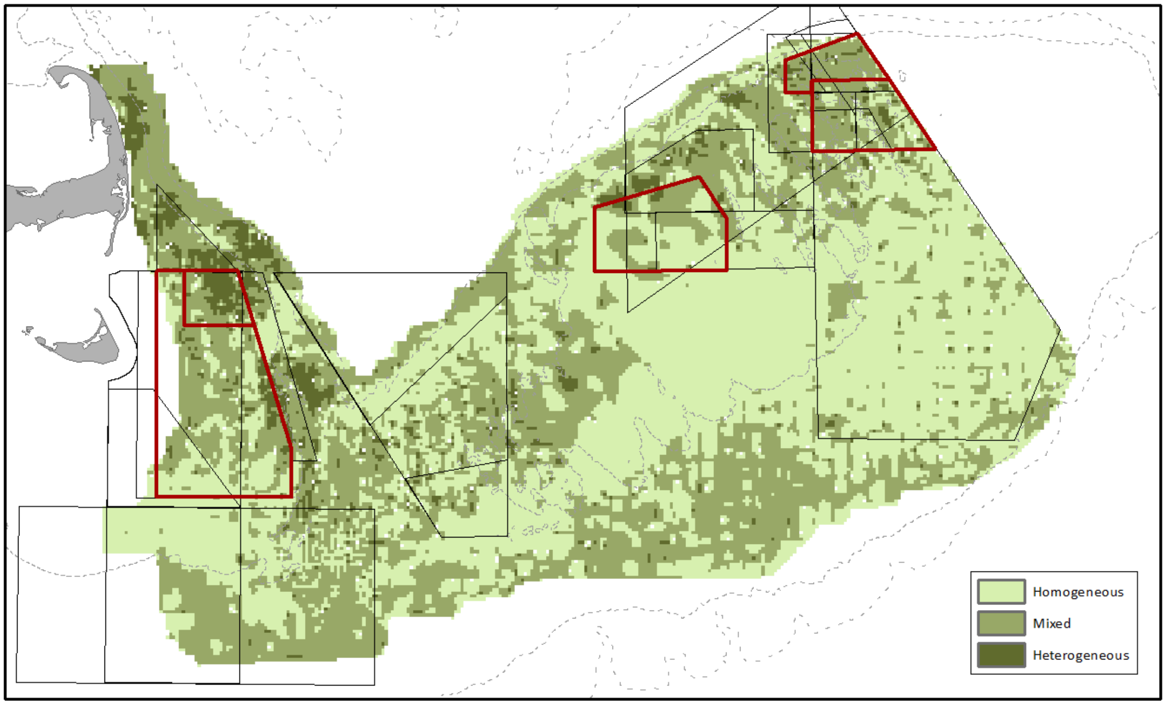
Map 15 – Largest grain size (Harris and Stokesbury 2010). The preferred alternatives are outlined in red.



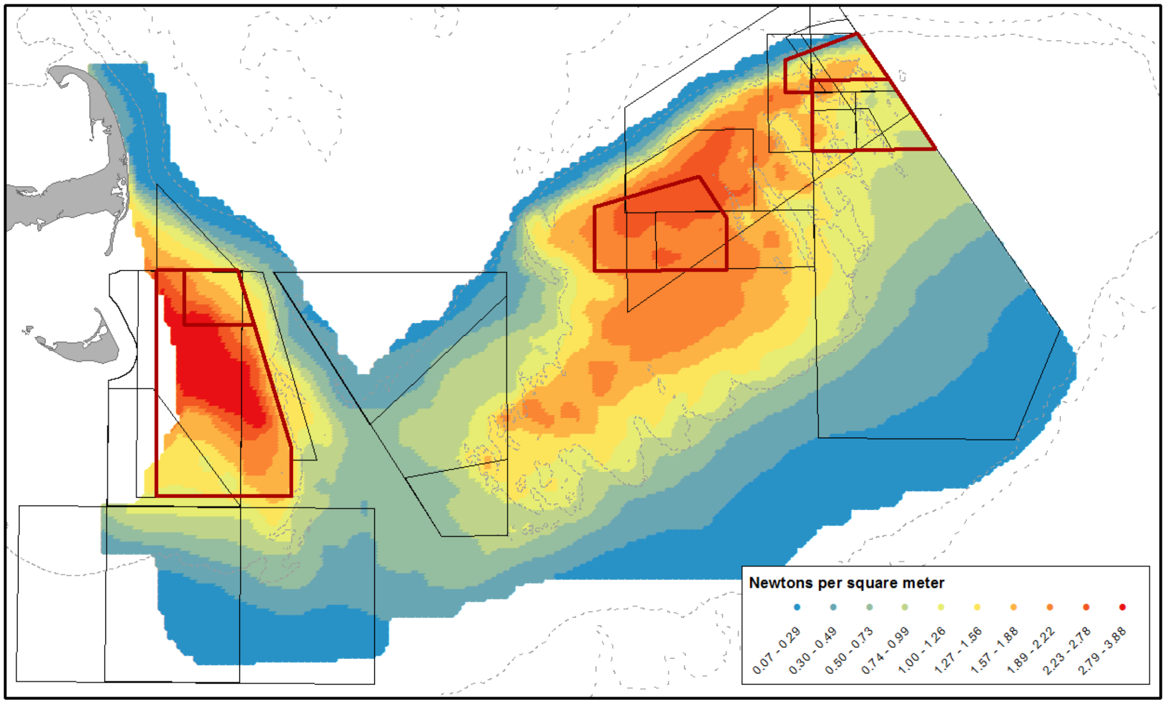
Map 16 – Sediment coarseness (Harris and Stokesbury 2010). The preferred alternatives are outlined in red.



Map 17 – Sediment heterogeneity (Harris and Stokesbury 2010). The preferred alternatives are outlined in red.



Map 18 – Benthic boundary shear stress (Harris et al 2012). Red areas have high shear stress values, and blue areas have low values. The preferred alternatives are outlined in red.



Map 19 – Sediment stability (Harris et al. 2012). Lower values in blue indicate areas of stable sediment, while index values in red indicate unstable areas. The preferred alternatives are outlined in red.

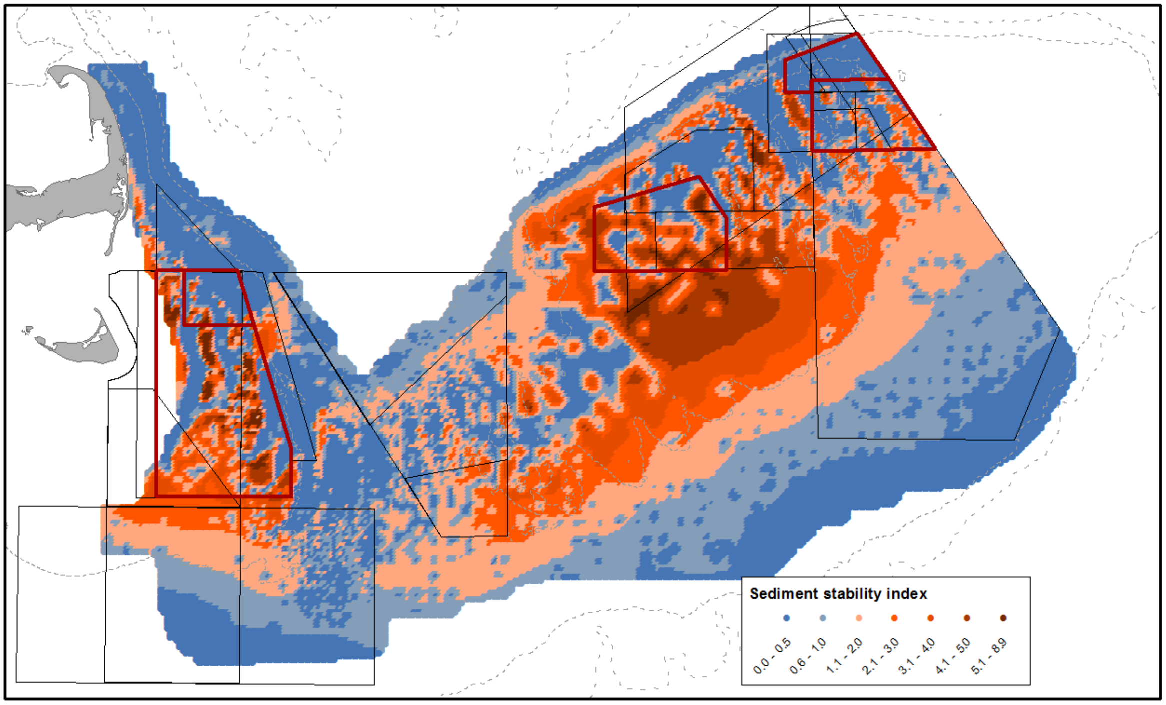


Table 26 – GB: minimum and maximum mobile bottom-tending gear vulnerability scores for each habitat management area, and the number of structured (10km x 10km) grids overlapping each area (*N*). Blanks indicate that the scallop dredge model domain did not cover the area, because it was beyond the maximum depth fished by that gear.

	Otter trawl			Scallop dredge			Hydraulic dredge		
	Min	Max	*N*	Min	Max	*N*	Min	Max	*N*
Management area									
Closed Area I EFH N (#1)	43.9	48.6	*18*	-	-	-	107.1	120.9	*14*
Closed Area I EFH S (#1)	44.8	48.7	*5*	47.7	51.7	*5*	107.9	113.5	*5*
Closed Area II EFH (#1)	48.3	57.2	*6*	50.7	59.4	*6*	119.2	126.4	*6*
Closed Area I GF (#1)	43.9	51.4	*37*	47.0	54.1	*18*	107.1	120.9	*33*
Closed Area II GF (#1)	41.7	57.2	*75*	47.4	59.4	*65*	106.5	133.3	*73*
Northern Edge (#3 and 4)	46.5	57.2	*6*	51.2	59.4	*4*	120.3	132.4	*6*
Georges Shoal Gear Mod Area (#4)	44.7	72.7	*9*	46.7	75.9	*9*	110.0	129.4	*9*
Georges Shoal 1 MBTG (#5)	44.2	58.3	*10*	46.6	61.1	*10*	108.0	114.3	*10*
Northern Georges Gear Mod Area (#5)	44.2	72.7	*76*	46.6	75.9	*74*	106.9	133.1	*76*
EFH Expanded 1 (#6A)	47.3	57.2	*11*	50.1	59.4	*11*	115.7	126.4	*11*
EFH Expanded 2 (#6B)	47.3	54.5	*7*	50.1	56.8	*7*	115.7	122.9	*7*
EFH South MBTG (#7)	48.0	48.3	*2*	50.6	50.7	*2*	112.6	120.1	*2*

	Otter trawl			Scallop dredge			Hydraulic dredge		
	Min	**Max**	***N***	**Min**	**Max**	***N***	**Min**	**Max**	***N***
Georges Shoal 2 MBTG (#7)	44.2	70.6	*10*	46.6	73.3	*10*	109.6	117.2	*10*
Northern Georges MBTG (#8)	44.2	72.7	*50*	46.6	75.9	*41*	107.1	132.5	*45*
Western area (#9)	50.3	72.7	*7*	52.4	75.9	*7*	112.0	129.4	*7*
Eastern area (#9)	45.3	53.2	*7*	48.0	55.4	*7*	106.9	120.1	*7*
Mortality area (#9)	48.4	57.2	*5*	51.2	59.4	*5*	120.3	126.4	*5*
Northern Edge Reduced Impact (#10)	48.4	57.2	*5*	51.2	59.4	*5*	120.3	126.4	*5*
Northern Edge MBTG Closure (#10)	45.3	53.2	*7*	48.0	55.4	*7*	107.0	120.1	*7*
GB/GSC region	**41.7**	**72.7**	**486**	**45.7**	**75.9**	**382**	**105.8**	**140.2**	**464**

Figure 11 – GB: Mean vulnerability scores for bottom trawl and scallop dredge, ranked according to lowest to highest trawl value. Blanks for CAIN indicate that the scallop dredge model domain did not cover the area, because it was beyond the maximum depth typically fished by that gear. The region-wide means for the Georges Bank/Southern New England region are 47.4 (otter trawl) and 49.9 (scallop dredge). Only potential mobile bottom-tending gear closures are shown.

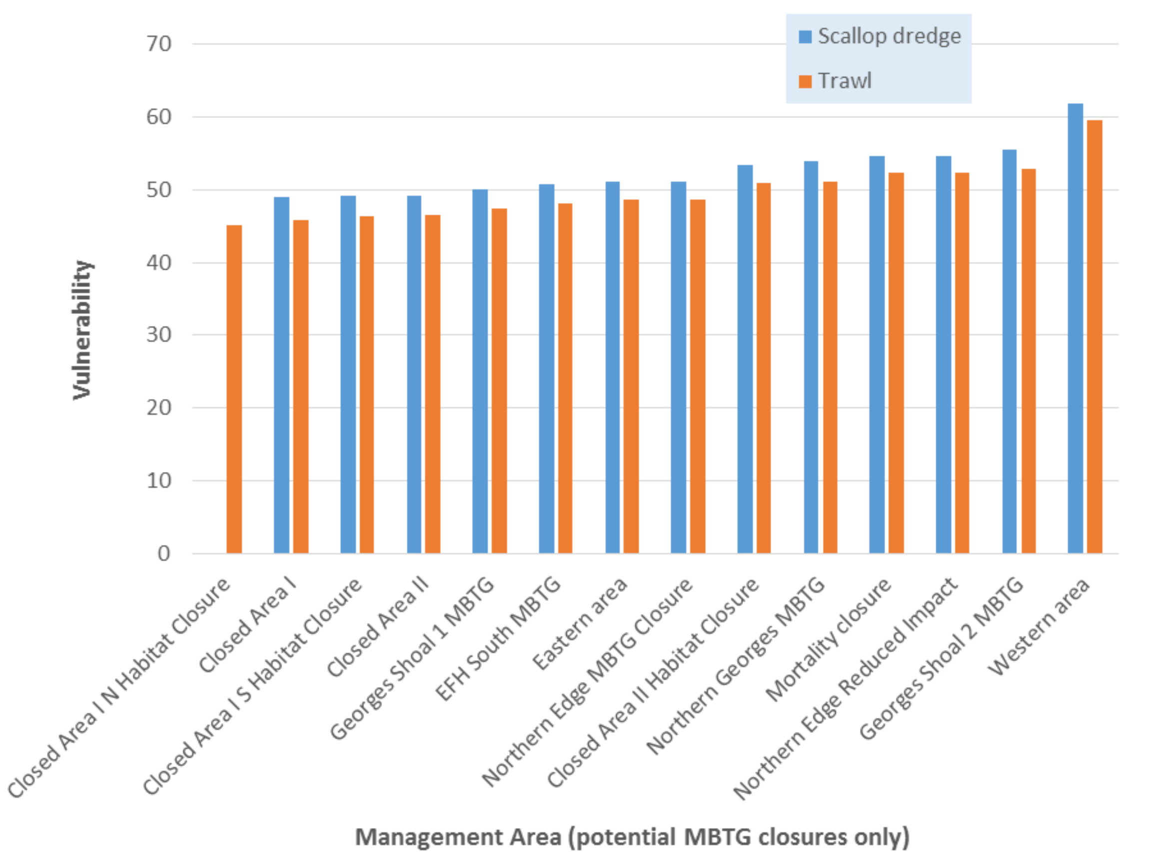


Table 27 – Overlap between Georges Bank HMAs HMAs and preferred alternative EFH designations. Species and lifestages in bold italicized type are associated with complex substrate. Juveniles shaded grey were positively weighted in the hotspot analysis. Overfished species are indicated with an asterisk (*). After each management area the alternatives it is a part of are listed in parentheses. Scores correspond to full/high=3, moderate=2, slight=1, none=0.

Species and lifestage	Closed Area II (1)	Closed Area II Habitat Closure Area (1)	Closed Area I (1)	Closed Area I Habitat Closure Area N (1)	Closed Area I Habitat Closure Area S (1)	Northern Edge HMA (3, 4)	Georges Shoal GMA (4)	Georges Shoal 1 MBTG Closure (5)	Northern Georges GMA (5)	EFH Expnded 1 (6A)	EFH Expnded 2 (6B)	EFH South MBTG Closure (7)	Georges Shoal 2 MBTG Closure (7, 10)	Northern Georges MBTG Closure (8)	Western HMA (9)	Eastern HMA (9)	Mortality (9)	Northern Edge RI HMA (10)	Northern Edge MBTG HMA (10)
Acadian redfish juvenile	Slight	None	Mod.	High	None	Slight	None	None	Slight	Slight	Slight	None	None	Slight	Slight	None	None	None	None
Acadian redfish adult	Slight	None	Slight	Mod.	None	Slight	None	None	Slight	Slight	Slight	None	None	Slight	None	None	None	None	None
American plaice juvenile	None	None	Slight	Mod.	None	None	Slight	None	Slight	None	None	None	None	Slight	None	None	None	None	None
American plaice adult	None	None	Slight	Mod.	None	None	None	None	Slight	None	None	None	None	Slight	None	None	None	None	None
Atlantic cod juvenile*	High	High	Mod.	Mod.	Mod.	High	Mod.	Slight	Mod.	High	High	**Full**	Mod.	Mod.	High	**Full**	**Full**	**Full**	**Full**
Atlantic cod adult*	High	**Full**	**Full**	**Full**	**Full**	High	High	High	High	High	High	**Full**	High	High	High	High	High	High	High
Atlantic halibut - all stages*	Mod.	Slight	Mod.	Mod.	Mod.	Slight	Slight	Slight	Slight	Slight	Slight	Slight	None	Slight	Slight	Slight	Slight	Slight	Slight
Atlantic wolffish - all stages*	**Full**	**Full**	Mod.	**Full**	None	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**	**Full**
Haddock juvenile	High	High	High	Mod.	High	High	Slight	Slight	Mod.	High	High	High	None	Mod.	Slight	High	High	High	High
Haddock adult	High	High	High	**Full**	High	Mod.	Slight	Slight	Mod.	Mod.	Mod.	High	Slight	Mod.	Slight	High	Mod.	High	Mod.
Ocean pout egg*	Slight	Slight	Slight	Slight	Slight	Slight	None	None	Slight	Slight	Slight	None	None	Slight	None	None	Slight	None	Slight
Ocean pout juvenile*	Slight	None	Slight	Slight	None	None	None	None	None	None	None	None	None	None	None	None	None	None	None
Ocean pout adult*	Mod.	High	Mod.	Mod.	Mod.	High	Slight	None	Slight	High	High	**Full**	None	Mod.	Slight	High	**Full**	High	**Full**
Pollock juvenile	Slight	Mod.	Mod.	High	Slight	High	Slight	None	Slight	Mod.	Slight	None	None	Slight	Slight	None	High	None	High
Pollock adult	Slight	Slight	Mod.	High	None	Mod.	Slight	None	Slight	Slight	Slight	None	None	Slight	None	None	Slight	None	Slight
Red hake egg, larvae, and juvenile	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	Mod.	High	**Full**	Mod.	**Full**	Mod.
Red hake adult	High	Mod.	High	High	Mod.	Mod.	Slight	Slight	Mod.	Mod.	Mod.	Mod.	None	Mod.	Mod.	Mod.	**Full**	Mod.	**Full**
Silver hake juvenile	Mod.	Mod.	Mod.	High	Slight	Mod.	Mod.	None	Mod.	Mod.	Mod.	Mod.	None	Mod.	Slight	Mod.	Mod.	Mod.	Mod.
Silver hake adult	Slight	Slight	Mod.	High	None	Slight	Slight	None	Slight	None	None	None	None	Slight	None	None	None	None	None
White hake juvenile	High	**Full**	High	**Full**	Mod.	**Full**	High	Mod.	High	High	High	High	Mod.	**Full**	Mod.	High	High	High	High
White hake adult	Slight	None	Mod.	High	None	Slight	None	None	Slight	None	None	None	None	Slight	None	None	None	None	None
Windowpane flounder juvenile*	Mod.	High	Mod.	None	Mod.	Mod.	High	High	Mod.	High	High	High	**Full**	Mod.	High	High	High	High	High
Windowpane flounder adult*	Mod.	High	Mod.	None	High	Mod.	High	High	Mod.	High	High	**Full**	**Full**	Mod.	**Full**	High	High	High	High
Winter flounder egg*	High	High	Mod.	None	High	Mod.	High	High	Mod.	High	High	**Full**	**Full**	Mod.	**Full**	High	High	High	High
Winter flounder larvae and adult*	Mod.	High	Mod.	None	High	Mod.	High	High	Mod.	High	High	**Full**	**Full**	Mod.	High	High	High	High	High
Winter flounder juvenile*	Mod.	High	Mod.	None	Mod.	Mod.	High	High	Mod.	High	High	High	**Full**	Mod.	High	High	High	High	High
Witch flounder juvenile*	Slight	Slight	None	None	None	Slight	Slight	None	Slight	Slight	Slight	None	None	Slight	None	None	Slight	None	Slight
Witch flounder adult*	Slight	Slight	Mod.	Mod.	None	Slight	Slight	None	Slight	Slight	Slight	None	None	Slight	None	None	Slight	None	Slight
Yellowtail flounder juvenile*	Mod.	Mod.	Mod.	Slight	High	Mod.	Mod.	Slight	Mod.	Mod.	Mod.	Mod.	Slight	Mod.	Mod.	Mod.	High	Mod.	High
Yellowtail flounder adult*	High	High	Mod.	Slight	High	Mod.	High	High	High	High	High	**Full**	Mod.	Mod.	High	High	High	High	High
Monkfish juvenile	Slight	None	None	None	None	Slight	None	None	None	None	None	None	None	Slight	None	None	None	None	None
Monkfish adult	Slight	None	Mod.	High	Slight	Slight	Slight	None	Slight	None	None	None	None	Slight	None	None	None	None	None
Smooth skate juvenile	Slight	None	Mod.	High	None	Slight	None	None	None	Slight	Slight	None	None	Slight	None	None	Slight	None	Slight

Species and lifestage	Closed Area II (1)	Closed Area II Habitat Closure Area (1)	Closed Area I (1)	Closed Area I Habitat Closure Area N (1)	Closed Area I Habitat Closure Area S (1)	Northern Edge HMA (3, 4)	Georges Shoal GMA (4)	Georges Shoal 1 MBTG Closure (5)	Northern Georges GMA (5)	EFH Expnded 1 (6A)	EFH Expnded 2 (6B)	EFH South MBTG Closure (7)	Georges Shoal 2 MBTG Closure (7, 10)	Northern Georges MBTG Closure (8)	Western HMA (9)	Eastern HMA (9)	Mortality (9)	Northern Edge RI HMA (10)	Northern Edge MBTG HMA (10)
Smooth skate adult	Slight	Slight	Mod.	High	*None*	Slight	*None*	*None*	*None*	Slight	Slight	*None*	*None*	Slight	*None*	*None*	Slight	*None*	Slight
Thorny skate juvenile*	Slight	*None*	Mod.	High	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Thorny skate adult*	Slight	Slight	Mod.	High	*None*	Slight	Slight	*None*	Slight	Slight	Slight	*None*	*None*	Slight	*None*	*None*	Slight	*None*	Slight
Barndoor skate – juv/adu	Mod.	High	Mod.	High	Mod.	High	Slight	Slight	Mod.	High	High	Mod.	*None*	Mod.	Slight	Mod.	High	Mod.	High
Little skate juvenile	High	Mod.	Mod.	Slight	**Full**	Mod.	High	**Full**	High	Mod.	Mod.	**Full**	**Full**	Mod.	High	**Full**	Mod.	**Full**	Mod.
Little skate adult	High	High	Mod.	Slight	**Full**	High	High	High	High	High	High	**Full**	High	High	High	High	High	High	High
Winter skate juvenile	High	High	Mod.	Slight	**Full**	High	High	High	**Full**	High	High	**Full**	**Full**	High	High	**Full**	High	**Full**	High
Winter skate adult	High	High	Mod.	Slight	**Full**	High	High	High	High	High	High	**Full**	High	High	High	High	High	High	High
Atlantic sea scallop - all	High	High	Mod.	Mod.	Mod.	Mod.	**Full**	High	High	High	High	**Full**	Mod.	Mod.	**Full**	**Full**	**Full**	**Full**	**Full**
Atlantic herring egg	Mod.	**Full**	Mod.	Mod.	Slight	High	Mod.	High	Mod.	**Full**	**Full**	**Full**	High	Mod.	Mod.	High	**Full**	**Full**	High
Total score (out of 129)	**80**	**77**	**82**	**81**	**61**	**77**	**66**	**53**	**70**	**78**	**77**	**68**	**48**	**71**	**61**	**69**	**79**	**69**	**79**
Score for s/l asso/w complex substrate (out of 84)	**55**	**51**	**54**	**56**	**41**	**54**	**40**	**35**	**44**	**53**	**52**	**45**	**32**	**46**	**39**	**45**	**52**	**45**	**52**
Score for juvs positively weighted in hotspot analysis (out of 18)	**12**	**11**	**12**	**14**	**6**	**13**	**7**	**5**	**9**	**12**	**11**	**9**	**5**	**9**	**9**	**9**	**12**	**9**	**12**
Score for overfished species (out of 54)	**35**	**37**	**33**	**24**	**29**	**31**	**33**	**27**	**29**	**37**	**37**	**33**	**26**	**29**	**31**	**33**	**38**	**33**	**38**
Count of species (out of 23)	**22**	**20**	**23**	**21**	**18**	**22**	**20**	**14**	**22**	**21**	**21**	**16**	**13**	**23**	**18**	**16**	**20**	**16**	**20**
Count of designations (out of 43)	**41**	**33**	**41**	**36**	**27**	**39**	**33**	**23**	**38**	**35**	**35**	**25**	**19**	**41**	**27**	**25**	**33**	**25**	**33**

Table 28 – Prey types consumed by species with a relatively high degree of overlap with Georges Bank HMAs. Values represent the percentage of stomach contents, by weight, in the NEMFC food habitats database, 1973-2005. Totals do not equal 100% as some stomach contents could not be identified.

Managed species	Amphi-pods	Decapod crabs	Decapod shrimp	Bivalves	Poly-chaetes	Echino-derms	Total benthic inverts	Fish	Total Benthic	Total pelagic	Total
Atlantic cod	0	14	5	7	1	1	28	6	34	25	59
Atlantic halibut	0	15	8	0	0	0	23	40	63	21	84
Barndoor skate	0	41	12	0	0	0	53	13	66	16	82
Haddock	13	2	3	2	9	23	52	1	53	4	57
Little skate	19	24	10	8	12	0	73	1	74	2	76
Monkfish	0	0	0	0	0	0	0	19	19	30	49
Ocean pout	4	12	0	8	3	67	94	0	94	0	94
Pollock	1	0	21	0	0	0	22	9	31	47	78
Red hake	4	7	24	1	2	0	38	2	40	23	63
Silver hake	1	0	15	0	0	0	16	5	21	50	71
Smooth skate	1	7	45	0	1	0	54	2	56	19	75
Thorny skate	1	7	8	0	24	0	40	11	51	16	67
White hake	0	0	8	0	0	0	8	3	11	44	55
Windowpane	15	14	27	0	0	0	56	12	68	6	74
Winter flounder	8	0	0	3	40	0	51	0	51	0	51
Winter skate	8	6	3	15	12	0	44	20	64	7	71
Yellowtail	25	1	0	3	38	0	69	0	69	0	69

Table 29 – Average diversity indices within the Georges Bank sub-region habitat management alternatives (Alternatives 9 and 10 were not updated for the FEIS). Indices exceeding the 75th percentile for each species group across all habitat management areas in all sub-regions are highlighted (red, large mesh; yellow, regulated species; green, all species).

		Alternatives									
		1 Habitat closures	1 Groundfish closures	2	3	4	5	6A	6B	7	8
Spring	*Tows*	*119*	*363*	*0*	*37*	*66*	*215*	*67*	*39*	*16*	*163*
	Lg mesh groundfish ISI	0.329	0.361	0.000	0.297	0.324	0.366	0.333	0.372	0.291	0.365
	Regulated spp. ISI	0.373	0.434	0.000	0.195	0.346	0.440	0.240	0.277	0.464	0.394
	All spp. SDI	1.060	1.175	0.000	0.718	1.005	1.165	0.832	0.879	1.233	1.1
Summer	*Tows*	*163*	*546*	*0*	*54*	*77*	*231*	*94*	*45*	*7*	*192*
	Lg mesh groundfish ISI	0.275	0.258	0.000	0.24	0.233	0.26	0.264	0.283	0.324	0.249
	Regulated spp. ISI	0.266	0.345	0.000	0.084	0.240	0.396	0.128	0.182	0.337	0.337
	All spp. SDI	0.805	0.997	0.000	0.459	0.732	1.077	0.606	0.762	1.081	0.955
Fall	*Tows*	*45*	*150*	*0*	*10*	*22*	*106*	*19*	*12*	*17*	*68*
	Lg mesh groundfish ISI	0.321	0.255	0.000	0.359	0.397	0.299	0.293	0.268	0.274	0.324
	Regulated spp. ISI	0.584	0.564	0.000	0.574	0.648	0.579	0.596	0.621	0.589	0.598
	All spp. SDI	1.460	1.407	0.000	1.533	1.704	1.467	1.501	1.47	1.613	1.545
Winter	*Tows*	*4*	*11*	*0*	*0*	*0*	*4*	*3*	*3*	*0*	*4*
	Lg mesh groundfish ISI	0.641	0.502	0.000	0	0	0.568	0.629	0.629	0	0.58
	Regulated spp. ISI	0.617	0.545	0.000	0	0	0.553	0.605	0.605	0	0.612
	All spp. SDI	1.601	1.329	0.000	0	0	1.305	1.662	1.662	0	1.381

Map 20 – GB weighted fish persistence. Source: TNC.

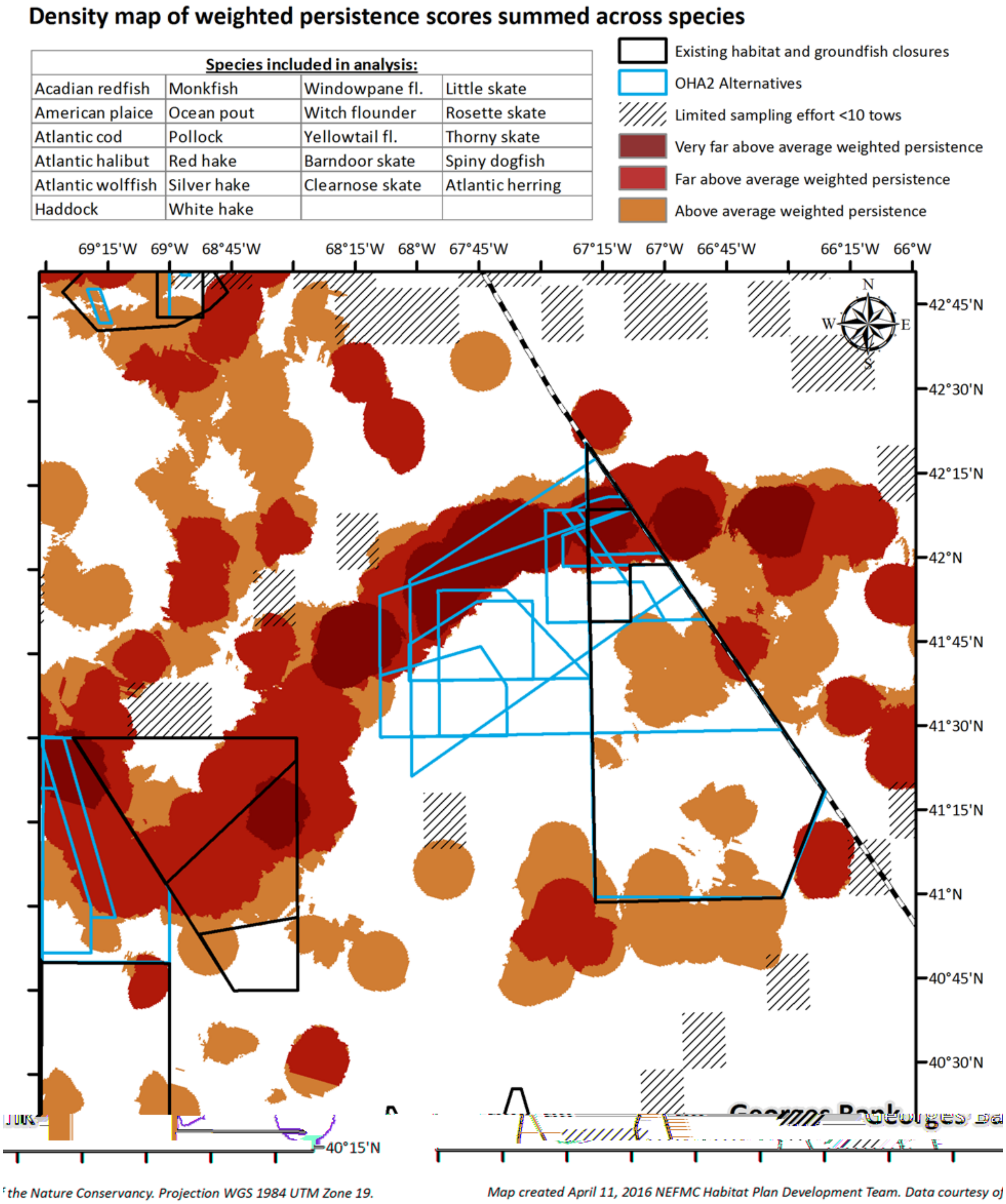
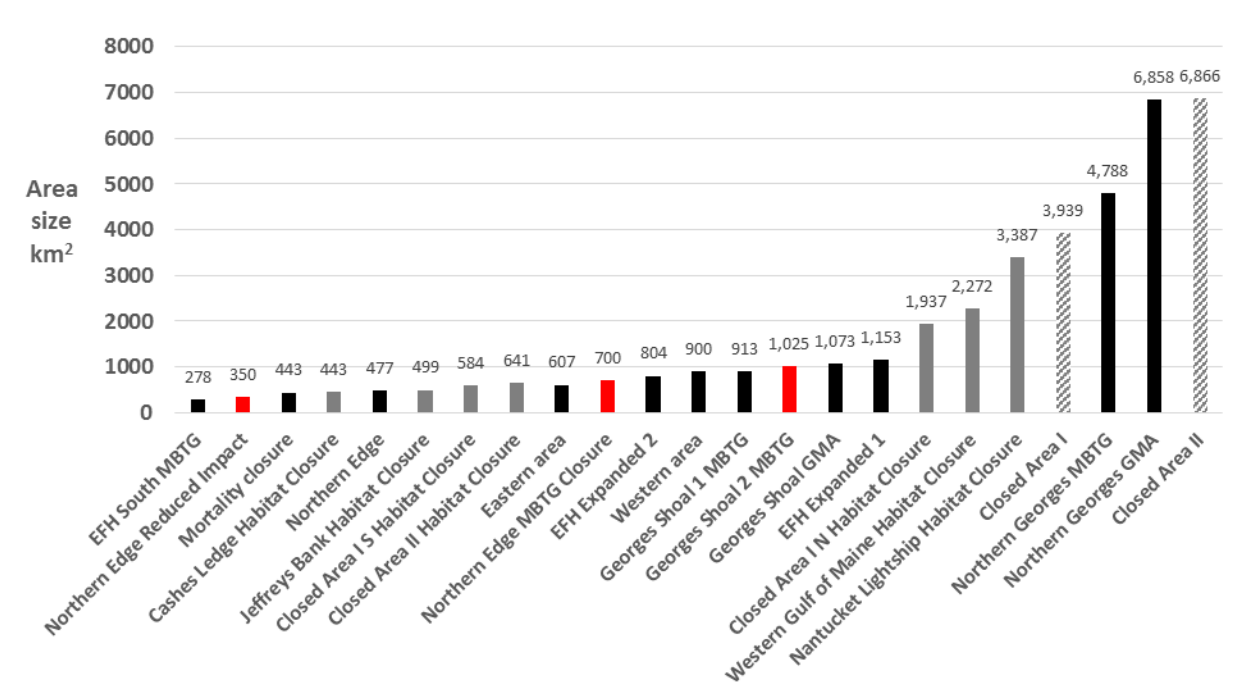


Figure 12 – Size comparison between Georges Bank HMAs (black and red bars, red=preferred) and no action habitat closure areas (grey bars). The Closed Area I and II groundfish closures are also shown (hatched).



3.2.4.1 *Alternative 1 (No Action)*

Alternative 1/No Action includes the existing Closed Area I and Closed Area II habitat and groundfish closures. As in other sub-regions, the Closed Area I and II Habitat Closure Areas are off-limits to mobile bottom-tending gears. The Closed Area I and II year-round groundfish closed areas are generally closed to gears capable of catching groundfish, but with more exemptions than the groundfish closures in the Gulf of Maine. Large portions of these areas not overlapping the habitat closures are fished by mobile bottom-tending gears. The portion of Closed Area II south of 41° 30’ and the central part of Closed Area I between the two habitat closures are fished on a periodic basis with scallop dredges as scallop access areas. The southern part of Closed Area II is also fished with bottom trawls as part of a groundfish Special Access Program. The portion of Closed Area II north of 42° 10’ is also accessible to otter trawl gear as part of a SAP. The northern portion of Closed Area I is fished with demersal longline gear but this gear type does not cause significant adverse effects on seabed habitats. There is generally no fishing in the Closed Area II Habitat Closure Area with the exception of lobster trapping, although lobster trapping appears to be concentrated mostly in the central portion of Closed Area II (between the scallop access area and habitat area).

The habitat closure in the northern part of Closed Area II overlaps fully with the juvenile cod Habitat Area of Particular Concern that was established in 1998 due to the area’s ecological importance and sensitivity to bottom trawling and dredging (see Section 3.1.2 in Volume 2). The Council re-affirmed the importance of this area for juvenile cod by selecting the No Action alternative as a preferred HAPC alternative in this amendment, and overlaps between the existing habitat closure/HAPC will be noted in the sections that follow. Fishing effects on habitat have been studied on this portion of Georges Bank since the mid-1990s (Collie et al. 1997, Collie et al. 2000, Hermsen et al. 2003, Collie et al. 2005, Stokesbury and Harris 2006, Asch and Collie 2008, Collie et al. 2009, Smith et al. 2013; see Volume 1, section 4.1.2 for details). Collectively, these studies suggest that the combination of fishing and natural disturbance influence benthic community dynamics on the northern edge of Georges Bank. These studies also draw a clear distinction between the dynamics associated with deeper habitats on the Northeast Peak in Canadian waters as compared to shallower and more naturally dynamic habitats within Closed Area II.

Except for the habitat closure in Closed Area II, the no action areas are generally less vulnerabile to gear impacts compared to the action alternative areas (Table 26, Figure 11). Thus, the Closed Area II Habitat Closure is a focal point for comparisons between alternatives. Dominant substrate composition (Table 24) and the structural features associated with these substrates drive the vulnerability scores in this sub-region, not high vs. low energy since all of the no action management areas are predominantly high energy (94-100%, depending on the area). Nearly all of the no action areas are dominated by sand (83-92%), with the exception of the Closed Area II Habitat Closure (only 32% sand). The fraction of gravel-pebble substrates ranges from 7-14% for areas other than the Closed Area II Habitat Closure, which has 53% granule-pebble coverage and is the only no action area with substantial cobble-dominated habitat (12%, vs. 0-2% for the other areas). Excluding the Closed Area II Habitat Closure, the total amount of gravel-pebble and cobble-dominated substrates in the three No Action areas is higher than in the habitat closure (900 km^2 vs. 420 km^2), but because the total size of the No Action areas (10,889 km^2) is 16 times larger than the habitat closure, these substrates only account for 8.25% of the No Action area. The same discrepancy is true for boulder-dominated substrates, but the area estimates for this habitat type are more approximate.

While both geological and biological seafloor structures provide important fish habitat, the SASI analysis assessed vulnerability based on geological habitat maps because sediment data were more readily available than epifaunal data region-wide. Rather than mapping biological habitats directly, the vulnerability of biological habitat features in SASI was assessed for individual species of epifauna that generally occur in association with each sediment type.

In general, the coarse substrates and higher vulnerability areas on Georges Bank occur within this habitat closure and extend west/southwest along the margin of the bank (Map 13). Overall, the Closed Area I habitat and groundfish closures and the portions of Closed Area II that are outside the habitat closure are relatively low vulnerability areas (Figure 11) and therefore do not make a substantial contribution to minimizing adverse effects in the Georges Bank sub-region. Although large portions of the existing groundfish management areas are already accessible via rotational fishing and special access programs, continued closure of existing lower vulnerability areas may be causing a redistribution of fishing effort onto vulnerable habitat types. It is difficult to estimate the extent to which effort displacement may be causing negative habitat impacts. Given the habitat characteristics of the Closed Area II Habitat Closure, and the existing opportunities for access, Alternative 1 is estimated to have positive impacts on habitat overall. However, the action alternatives afford an opportunity to increase the overall amount of vulnerable habitat that would be protected within habitat management areas, and to reduce the potential for any negative effects and inefficiencies associated with displacement of effort. Alternative 1/No Action minimizes adverse impacts within the Northern Edge Cod HAPC via a mobile bottom-tending gear closure of the entire area.

Alternative 1/No Action is expected to have positive impacts relative to Alternative 2 (no habitat closures) and neutral impacts relative to the preferred approach (Alternative 10). Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.

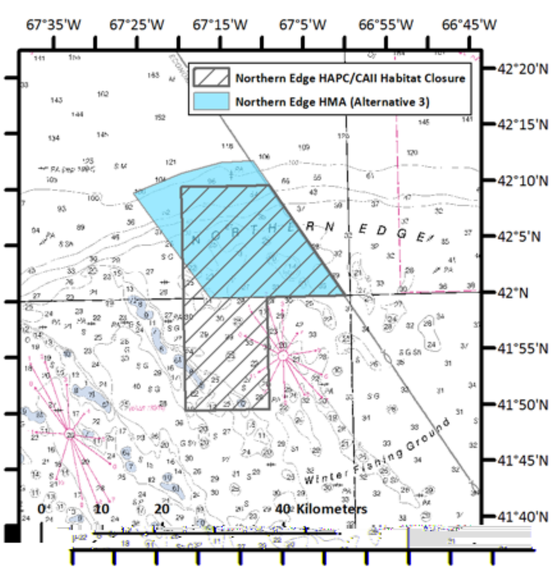
3.2.4.2 ***Alternative 2 (No Habitat Management Areas)***

Under this alternative, there would be no specific protection provided for benthic habitats through limits on the use of mobile bottom-tending gears. Closed Areas I and II could remain in place seasonally as spawning areas (the preferred alternative includes Closed Area I North and Closed Area II as spawning closures from February 1-April 15), but such seasonal protections would not allow much time for recovery of many seafloor habitat features, and would not provide protection later in the spring and summer during periods of juvenile fish settlement. In the absence of specific habitat management areas where mobile bottom-tending gear use is managed directly, minimization of adverse effects would rely on fishing as efficiently as possible, with the greatest catches for the least swept area. As noted above, portions of the no action areas prohibit mobile bottom-tending gear fishing in habitat types that are not especially vulnerable, specifically in the Closed Area I habitat closure areas. This alternative, as well as the other action alternatives in this sub-region, afford an opportunity to increase flexibility in terms of fishing location on Georges Bank. This might increase efficiency somewhat, thereby reducing swept area while fishery harvest remains constant. However, these possible benefits are outweighed by costs associated with allowing fishing all along the northeastern flank of the bank within habitat types that are more vulnerable to accumulating fishing impacts. These vulnerable habitat types include the existing Closed Area II Habitat Closure/Habitat Area of Particular Concern. Thus, it is estimated that Alternative 2 would have a negative impact on seabed habitats relative to the other habitat management alternatives in this sub-region, including Alternative 1/No Action, with neutral impacts relative to alternatives that include gear modification options only (Alternatives 3, 4, 5, 6A, and 6B implemented with Options 3 and 4). Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.

It is important to note that even if there are no year-round habitat closure areas on Georges Bank, the overall amount and distribution of fishing effort would still be regulated using other management tools. Because rotational management accounts for a large fraction of activity in the scallop fishery, it has a major influence on patterns of scallop dredging on Georges Bank, regardless of whether habitat closures are removed or adjusted. Scallop access area boundaries in Closed Area I would likely be expanded if any of the action alternatives is selected for this sub-region. Under many of the action alternatives, sufficient scallop biomass on the northern edge would be open to fishing such that a new access area along the northern edge would make sense. Whether one or two access areas are adjusted, the access schedule and trip limits would be adjusted to optimize yield. Typically Georges Bank access areas have been fished every three years, which means that at least in terms of scallop fishery adverse impacts within rotational management areas, there would be some time for habitat recovery to occur between access fisheries. For habitat features with longer recovery times, even occasional fishing could generate adverse impacts, but for lower vulnerability habitats, rotational fishing alone could provide important opportunities for recovery. Rotational fishing could also be seasonally restricted to mitigate negative effects on particular resources. Because the Council has specified that rotational access will be considered before reopening any currently closed areas on Georges Bank to scallop fishing, these issues will be further explored in a trailing scallop management action should habitat closures on Georges Bank change as a result of this amendment.

3.2.4.3 *Alternative 3*

This alternative would designate the Northern Edge HMA with one of the four mobile bottom-tending gear restrictions, and remove the existing Closed Area I and II habitat and groundfish closures. The 476 km^2 Northern Edge HMA overlaps with the 641 km^2 Closed Area II Habitat Closure Area (see map below), eliminating the southern part of the habitat closure, but extending the area further west and north. Fifty eight percent of the existing habitat closure is encompassed by the Northern Edge HMA. As would be expected given this overlap, the percent composition of hard bottom substrates in the two areas is very similar (Table 24). The Northern Edge HMA encompasses 54 km^2 of cobble and boulder-dominated habitat (69% of the area encompassed by CAII EFH), and 222 km^2 of granule-pebble-dominated habitat (65% of CAII EFH). Thus, the majority of gravel habitat area encompassed by the Closed Area II Habitat Closure is encompassed by the Northern Edge HMA. The two areas also have similar vulnerability (Table 26), i.e. the Northern Edge HMA area is highly vulnerable to adverse impacts from mobile bottom-tending gear.



The Northern Edge HMA and Closed Area II Habitat Closure are similar in terms of both EFH overlap (Table 27) and species persistence (Map 20). Because it extends into slightly deeper waters, the Northern Edge HMA includes some designated EFH for redfish and monkfish, but otherwise the range of overlapping designations is the same, and both areas have a high degree of overlap with juvenile cod EFH in particular. In general, the very high persistence areas run along the edge of the bank, and do not overlap the southern portion of the existing closure, but do overlap the northern part of the existing area as well as the Northern Edge HMA.

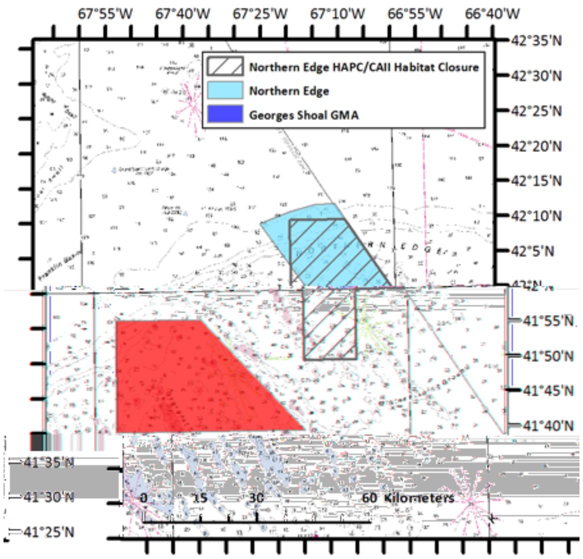
As noted above, with the exception of the Closed Area II Habitat Closure, the Alternative 1/No Action areas provide limited habitat conservation benefits because they contain a high proportion of lower vulnerability habitat types or are already fished by mobile bottom-tending gears. Given the similarities between the Closed Area II Habitat Closure and the Northern Edge HMA, and the assessment that the most important conservation benefits of Alternative 1/No Action result from the Closed Area II Habitat Closure, Alternative 3 with Option 1 or 2 offers similar habitat conservation benefits relative to Alternative 1/No

Action, likely somewhat fewer given the smaller size of the area. Thus, overall, the habitat impacts of Alternative 3 with Option 1 or 2 are expected to be slightly positive to positive.

Comparing between Options 1-4, Option 1, complete closure to mobile bottom-tending gears, offers the highest level of habitat conservation benefit. Option 2 for this area is going to have similar benefits, as most of the Northern Edge HMA remains within a paralytic shellfish poisoning closure, so little hydraulic dredging would be expected within the HMA, even if that gear type is exempted. In addition, clam dredging to date on Georges Bank has been focused on locations further to the west. Alternative 3 with Option 3 or 4 would likely have negligible habitat conservation benefits and would thus have a negative impact relative to Alternative 1/No Action, which is expected to have positive impacts. Scallop dredges would be allowed to fish unrestricted in the area under Option 3 or 4, and there would likely be substantial levels of scallop fishing within the HMA. This effort would most likely be part of a rotational access program, given the high abundance of scallops in the area. With these gear modification options, trawl gears would have restricted length and elevated ground cables (Option 3) or no ground cables (Option 4), but the catchability tradeoff and therefore net change in area swept are not well understood and cannot be estimated (see section 3.1.2.3). Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.

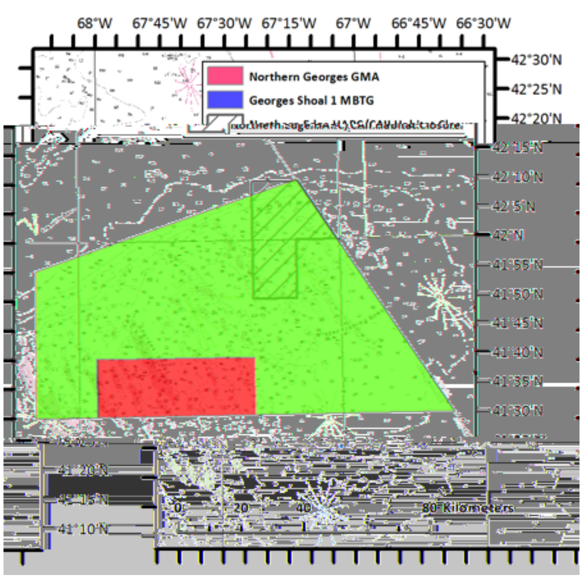
3.2.4.4 ***Alternative 4***

Alternative 4 is similar to Alternative 3, except that it includes an additional gear modification area west of Closed Area II (see figure below). Given the substrate composition of the gear modification area, it is well-sited to encompass more vulnerable seabed types, but the expected habitat benefits associated with the gear modification area as compared to the area's current status as an open fishing area are not known, but are probably negligible (see section 3.1.2.3). Overall, impacts of Alternative 4 should be very similar to those for Alternative 3, above, given the negligible benefits associated with the gear modification area. Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.



3.2.4.5 *Alternative 5*

Alternative 5 includes the large Northern Georges Gear Modification Area and the smaller Georges Shoal 1 HMA which would be closed to mobile bottom-tending gears. The 6,838 km^2 Northern Georges Gear Modification Area is well located to encompass much of the vulnerable seabed on Georges Bank (Map 13), with a northern boundary that runs approximately along the 100 m contour. There is approximately 95% overlap with the current Closed Area II habitat closure and habitat area of particular concern (see below). The area encompasses nearly 700 km^2 of cobble/boulder habitat, and approximately 1,350 km^2 of additional fine gravel habitat (Table 24). Like the large Northern Georges mobile bottom-tending gear closure HMA in Alternative 8, this area overlaps a large number of EFH designations. However, given the diverse range of depths and locations encompassed within the HMA, these overlaps are often slight or moderate, such that the composite scores are on the lower side relative to other HMAs analyzed (Table 27). However, despite this area being well sited for habitat management, the habitat protection benefits associated with gear modification areas in general are uncertain and likely negligible (see section 3.1.2.3), such that this area is not expected to contribute positively to adverse effects minimization in the sub-region.

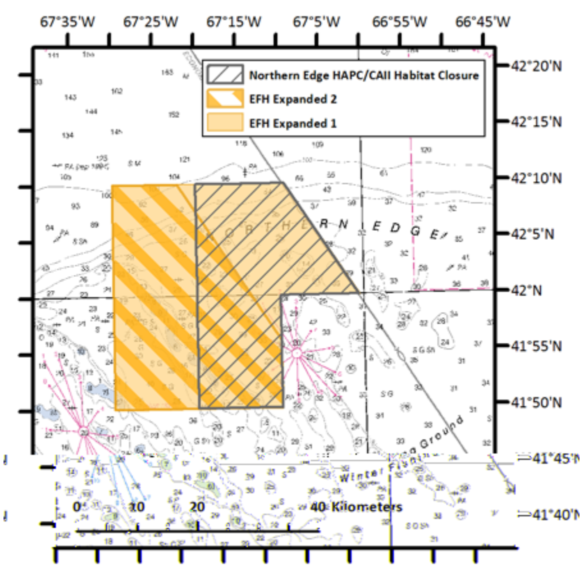


Alternative 5 also includes a smaller mobile bottom-tending gear closure (Georges Shoal 1 MBTG closure) towards the center of the bank, which has no overlap with the existing habitat closure area (see figure at left). Of the various action alternative areas, the mobile bottom-tending gear closure area is sandier than other management areas in the sub-region (Table 24), has the lowest vulnerability (Figure 11), has low EFH overlap scores (Table 27), and no overlap with high fish persistence areas (Map 20). It is also not expected to contribute positively to adverse effects minimization on Georges Bank.

Therefore, overall, relative to Alternative 1/No Action and Alternative 10, the preferred alternative, Alternative 5 is expected to have negative impacts. It would largely eliminate conservation measures in the existing Closed Area II Habitat Closure, trading the existing area for a gear modification area with uncertain but likely negligible benefits and a mobile bottom-tending gear closure that is not well located to encompass vulnerable seabed types. Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.

3.2.4.6 *Alternatives 6A and 6B*

Alternative 6A would extend the Closed Area II Habitat Closure to the west and increase its size by roughly 80%. Alternative 6B also shifts the area to the west, but removes an 8 nautical mile wide corridor along the EEZ. This adjustment increases the existing area's size by about 25%. Both modifications have similar percent coverage of granule-pebble and cobble substrate relative to sand as compared with the existing Closed Area II Habitat Closure, which is not unexpected as they overlap. Alternative 6A covers 100% of the Closed Area II Habitat Closure, while 6B covers approximately 47% of the existing area (see figure below).



If Alternative 6A is implemented with Option 1 or 2, there would be highly positive impacts on habitat, and positive impacts relative to Alternative 1/No Action, given that the 6A area encompasses a larger area containing vulnerable seabed habitats as compared to the existing Closed Area II Habitat Closure. At this time, clam dredging is very limited within the area just west of Closed Area II overlapping this alternative (see Figure 29), so there is not expected to be a difference between Options 1 and 2 in the short term. It is possible that over time the clam fishery on Georges Bank could shift west, such that Alternative 6A, Option 2 would have fewer conservation benefits than Alterntaive 6A, Option 1.

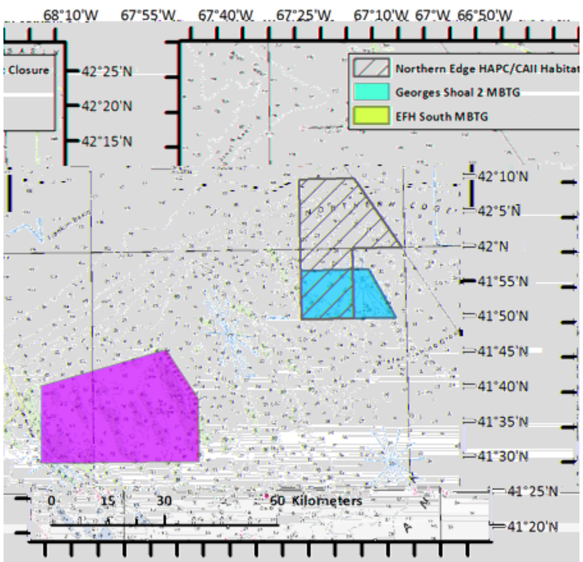
Alternative 6B with Option 1 or 2 is expected to have slightly positive to positive impacts on habitat. Negative impacts are expected relative to No Action. While there would be a slight increase in overall area protected (804 km^2 vs. 641 km^2), the 6B area eliminates continued protection of an area that has been closed to mobile bottom-tending gear fishing for nearly 20 years in exchange for areas further west that are currently open to fishing. Given that habitat recovery of some features in cobble-dominated environments may take two to five years, continued protection of recovered biological epifauna in an existing area is probably of greater benefit vs. new conservation measures in a currently open area containing similar geological structures. Further, the existing habitat closure has a greater proportion of stable sediments (Map 19). The discussion above regarding Option 1 vs. Option 2 applies to this alternative as well.

If either Alternative 6A or Alternative 6B is implemented with Option 3 or 4, impacts are expected to be very similar to those described above for Alternative 2. Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.

3.2.4.7 *Alternative 7*

Alternative 7 includes two HMAs, both of which would be closed to mobile bottom-tending gears (Option 1 or 2). The EFH South HMA overlaps with the southern part of the existing Closed Area II Habitat Closure (total area of overlap is approximately 28%), and includes some areas to the east of the existing habitat closure as well. The Georges Shoal 2 HMA is between Closed Area I and Closed Area 2, with Georges Shoal along its eastern side and Cultivator Shoal along its western side. In combination, the two areas cover about 1300 km^2, which is twice the size of the existing Closed Area II Habitat Closure.

The EFH South HMA is a relatively small area that is well-surveyed (Table 25) and is 53% sand, 38% granule-pebble, and 8% cobble (Table 24). Given a relatively higher coverage of sand substrate as compared to some of the other management areas in the sub-region, it has slightly lower vulnerability scores, although they are still higher than the No Action areas, with the exception of the Closed Area II Habitat Closure. The EFH South HMA has lower EFH overlap scores than the existing Closed Area II habitat closure (Table 27) and does not overlap with high fish persistence areas (Map 20).



The Georges Shoal 2 HMA is a larger area (1,025 km^2) that compares favorably with other HMAs in terms of having a high percent cobble coverage (Table 24) and therefore overlaps with higher vulnerability grids (Table 26 and Map 13). However, the data support values are somewhat lower (Table 25), so these estimates of substrate coverage and vulnerability are less certain. The Georges Shoal 2 HMA has less overlap with designated EFH than some other management areas in the sub-region (Table 27). The area is relatively shallower than the HMAs further north and east, and has high benthic boundary shear stress (Map 18), which contributes to the relatively large proportion of unstable sediments in the HMA (Map 19). Relative to the Closed Area II Habitat Closure, the Georges Shoal 2 HMA has less overlap with cod, haddock, yellowtail flounder, barndoor skate, and scallop EFH. The HMA does not overlap areas of high fish persistence (Map 20).

Given that both HMAs are of moderate value in terms of their substrate characteristics and EFH overlap, and do not coincide particularly with high fish persistence areas, an important consideration is the extent to which these HMAs may displace fishing effort with mobile bottom-tending gears into other nearby areas if implemented. Because it is located entirely within the

Closed Area II Habitat Closure and Closed Area II, the EFH South HMA is currently closed to various types of fishing including scallop dredging, bottom trawling, and clam dredging. The area lies along the southern edge of a scallop bed on the northern edge of Georges Bank, and would likely experience relatively limited amounts of scallop fishing were it to reopen to fishing (see short and long term yield analysis in the scallop section of Volume 5). Some groundfish trawling would be likely as well, although it is difficult to speculate as to how important this specific area would be as it has been closed long term. The surfclam resource does overlap this HMA (see clam fishery impacts section in Volume 5), but the area remains part of a PSP closure which would need to be lifted before hydraulic dredging could take place, even if Closed Area II and the Closed Area II Habitat Closure were removed.

The Georges Shoal HMA is easier to evaluate because it is currently open to fishing with mobile bottom-tending gears. Most of the revenue currently generated in the HMA is from surfclams harvested with hydraulic dredges, with groundfish trawling being the second largest revenue generator (see Figure 30, Table 59, and Table 61 in the human communities impacts section of this volume for details). Scallop dredging is virtually non-existant within the HMA. Clam dredging has increased recently, while groundfish trawling in the HMA has declined. In combination, these two HMAs would likely lead to displacement of clam dredging, and to some extent bottom trawling, but would have limited effects on the distribution of scallop dredging.

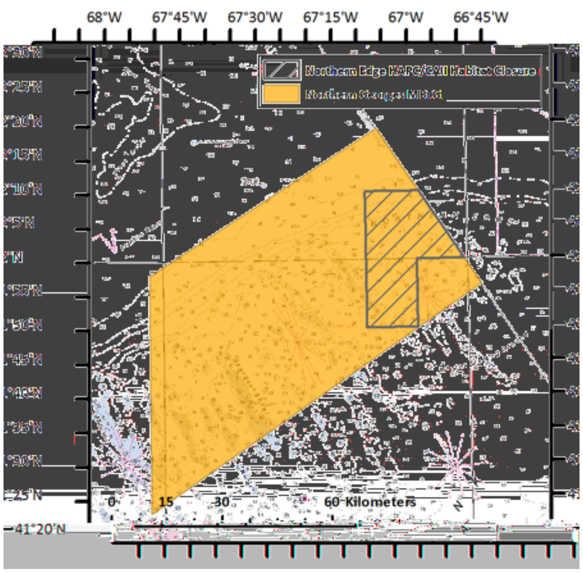
Based on the existing distribution of clam dredging on Georges Bank, the areas to the west of the Georges Shoal 2 HMA including those around Cultivator Shoal would be the most likely alternate fishing grounds, although there are surfclams elsewhere on the bank as well. Based on oral and written public comments provided during OHA2-related and subsequent Council and Committee meetings, given fixed costs associated with testing for paralytic shellfish poisoning on clam dredge trips, the industry targets clams on Georges Bank using larger vessels in areas known to have high catch per unit effort. Since the Georges Shoal 2 HMA appears to be intermediate between other areas on the northern half of Georges Bank in terms of vulnerability, EFH value, and sediment complexity and stability, it is not possible to fully evaluate whether shifting clam dredging out of this HMA would have net positive or net negative impacts. If effort does shift west towards Cultivator Shoal, an area that is generally sandier and apparently less vulnerable to fishing impacts, net impacts would likely be positive, but if fishing activity moves northeast along the northern edge, net impacts could be negative. Given high catch rates of clams on Georges Bank generally compared to elsewhere in the region, and recent increases in clam dredging on the bank, it seems unlikely that effort in the fishery on Georges Bank would simply decline, or shift to the mid-Atlantic.

Overall, Alternative 7 would have slightly positive impacts on habitat, and negative impacts relative to Alternative 1/No Action. If Option 2 is selected instead of Option 1, impacts are still expected to be slightly positive, but less so than with Option 1, because the Georges Shoal 2 HMA is heavily fished with clam dredges and these impacts would not be minimized. This is expected due to the tradeoff between the existing Closed Area II Habitat Closure which is centered on stable, granule-pebble, cobble, and boulder habitats and has a high degree of overlap with designated EFH and high fish persistence areas, vs. the and Georges Shoal 2 HMA. Alternative 7 would have positive impacts relative to Alternative 2, given the attributes of the two HMAs and their potential for new or continued displacement of adverse fishing impacts.

Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.

3.2.4.8 *Alternative 8*

Alternative 8 includes the single large (4,788 km^2) Northern Georges HMA that covers most of northern Georges Bank and much of the vulnerable habitat identified in the sub-region. The Northern Georges HMA overlaps 100% with the Closed Area II habitat closure and extends well beyond it to the west. Because it covers such a broad area, the HMA includes a wide range of habitat types (Table 24), including some low energy areas off the edge of the bank in deeper waters.



Because the area is large and includes more diverse habitat types and a range of depths, the overlap with any given EFH designation is more likely to be slight or moderate, which is reflected in the total EFH overlap scores. However, it is the only area besides Closed Area I that overlaps designations for all 23 species included in the EFH overlap analysis. It makes sense that these two areas are similar in this regard as Closed Area I also encompasses a range of habitat types and depths, and is of similar size. Because it straddles the edge of the bank where high fish persistence areas occur, the northern half of the HMA has a high degree of overlap with the areas of very far above average weighted persistence.

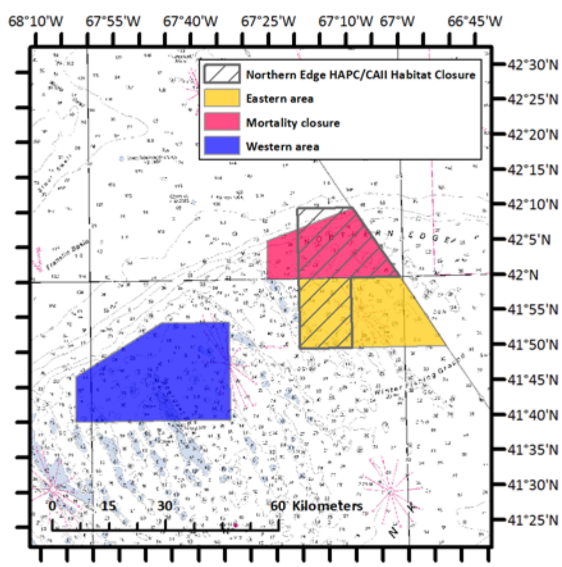
Because the area so comprehensively covers the vulnerable seabed types on Georges Bank, it is expected to have a larger magnitude of positive habitat impacts relative to all other alternatives. However, as discussed in the economic impacts analysis, the area is expected to displace significant amounts of fishing effort. Because the most vulnerable habitat types on Georges Bank are generally encompassed by this HMA, it is unlikely to displace fishing effort onto more vulnerable substrates within the sub-region. To the extent that this fishing is shifted onto less productive fishing grounds and would, therefore, be conducted less efficiently, with higher area swept per amount of fish landed, habitat impacts associated with some Georges Bank fishing trips could increase, thus reducing to some extent the positive benefits associated with the HMA. However, the benefits of protecting a large area of high value habitats within the HMA is expected to be a more important determinant of the overall habitat impact of this alternative than the CPUE reductions associated with effort displacement.

Much of the Georges Shoal 2 HMA discussed under Alternatives 7 and 10 is encompassed within the Northern Georges MBTG HMA, such that Alternative 8, Option 1 is expected to displace substantial amounts of clam dredging. However, because this alternative also encompasses vulnerable habitats to the east of the Georges Shoal 2 HMA, the potential patterns of effort displacement in the clam dredge fishery are likely somewhat different. Under Alternative 8, Option 1 it is more likely that clam dredging would shift west, towards sandier, lower vulnerability habitats around Cultivator Shoal, and there is less concern that clam dredge impacts would shift into more vulnerable areas. If Option 2 were selected for this alternative, clam dredging would be allowed throughout most of the HMA, west of the remaining portion of the PSP closure overlapping Closed Area II. This would reduce the habitat conservation benefits of the alternative. However, Alternative 8, Option 2 is still expected to have positive impacts relative to Alternative 1/No Action given that clam dredging is currently allowed in these locations and bottom trawling and scallop dredging would be restricted.

Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.

3.2.4.9 *Alternative 9*

Alternative 9 includes two mobile bottom-tending gear closures (the Eastern HMA within CAII south of 42° N, and the Western HMA that is roughly centered on the northern end of Georges Shoal). The alternative also includes a mortality closure north of 42° N that would have management measures consistent with those in groundfish Closed Area II. The assumption is that scallop access could be developed within the mortality closure but that groundfishing activity would be prohibited. The Eastern HMA and Mortality Closure combined overlap the existing Closed Area II Habitat Closure by 95%. While the Eastern HMA overlaps an ongoing PSP closure, the Western HMA could be implanted as a mobile bottom-tending gear closure, Option 1, or with an exemption for hydraulic dredges, Option 2.



The eastern and western mobile bottom-tending gear closure areas that make up Alternative 9 have higher percent coverage of cobble and boulder substrates than the No Action areas, with the exception of the Closed Area II Habitat Closure. The unstructured SASI grids overlapping the western area in particular have the highest coverage of cobble of any of the management areas in the Georges Bank sub-region. The eastern area is relatively sandier (approximately 58% sand), although it has coarse substrate relative to the Georges Bank region as a whole (approximately 85% sand). Combining all types of gravel (granule-pebble, cobble, and boulder), the mortality closure proposed in this alternative has the highest percent coverage of gravel of any management area in the region (approximately 81%). Data support for all three areas is very high, with 96% of the mortality closure having the highest density of supporting substrate data (category 7 out of 7).

In terms of their overall size, the three areas included in Alternative 9 cover approximately 2,000 km^2. This is much smaller than Alternative 8 (4,800 km^2), slightly smaller than Alternative 10 (2,075 km^2), larger than Alternative 7 (1,100 km^2), and smaller than the No Action habitat closures (3,300 km^2). In combination, the areas cover 429 km^2 cobble and boulder habitat (86 km^2 expected to be fished rotationally) and 684 km^2 granule pebble habitat (265 km^2 expected to be fished rotationally). These totals exceed all three no action habitat closures combined, but include only 68% as much cobble and boulder habitat and 54% as much granule-pebble habitat as the Alternative 8 Northern Georges MBTG HMA.

Vulnerability scores for SASI grids overlapping the three management areas are within the range of scores identified for other Georges Bank sub-region action alternative areas and the No Action Closed Area II Habitat Closure. In general, the other four No Action areas have lower vulnerability scores. Scores are slightly higher for the western and mortality closures as compared to the eastern area, and there is a higher degree of overlap between the western and mortality closures with the LISA clusters, as compared to the eastern area, which borders the southern edge of the LISA cluster footprint. This makes sense because the vulnerability scores and associated LISA clusters are driven by the underlying substrate maps, and the eastern MBTG closure in Alternative 9 is relatively sandier, as described above. All three Alternative 9 areas are more vulnerable to trawls, scallop dredges, and hydraulic clam dredges than the average habitat types in the Georges Bank/Great South Channel sub-region as a whole. That said, given the extent to which the various action alternative areas overlap with one another spatially, and the resolution of the SASI vulnerability/LISA grid (100 km^2 cells), the vulnerability results are not especially useful for fine discriminations between action alternative areas. They do indicate generally that the Alternative 9 areas, many other action alternative areas, and Closed Area II Habitat Closure Area overlap the higher vulnerability portions of Georges Bank.

As would be expected from their degree of spatial overlap, the existing Closed Area II Habitat Closure and the Mortality Closure have very similar EFH overlap scores. Like the northern portions of the existing closure, the Mortality Closure has a strong overlap with high persistence areas. While the Western MBTG HMA has lower EFH overlap scores compared to some of the areas further east, it compares favorably with the Georges Shoal 2 HMA (and the Georges Shoal 1 HMA). The Eastern MBTG HMA has intermediate EFH overlap scores between the other areas that comprise this alternative. The species and designation that do not overlap the Eastern MBTG HMA are generally found in deeper waters, and are often more typically associated with the Gulf of Maine (specifically, smooth and thorny skate, pollock, monkfish, American plaice, and witch flounder). In general these species have a low degree of overlap with the Georges Bank habitat alternatives, with the exception of the existing the Closed Area I North Habitat Closure. The Eastern MBTG HMA does not overlap with high persistence areas, and the Western MBTG HMA has limited overlap.

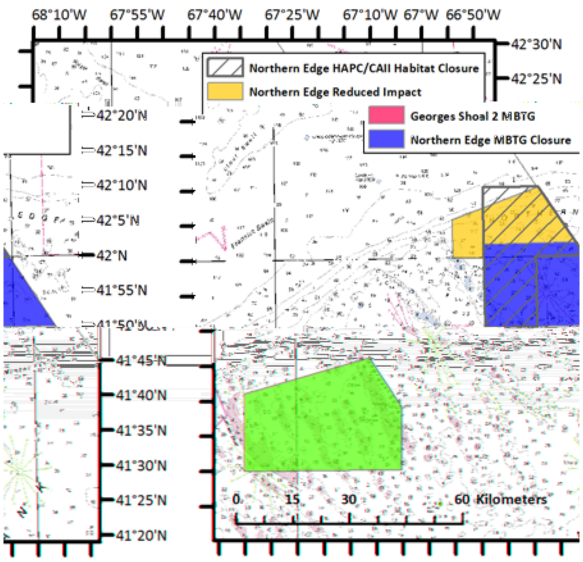
The management measures that would be applied in each of the areas will influence how effective the alternative would be in terms of maintaining the functional value of vulnerable habitats. Based on the SASI model analyses, the areas included in this alternative are considered vulnerable to the three mobile bottom-tending gear types most commonly used in the region. Therefore, protection from impacts associated with these gears will best maintain the function of these habitats so that they can provide shelter from predation and refuge from flow during feeding. The western and eastern areas would be implemented as closures to mobile bottom-tending gears, which will allow for recovery of structure-forming organisms in the western area, and will maintain existing conditions in the eastern area. If clam dredges were allowed in the Western HMA (Option 2), this would reduce the conservation benefits of the area compared to

Option 1. Clam dredges, scallop dredges, and bottom trawls are all fished in the Western HMA (Figure 32). The mortality closure, if managed the way Closed Area II is managed at present, would prohibit clam dredges, scallop dredges unless fishing in the Closed Area II scallop access area, and bottom trawls, unless fishing in the Eastern U.S./Canada SAP. The SAP area overlaps the western part of the mortality closure that lies outside of CAII. It is difficult to estimate the net impacts of the alternative on physical habitats without knowing how the mortality closure might be managed in terms of groundfish or scallop access. The impacts of these activities would be evaluated in any actions contemplating access to the area, with development of a scallop access area being the most likely adjustment in the next few years. Because the bulk of the mortality closure area has been off limits to scallop dredges and bottom otter trawls since 1994, any recovery of structured benthic habitats that has occurred since closure could be compromised by allowing fishing access, even if that access is on a limited or rotational basis. That being said, fishing in a groundfish SAP or scallop access area is controlled relative to open area fishing and access seasons or possession limits could be set to minimize impacts on habitat or bycatch.

Overall, Alternative 9 with Option 1 in the Western HMA is estimated to have positive habitat impacts, i.e. neutral impacts relative to Alternative 1/No Action. This conclusion accounts for the habitat value of the proposed areas combined with the impacts of periodic fishing in a large part of the existing habitat closure. Currently there are no adverse effects minimization measures west of the existing closures where the Western HMA is located, and this area contains vulnerable habitat types that have a moderate degree of overlap with EFH and some overlap with high persistence areas. Rotational management of scallop dredging within the mortality closure would allow for intervals when the habitat would be unfished, eliminating disturbance to the seafloor during times of juvenile fish settlement and allowing for benthic recovery during closed years. On Georges Bank, rotational management areas are generally fished every three years, although this is based on scallop yield within the areas and is not a set schedule. If Option 2 hydraulic dredge exemption is selected for the Western HMA, the habitat benefits of this alternative would decrease, and would likely be reduced relative to Alternative 1/No Action. Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.

3.2.4.10 *Alternative 10 (Preferred Alternative)*

Alternative 10 is very similar to Alternative 9, except it includes the Georges Shoal 2 HMA in the west instead of the Western HMA, and the internal boundary between the mortality closure and mobile bottom-tending gear closure in Alternative 10 places more area (roughly 100 km^2) inside the MBTG closure, instead of within the area where scallop dredges might be fished in the future. In addition, under Alternative 10 the allowable activities in the northeasternmost area are more clearly specified. The area is referred to as a ‘reduced impact’ HMA to indicate an intermediate level of activity and therefore a level of impacts between a complete closure to MBTG and an open fishing area. Alternative 10 also includes a seasonal closure to scallop dredging between June 15 and October 1 which would influence when dredging can take place within the Reduced Impact HMA. The Georges Shoal 2 HMA would include an exemption for hydraulic clam dredges for one year, continuing status quo management relative to that gear in that area. After one year the exemption would sunset, unless a long-term exemption is granted, perhaps within specific sub-areas. The specifics of both the scallop rotational access area and schedule and the potential for clam exemption areas would be determined in future actions.



In terms of the western areas overlapping Georges Shoal, Alternative 10 is the same as Alternative 7. Considering the western areas only, the impacts of Alternative 9 and Alternative 7/Alternative 10 are somewhat different, given the different habitat characteristics of the Georges Shoal 2 HMA (Alternative 7/Alternative 10) vs. the Western HMA (Alternative 9). While the Georges Shoal 2 HMA is slightly larger, it is generally sandier (Table 24, Map 14, Map 21), and less stable (Map 19). Although the Western HMA in Alternative 9 is smaller by approximately 100 km^2, it has a greater coverage of granule-pebble, cobble, and boulder than Georges Shoal 2, measured both as a percentage and as an absolute number in km^2 (Table 24). The Western HMA in Alternative 9 also has better overlap with designated EFH relative to the Georges Shoal 2 HMA in Alternatives 10 and 7 (Table 27).

In terms of the eastern areas, Alternative 9 and Alternative 10 are very similar, because the two alternatives have the same overall footprint. The northernmost areas, Mortality Closure (Alternative 9) and Reduced Impact HMA (Alternative 10) are very stable areas with a high percent coverage of granule-pebble, cobble, and boulder substrates (Table 4). The adjacent habitats to the south are somewhat sandier and less stable. Alternative 10 adjusts the boundary between these two areas, which should lead to slightly increased habitat conservation benefits associated with Alternative 10 compared to Alternative 9, because an additional 93 km^2 would be closed entirely to mobile bottom-tending gears. Both Alternative 9 and Alternative 10 would protect more vulnerable benthic habitat as compared to the eastern part of Alternative 7, the EFH South MBTG HMA. This is because the EFH South HMA in Alternative 7 is smaller, sandier, and does not overlap the very stable, gravelly habitats on the edge of the bank. Similar to Alternative 1/No Action, the eastern parts of Alternative 9 and Alternative 10 encompass complex, stable, benthic habitats vulnerable to fishing gear impacts. A major difference between Alternative 1/No Action vs. Alternative 9 or Alternative 10 is that scallop fishing could be allowed in the Mortality Closure (9) or Reduced Impact HMA (10), if approved in a potential future action, but this gear is not currently allowed in the Closed Area II Habitat Closure Area. Other alternatives that would continue to prohibit scallop dredges in some or all of the existing closure include Alternatives 3, 4, 6A, and 8, assuming management Option 1 or 2 is selected, while Alternatives 5 and 7 would allow dredging in all (5) or most (7) of the bed on the northern edge. Alternative 6B would close existing scallop grounds west of the current closure but open up other areas currently closed along the EEZ boundary.

Under Alternative 10, scalloping would only be permitted as part of the rotational management system, which is expected to produce impacts intermediate between full closure to the gear and open access fishing. Specifically, under rotational management, an overall catch limit for the area would be set for each year the area is open to fishing, and fishing would likely not occur every year in order to optimize scallop yield. In general the Georges Bank access areas have been fished every three years, which would allow for recovery of some benthic features (most geological features, ascidians, bryozoans, hydroids, some polychaete worms), but is shorter than the recovery time of others, which were estimated to occur over a two to five year range (anemones, the lacy tube worm *Filograna implexa*, sponges). The overall catch limit and access schedule could be set conservatively, in order to mitigate negative impacts, for example with lower annual limits for the area or a greater time interval between access fisheries, but this analysis does not make any assumptions about specifications for the area beyond the fact that they would be set broadly to optimize scallop yield while balancing EFH protection, reduced bycatch, and other considerations.

The seasonal closure would limit scalloping in the Reduced Impact HMA to the late fall, winter, and spring, November 1-June 14. The end of this period in the spring is a time of higher meat yields, but the winter months have lower yields, which translates into increased fishing time to harvest a specific possession limit. The seasonal closure element may therefore contribute slight negative impacts on habitat from a swept area perspective, assuming a fixed scallop access fishery possession limit. However, the seasonal closure would preclude scallop dredging during the summer months, when age-0 groundfish including cod and haddock are recruiting to the seafloor and require adequate feeding opportunities and shelter from predation. The scallop rotational allocation would consider the seasonality of access in determining a biologically appropriate possession limit.

Alternative 10 is expected to have similar, perhaps slightly negative impacts relative to Alternative 9. While Alternative 9 includes the Western HMA, which is expected to have higher habitat conservation value than the Georges Shoal 2 HMA, Alternative 9 also has a smaller mobile bottom-tending gear closure in the east, and does not include a seasonal scallop dredge restriction, which would protect juvenile fish in the area during an important period for settlement and recruitment to the fishery.

As preferred, Alternative 10 would implement a clam dredge exemption with a one year sunset in the Georges Shoal 2 HMA, which means the area will become a complete mobile bottom-tending gear closure a year after implementation, unless specific exemptions are authorized in a trailing management action.

Alternative 10 and Alternative 1/No Action are expected to have a similar magnitude of impacts on seabed habitats. Alternative 10 protects structured habitats on and west of Georges Shoal, controls fishing activities in the northeastern corner of the bank in the Reduced Impact HMA, including a mobile bottom-tending gear closure during the summer months, and maintains a closure to mobile bottom-tending gears in a 700 km^2 area south of 42° N. Given the large number of alternatives in this sub-region, a comprehensive summary comparing the impacts of various alternatives is provided as a standalone discussion in section 3.2.4.11.

3.2.4.11 *Comparison of impacts across alternatives*

Given the large number of alternatives and gear restriction options, this section compares the impacts of the various alternatives in this sub-region, rather than listing these comparisons as part of the discussion for each separate alternative. The approach is to rank the various alternatives, by gear restriction option, if appropriate, and then discuss the rationale behind the rankings. Overall, all the action alternative HMAs are on the northern edge and central portion of the bank. Important determinants of the habitat conservation value of a particular alternative include habitat type (specifically, sediment distribution and sediment stability) and vulnerability, overlap with designated EFH and areas of above average fish persistence, and the amount and distribution of current fishing activity within the HMAs by various mobile bottom-tending gears, including expected fishing activity within existing closures that would re-open. Unlike in the Gulf of Maine, where hydraulic dredging is not common, exemptions for hydraulic dredges under Option 2 affect determinations about impacts because this gear is used frequently in some of the Georges Bank HMAs. Area size is also considered.

Alternative 8 with Option 1 would have the largest magnitude of positive impacts relative to any other alternative, followed by Alternative 8 with Option 2. Because clam dredging overlaps the western part of the Northern Georges MBTG HMA, exempting this gear would reduce habitat benefits. Alternative 6A is expected to rank next in terms of magnitude of positive impacts. Selection of Option 1 vs. Option 2 is not likely to influence outcomes, at least immediately, as clam dredging is concentrated further west. Overall, these approaches are expected to have positive impacts relative to Alternative 1/No Action.

Two alternatives are expected to have similar impacts to Alternative 1/No Action, Alternative 9 with Option 1 in the Western HMA, and Alternative 10 as preferred. Alternative 9 with Option 2 in the Western HMA would have slightly negative impacts relative to Alternative 1/No Action.

Alternatives 3, 4, and 6B, with Option 1 or 2, are expected to have similar impacts to one another, and slightly negative impacts relative to No Action.

Alternative 7, Option 1, followed by Alternative 7, Option 2, are expected to have negative impacts relative to Alternative 1/No Action.

Alternatives 5, 2, and any of the gear modification only alternatives (Alternatives 3, 4, 6A, 6B with Options 3 or 4) are expected to have few if any habitat conservation benefits, and highly negative impacts relative to Alternative 1/No Action.

3.2.5 Great South Channel/Southern New England

There are six habitat management alternatives for the Georges Bank sub-region: (1) no action Nantucket Lightship Habitat Closure Area and Groundfish Closed Area, (2) no HMAs, (3) Great South Channel East HMA and Cox Ledge HMA, (4) Great South Channel HMA and Cox Ledge HMA, and (5) Nantucket Shoals HMA and Cox Ledge HMA, and (6) Nantucket Shoals West MBTG HMA as a mobile bottom-tending gear closure and Great South Channel Gear Modification Area. Any areas in Alternatives 3, 4, or 5 could have any of the options applied to them. The Council's preferred alternative is to designate the Cox Ledge HMA as a closure to hydraulic dredges, and an area where trawls would not be allowed to use groundcables. In addition, the Council recommends designation of the Great South Channel HMA, with a complete restriction on mobile bottom-tending gears in the northeastern corner, and temporary, one year exemption for hydraulic clam dredges in the rest of the area. The impacts of the preferred alternative are discussed below under Alternative 4.

The habitat areas in this region and the Georges Bank areas overlap a similar range of EFH designations, although the number of species and designations, as well as the total scores, are slightly lower for this sub-region as compared to Georges Bank. Either the Alternative 1/No Action Nantucket Lightship Closed Area or its overlapping habitat closure, or both, have full or high overlap with adult cod EFH; adult windowpane, winter, and yellowtail flounder EFH; juvenile and adult winter and little skate EFH; juvenile and adult herring EFH, and sea scallop EFH. These areas have a moderate degree of overlap with juvenile and/or adult EFH for halibut, haddock, ocean pout, red hake, white hake, monkfish, and barndoor skate.

Four of the habitat management areas included in Alternatives 3 to 6 (Great South Channel East, Great South Channel, Nantucket Shoals, Nantucket Shoals West) are highly overlapping and therefore have similar overlaps with designated EFH. Thus, the EFH designations alone are not an especially useful metric for contrasting the conservation benefits of these areas, although there is a general downward trend in the numeric total score/number of species/number of designations metrics moving from Alternative 3 to Alternative 6, as the HMAs add area to the west and lose area to the east. Relative to the Alternative 1/No Action areas, there is a higher degree of overlap with juvenile winter flounder EFH, and a lesser degree of overlap with juvenile and adult yellowtail flounder EFH. There is also a lesser degree of overlap with adult little skate EFH. Moving from Alternative 3 to Alternative 6, the Nantucket Shoals West area has only a slight overlap with adult cod EFH. Also, the overlaps with scallop and herring EFH decrease moving from Alternative 3 to Alternative 6. Because the scallop EFH designation in particular is very general (EFH = presence in any survey), a ‘slight’ overlap with the westernmost Nantucket Shoals West area indicates fairly reliably that there is very little correspondence between this area and important scallop habitat.

The Great South Channel Gear Modification Area, which lies to the east of the areas described above includes habitats for a somewhat different array of species, and has the highest numeric EFH overlap scores of any area in the sub-region. However, this area is only envisioned as a trawl gear modification area and not as a mobile bottom-tending gear closure. Relative to the areas listed above, there is a higher degree of overlap with EFH for juvenile and adult Atlantic cod and yellowtail flounder; juvenile haddock, pollock, and white hake; and with adult ocean pout. There is also full overlap between this area and sea scallop EFH.

The two Cox Ledge subareas comprising the Cox Ledge HMA also have a somewhat different overlap with designated EFH relative to the other areas. Relative to the other HMAs in the sub-region, the areas have a higher degree of overlap with EFH for haddock, ocean pout, silver hake, and windowpane flounder. The Cox Ledge HMA is included with Alternatives 3-6, so it would provide additional protection for the above species’ habitats when combined with the Great South Channel/Nantucket Shoals areas.

Across the species that have the highest degree of overlap with the Great South Channel/Southern New England HMAs, i.e. cod, barndoor skate, haddock, little skate, monkfish, ocean pout, red hake, silver hake, white hake, windowpane flounder, winter flounder, winter skate, and yellowtail flouder, a diverse array of benthic prey types are consumed (Table 34). Decapod shrimp constitute over 5% by weight of the diet of seven of these species, decapod crabs are important to six species, and polychaetes to five species. Amphipods are consumed in large quantities by haddock, little skate, windowpane, winter flouder, winter skate, and yellowtail flounder; haddock and ocean pout eat large amounts of echinoderms; and cod, little skate, ocean pout, and winter skate eat bivalve mollusks. As shown in the maps prepared for Appendix H, all of these prey types are found in Southern New England. However, based on a review of the scientific literature on gear effects, there is little evidence for long-term impacts of fishing on these types of benthic prey (see Appendix H, section 4.0 for details). Further, all of the managed fishes consume multiple prey types. Therefore, substantial positive or negative impacts of the HMAs on the benthic invertebrate prey base in this sub-region appear unlikely to result from this amendment, regardless of which alternative is selected.

There are two HAPCs in this sub-region (Map 22). The Inshore Juvenile Cod HAPC includes waters off the Massachusetts coast to 20 meters deep, and overlaps slightly with the Nantucket Shoals and Nantucket Shoals West HMAs. The Great South Channel Juvenile Cod HAPC overlaps partially with the various Great South Channel and Nantucket Shoals HMAs proposed in Alternatives 3-6, particularly the Great South Channel East HMA (Alternative 3) and to a lesser extent the preferred alternative Great South Channel HMA (Alternative 4). The Great South Channel Juvenile Cod HAPC includes additional waters north and east of the HMAs to a depth of 120 m.

Table 35 shows groundfish diversity, regulated species diversity, and all species diversity for the Great South Channel/Southern New England habitat management alternatives. Alternatives with the highest diversity values (75^{th} percentile of each season) for each diversity index across all alternatives in all sub-regions are shaded (red=groundfish, yellow=regulated species, green=all species). In general none of the HMAs in this sub-region are high diversity relative to other HMAs in other sub-regions.

The weighted persistence analysis identified notable areas within the existing habitat and groundfish closures, and within all of the proposed HMAs (Map 23). The northeastern corner of the Great South Channel East and Great South Channel HMAs was identified as ‘very far above average persistence/highest diversity’. Shallower areas overlapping these HMAs, and much of the Nantucket Shoals and Nantucket Shoals West HMAs were not identified as notable. Notable areas were also sparse in the Cox Ledge and Nantucket Lightship Areas.

The distribution of fishing effort by gear type and resultant expected adverse impacts through 2009 are described and mapped in Volume 1, Section 4.2.2.2. Fishing activity by gear type and fishery through 2012 is also described and mapped in Volume 1, Section 4.3. This volume, Section 4.2, summarizes revenue by gear type within each proposed HMA, through 2014. Bottom trawls are typically used in the Great South Channel, along the eastern edge of the Great South Channel and Great South Channel East HMAs, and also to the west of the existing Nantucket Lightship Closure Area offshore of Rhode Island. Target species include groundfish, whiting, skates, summer flounder, and spiny dogfish, with effort distribution varying somewhat for each fishery . Similar to Georges Bank, squid trawling in the Great South Channel/Southern New England sub-region occurs along the shelf break, and also nearshore, south of Cape Cod and off Rhode Island and Long Island, New York.

The Great South Channel west of what is currently Closed Area I is an important open area scallop ground that shows consistent fishing activity on an annual basis, and the eastern section of the Nantucket Lightship Closed Area is fished on a rotational basis. The areas are fished by both the general category IFQ fishery and by the limited access fishery. Clam dredge effort tends to occur west of the scallop dredge effort, generally in shallower waters. Activity on Nantucket Shoals has expanded since the beginning of the time series evaluated for the SASI model (i.e. since 1996). Increases over time in clam dredge revenue from the proposed HMAs is clearly shown in the bar charts in this volume, Section 4.2.5.

Longlining for groundfish occurs west of Closed Area I, and also along the shelf break south west of the Nantucket Lightship Closed Area. Gillnetting for multispecies, skates, monkfish, and dogfish occurs west of Closed Area 1, as well as offshore of Rhode Island. The lobster trap fishery operates in coastal Southern New England waters as well as along the shelf break, and there is an emerging Jonah crab fishery along the shelf break as well. Additional discussion regarding potential shifts in fishing effort under various alternatives is provided in the Alternative 1/No Action section below.

Overall, the action alternative habitat management areas in this sub-region are large in size relative to the No Action suite of habitat closure areas across all sub-regions, although smaller than the Nantucket Lightship Habitat Closure that they are proposed to replace (Figure 14). The exceptions are the two smaller HMAs on Cox Ledge, which are slightly larger than some of the smaller HMAs in the central Gulf of Maine (Fippennies Ledge, Platts Bank). The preferred alternative Great South Channel HMA is comprised of two sub-areas, a smaller mobile bottom-tending gear closure, and a larger area where clam dredges will continue to be allowed for one year while longer term exemption to portions of the area is considered by the Council.

Table 30 – GSC-SNE: Dominant substrate coverage within each management area. Italicized values under the Great South Channel HMA indicate sub-sections that would be defined as mobile bottom-tending gear closures or have a one year exemption for clam dredges. Values are provided in square kilometers and as a percentage of the total.

Area name and type (Alternative #)	Substrate										Area, km^2
	Low energy					High energy					
	M	S	G	C	B	M	S	G	C	B	
No action EFH											
Nantucket Lightship EFH	106	1,061	0	0	0	25	2,081	60	22	0	3,354
(#1)	3%	32%	-	-	-	1%	62%	2%	1%	-	
No action groundfish											
Nantucket Lightship GF	726	1,703	0	0	0	145	3,278	198	15	<1	6,066
(#1)	12%	28%	-	-	-	2%	54%	3%	<1%	<1%	
Habitat management areas											
Cox Ledge (#3-6)	0	0	0	0	0	12	146	13	12	16	199
	-	-	-	-	-	6%	73%	6%	6%	8%	
Great South Channel	0	0	0	0	0	6	1,799	890	561	79	3,334
East (#3)	-	-	-	-	-	<1%	54%	27%	17%	2%	
Great South Channel	0	0	0	0	0	4	1,537	552	408	44	2,545
(#4)	-	-	-	-	-	<1%	60%	22%	16%	2%	
MBTG closure	0	0	0	0	0	0	*98*	*125*	*66*	*30*	*319*
section	-	-	-	-	-	-	*31%*	*39%*	*21%*	*9%*	
Clam exemption	0	0	0	0	0	4	*1,439*	*427*	*342*	*15*	*2,227*
section	-	-	-	-	-	<1%	*65%*	*19%*	*15%*	*1%*	
Nantucket Shoals (#5)	0	0	0	0	0	8	1,571	430	269	31	2,319
	-	-	-	-	-	<1%	68%	19%	12%	1%	
Nantucket Shoals, west	0	0	0	0	0	8	2,178	453	269	28	2,936
(#6)	-	-	-	-	-	<1%	74%	15%	9%	1%	
Great South Channel	0	0	0	0	0	8	1,219	729	328	44	2,328
Gear Mod Area (#6)	-	-	-	-	-	<1%	52%	31%	14%	2%	
Georges Bank/GSC	**1,145**	**10,104**	**342**	**60**	**0**	**487**	**31,219**	**3,952**	**1,567**	**115**	**48,992**
region	**2%**	**21%**	**1%**	**<1%**	**0%**	**1%**	**64%**	**8%**	**3%**	**>1%**	

Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

Table 31 – GSC-SNE: Data support within each management area. Values are provided in square kilometers and as a percentage of the total.

Area name, and type (number of overlapping unstructured grids, Alternative #)	Data support							Area, km²
	Low	Moderate			High			
	1	2	3	4	5	6	7	
No action EFH								
Nantucket Lightship EFH (603, #1)	118 4%	931 28%	440 13%	12 <1%	310 9%	1,519 45%	22 1%	3,354
No action groundfish								
Nantucket Lightship GF (3,509, #1)	227 4%	1,872 31%	236 4%	16 <1%	543 9%	2,527 42%	646 11%	6,066
Habitat management areas								
Cox Ledge (37, #3-6)	0 -	48 24%	43 22%	0 -	11 6%	96 48%	1 1%	199
Great South Channel East (2,186, #3)	0 -	44 1%	557 17%	141 4%	11 <1%	2,303 69%	279 8%	3,334
Great South Channel (1,518, #4)	0 -	44 2%	538 21%	108 4%	11 <1%	1,694 67%	151 6%	2,545
MBTG section	0 -	0 -	6 2%	11 3%	0 -	276 87%	26 8%	*319*
Clam exemption section	0 -	44 2%	532 24%	97 4%	11 <1%	1,418 64%	125 6%	*2,227*
Nantucket Shoals (1,134, #5)	0 -	175 8%	752 33%	98 4%	43 2%	1,167 51%	74 3%	2,319
Nantucket Shoals, west (1,244, #6)	0 -	529 18%	930 32%	109 4%	43 1%	1,249 43%	76 3%	2,936
Great South Channel Gear Mod Area (1,656, #6)	0 -	0 -	104 5%	59 3%	0 -	1,907 82%	257 11%	2,328
Georges Bank/GSC Region (17,663)	**2,191 4%**	**9,470 19%**	**4,340 9%**	**500 1%**	**6,888 14%**	**22,998 47%**	**2,604 5%**	**48,992**

Area indicates the total areal coverage of the unstructured grids that have their center point within the HMA, and is not the same as the exact size of the HMA.

Map 21 – GSC-SNE: SASI dominant substrate, data support, and vulnerability outputs (trawl gear). Management areas not shown in the upper left panel are from other sub-regions. Red outlined cells on the trawl vulnerability panel are LISA clusters.

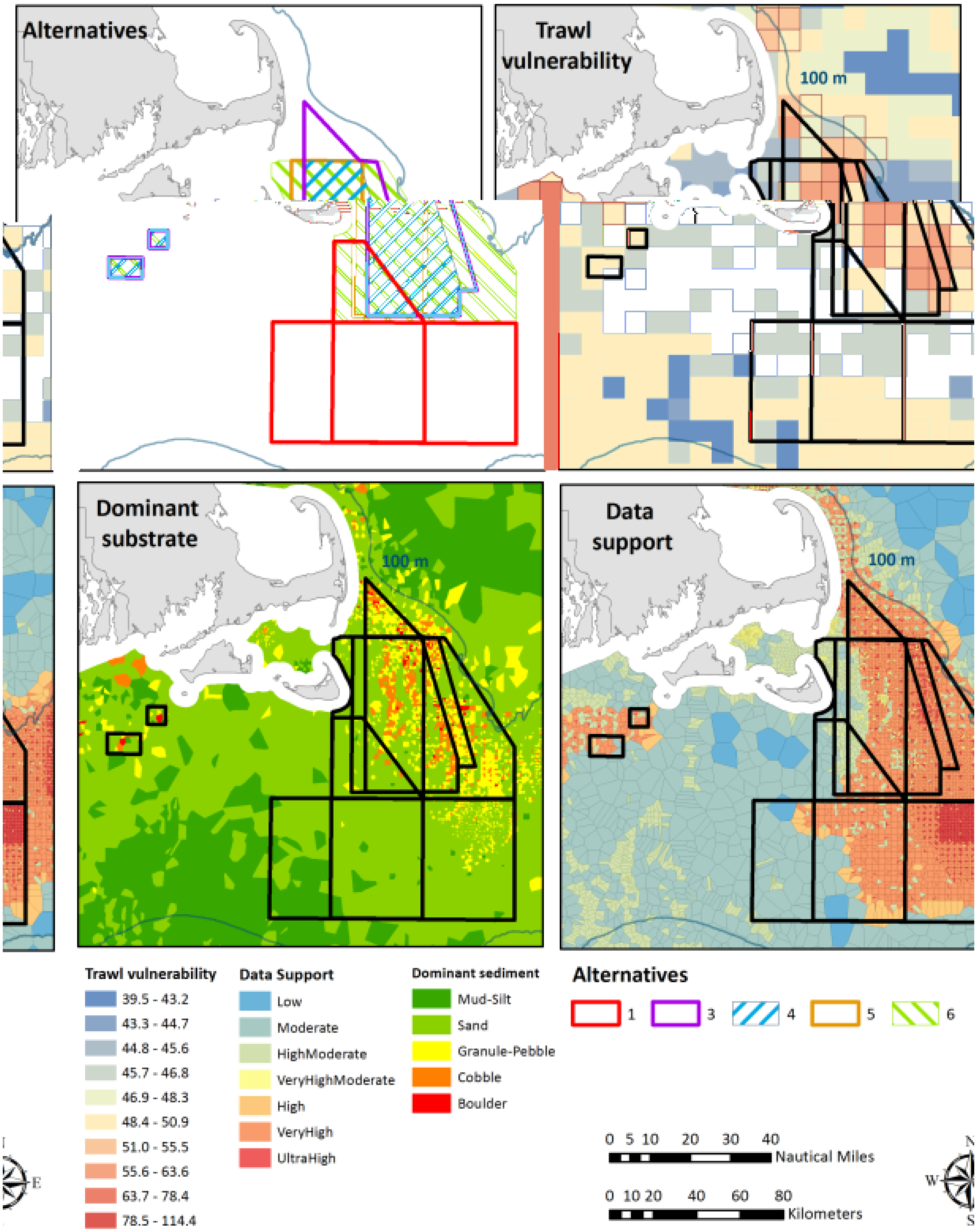


Table 32 – Minimum and maximum mobile bottom-tending gear vulnerability scores for each habitat management area in the Great South Channel/Southern New England sub-region, and the number of structured (10km x 10km) grids overlapping each area (*N*). Blanks indicate that the scallop dredge model domain did not cover the area, because it was beyond the maximum depth fished by that gear.

	Otter trawl			Scallop dredge			Hydraulic dredge		
	Min	Max	*N*	Min	Max	*N*	Min	Max	*N*
Management area									
Nantucket Lightship EFH (#1)	44.4	50.0	*31*	47.1	52.4	*31*	107.2	133.6	*31*
Nantucket Lightship GF (#1)	42.2	49.2	*66*	46.3	51.8	*62*	107.2	136.0	*65*
Cox Ledge (#3-6)	47.0	48.3	*3*	48.8	50.7	*3*	109.1	111.9	*3*
Great South Channel East (#3)	44.4	63.6	*34*	47.1	66.1	*34*	108.3	122.8	*34*
Great South Channel (#4)	44.4	63.2	*26*	47.1	65.5	*26*	108.3	119.2	*26*
Nantucket Shoals (#5)	44.4	63.2	*22*	47.1	65.5	*22*	107.3	119.2	*22*
Nantucket Shoals West (#6)	44.4	63.2	*29*	47.1	65.5	*29*	107.3	119.2	*29*
Great South Channel Gear Modification Area (#6)	44.7	63.6	*20*	47.7	66.1	*19*	109.6	122.8	*20*
GB/GSC region	**41.7**	**72.7**	***486***	**45.7**	**75.9**	**382**	**105.8**	**140.2**	***464***

Figure 13 – GSC/SNE Mean vulnerability scores for bottom trawl and scallop dredge.

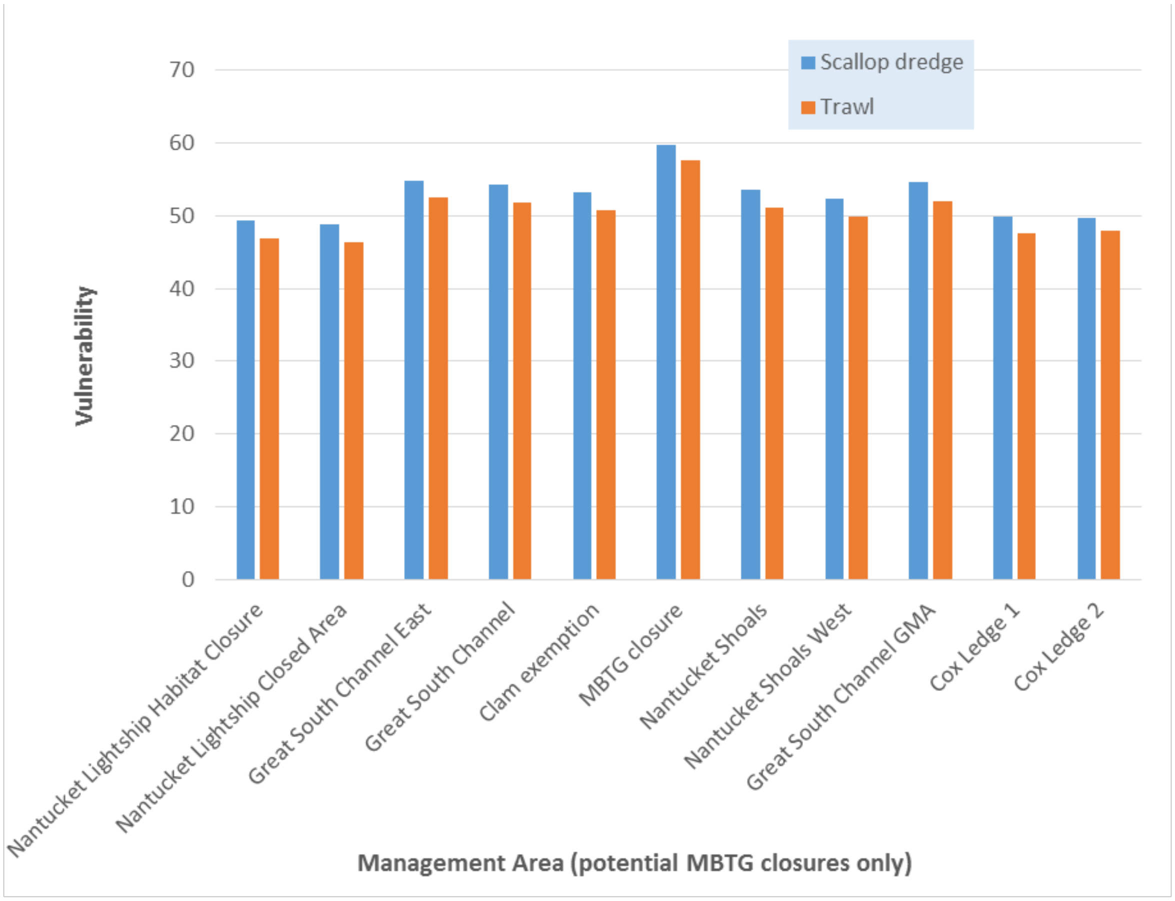


Table 33 – Overlap between Great South Channel HMAs and preferred alternative EFH designations. Species and lifestages in bold italicized type are associated with complex substrate. Juveniles shaded grey were positively weighted in the hotspot analysis. Overfished species are indicated with an asterisk (*). After each management area the alternatives it is a part of are listed in parentheses. Scores correspond to full/high=3, moderate=2, slight=1, none=0.

Species and lifestage	Nantucket Lightship Closed Area (1)	Nantucket Lightship Habitat Closure Area (1)	Great South Channel East HMA (3)	Great South Channel HMA (4)	Nantucket Shoals HMA (5)	Nantucket Shoals West HMA (6)	Great South Channel GMA (6)	Cox Ledge HMA (3, 4, 5, 6)
Acadian redfish juvenile	None	None	None	None	None	None	Slight	None
Acadian redfish adult	None	None	None	None	None	None	None	None
American plaice juvenile	None	None	Slight	None	None	None	None	None
American plaice adult	None	None	None	None	None	None	None	None
Atlantic cod juvenile*	Moderate	Moderate	High	High	High	High	High	High
Atlantic cod adult*	High	Moderate	Moderate	Moderate	Moderate	Slight	**Full**	High
Atlantic halibut - all stages*	Moderate	Moderate	Slight	None	None	None	Moderate	None
Atlantic wolffish - all stages*	None	Slight	High	High	High	High	High	Moderate
Haddock juvenile	Moderate	Moderate	Slight	Slight	Slight	Slight	High	High
Haddock adult	Moderate	Slight	Slight	None	None	None	Moderate	None
Ocean pout egg*	Moderate	Moderate	Slight	Slight	None	None	Moderate	**Full**
Ocean pout juvenile*	Slight	Slight	Slight	None	None	None	Slight	High
Ocean pout adult*	Moderate	Moderate	Slight	Slight	Slight	Slight	High	**Full**

Species and lifestage	Nantucket Lightship Closed Area (1)	Nantucket Lightship Habitat Closure Area (1)	Great South Channel East HMA (3)	Great South Channel HMA (4)	Nantucket Shoals HMA (5)	Nantucket Shoals West HMA (6)	Great South Channel GMA (6)	Cox Ledge HMA (3, 4, 5, 6)
Pollock juvenile	Slight	Slight	Slight	Slight	Slight	Slight	High	Slight
Pollock adult	*None*	*None*	*None*	*None*	*None*	*None*	Slight	*None*
Red hake egg, larvae, and juvenile	Moderate	Moderate	Slight	Slight	Slight	Slight	Slight	Moderate
Red hake adult	Moderate	Moderate	Slight	*None*	*None*	*None*	Moderate	Slight
Silver hake juvenile	*None*	*None*	Slight	*None*	*None*	*None*	*None*	Slight
Silver hake adult	Slight	*None*	*None*	*None*	*None*	*None*	Slight	Slight
White hake juvenile	Moderate	Moderate	Moderate	Slight	Slight	Slight	High	Slight
White hake adult	*None*	*None*	Slight	*None*	*None*	*None*	Slight	*None*
Windowpane flounder juvenile*	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	**Full**
Windowpane flounder adult*	High	High	High	High	High	High	High	**Full**
Winter flounder egg*	Slight	Slight	Moderate	Moderate	Moderate	Moderate	Slight	*None*
Winter flounder larvae and adult*	High	High	High	High	High	High	High	**Full**
Winter flounder juvenile*	Moderate	Moderate	High	High	High	High	Moderate	**Full**
Witch flounder juvenile*	Slight	*None*	*None*	*None*	*None*	*None*	*None*	*None*
Witch flounder adult*	*None*	*None*	*None*	*None*	*None*	*None*	Slight	*None*
Yellowtail flounder juvenile*	High	High	Moderate	Moderate	Moderate	Moderate	High	High
Yellowtail flounder adult*	High	High	Moderate	Moderate	Moderate	Moderate	High	High
Monkfish juvenile	Slight	Slight	Slight	*None*	*None*	*None*	*None*	Slight
Monkfish adult	Moderate	Moderate	Slight	*None*	*None*	*None*	Slight	Slight
Smooth skate juvenile	*None*	*None*	*None*	*None*	*None*	*None*	Slight	*None*
Smooth skate adult	*None*	*None*	*None*	*None*	*None*	*None*	Slight	*None*
Thorny skate juvenile*	*None*	*None*	*None*	*None*	*None*	*None*	Slight	*None*
Thorny skate adult*	*None*	*None*	*None*	*None*	*None*	*None*	Slight	*None*
Barndoor skate – juv/adu	Moderate	Moderate	Slight	Slight	Slight	Slight	Moderate	*None*
Little skate juvenile	High	High	Moderate	High	High	High	Moderate	**Full**
Little skate adult	High	High	Moderate	Moderate	Moderate	Moderate	High	Moderate
Winter skate juvenile	**Full**	High	High	High	High	High	High	**Full**
Winter skate adult	High	High	High	High	High	High	High	High
Atlantic sea scallop - all	**Full**	Moderate	Moderate	Moderate	Moderate	Slight	**Full**	**Full**
Atlantic herring egg	High	High	High	High	Moderate	Moderate	**Full**	Slight
Total score (out of 129)	**65**	**61**	**57**	**48**	**46**	**44**	**77**	**62**
Score for s/l asso/w complex substrate (out of 84)	**44**	**42**	**38**	**34**	**32**	**30**	**55**	**41**
Score for juvs positively weighted in hotspot analysis (out of 18)	**6**	**7**	**9**	**8**	**8**	**8**	**14**	**12**
Score for overfished species (out of 54)	**30**	**29**	**29**	**27**	**26**	**25**	**37**	**35**
Count of species (out of 23)	**18**	**17**	**19**	**16**	**16**	**16**	**22**	**17**
Count of designations (out of 43)	**30**	**29**	**32**	**23**	**22**	**22**	**37**	**27**

Map 22 – Overlap between selected Great South Channel/Southern New England sub-region HMAs and HAPCs.

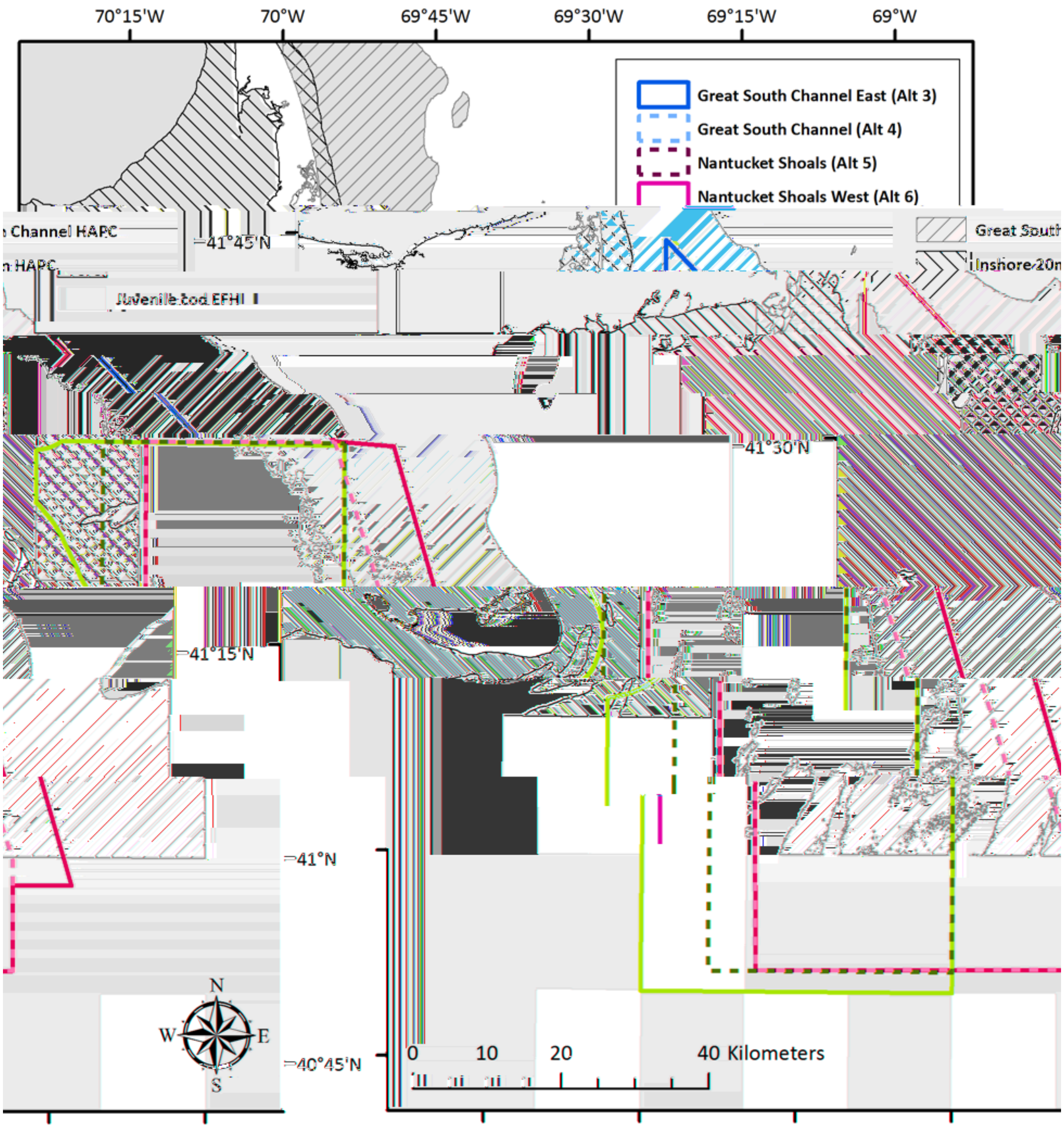


Table 34 – Prey types consumed by species with a relatively high degree of overlap with Great South Channel/Southern New England HMAs. Values represent the percentage of stomach contents, by weight, in the NEMFC food habitats database, 1973-2005. Totals do not equal 100% as some stomach contents could not be identified.

Species	Amphi-pods	Decapod crabs	Decapod shrimp	Bivalves	Poly-chaetes	Echinoderms	Total benthic inverts	Fish	Total Benthic	Total pelagic	Total
Atlantic cod	0	14	5	7	1	1	28	6	34	25	59
Barndoor skate	0	41	12	0	0	0	53	13	66	16	82
Haddock	13	2	3	2	9	23	52	1	53	4	57
Little skate	19	24	10	8	12	0	73	1	74	2	76
Monkfish	0	0	0	0	0	0	0	19	19	30	49
Ocean pout	4	12	0	8	3	67	94	0	94	0	94
Red hake	4	7	24	1	2	0	38	2	40	23	63
Silver hake	1	0	15	0	0	0	16	5	21	50	71
White hake	0	0	8	0	0	0	8	3	11	44	55
Windowpane	15	14	27	0	0	0	56	12	68	6	74
Winter flounder	8	0	0	3	40	0	51	0	51	0	51
Winter skate	8	6	3	15	12	0	44	20	64	7	71
Yellowtail	25	1	0	3	38	0	69	0	69	0	69

Table 35 – Average diversity indices within the Great South Channel/Southern New England sub-region habitat management alternatives. Indices exceeding the 75th percentile for each species group across all habitat management areas in all sub-regions are highlighted (red, large mesh; yellow, regulated species; green, all species).

		Alternative						
		1 Habitat closure	1 Groundfish closure	2	3	4	5	6
Spring	*Tows*	*108*	*245*	*0*	*98*	*40*	*26*	*142*
	Large mesh groundfish ISI	0.348	0.358	n/a	0.343	0.296	0.311	0.325
	Regulated spp. ISI	0.505	0.509	n/a	0.36	0.392	0.413	0.34
	All spp. SDI	1.075	1.123	n/a	1.26	1.36	1.391	1.176
Summer	*Tows*	*48*	*162*	*0*	*88*	*16*	*9*	*157*
	Large mesh groundfish ISI	0.156	0.311	n/a	0.346	0.319	0.345	0.334
	Regulated spp. ISI	0.452	0.352	n/a	0.271	0.407	0.412	0.261
	All spp. SDI	1.158	1.024	n/a	0.93	1.248	1.15	0.924
Fall	*Tows*	*101*	*221*	*0*	*47*	*34*	*24*	*61*
	Large mesh groundfish ISI	0.302	0.292	n/a	0.299	0.281	0.313	0.352
	Regulated spp. ISI	0.428	0.44	n/a	0.536	0.521	0.508	0.576
	All spp. SDI	1.069	1.107	n/a	1.421	1.376	1.356	1.478
Winter	*Tows*	*15*	*35*	*0*	*8*	*5*	*4*	*7*
	Large mesh groundfish ISI	0.356	0.357	n/a	0.416	0.441	0.44	0.404
	Regulated spp. ISI	0.403	0.474	n/a	0.535	0.522	0.518	0.54
	All spp. SDI	1.149	1.225	n/a	1.405	1.535	1.613	1.455

Map 23 – GSC-SNE weighted fish persistence. Source: TNC.

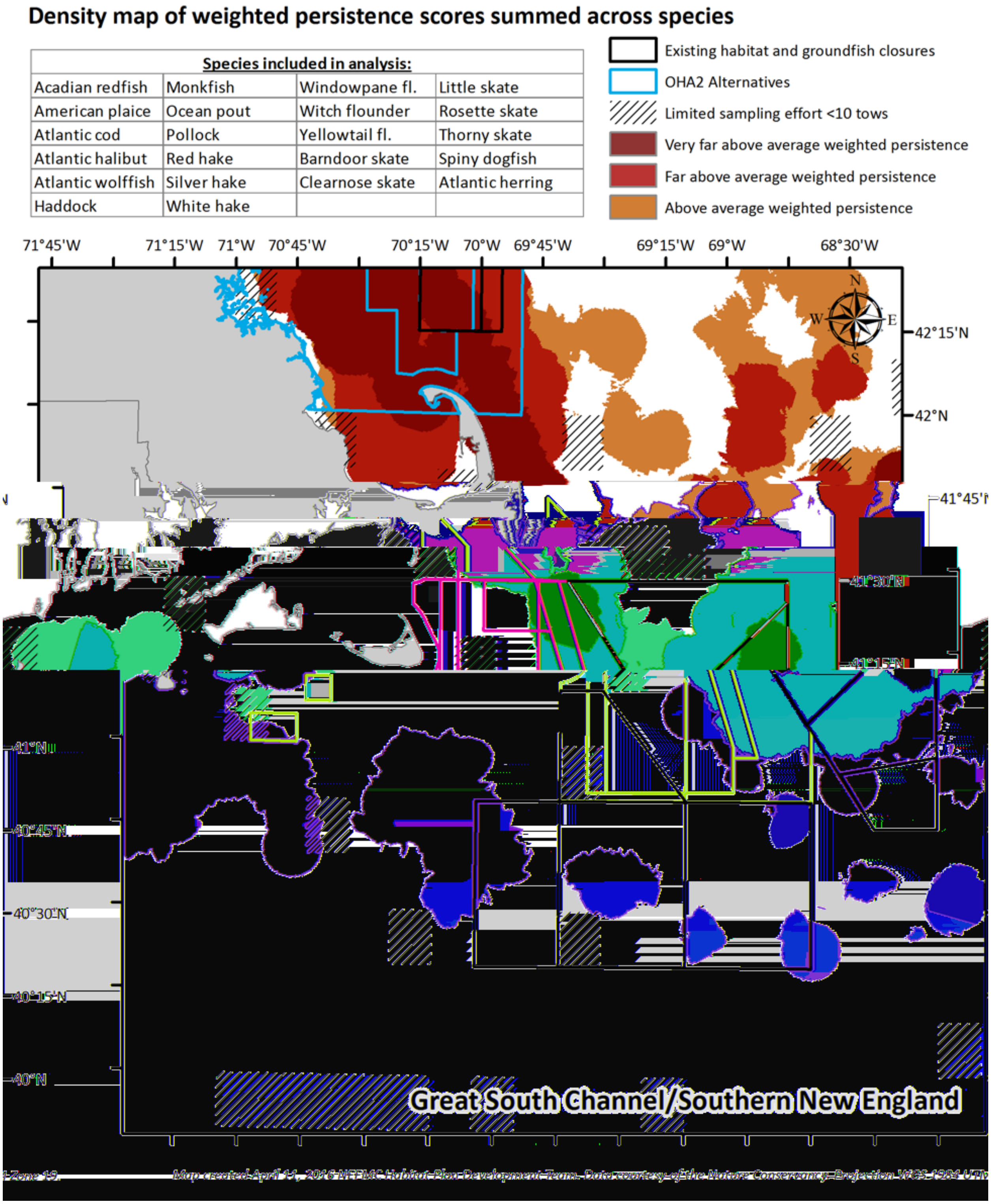
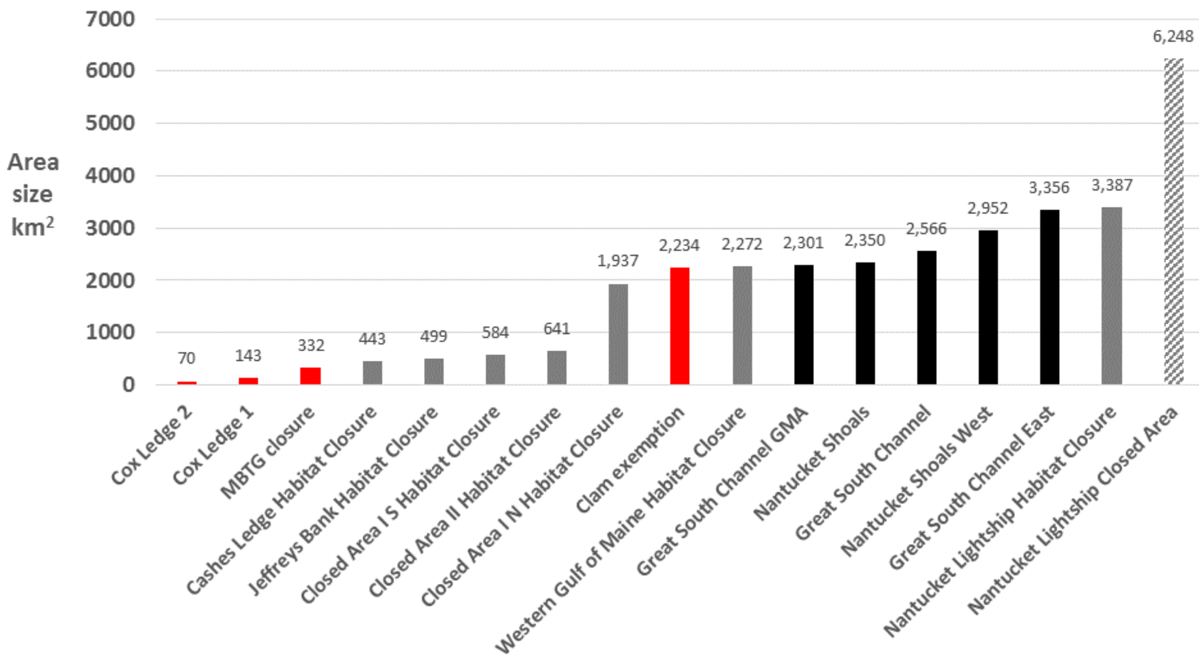


Figure 14 – Size comparison between Great South Channel/Southern New England HMAs (black and red bars, red=preferred) and no action habitat closure areas (grey bars). The Nantucket Lightship Groundfish Closed Area is also shown (hatched).



3.2.5.1 *Alternative 1 (No Action)*

Relative to the various action alternative areas, the Nantucket Lightship Habitat Closure is not as vulnerable to fishing gear impacts (Figure 13), and consists mainly of high and low energy sand-dominated habitats (Table 30) as compared to the various action alternative areas which have higher percentages of gravel habitats. The No Action areas have lower mean vulnerability scores for trawl and scallop dredge gear relative to the action areas (Figure 13). Data support for the sediment map and SASI vulnerability modeling drops off abruptly in the western portions of the two No Action areas where no video survey data were collected (Map 21). The vulnerable habitats are located northeast of the existing closures and, for the most part, are inside the action alternative areas (upper right panel Map 21). The only portion of this alternative currently off limits to mobile bottom tending gear is the Nantucket Lightship Habitat Closure. Scalloping is allowed in the Nantucket Lightship Closed Area east of the habitat area, and clam dredging is allowed in both the eastern and western portions of the Nantucket Lightship Closure Area, so these areas offer limited habitat conservation benefits.

The EFH value of the existing closures is somewhat mixed in comparison with the action alternatives (Table 33). As noted above, the highest EFH overlap scores overall, considering the total score, species associated with complex substrates, juveniles weighted in the hotspot analysis, overfished species, and overall count of species, are associated with the area furthest east, the Great South Channel Gear Modification Area, which is part of Alternative 6. The No Action areas do score well in terms of total score, species associated with complex substrate, and overfished species, but do not have as high a score for species positively weighted in the hotspot analysis as compared to the action alternative areas. Notably, the No Action areas have a lower degree of overlap with juvenile cod and juvenile winter flounder EFH relative to the action alternative areas. Relative to other alternatives in other sub-regions, none of the areas in this sub-region are noteworthy in terms of their species diversity (Table 35). Both the No Action and action areas overlap slightly with areas of high species persistence, but the most notable areas in that analysis are in the northeastern corners of the action alternative areas vs. within the existing closures.

The No Action areas are notable for their very large size; the habitat closure alone is larger than any of the action alternative areas in Alternatives 3-6 (Figure 14). However, in terms of area covered by more vulnerable gravel (granule/pebble, cobble, and boulder) habitat types, the No Action areas perform poorly in comparison with any of the action areas. For example, Cox Ledge HMA has half as much gravel-dominated substrate as the Nantucket Lightship EFH closure, despite being only 6% of the size (Table 30). The preferred alternative HMA, the Great South Channel HMA in Alternative 4, includes approximately 1000 km^2 of these three substrates, while the existing EFH closure has less than 100 km^2 of gravel habitat (Table 30).

To summarize, although the Alternative 1/No Action management areas have a reasonable degree of overlap with designated EFH, they perform poorly in terms of the extent to which they encompass more vulnerable habitat types and areas of above average species persistence. Given that other alternatives proposed in this sub-region have a much greater degree of overlap with these more vulnerable habitat types, the question becomes whether or not the restrictions on fishing in the existing closures are having a net negative effect because they have displaced fishing effort onto more vulnerable habitat types in the sub-region, or if the effects of the closures are generally neutral. Given current patterns of fishing effort, and likely shifts if existing closures are reopened (discussed below), it seems more likely that the existing closures are having a neutral effect.

In terms of bottom trawling, effort is currently concentrated north and east of the action alternative areas, overlapping mostly with Alternative 3/Great South Channel East. It appears unlikely based on current distributions of fishing effort surrounding the existing closures that there would be major shifts from these areas into the current Nantucket Lightship habitat and groundfish closures if they reopen. There could be local effort shifts under Alternative 3, and to a lesser extent, Alternative 4, but Alternatives 5 and 6 do not overlap bottom trawl grounds. Thus, it appears likely that fishing will continue to occur over more vulnerable seafloor types regardless of whether No Action is continued or an action alternative is selected, although some shifts in trawl effort are expected as a result of Alternatives 3 and 4.

Scallop dredging is currently concentrated west of the Great South Channel, generally east of all of the action alternative HMAs except for Great South Channel East. Substantial levels of scallop dredging could occur within the habitat closure in the near future should it reopen, given that a significant recruitment event was observed in that area in the 2014 and 2015 surveys. While the exact yields that may come from that area are uncertain, given that natural mortality rates on young scallops in dense beds can be high, this resource will likely become available to the fishery for the 2018 fishing year, and would most likely be managed as a rotational access area. The heavily fished area west of what is now Closed Area I is managed as an open area with mortality controlled by days at sea limits. Shifting from No Action to one of the action alternatives would most likely lead to a net increase in scalloping in the sub-region, rather than a shifting of effort from the open areas to the new access area. The exception to this might be Alternative 3, which overlaps a large enough fraction of scallop biomass that overall effort in the open areas could decline. Additional discussion of scallop yields in these areas is provided in section 6 of Volume 5.

Prior to 2004, the Nantucket Lightship habitat closure was fished for clams, and the clam survey indicates that there are clam resources in the area (see section 10.2.1 of Volume 5), specifically surfclams in the northern part of the habitat closure, and quahogs to the south. The action alternative areas generally overlap with surfclams only. Shifting from No Action to no closures (Alternative 2) might result in some shifts in surfclam dredging, expanding the area of Natucket Shoals accessible to the fishery, and would likely lead to some renewed ocean quahog dredging in the current habitat closure. Shifting from No Action to any one of the action alternatives with Option 1 would almost certainly result in a net decrease in clam dredging in the sub-region, because the action alternative areas overlap significantly with surfclam grounds.

The SASI vulnerability assessement indicates that sand features in high energy sand habitats (such as those found in the No Action areas) are likely to recover quickly from disturbance, which is why these areas are predicted to be less vulnerable to mobile bottom-tending gear than nearby gravel habitats (see upper right panel on Map 21). Given that the No Action areas are lower vulnerability, effort shifts into these areas and away from more vulnerable seafloor types would have positive impacts, but based on the assessment above for clam dredges, scallop dredges, and bottom trawls, such shifts from more to less vulnerable habitats do not appear likely. Considering these factors, Alternative 1 is likely to be having an overall neutral impact on seafloor habitats in this sub-region, because opening the existing closures is not expected to influence the distribution of fishing substantially.

Because all of the newly developed HMAs in this sub-region (Alternatives 3-6) better encompass vulnerable habitats, Alternative 1 would have negative impacts relative to Alternatives 3-5 if these alternatives are implemented as mobile bottom-tending gear closures (Option 1, and to a lesser extent, Option 2), or relative to Alternative 6, which includes a mobile bottom-tending gear closure and gear modification area. Because the Nantucket Shoals region represents an active fishing ground for surfclams, there are meaningful differences in impacts between Options 1 and 2, with Option 2 having fewer conservation benefits. Depending on the alternative, and the extent to which it would displace scallop dredging and bottom trawling vs. just surfclam dredging, the impacts of Alternatives 3-5 with Option 2 range from closer to neutral to slightly positive, relative to No Action. If gear modification options are selected for Alternatives 3-5 (Option 3 or 4), these alternatives would likely have neutral impacts relative to Alternative 1/No Action. While the net effects of trawl gear modifications on EFH are uncertain, the gear modification options would not restrict clam or scallop dredges.

The No Action areas afford no protection for the habitats within the two HAPCs in this sub-region.

3.2.5.2 *Alternative 2 (No Habitat Management Areas)*

Under this alternative, there would be no specific protection provided for benthic habitats through limits on the use of mobile bottom-tending gears. The No Action areas in this sub-region are not effective in terms of encompassing vulnerable habitats. However, if these areas are removed via Alternative 2, it does not appear likely that effort will shift from more vulnerable habitat types into less vulnerable habitat types. Thus, Alternative 2 is expected to have neutral impact relative to Alternative 1/No Action. Alternative 2 would have negative impacts relative to Alternatives 3, 4, 5, and 6 if Option 1 is selected, because these alternatives would protect vulnerable habitat types used by various managed species from the adverse effects of mobile bottom-tending gear fishing.

If Alternative 3, 4, or 5 is adopted but with Option 2, clam dredging would continue in the Great South Channel/Nantucket Shoals region. Clam dredging constitutes the majority of mobile bottom-tending gear fishing in some of the HMAs, particularly in Alternatives 5 and 6, and to a lesser extent in Alternatives 4 and 3. Alternative 2 is, therefore, likely to have neutral impacts relative to Alternatives 5 and 6 with a clam dredge exemption, and negative impacts relative to Alternatives 3 and 4 with the clam dredge exemption, because other types of mobile bottom-tending gear impacts will be displaced from the Alternative 3 and 4 areas even if clam dredges are exempted from restrictions. The preferred gear restrictions for Alternative 4 are intermediate between Option 1 and Option 2, and therefore Alternative 2 would have negative impacts relative to the preferred alternative. Alternative 2 is expected to have neutral impacts relative to Alternatives 3-5 with Option 3 or 4, because these gear modification approaches allow all mobile bottom-tending gears to still be used, which is similar to a no closure scenario, with possible changes in bottom trawl fishing activity that could lead to a net increase or net decrease in seafloor contact.

Alternative 2 affords no protection for the habitats within the two HAPCs in this sub-region.

3.2.5.3 *Alternative 3*

Alternative 3 includes the Great South Channel East HMA and Cox Ledge HMA. The Great South Channel East is the largest of the action alternative areas in the sub-region at 3,356 km^2, and roughly comparable in size to the existing Nantucket Lightship EFH closure (3,387 km^2). This area also has the largest proportion of cobble- and boulder-dominated habitat, with 17% cobble and 2% boulder coverage and over 600 km^2 cobble and boulder habitat in total (Table 30). Data support is high for 77% of the area, meaning that these larger grain sizes are detectable in the substrate data overlapping most of the management area (Table 31). Greater uncertainty in substrate classification due to lower data support occurs in the western portion of the area (Map 21). Habitat vulnerability in this HMA, and the other action alternative areas, is higher than for the existing Nantucket Lightship EFH closure (Figure 13, upper right panel of Map 21). Of all the action alternatives areas except the gear modification area in Alternative 6, the Great South Channel East HMA has the highest overall score on the EFH overlap metric, and the northeastern corner includes notable areas in the species persistence analysis. Given these attributes, implementation of the Great South Channel East HMA with Option 1 is expected to have a highly positive impact on seabed habitats.

As noted above, hydraulic clam dredges are used frequently in this sub-region as compared to other sub-regions, so their exemption from the HMA restrictions (Options 2, 3, or 4) or not (Option 1) affects the habitat conservation benefits of any particular area. This is different than the situation in the Gulf of Maine sub-regions where the habitat impacts of Options 1 and 2 are generally equivalent to one another due to reduced clam resource abundance and the absence of a hydraulic clam dredge fishery. As shown in the economic impacts sections (4.2.5), clam dredging represents an increasing fraction of overall revenues across all gear types from the Great South Channel East HMA (Alternative 3) to the Nantucket Shoals West HMA (Alternative 6). In some of these HMAs, the adverse effects associated with trawls and scallop dredges are likely minimal given the depth and location of the areas, such that clam dredges generate most of the adverse effects. However, this is not the case for the Great South Channel East HMA, where there is some scallop dredging and bottom trawling which is expected to be displaced outside the area if it is closed to these gears. Thus, Alternative 3 with Option 2 would have moderately positive impacts on habitat, even with an exemption for hydraulic dredges, albeit fewer positive impacts as compared to Alternative 3, Option 1.

Selecting Option 3 or 4 for the Great South Channel East HMA is not expected to have positive impacts on habitat. The trawl gear modifications would not reduce adverse effects associated with clam and scallop dredging, and the net effects on trawl-related adverse effects could increase or decrease, depending on how gear efficiency is affected by the required modifications.

The Cox Ledge HMA is the same for Alternatives 3-6. The two sub-areas in combination are much smaller (213 km^2) than the Great South Channel/Nantucket Shoals HMAs. The southern area overlaps Cox Ledge itself, while the northern area overlaps a feature known as 19 Fathom Bank. The areas overlap the edge of the video survey sampling region as it existed when the SASI base grid was developed, so while the presence of cobble- and boulder-dominated habitats is well known, the actual substrate map is not very well resolved spatially, especially along the northern edge of the 19 Fathom Bank area and the southern edge of the Cox Ledge area. Therefore, while it can be stated confidently that the full range of gravel sizes are present in the areas, the percent coverage of various substrates is not well understood. Adverse effects from various types of fishing occur in these two areas , but lower impact gillnet and trap gears are prevalent in recent years (see section 4.2.5). Designation of the Cox Ledge HMA with Option 1 or 2 would primarily serve to prevent trawl gear impacts. Other mobile bottom-tending gears including scallop dredges, clam dredges, and squid trawls appear to be used to a lesser extent. Designation of the Cox Ledge HMA is expected to have slightly positive habitat impacts if implemented with Option 1 or 2, relative to no habitat management area in this location. These options are probably similar in terms of impacts as hydraulic clam dredging appears to be limited in the area. Designation of the HMA if implemented with Option 3 or 4 is expected to have neutral impacts on habitats, for reasons previously discussed.

Overall, given the habitat characteristics of the Great South Channel East and Cox Ledge HMAs, and the potential for reducing adverse effects on these habitats by displacing mobile bottom-tending gear activity to other areas, Alternative 3, Option 1 would have highly positive habitat impacts, and positive impacts relative to any of the other alternatives considered in this sub-region. Alternative 3 with Option 2 is likely to have positive impacts relative to Alternative 1/No Action, and relative to Alternatives 4-6 with Option 2, but is expected to have negative impacts compared to Alternatives 4-6 with Option 1. Alternative 3 with Option 3 or 4 would have neutral impacts as compared to Alternative 1/No Action, Alternative 2, and Alternatives 4 and 5 with Option 3 or 4. Alternative 3 with Option 3 or 4 would have negative impacts relative to Alternatives 3-5 with Option 1 or 2, and relative to Alternative 6, which includes a mobile bottom-tending gear closure and a gear modification area.

Alternative 3 overlaps somewhat with the Great South Channel Cod HAPC, and would minimize adverse impacts over part of the HAPC if implemented with Option 1 or Option 2. There is no overlap between this alternative and the Inshore Juvenile Cod HAPC, which is mostly in state waters.

3.2.5.4 *Alternative 4 (Preferred Alternative)*

Alternative 4 includes the Great South Channel HMA and Cox Ledge HMA. This is the preferred alternative and therefore a specific set of fishing restriction options have been recommended. In the northeastern corner of the Great South Channel HMA, which represents about 13% of the area by size at 322 km^2, all mobile bottom-tending gears would be prohibited. In the remaining 87% of the area, 2,234 km^2, clam dredging would be allowed for one year following implementation of the amendment, during which time continued exemption in some or all of the area will be evaluated by the Council (a trailing framework is already under development). This amendment, with the one-year clam exemption, continues to allow a fishing activity that is already occurring in the area, and if longer term HMA exemptions are not developed in a trailing action, the area would be closed to hydraulic dredging after one year. Thus, over the long term, the preferred alternative could have impacts similar to a full mobile bottom-tending gear closure, or it could have fewer positive benefits, depending on the extent to which continued hydraulic dredge access is allowed.

The Great South Channel HMA is a subset of the Great South Channel East HMA and overall has a similar distribution of habitat types (i.e. similar percent coverage of cobble and boulder areas, Table 30). Habitat vulnerability is similar between the two HMAs as well (Table 32, Figure 13). The mobile bottom-tending gear closure area in the northeast corner covers approximately 21% of the cobble and boulder dominated habitats in the Great South Channel HMA, or 95 km^2, and about 23% of the granule-pebble dominated habitat (125 km^2). The sediment distribution is shown on Map 14. Sediments are predicted to be more stable in the mobile bottom-tending gear closure (Map 19), with an average sediment stability index of 0.69 (< 1 = stable) vs. an average index of 2.0 in the clam exemption area. Thus, the mobile bottom-tending gear closure portion is relatively more vulnerable to impact than the area where the use of clam dredges would be permitted. However, despite the mobile bottom-tending gear closure portion being well located to encompass a substantial fraction of vulnerable substrate types, there are stable cobble and boulder habitats within the areas that would remain fishable with clam dredges. Specifically, the clam exemption area includes an additional 357 km^2 of cobble and boulder habitat and 425 km^2 of granule-pebble habitat.

As compared with the Great South Channel East HMA, the Great South Channel HMA has somewhat lower EFH overlap analysis scores in all categories (total score, complex habitat-associated species, juveniles weighted in hotspot analysis, overfish species, total species count, total designation count, Table 33). However, the Great South Channel HMA has higher scores than the Nantucket Shoals and Nantucket Shoals West areas. The notable areas in the species persistence analysis with very far above average scores overlap mostly with the portions of the Great South Channel East HMA that are north and east of the Great South Channel HMA (Map 23). There is very little overlap with the Nantucket Shoals and Nantucket Shoals West HMAs. As previously noted, there are very few high species diversity results for the Great South Channel/Southern New England, so this is not a useful metric for comparing across alternatives in this sub-region (Table 35).

On Cox Ledge, the preferred alternative would designate the area as a closure to hydraulic clam dredges, where trawls would not be allowed to use ground cables and scallop dredges would be allowed. Given the relatively small amount of fishing activity within the HMA, this preferred approach has lower magnitude, and less certain, habitat benefits than a mobile bottom-tending gear closure (Option 1), but probably not substantially so.

Overall, Alternative 4 with Option 1 is expected to have moderately positive impacts on habitat. As preferred, this alternative is expected to have slightly to moderately positive impacts on habitat, depending on clam dredge restrictions enacted over the longer term. Given that the habitat types in the Alternative 3 and 4 areas are similar, the smaller Alternative 4 area affords less protection for vulnerable seabed in the sub-region and therefore the positive impacts would be reduced relative to Alternative 3, but still remain positive relative to Alternative 1/No Action, Alternative 2, or any of the alternatives with gear modification options (Options 3 and 4) only.

Alternative 4 Option 2 is likely to have slightly positive impacts on habitat, with positive impacts relative to Alternative 1/No Action, and relative to Alternatives 5-6 with Option 2, but have negative impacts compared to Alternatives 3-6 with Option 1. Because Alternative 4 includes more cobble/boulder habitat than the Nantucket Shoals and Nantucket Shoals West HMAs included in Alternatives 5 and 6, and has a greater degree of overlap with designated EFH, Alternative 4 would have positive impacts relative to Alternatives 5 and 6, if the same options are selected. If implemented with Option 3 or 4, the impacts of Alternative 3 are expected to be neutral relative to Alternative 1/No Action or Alternative 2.

As preferred, with the northeastern corner of the Great South Channel HMA managed as a mobile bottom-tending gear closure, and possible continued exemption for clam dredges in the remainder of the areas, impacts are likely intermediate to Option 1 or Option 2 throughout, i.e. impacts would be slightly to moderately positive. The preferred alternative designates the Cox Ledge HMA as a closure to clam dredges where bottom trawl vessels would not be allowed to use ground cables. In combination, the Cox Ledge measures likely have a neutral to slightly positive habitat impacts within the HMA, but contribute little to the impacts of the alternative overall.

Alternative 4 overlaps somewhat with the Great South Channel Cod HAPC, although to a lesser extent than Alternative 3, and would minimize adverse impacts over part of the HAPC if implemented as preferred. There is no overlap between this alternative and the Inshore Juvenile Cod HAPC, which is mostly in state waters.

3.2.5.5 *Alternative 5*

Alternative 5 includes the Nantucket Shoals HMA and Cox Ledge HMA (2 sub-areas). The Nantucket Shoals HMA overlaps with the Great South Channel East and Great South Channel HMAs, and overall is somewhat sandier than these two areas (Table 30, Map 21). The Nantucket Shoals HMA is a subset of the Nantucket Shoals West HMA (Alternative 6). Given that the Nantucket Shoals HMA is similar in size to the Great South Channel HMA (Alternative 4) but has a lower percent coverage of cobble and boulder habitats, the alternative would afford less protection for vulnerable seabed in the sub-region and therefore has a lesser positive impact relative to Alternative 4 (and 3), but still a positive impact relative to Alternative 1/No Action, if implemented with Option 1 or 2. Alternative 5, Option 1 likely has slightly to moderately positive impacts, and Alternative 5, Option 2 likely has slightly positive impacts. If implemented with Option 3 or 4, impacts are expected to be neutral relative to Alternative 1/No Action, and relative to Alternative 2.

Alternative 5 overlaps somewhat with the Great South Channel Cod HAPC, and would minimize adverse impacts over part of the HAPC if implemented with Option 1 or Option 2. There is also a small amount of overlap between this alternative and the Inshore Juvenile Cod HAPC, which is mostly in state waters.

3.2.5.6 *Alternative 6*

Alternative 6 includes the Nantucket Shoals West HMA as a mobile bottom-tending gear closure, and the Great South Channel Gear Modification Area. The Nantucket Shoals HMA overlaps with the Great South Channel East and Great South Channel HMAs, and overall is somewhat sandier than these two areas (Table 30, Map 21). The Nantucket Shoals West HMA is an expansion of the Nantucket Shoals HMA that extends west to Massachusetts state waters. Given that the area is essentially a larger version of the Nantucket Shoals HMA, but the extension is into sandy, lower vulnerability habitat types, impacts are expected to be similar to those for Alternative 5, Option 1 or 2, i.e. slightly to moderately positive (Option 1) or slightly positive (Option 2). The gear modification component of this alternative has an uncertain but likely negligible contribution to overall habitat impacts.

Alternative 6 overlaps somewhat with the Great South Channel Cod HAPC, and would minimize adverse impacts over part of the HAPC if implemented with Option 1 or Option 2. There is also a small amount of overlap (where depth is less than 20 meters) between this alternative and the Inshore Juvenile Cod HAPC, which is mostly in state waters.

3.3 Spawning protection alternatives

Spawning protection alternatives generally restrict gears capable of catching groundfish. Some of the areas included in the no action alternatives are currently implemented on a year round basis, but all of the areas included in the action alternatives would be implemented seasonally. Seasonal areas generally have a negligible benefit in terms of increasing benthic habitat protection, because any restrictions on fishing would be temporary, and many benthic, structure-forming invertebrates have recovery times exceeding one year, such that more continuous protection from impact would be required to maintain seabed habitat structures. The habitat vulnerability section of the Affected Environment (Volume 1) as well as Appendix D discuss habitat recovery times in greater detail.

Seasonal restrictions on fishing could afford some protection to the habitats used by invertebrate fauna that are a prey source for managed species. (Prey availability and the quality and quantity of prey habitat are elements of EFH). In this way, seasonal closures could provide limited habitat benefits by temporarily increasing the abundance of prey. The amount of benefit would depend on whether episodic prey recruitment events coincided with the duration of the spawning closure. Such overlaps may exist in some areas and in some years since prey recruitment and spawning closures tend to occur in the spring time. There presumably could be a more lasting effect – extending beyond the end of the closure – if prey organisms that recruit to bottom habitats that are undisturbed by fishing during the closure survive in greater numbers than they would have if fishing had continued unabated.

However, recovery of more vulnerable structure forming habitat features from fishing impacts takes longer. Thus, continual protection from mobile bottom-tending gear fishing is needed to best protect structure-forming organisms such as sponges or bryozoans and geological features like cobble piles. Overall, seasonal closures to gear capable of catching groundfish will provide limited if any benefits in terms of protecting seabed structures and enhancing the habitat value that those structures provide to managed resources. The inshore Gulf of Maine areas covered by these closures have vulnerable habitat types, so the potential increases in fishing time could have negative effects. If these management areas were generally in low vulnerability habitats, the conclusion would be different.

3.3.1 Gulf of Maine

3.3.1.1 *Alternative 1A (Regulatory No Action, Preferred Alternative)*

This alternative includes year-round closure of the Cashes Ledge and Western Gulf of Maine closed areas, the Gulf of Maine Cod Protection Areas, and the Gulf of Maine Cod Spawning Protection Area (commonly referred to as the “Whaleback” area). It is similar to 1B except that the months and blocks that are closed in the spring are somewhat different, and additional closure blocks are added during the late fall and early winter.

Because they are closed seasonally, the Gulf of Maine Cod Protection Areas and the Gulf of Maine Cod Spawning Protection Area do not provide positive seabed habitat protection benefits. To the extent that they preclude efficient capture of groundfish aggregated for spawning purposes, they could actually have negative impacts on seabed habitats as fishing time would increase to harvest these species up to their annual catch limits in other locations during the closed season, or within the closure during another season. These impacts are highly uncertain.

In summary, positive seabed habitat impacts of the year-round closure of the Cashes Ledge and Western Gulf of Maine Closure Areas aside, spawning protection Alternative 1A has highly uncertain but likely slightly negative impacts on seabed habitats.

3.3.1.2 *Alternative 1B (Baseline No Action)*

This alternative includes year-round closure of the Cashes Ledge and Western Gulf of Maine closed areas, the sector and common pool rolling closures, and the Gulf of Maine Cod Spawning Protection Area (the "Whaleback" area). It is similar to 1A except that the months and blocks that are closed in the spring are somewhat different, and there are no additional closure blocks added during the late fall and early winter.

Because they are closed seasonally, the sector and common pool rolling closures and the Gulf of Maine Cod Spawning Protection area do not provide positive seabed habitat protection benefits. To the extent that they preclude efficient capture of groundfish aggregated for spawning purposes, they could actually have negative impacts on seabed habitats as fishing time would increase to harvest these species up to their annual catch limits in other locations during the closed season, or within the closure during another season. These impacts are highly uncertain. Further, the magnitude of any impact along these lines associated with the common pool rolling closure areas is likely negligible. The common pool rolling closures apply to relatively few vessels, and therefore have little effect on the overall distribution of fishing effort during the closure months. The sector rolling closures and the Gulf of Maine Cod Spawning Protection Area affect more vessels and therefore have a greater effect on the overall distribution of fishing. The inshore Gulf of Maine areas covered by these rolling closures have vulnerable habitat types, so the potential increases in fishing time could have negative effects. If these management areas were generally in low vulnerability habitats, the conclusion would be different.

In summary, positive seabed habitat impacts of the year-round closure of the Cashes Ledge and Western Gulf of Maine Closure Areas aside, Alternative 1B has highly uncertain but likely slightly negative impacts on seabed habitats.

3.3.1.3 *Alternatives 2A and 2B*

Impacts of the removal of the year-round fishing restrictions in the Cashes Ledge and Western Gulf of Maine groundfish closures are discussed in sections 3.2.2.3, 3.2.2.4, 3.2.3.3, 3.2.3.4, 3.2.3.5, and 3.2.3.6. Seabed impacts associated with maintenance of the existing sector rolling closures and Gulf of Maine Cod Spawning Protection Area may be slightly negative, if these areas lead to increased fishing time because vessels cannot target spawning aggregations. As discussed above, these impacts are highly uncertain. To the extent such negative impacts exist, there would also be slightly negative impacts of designating the Massachusetts Bay Spawning Protection Area.

No difference in impacts between Option A and Option B is expected because seabed impacts of recreational hook and line fishing are assumed to be negligible, such that their prohibition from the areas, compared to an exemption from the prohibition, would not influence the magnitude of habitat impacts.

In summary, moderately negative seabed habitat impacts of removing the Cashes Ledge and Western Gulf of Maine areas aside, Alternatives 2A and 2B have highly uncertain but likely slightly negative impacts on seabed habitats due to possible increased in fishing time.

3.3.1.4 *Alternative 3 (Preferred Alternative)*

As noted above, there could be slight negative impacts of effort displacement associated with designation of the Massachusetts Bay Spawning Protection Area. Thus, in combination with either Alternative 1A or Alternative 1B, the impacts of Alternative 3 on seabed habitats are expected to be slightly negative but are highly uncertain.

3.3.1.5 *Alternative 4 (Preferred Alternative)*

This alternative adds a closure of Block 125 in the western Gulf of Maine during the second half of April. It could be combined with the regulatory No Action Alternative 1A. Given the potential for effort displacement, the impacts of Alternative 3 on seabed habitats are expected to be slightly negative but are highly uncertain. There are no additional impacts relative to Alternative 1B or 2 because these alternatives include closures of this block during the entire month of April.

3.3.2 Georges Bank and Southern New England

3.3.2.1 *Alternative 1 (No Action)*

This alternative includes year round closure of the Georges Bank groundfish closed areas, Closed Area I, Closed Area II, and the Nantucket Lightship Closed Area, as well as a seasonal closure during the month of May. Any impacts to seabed habitats resulting from the May seasonal closure are probably negligible. Restrictions on fishing in this area apply to a small number of vessels, such that the area has limited overall impact on the distribution of fishing effort in the Georges Bank region.

To the extent that year-round fishing restrictions in Closed Area I, Closed Area II, and Nantucket Lightship Closed Area preclude efficient capture of groundfish, scallops, or other fishery resources contained within the closed areas, they could have slightly negative impacts on seabed habitats as fishing time would increase to harvest these species up to their annual catch limits from other locations. For resources that are mobile, and move in and out of the closures, this may be less of a concern, as these fish could be harvested outside the closed area boundaries. For resources that are sedentary, particularly scallops, any increases in fishing time that result from application of these closures could have a greater impact. However, areas within the groundfish closures that have high concentrations of scallops and are not within existing habitat management areas are fishable by the scallop industry on a rotational basis (i.e. rotational access fisheries in central Closed Area I, southern Closed Area II, and eastern Nantucket Lightship Closed Area). Any impacts resulting from inability to efficiently harvest scallops within these habitat closures are more appropriately associated with the no action habitat management alternatives, even though the habitat areas overlap the groundfish areas (see discussion in section 3.2.4.1 for Georges Bank and section 3.2.5.1 for the Great South Channel). The same holds true for possible impacts associated with displacement of the clam fishery in the habitat closed area portion of the Nantucket Lightship Closed Area.

The analyses prepared for Framework 48 to the Northeast Multispecies FMP, as well as the analyses in the economic impacts sections of this document, evaluate the extent to which fishing might be more efficiently prosecuted if the groundfish areas were not closed. While such assessments are difficult to make, it appears that catch rates of groundfish would not be significantly higher inside the closed areas, and therefore you would not expect their removal or conversion to seasonal areas to result in a large reduction in fishing time, area swept, and thereby seabed habitat impacts. However, more flexibility in fishing location would probably result in a reduction in fishing time, not an increase, if we assume that fishermen strive to operate efficiently to minimize their variable costs. Thus, keeping these areas in place year-round via Alternative 1/No Action may have a low negative impactx on seabed habitats. This determination is uncertain, and impacts may be closer to neutral.

3.3.2.2 *Alternatives 2A and 2B*

These alternative remove the Nantucket Lightship Closed Area and May closure, and make Closed Area I and Closed Area II seasonal closures in the late winter and early spring. Direct impacts of the removal of year-round closed areas on the protection of seabed habitats in this region are discussed in 3.2.4.2-3.2.4.8 (Closed Areas I and II), and 3.2.5.2-3.2.5.6 (Nantucket Lightship Closed Area). Option A would restrict commercial gears capable of catching groundfish only, while Option B would restrict both commercial and recreational gears.

To the extent that seasonal implementation of Closed Area I and Closed Area II precludes efficient capture of groundfish, scallops, or other fishery resources contained within the closed areas, they could have negative impacts on seabed habitats as fishing time would increase to harvest these species up to their annual catch limits. In general, it is difficult to predict how spatial and temporal distribution of groundfishing effort would vary if these closures were kept in place seasonally, as this alternative specifies, instead year-round, as in the no action alternative. However, removal of the Nantucket Lightship groundfish closure and the May closed areas, combined with limited seasonal application of Closed Area I and Closed Area II, probably would improve operational efficiency and therefore reduce fishing time, area swept, and seabed impacts, at least slightly.

In summary, the combined changes in area management will result in increased flexibility in fishing location choice relative to Alternative 1/No Action, and therefore Alternative 2 may have slightly positive impacts on seabed habitats. Alternatively, if there are not increases in efficiency and decreases in gear contact with the seafloor, impacts may be neutral. Effects are unlikely to be negative as it can be assumed that fishing would only become more efficient given increased flexibility. These magnitude and direction of these impacts are uncertain and depend on spatial shifts in fishing effot and changes in capture efficiency, both of which are difficult to estimate. Positive impacts to habitats will result if fishing is displaced away from more vulnerable seabed and/or if catch rates increase such that bottom contact time decreases. No difference in impacts between Option A and Option B is expected because seabed impacts of recreational hook and line fishing are assumed to be negligible, such that their prohibition from the area as compared to an exemption from the prohibition would not influence the magnitude of habitat impacts.

3.3.2.3 *Alternative 3A and 3B (Preferred Alternative 3B)*

These alternatives are similar to Alternatives 2A and 2B except only the northern portion of Closed Area I would become a spawning closure. Because Alternatives 2 and 3 are so similar, large differences in impacts between them are not expected, i.e. impacts would likely be neutral to slightly positive. Therefore, Alternatives 3A and 3B are also expected to have slightly positive impacts on seabed habitats relative to Alternative 1/No Action, which maintains additional area closures, most on a year-round basis. As for Alternative 2, the magnitude of these impacts is uncertain.

3.3.2.4 *Alternatives 2 and 3, Option C (Preferred Alternative 3C)*

This option would exempt scallop dredge vessels from spawning closure restrictions and could be selected in addition to either 2A or 2B. If this option is added to any of Alternatives 2A, 2B, 3A, or 3B, there would be fewer restrictions on fishing locations that could preclude operational efficiency, and therefore Option C is expected to generate slightly greater positive impacts on seabed habitats compared to Alternatives 2A/B and 3A/B alone. The overall magnitude of impacts combining Option C with either Option A or Option B is still expected to be slightly positive, at most, and could be neutral depending whether the scallop fishery is authorized to fish within access areas in either Closed Area I or Closed Area II in any given year. Because access to scallop biomass within these closures is granted through the rotational closure/access area system, the total amount of removals from these areas is regulated by an overall possession limit. Thus, decreased seabed contact and therefore positive impacts would be a function of fishing during times when scallop yield per recruit/meat weights are higher, which typically occurs on Georges Bank in the late spring and summer, near the end of the Febuary 1-April 15 spawning closure window. Given the small window of overlap between higher meat weights and the spawning closure, any positive impacts that result from Option C are likely to be small in magnitude.

3.4 Dedicated habitat research area alternatives

Impacts of DHRA designations on the physical and biological environment will mostly be long term, indirect, positive impacts that stem from an improved understanding of the relationship between habitats and fish survival, growth, and reproduction. This may lead to refined management strategies that promote habitat conservation and stock productivity as it relates to habitat. These positive impacts assume that the DHRAs are used to conduct research that relates to the agenda presented in Volume 3; however if they are not, the Alternative 5 sunset provision, would trigger removal.

Because the DHRA boundaries are the same as some of the habitat management area boundaries, the figures, tables, and maps in the habitat management area sections of this document can be referred to for understanding habitat type and vulnerability within each DHRA. Specifically, the Eastern Maine DHRA = Eastern Maine Small HMA, the Stellwagen DHRA = Stellwagen Large HMA, and the Georges Bank DHRA = Closed Area I South Habitat Closure Area.

3.4.1 Alternative 1 (No Action)

Currently there are no DHRAs designated. If none of the candidate DHRAs (Alternative 2, 3, and/or 4) are selected, then no action conditions would continue. DHRAs are expected to focus habitat-oriented research activities on particular topics and in particular locations. DHRAs are also intended to streamline the permitting process, if the proposed research is in line with the DHRA research objectives. Finally, measures associated with the DHRA designations could afford additional research opportunities that may not be available without DHRA designation. Specifically:

- If the Eastern Maine Small area is not designated as a Habitat Management Area with the Option 1 mobile bottom-tending gear prohibition, the DHRA designation would be the only mechanism for establishing these conditions.
- If the Western Gulf of Maine Groundfish Closure Area is removed, the DHRA designation would be the only mechanism for maintaining no action fishing restrictions on gear capable of catching groundfish and on mobile bottom-tending gear use. The reference area element of this DHRA designation is the only mechanism for creating a no-groundfishing area in the New England region.
- If the Closed Area I South Habitat Closure Area is removed and the Closed Area I groundfish closure is converted to a seasonal spawning area, the DHRA designation in this area would be the only mechanism that would maintain the year-round prohibition on the use of mobile-bottom tending gears.

Thus, depending on the other overlapping management areas selected, and the measures applied within those areas, selecting no action could have indirect negative impacts on seabed habitats and greatly impact both ongoing research and opportunities for future targeted research because the appropriate conditions for conducting research will not be created. No Action is not the preferred research area alternative, except within the eastern Gulf of Maine.

3.4.2 Alternative 2

Alternative 2 would designate a Dedicated Habitat Research Area in the eastern Gulf of Maine. The Eastern Maine DHRA is uniformly low energy, but contains a diversity of sediment types including mud, granule-pebble, and cobble according to the sediment classification developed for the SASI model (Table 4). This sediment classification is moderately well supported as the area has only been sampled with grab-sampling technology vs. visual surveys capable of detecting the largest sediments (Table 5). A more accurate depiction of bottom type in the area is the Maine Bottom Type data set (Map 3), although these data only cover the inshore portion of the DHRA. The Maine Bottom Type data depict the inshore portions of the DHRA as consisting of bedrock outcrops interspersed with mud. Ideally, the DHRA would include a full range of sediment types, encompassing sand and finer gravels as well as muds and rock, but sand and gravel are generally less commonly found seabed types in the inshore Gulf of Maine (see additional Maine Bottom Type maps in section 4.2.1.1 of Volume 1).

Compared to the other DHRA alternative areas, the Eastern Maine DHRA has relatively high large mesh groundfish diversity index values (Table 9). In the spring, diversity across all species groups (large mesh groundfish, regulated/managed species, and all species) is higher in the Eastern Maine DHRA than in any other DHRA. The Eastern Maine DHRA is not especially well sampled in other seasons, with only six tows in the fall surveys, two tows in the winter surveys, and no tows in the summer shrimp or scallop surveys. The higher large mesh groundfish diversity values are consistent with the potential for the area to serve as a useful research site for examining groundfish recovery in the eastern Maine region. Groundfish recovery is a key study topic in this region, given recent dam removals and expected associated increases in prey availability that are expected to benefit groundfish stocks over the medium to long term.

In terms of baseline data, the area includes longline survey data collected in a sentinel survey conducted during 2010-2013 (most recently summarized in Chen et al.). The broad scale fish surveys covering the region are the Maine/New Hampshire and NMFS bottom trawl surveys, and the longline sentinel survey is intended to complement these data sets. The main purpose of the sentinel survey is to provide indices of abundance and habitat preference information for groundfish species (i.e. cusk, cod, white hake, and Atlantic halibut) in a traditionally important fishing area not well sampled by other monitoring programs. Depth and sediment appear to be key factors determining the catch rates of cod, cusk, white hake, and halibut. Because the survey uses a combination of jigging (inshore of proposed DHRA) and longline sampling, it is able to sample areas that are difficult to survey with bottom trawl gears (i.e. rocky outcrops). The latter two years of the survey were conducted with a stratified random design, and in 2013 jigging was also conducted at many of the longline stations. Survey protocols have become increasingly standardized over time with 2010 and 2011 considered pilot years.

Designation of the Eastern Maine DHRA is expected to have moderately positive, indirect benefits to seabed habitats via facilitation of research that will improve resource management over the long term. If a DHRA is created in this area in the absence of an overlapping Habitat Management Area, there would be a moderate positive habitat impact. However, the Council's preferred approach is the opposite, i.e. to designate the Small Eastern Maine HMA as a mobile bottom-tending gear closure, and not to designate the area as a DHRA.

3.4.3 Alternatives 3A, 3B, and 3C (3C preferred)

Alternative 3 would designate the Stellwagen DHRA with a reference area along the southern border (Option A), a reference area shifted five nautical miles north (Option B), or no reference area (Option C).

The area is appropriately sited for facilitating habitat-related research, and new studies in this area would build on a large amount of prior work. Due to its close proximity to shore, a diversity of habitat types and marine species, and partial overlap with the Stellwagen Bank National Marine Sanctuary (SBNMS), there have been numerous geologic and ecological studies to serve as a baseline. With funding support from the SBNMS, the U.S. Geological Survey has mapped the area with continuous coverage multibeam acoustics (Valentine et al 2005) and identified boulder ridges using various types of information including topographic and backscatter data, terrain ruggedness index values, and thousands of video and photographic stations (Valentine et al 2005). Some of the boulder ridges are quite large, with the largest tens of meters wide and hundreds of meters long, with a maximum height of 18 m (Valentine et al 2005). The ridges are composed of cobbles and boulders interspersed with voids, and harbor an array of attached organisms as well as various fish species (Valentine et al 2005).

Other studies have focused on the ecology of fishes, their relation to variation in habitat, patterns and variation in biological diversity and the ecological effects of fishing (e.g. Auster et al. 1996, 1998, 2001, 2003b; Auster and Lindholm 2005; Grannis 2005, Kropp et al. 2000, Lindholm et al. 2001, 2007, Lindholm and Auster 2003, Nenadovic 2009, Tamsett et al. 2010). In summary, a diversity of species, including some species managed by the Council, exhibit associations with habitat features at multiple spatial scales (i.e., biologic and geologic structural features of the environment from short lived hydroids to long lived sponges as well as textural elements in fine grain mud and sand to boulders, sediment types based on grain size, and regions and seasons defined by temperature and depth). Direct observation demonstrated that in general, the impacts of fishing gear reduce the structural complexity of biologic and geologic habitats and smooth sedimentary bedforms. Removal of habitat features reduce survival of juvenile fishes in laboratory experiments and can have population level effects if such results are scalable to larger areas. Further, these observations suggest the potential for match-mismatch dynamics between short-lived species that function as habitat or principal prey for juvenile fishes in fine-grain sedimentary habitats. While a good deal is known in regards to habitat associations of fish in this area compared to others in the Northeast Shelf Large Marine Ecosystem, actual linkages between habitat attributes and survivorship, growth and productivity of managed species at the scale that management operates remain to be conducted.

Grannis (2005), Nenadovic (2009) and Tamsett et al. (2010) contain detailed results from the Seafloor Habitat Recovery Monitoring Program (SHRMP) that began in 1998 at the time of designation of the Western Gulf of Maine Closure Area. Time series photographic observations of emergent and epifaunal species in mud, sand, gravel and boulder reef habitats, as well as grab samples of infaunal species in fine grain sediments, from inside and outside the closure were collected (infaunal samples 1998-2004, imagery 1998-2010). Overall, species composition was dynamic across years, habitats and fishing treatments (i.e., inside and outside the closure). That is, while community composition was dynamic due to natural variation, the effects of fishing remain clear. While communities inside the closed area are recovering from disturbance due to fishing, the recovery is not progressing as expected from studies conducted elsewhere. Communities to date have not reached a stable “climax” community state, so it is unclear if communities exhibit predictable succession, or are stochastic such that disturbances produce recovery to a new or different state. In regard to fine grained sedimentary habitats, sand infauna appeared to be most resilient to fishing disturbance in contrast to mud infauna, although both mud and sand epifaunal community structure was statistically different between fished and unfished sites. This project has been (and continues to be) funded by Stellwagen Bank National Marine Sanctuary, which is planning on the project’s long-term implementation.

Benthic habitats in this area have also been surveyed with still and video imagery using various ROVs and submersibles from 1984-2010 (NURTEC video archive), the U.S. Geological Survey SEABOSS system, the School for Marine Science and Technology video and still camera pyramid, and the Woods Hole Oceanographic Institution HabCam system (Howland et al. 2006). Coverage from these image sets and associated data sets varies but these can establish baseline conditions across a diverse set of habitats and over time.

The current management regime in the combined Western Gulf of Maine Groundfish and Habitat Closure Areas limits bottom-tending gear as well as fixed gear capable of catching groundfish (i.e., gillnet, longline). This is why this research area is proposed as a closure to mobile bottom-tending gears and commercial gears capable of catching groundfish, versus a closure to mobile bottom-tending gears only. The preferred habitat management alternative retains both of these areas, with a modification to the habitat closure to align the eastern boundaries, as well as maintaining the exisiting management measures.

The selection of a reference area would add a prohibition on recreational fishing for groundfish. The reference area component specifically (Alternatives 3A and 3B) would allow research that investigates the ecosystem implications of a no-groundfish-take area. In general, aside from the

Ammen Rock HMA which is more restrictive, the most restrictive Habitat Management Area designations proposed in this amendment would prohibit the use of all mobile bottom-tending gear (potentially additional gears capable of catching groundfish in eastern Gulf of Maine Alternative 2), allowing all other forms of fishing. While logical in regards to minimizing adverse effects on EFH, prohibiting only commercial fishing gears constrains the utility of DHRA designations in regards to developing knowledge of use in future fishery management decisions.

In addition, there is no opportunity in such a regime to assess and compare impacts of fixed gears with mobile gears under a range of effort and across habitats (or the synergistic effects of different gears in particular habitats) or assess the effects of removal of species that exert effects on seafloor communities in regards to habitat and prey. Fixed gear impacts, and the effects of fish removals, can be significant based on general understanding from current research, at least at small spatial scales (e.g. Steneck et al 2004). Research that parses effects to particular gears, levels of effort and links responses to community state would produce relatively unambiguous results for use in decision-making in regards to habitat conservation for fisheries objectives. Allowing significant removals only by fixed gears and/or recreational catch would greatly impede work to link habitat condition to productivity of managed species. Despite more than 15 years since the passage of the Magnuson-Stevens Act EFH provisions, we have not significantly improved our knowledge linking the state of seafloor habitats to the productivity of managed species. Existing time series of recovery dynamics in this area are ongoing with no obvious ecological endpoint as yet to understand the dynamics of seafloor habitat recovery in the Gulf of Maine region.

Designation of the Stellwagen DHRA is expected to have positive, indirect benefits to seabed habitats, via facilitation of research that will improve resource management over the long term. Note that the Council recommended retaining both the Western Gulf of Maine Closure Area and Western Gulf of Maine Habitat Closure Area, such that these positive impacts are expected to result from the DHRA designation itself. Alternatives 3A and 3B would have greater positive impacts than Alternative 3C, for reasons noted above.

3.4.4 Alternative 4 (preferred)

Alternative 4 would designate a Dedicated Habitat Research Area on Georges Bank. Seabed types in the Georges Bank DHRA are generally high energy, sand- and granule-pebble dominated (see data for Closed Area I South in Table 24). This area is well-sampled by the video survey so the sediment map developed for the Swept Area Seabed Impact analysis is likely to be an accurate reflection of actual conditions.

Relative to other locations in the New England region, the Georges Bank DHRA has moderate to low diversity indices for large mesh groundfish, regulated/managed species and all species caught in the surveys (see maps and tables in Volume 1, Section 4.2.3). The table in Volume 1 indicates that the Georges Bank DHRA (= Closed Area I South Habitat Closure) is below the 75^{th} percentile for all indices except for large mesh groundfish in the winter survey. This indicates that research conducted in the area will have application to a relatively narrower array of species given these relatively lower diversity indices. Overall, designation of the Georges

Bank DHRA is expected to have slightly to moderately positive, indirect benefits to seabed habitats, via facilitation of research that will improve resource management over the long term.

3.4.5 Alternative 5 (preferred)

This alternative would implement a sunset provision whereby any DHRA designations implemented by the amendment could be removed administratively after a three year period if specific conditions are not met. To the extent that the possibility of administrative removal encourages earlier and/or more active investment in the research areas, it could lead indirectly to positive impacts on seabed habitats. If the sunset provisions are used to remove a DHRA, this could result in a relaxing of fishing restrictions in the area, which might have negative impacts on seabed habitats in the absence of overlapping habitat management area restrictions, and provided that that that the underlying habitats are vulnerable to fishing. Preferred alternatives include designation of the Stellwagen and Georges Bank DHRAs, and the former has overlapping groundfish and habitat management area designations and gear restrictions, while the latter does not. However, the habitat types in the Georges Bank DHRA are generally less vulnerable to impact, such that the effects of the DHRA sunsetting would be neutral to slightly negative.

3.4.6 General impacts of conducting research within DHRAs

Research activities within DHRAs should improve our understanding of the ecological effects of fishing activity across a variety of habitat types, and improve models used to evaluate habitat impacts. DHRAs will facilitate coordinated work amongst various researchers and build upon past studies and baselines. Research conducted within DHRAs could address questions on topics including gear impacts on habitat, habitat recovery, natural disturbance on habitat, and species productivity within habitat areas.

Although the Council supports research that improves knowledge of the seafloor, research activities should not jeopardize the overall goals for habitat protections, particularly within research areas that are co-designated as Habitat Areas of Particular Concern or Habitat Management Areas. Research gear may include mobile bottom-tending gear that may have adverse effects on seabed habitats. More than minimal adverse impacts from research activity within areas designated as HMAs and/or HAPCs should be avoided as much as possible.

This discussion considers potential impacts associated with research conducted in DHRAs and elsewhere in the region. While these impacts are not a direct result of decisions made in this amendment, they are reasonably foreseeable future actions under NEPA, especially within DHRAs.

Permitting process

Currently, scientific research activities are approved or acknowledged by NMFS Regional Administrator through exempted fishing permits (EFPs) or letters of acknowledgement (LOAs) issued to the researcher(s). Certain research activities do not need to obtain an EFP, including research conducted by accredited educational institutions that allow incidental catch of managed species during research activities, and research conducted aboard scientific research vessels. Investigators are not required, but are encouraged, to obtain a letter of acknowledgement for such activities, and must also consult with other applicable laws such as Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA) to determine compliance. Individuals that propose to conduct research activities that would otherwise be prohibited in the regulations that do not meet the definition for scientific research are required to submit for approval to NMFS an exempted fishing permit application, to conduct research in Federal waters. Currently through the EFP/LOA application process, NMFS evaluates proposed research activity for compliance with applicable Federal laws (i.e. MMPA, ESA, NEPA, and Magnuson-Stevens Act, including EFH regulations). The DHRA designation would help to ensure that proposed research activities do not jeopardize habitat management objectives.

Impacts to the seabed

The EFP application review process involves a habitat review that considers whether the proposed research activity would have adverse impacts to the areas designated as EFH. Adverse impacts are those impacts that reduce the quality or quantity of EFH. Substantial impacts to EFH are those impacts that are more than minimal and not temporary. Considerations for impacts to habitat should include the duration of bottom contact (tow speed, length of tows, total number of tows, gear width) and swept area. This is particularly important for gear types that have a greater degree of impact per unit area, such as mobile bottom-tending gears. In addition to the amount of research fishing, an evaluation of a particular project should consider the underlying characteristics of the area where the research is proposed. This could include an evaluation of the geological and biological characteristics of the area, as well as the hydrodynamic characteristics. These factors will influence both the susceptibility of the habitat to impact, as well as the recovery time.

Species removal

Applications for an exempted fishing permit to conduct habitat research should include information on projected estimates of catch for managed species, endangered species, and marine mammals. Impacts to protected resources (ESA-listed species and marine mammals) are considered during consultation with NMFS' Protected Resources Division. Research activity must comply with provisions of ESA and MMPA. The EFP application process typically involves consultation with NMFS' Protected Resources Division through an ESA Section 7 Consultation or a biological opinion.

Disruption of spawning activity

Mobile bottom-tending gear and gears capable of catching groundfish could have adverse impacts on spawning activity during spawning seasons. Spawning season varies by species, and fish aggregate during spawning activity; therefore, species removal would likely increase during spawning season. In addition to increased fish removals, research activity may also disrupt spawning events. Research activity outside of the spawning season are not likely to adversely impact spawning. However, environmental factors such as temperature may affect spawning activity in time and duration, so mitigation measures should be employed when necessary to avoid or minimize disruption of spawning activity within spawning management areas.

4 Human communities

This section describes impacts on the fishing community, with a focus on revenue displacement under various spatial management alternatives, by gear type. Both economic and social impacts are described for each alternative in the sections that follow. Additional discussion pertinent to specific fisheries is provided in Volume 5, along with biological impacts for the resources managed by those fisheries.

4.1 Approach to analysis

This section describes the analytical approach and assumptions associated with the human community impacts analysis.

4.1.1 Economic analyses

Benefit-cost analysis is a tool economists often use to assess management trade-offs such as those contained in this amendment. This type of analysis consists of adding up the discounted flow of expected benefits and subtracting the discounted flow of expected costs to generate an understanding of whether the net benefits generated from an alternative are positive or negative. Put another way, benefit-cost analysis answers the question "do the expected benefits from an alternative outweigh the expected costs of implementation?" In reality, neither the benefits nor the costs of fishery management alternatives can be fully quantified in the rigorous manner necessary for comprehensive benefit-cost analysis. For example, changes in profits are the most accurate assessment of the benefits and costs of area management that accrue to fishermen, as they correspond to producer surplus and true welfare change. Economic tools by which these welfare measurements can be made exist, however the complexity of this amendment precludes their implementation here. In this document, gross revenues generated within a management area serve as an upper bound for the cost of closing areas to fishing. The degree to which this overstates the true costs of closing that area will depend on a fishermen's next best fishing alternative, a choice that is typically difficult to forecast. The analyses in this section do investigate possible alternative fishing location choices, based on current distributions of effort, or, in the case of existing closures, observed catches along closure boundaries.

The previous discussion highlights an issue that is difficult to resolve. Estimates of gross revenue changes, as a result of closing or opening areas, result in very specific, quantitative values. Increases in stock productivity that may result from closures of habitat management areas to specific gear types are not estimated quantitatively in this amendment. When evaluating the economic and biological impacts analysis, caution needs to be exercised so that the lack of a quantitative estimate of biological effects is not interpreted as being an indication of less meaningful impacts.

The benefits of area management to fishermen rely on increases in productivity in managed resources through protection of the most vulnerable and critical fish habitat. As stated in the Purpose and Need (Volume 1) the amendment aims to enhance the role area management plays in achieving optimum yield. Specifically, species productivity is assumed to be enhanced by protecting habitat both important to critical groundfish life stages and most susceptible to adverse effects from fishing. Critical life stages are defined within this document as juvenile and spawning individuals. Section 4.1 of Volume 1 discusses the linkages between habitat and fishery productivity. Although the general role that suitable habitat plays in enhancing recruitment has been established, there are at this time no quantifiable linkages between habitat and productivity. This means that there is no direct estimate of the net difference in the quantity of fish that would be available due to the alternatives under consideration, a critical component of quantifying the expected benefit of area management to fishermen. However, proxy measures are used to assess the relative importance of alternatives in their ability to generate the benefits of interest. Specifically, the Swept Area Seabed Impact model (Appendix D) identifies the relative susceptibility of bottom types to fishing disturbance, and can quantify impacts of current fishing pressure. The groundfish hotspot analysis identifies areas in which significant concentrations of juvenile and spawning groundfish occur. The confluence of these two analyses are assumed to identify the areas most likely to generate benefits in productivity from area management, in terms of groundfish stock enhancement. As noted above, unlike estimates of gross revenues based on current fishing activity, it is not currently possible to translate these benefits into an economic measure.

A number of important assumptions underpin the translation of biological impacts to groundfish into economic impacts to the groundfish fishery, and these warrant specific discussion. First, it is assumed that the SASI and hotspot analyses combine to identify both the most important and the most vulnerable habitat for groundfish productivity. This is likely an appropriate assumption for federal waters, given the scientific review of each approach. However, the SASI analysis/spatial domain does not include state waters, and while the hotspot analysis does include state data, the juvenile groundfish habitat management areas identified explicitly excluded state waters as the result of a policy decision. The exclusion of state waters from proposed management areas was a strategic decision by the Council given the jurisdictional management bounds between state and federal waters. Despite these analytical and policy choices, there is a real potential that effort will be shifted onto habitats in these inshore areas that are even more critical and vulnerable than those identified within these analyses.

The second assumption is that the catch per unit effort is not starkly different inside versus outside alternative management areas. This assumption likely holds in the Eastern and Central Gulf of Maine sub-regions, given their relatively lower concentration of effort and landings, which in turn suggests a more marginal status as productive fishing grounds. This assumption likely does not hold for a subset of alternatives on Georges Bank and the Great South Channel, where the scallop resource is concentrated within some portions of the existing closures. In the Western Gulf of Maine, this assumption likely does not hold for the southern half of the current Gulf of Maine closure, given the high concentration of groundfish landings and effort in statistical area 514. Maps in the large mesh groundfish fishery section 4.3.1.2 in Volume 1 provide a sense of the distribution of groundfish landings and observed effort in this sub-region. It is not possible to test how poorly the assumption of equal catch per unit effort approximates reality in the Western Gulf of Maine sub-region given existing data, and the final trade-off depends on both the size of effort shifted and catch per unit effort, which are also unquantifiable. Nevertheless, properly sited management areas should lead to a net positive impact on the groundfish fishery though improvments to groundfish stocks. It is important to note that the habitat damage function assumed in the SASI model influences this determination. The SASI model assumes a linear damage function, which implies that units of fishing effort and associated habitat impact are additive and equal to one another in their effects on habitats and stocks that use those habitats. However, it is possible that the initial passes of fishing gear in an area are most damaging, or that, conversely, impacts of fishing are most important once a threshold level of activity is reached, such that there is a tipping point beyond which the effects of fishing on the seabed are more important. A final assumption is that productivity gains from spatial management are beyond what is achievable through existing mortality controls alone.

The overarching assumption within the economic analysis is that all these underpinning assumptions hold, and productivity gains directly correspond to future economic benefits of a commensurate magnitude. For example, a highly positive impact on groundfish productivity is assumed to generate a highly positive future impact on the groundfish fishery by increasing the rate of recruitment to the fishery and thus increasing the revenue generated by fishermen. Conversely, a highly negative impact on groundfish stocks is assumed to translate into highly negative future impacts to the groundfish fishery.

Benefits and costs of management decisions do not only accrue to fishermen. Society benefits more generally from both habitat protection and increased groundfish productivity, and is potentially negatively impacted by decreases in seafood availability, which could occur due to area exclusions, or might be influenced in the longer term via habitat management choices that reduced stock production. These benefits are extremely hard to quantify. For example, Wallmo and Edwards (2008) find 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 Rutstrom 2008).

Impacts of area management ripple through the economy, with effects on suppliers of fishermen, including gas stations, bait and ice suppliers, and other service providers. Additionally, after the first point of sale, a host of other related industries, including seafood retailers, restaurants, transportation firms, and all of their suppliers, are also impacted by area management decisions. Again, the lack of direct measures for the exact changes in landings, as well as the sheer number of area management permutations under consideration and fisheries affected within this amendment, preclude any discussion of these second-order impacts.

Consumers of fish would also benefit from increased groundfish productivity and may be negatively impacted by decreases in the supply of fish. 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. See Lee and Thunberg (2013) for 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.

The economic impacts of amendment alternatives thus represent a partial analysis using proxies for the true benefits and costs expected to accrue solely to fishermen. This naturally abstracts away from the broader societal benefits one would calculate under optimal circumstances.

The final piece of information necessary to estimate net benefits is a manner in which current costs and benefits can be compared to future costs and benefits. In economics this is achieved through selecting an appropriate discount rate, which casts current and future costs and benefits in terms of their present value. See Arrow et al. (2013) for a clear explanation of the reasoning for, assumptions underlying, and difficulty in choosing discount rates. Given that we have only proxies for the benefits and costs of area management, and that these proxies are highly qualitative, discounting is not possible in any rigorous manner. In this analysis, expected benefits and costs are therefore broken into short term and long term timeframes, without any netting between the time horizons. Timeframes here are defined differently than the short-run and long-run definitions traditionally used in economics. In this analysis, we use short term to identify the timeframe between the present and the full realization of the impact of the areas, while the long term starts when the full impacts are realized and continues indefinitely. For some alternatives this is not problematic, in that the sign of the impacts (positive or negative) are the same in both the short term and long term. However, for other alternatives discounting could play an important role in whether the net benefits are positive or negative. This is especially true when the magnitude of benefits and costs are large, and differ in sign between the short term and long term timeframes. In these circumstances, an explicit discussion of the role discounting could play is incorporated in the economic impacts of alternatives.

A number of steps taken for the sake of brevity are discussed here for completeness. Conflicts between different gear types as fishing effort shifts in response to changes in area management are an important concern for many stakeholders. Although not universally addressed, a discussion of potential increases or decreases in conflict is incorporated into alternatives with large expected shifts in effort. After a very brief overview of the census of fishing occurring in and/or around areas of concern, the economic analyses focus on gears and modes (i.e. recreational vs. commercial fishing) directly impacted by the Options under consideration for a specific alternative. This means that if a gear type or fishing mode is not identified and discussed directly, it is not directly managed under the specific Options being considered.

The magnitude of expected impacts for an alternative are relative to all other alternatives being considered within the Omnibus Amendment, in order to ensure consistency and comparability across sub-regions. Each alternative also identifies the total revenue generated by a specific gear type, as well as the percentage of community level revenue currently being generated within the areas encompassed by an alternative, in order to understand any differential impacts of alternatives and Options. Area management is ultimately implemented by restricting specific gear types from fishing in areas of concern. The economic analysis therefore focuses on impacts at the gear level. However, the Fishery Management Council system is structured by Fishery Management Plan, which considers individual stocks or stock complexes. Where differential impacts between species/FMP are clear, these are highlighted within the discussion of relevant alternatives.

The economic analysis is comprised of four main components. The first uses Vessel Trip Reports (VTR) and Clam Logbooks to identify the magnitude and composition of fishing revenues in areas currently open to fishing but being considered for area management in this amendment. The second uses the spatial data from the Vessel Monitoring System (VMS) polls to refine the estimate of fishing effort in area alternatives currently open to fishing, for those boats currently utilizing the VMS system. The third analyzes revenue currently being generated in each of the areas being considered for management by party and charter recreational vessels (this analysis does not include private recreational effort). The fourth looks at observed hauls adjacent to currently closed areas to assess the types of effort shifts that might be expected with a reopening of these areas, e.g., increased opportunities for harvest of particular stocks.

Given that this action has the potential to affect all federally managed FMPs, it is important to develop as complete a picture as possible of the spatial distribution of fishing effort by gear type. The self-reported VTR and Clam Logbook datasets have spatial fishing locations for federally managed fisheries within the New England and Mid-Atlantic regions, with individuals reporting a single spatial position that looks to represent the totality of fishing conducted on a trip. For reporting purposes these trips are defined as a single statistical area/gear combination, with individuals required to report a new VTR whenever either the gear or statistical area fished changes. Previous studies have identified that the self-reporting underreports these switches in gear and statistical area (Palmer and Wigley 2007, 2009). Furthermore, given that commercial fishing trips can be quite long, a single spatial point is unlikely to adequately represent the actual footprint of fishing on any given trip. Because of this, a statistical approach was developed for this amendment in order to better represent the footprint of fishing associated with the self-reported spatial data point.

The New England Fishery Observer Program (NEFOP) database records the spatial potion of haul/set beginning and end points. Fishermen file VTRs regardless as to whether they are carrying observers or not. By joining the observed haul positions with the VTR data, the cumulative distribution function (cdf) of the distance between observed hauls and self-reported VTR points can be estimated. Furthermore, this cdf can be modeled as a function of variables that are reported on all VTRs. This means that the model estimates the probability that all the hauls associated with a trip fall within a given distance from the self-reported VTR location, as a function of variables that would be expected to influence the actual footprint of fishing. For example, it is likely that longer trips have hauls dispersed across larger geographical areas when compared to shorter trips. This in turn means that the VTR locations are less and less representative of the spatial footprint of a trip's fishing activity as trips increase in length. The model can then be used to estimate confidence intervals for the fishing footprint of each and every VTR point in the database, regardless of whether it was observed through the NEFOP program. This allows for a more realistic spatial footprint of trips to be represented, which in turn provides a better understanding of the fishing occurring in and around areas being considered for area management.

The cumulative distribution function was estimated using a three parameter gamma distribution (location = mean, shape = kappa, scale = sigma), which outperformed alternative specifications including log-normal and exponential functions, as determined by Akaike's Information Criterion. Regression results can be found in Table 36.

Table 36 – Estimation of gamma distribution cumulative distribution function, for distance between observed hauls and self-reported VTR fishing location

Variables	Haul Distance Regression
Drift Gillnet	-0.521***
	(0.118)
Longline	-0.663***
	(0.0950)
Midwater Trawl	-0.333***
	(0.0886)
Scallop Dredge	-0.870***
	(0.0415)
Sink Gillnet	-0.382***
	(0.0526)
2 day trip	0.304***
	(0.0519)
3 day trip	0.717***
	(0.0562)
4 – 6 day trip	1.008***
	(0.0495)
7 – 8 day trip	1.171***
	(0.0522)
9 – 10 day trip	1.370***
	(0.0569)
11 – 14 day trip	1.609***
	(0.0602)
15 – 16 day trip	1.702***
	(0.0954)
17 + day trip	1.887***
	(0.127)
Non - S. NE/Mid-Atlantic	-0.124***
	(0.0343)
Constant	0.906***
	(0.0492)
ln(sigma)	0.287***
	(0.00625)
kappa	-0.0371*
	(0.0214)
Observations	417,535

Robust standard errors in parentheses, clustered at the permit level
*** p<0.01, ** p<0.05, * p<0.1

Gear type and days absent explain a large portion of the variability in reporting accuracy, as would be expected, while the area fished (Mid-Atlantic versus New England) has a small but significant effect on the estimated spatial footprint of a VTR trip. The parameter estimates were then used to estimate the 25th, 50th, 75th, and 90th percentile confidence intervals for all the VTR points from calendar years 2005 to 2012.

In order to assess the relative impact of area management alternatives, these confidence intervals were linked to trip-level gross revenues, generated from the VTR reported landings using a monthly average price at the four-digit NESPP4 species code (i.e., species plus market category). This revenue was then attributed spatially, assuming a uniform distribution for each confidence interval (25 percent of the revenue generated from each trip was attributed to that trip's 25th, 50th, 75th, and 90th percentile rings respectively). Although still an abstraction from reality, the distribution of revenue from a trip based on the statistical analysis of that trip's spatial footprint is more realistic than, and thus an improvement over, attributing all of a trip's revenue to a single point. Areas where fishing is known not to occur, for example on land, or bottom trawl effort within existing habitat management areas, were erased from the spatial footprint of a given trip. Finally, revenue was attributed to each area management alternative by taking the percentage of the confidence interval rings falling within a given alternative, on a trip-level basis, and summing across all trips. Impacted revenue is thus a combination of the percentage of a trip's footprint estimated to occur within a region, and that trip's total revenue, summed across all trips. A low per-trip revenue estimate can thus be driven either by a low probability that a trip occurred in a region, a low total trip revenue, or a combination of the two.

Data from 2005 – 2012, broken into three, five, and 8 year time horizons, are presented in the VTR analysis. An eight year window was chosen to ensure focus was maintained on the most recent years, which is most analogous to the current biological and managerial environment, while still providing a sense of historical trends. The comparison of three separate time horizons highlights these longer term trends in the data.

The VTR analysis provides a high level overview of the types, and relative magnitude, of fishing occurring in management alternatives currently open to fishing. However, as previously mentioned it serves as an upper bound for the actual cost of a management alternative, and likely overestimates the final cost of a management alternative. A more refined spatial dataset exists in the form of VMS, which was used where available to provide a complementary analysis of fishing effort. Records and Demarest (2013) estimated a logit model which assesses a conditional probability of fishing, based on trip characteristics (including vessel size and primary gear used on trip) and VMS poll (including imputed speed, depth, depth change, and distance to known fishing hotspots). This model can then be used to assess the probability-weighted effort associated with each VMS poll. This approach was used to develop a complementary estimation of fishing effort by management area for those trips monitored by VMS and classified as Limited Access Scallop fishery, the Limited Access General Category Scallop fishery, Shrimp Trawl fishery, and Bottom Trawl fishery. It is important to note that 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.

Recreational party and charter fishing was assessed using VTR data. Unlike the treatment of the commercial data, recreational VTR was analyzed using the traditional inside/outside approach. This means that if a VTR latitude/longitude position falls within an area of interest, the entirety of that report's gross revenue is attributed to that area. Although the caveats to this type of analysis previously highlighted still apply, party/charter recreational trips are not subject to observer monitoring, and thus a more rigorous analysis of their spatial footprint is not possible at this time. The revenue itself is generated as a function of the number of anglers reported to have fished on the VTR, because revenue in the charter/party fishery is a function of the number of paying customers on a given fishing trip. Average revenue per paying angler was estimated for each state from which recreational trips embarked, using NOAA's Marine Recreational Information Program (MRIP) data. A value for a trip was then generated by multiplying the state-specific average revenue per paying customer by the number anglers reported to have fished on the VTR. There is no trip by trip location data for private recreational fishing activity, so private recreational trips are not included in the recreational revenue analyses and it is not possible to use the analyses in this document to understand potential impacts on private recreational fishing activity.

Current management areas are subject to varying exclusions, exemptions, and regulations. Thus, it is not enough to just look at what fishing is currently being conducted if the goal is to characterize potential fishing activity should an area re-open. Observer data from both the At-Sea Monitoring and NEFOP programs from the waters adjacent to current closures were used in order to assess the net impacts expected to arise from the management alternatives under consideration. The data analyzed consisted of all haul and set beginning and end points falling within a ten nautical mile buffer of currently closed areas, a distance consistent with analyses previously developed for Northeast Multispecies Framework 48. Monthly average revenues by species were estimated by summing across all haul/set events. All species contributing > 5% of a haul's revenue in a single month were reported, in order to understand the potential for seasonal changes in species importance to a given gear type. The dominant species within these areas are then evaluated qualitatively in terms of their likelihood of generating additional benefits to fishermen. The analysis assumes that species composition within closed areas is similar to adjoining waters.

For each alternative, concluding statements related to net impacts rely on these four analyses, combined with impacts described in other sections of the document, especially impacts to groundfish and the scallop resources. Of particular importance were Scallop Plan Development Team analyses to estimate the costs and benefits of area management alternatives within Georges Bank, primarily in the Great South Channel and along the northern edge where there is significant sea scallop biomass and fishing effort.

The impact of alternatives is delineated by vessel length, in order to better understand the segments of the fishery most affected by each alternative. Vessels were binned into small (<50 ft), medium (50 ≥ ft and < 70 ft), large (≥ 70 ft) and unknown categories, when possible. These length categories are frequently used for analysis across fisheries (see for example, Steinback and Thunberg 2006; Georgianna, Cass, and Amaral 1999). These length categories differ slightly than those most recently used for the groundfish fishery. However, the < 30 ft category used in the groundfish fishery only contained 48 active vessels in 2012, and vessel categories differ across FMP, including the use of gross tonnage instead of length categories. Given the lack of universal standards applied within the Council, the vessel categories chosen are consistent with previous research conducted across all fisheries.

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. The economic analysis in the Omnibus Amendment is thus aggregated to at least three reporting units, in order to preserve confidentiality. Any data with less than three reporting units is censored to comply with this federal law.

4.1.2 Social impacts analyses

National Standard 8 of the MSA demands that "Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of over fishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities" (16 U.S.C. §1851(2)(8)). The current interpretation of National Standard 8, as described in the National Standard Guidelines (50 CFR part 600.345), 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. *Sustained participation* is interpreted as continued access to the fishery within the constraints of the condition of the resource. NMFS interprets National Standard 8 only as a consideration of continued overall access to fishery resources and not as 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. In general, the social impacts anlaysis, similar to the economic impacts analysis, focuses on fishing communities, and not on the welfare of the public more broadly.

The need to measure, understand and mitigate the social impacts of fisheries management is an essential part of the management process. Managers have an obligation to consider how policy changes affect the human context of the fishery, including the direct and indirect impacts on the safety, wellbeing, quality of life, fishery dependence, culture, and social structure of communities. These impacts can be felt at the individual, family, and community level which can make measuring and considering them difficult as the impact variables are typically differentially distributed. There is general consensus however, as to the types of impact to be considered, the section of the human environment where the impacts may be felt, likely social impacts, and the steps to enhance positive impacts while mitigating negative ones (ICPGSIA, 2003).

A fundamental difficulty exists in attributing social change to specific factors, such as management regulations when communities or other societal groups are constantly evolving in response to numerous additional external factors, such as market conditions and technology. Increasingly important influences in coastal communities include demands for recreational uses of the waterfront and tourism. Certainly, fishery management regulations influence the direction and magnitude of social change, but attribution is difficult with the tools and data available. Attribution is particularly difficult considering the dynamic and fluid nature of fishing communities. As a result, while this assessment focuses generally on the social impacts of the proposed fishing regulations, it is recognized that external factors are also influencing 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.

Broadly defined, social impacts that need to be considered are the "social and cultural consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society" (Burdge and Vanclay 1995). Identifying possible social impact variables is a topic of much debate, but the development of standard definitions for a set of the most common and consequential social impacts are underway. The current NMFS "Guidelines for Social Impact Assessment," provides some assistance in defining relevant social factors/variables. It is suggested that the following five social factors/variables should be considered when comparing the preferred management alternative to the alternatives not selected:

- The *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.
- The *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.
- The 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.
- The *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.
- The *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 new surveys currently being implemented will begin to alleviate this. The academic literature provides multiple lists of potential social variables, but such lists should not be considered "exhaustive" or "a checklist" (ICGPSIA, 1994; Vanclay, 2002; Burdge, 2004).

The analyses in this amendment evaluate 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 it is possible that the social impacts of some measures under consideration will be experienced solely by one community group or another, it is more likely that some 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 when there are multiple overlapping management measures, such as in this proposed action. There is also a wide variation in the acceptance of area closures among stakeholders based on the intended goals (reduce bycatch, protect spawning aggregations, protect habitats, etc.) of a possible closure and its duration (temporary, seasonally recurring, or permanent) (Pita et al. 2011). 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. In the discussion below, the general attitudes of the non-fishing public are described.

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 will indicate the likely directional impacts of specific measures e.g., positive, negative, or neutral. 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.

4.1.2.1 ***Habitat management alternatives***

There are numerous social impacts associated with the habitat management alternatives. While each alternative includes distinct elements, impacts can be associated with four general actions: 1) maintaining the status quo/the no action alternative, 2) opening or modifying previously closed areas, 3) closing new areas, 4) gear modifications/exemptions. This section provides a discussion of the social impacts that are most likely to result from these four management tools.

Maintaining the Status Quo

The No Action alternatives would result in mainly neutral impacts as they would maintain the status quo. There may be some positive social impacts associated with the stability created by continuing current management strategies that allow for fishermen to keep consistent, long-term plans. In scenarios where there are currently no closed areas there could be possible small negative social impacts on the *Attitudes, Beliefs, and Values* of the fishermen regarding management if they see this alternative as a missed opportunity to implement new management that could help improve fish populations. These negative impacts on the *Attitudes, Beliefs, and Values* of the fishermen may also occur in scenarios where the no action alternative will maintain current closed areas. In informational interviews conducted by the Council, fishermen questioned the success of the current closed areas, citing the continued decline of many groundfish stocks.

Moderate, indirect positive impacts on the *Attitude, Beliefs, and Values* of the non-fishing public who are concerned with the management of the ocean and living marine resources are expected from the majority of the status quo alternatives, when compared to the action alternatives that reduce the square mileage of closed areas. However, moderate, indirect negative impacts on this segment of society may also occur in scenarios where the *status quo* does not improve fisheries management or general ocean conditions as well as the action alternatives.

Opening previously closed areas

There are also a number of social impacts associated with opening all or a portion of a previously closed area. Opening additional areas for access to fishing can create opportunities for increased catch and revenue, leading to increased occupational opportunities and positive impacts on the *Historic and Present Participation* as well as the *Size and Demographics* in the affected fisheries. Fishermen often comment that once areas are closed, they are never opened again, so the opening of previously closed areas may have a positive impact on the *Attitudes, Beliefs, and Values* of fishermen regarding the flexibility of management. Additionally, opening areas for fishing allows fishermen more flexibility in their harvesting behavior. This can have positive impacts on the *Non-Economic Social Aspects* of the fishing industry as it allows harvesters more freedom regarding when and where they fish, which may allow them to take fewer risks, fish more safely, and create schedules that are less constrained.

The increased flexibility in harvesting behavior associated with opening closed areas can also have positive social impacts on *Social Structures and Organizations* by relieving congestion and conflict associated with concentrated fishing efforts along the edges of closed areas. When the original seasonal and year-round groundfish closures were implemented in the Gulf of Maine, the shift in otter trawl fishing effort was highly concentrated to the borders of those closed areas (Murawski et al 2005). The shift in effort in an attempt to "fish the line" has been shown to be part of an optimal fishing strategy capitalizing on the biological "spillover" from a closed area (Kellner et al. 2007). Because closed areas do not reduce fishing effort, they only displace it, (Halpern et al. 2004, Greenstreet et al. 2009) the subsequent concentration of effort localized at the boundaries of closures can lead to crowding and gear conflicts among fishermen (Suuronen et al. 2010). Re-opened closed areas would conversely reduce congestion next to these areas and remove the incentive to fish around the area's boundaries since the vessels would no longer capitalize on the biological "spillover." Relieving this congestion and conflict would have a positive social impact on *Social Structures and Organizations*. If the existing closed areas are seen as benefiting a particular segment of the fishery at the expense of another, their removal will also have a positive impact on *Social Structures and Organizations* through the increased perception of fairness across fisheries.

There are potential negative social impacts as well. First, if the current closed areas are improving fish stocks, creating a spillover benefit into fishable areas, this benefit is lost. Second, there is the potential for gear conflicts resulting from opening closed areas. Some gear types have been exempted from current closure areas and the addition of new, competing gears may cause conflicts between user groups which can exacerbate intra- and intercommunity conflicts, create additional perceptions of inequity, and weaken overall cohesion within communities. These conflicts can occur within a gear type as well, if the perception of larger available catches in a newly opened area creates a derby fishery, resulting in intense fishing effort concentrated in the area, landings that are too high, in too short a time period, causing lower prices and a waste of quota.

Minor to moderate, indirect negative impacts on the *Attitude, Beliefs, and Values* of the non-fishing public who are concerned with the management of the ocean and living marine resources are expected from the action alternatives, if the belief is that a larger amount of closed area is better for marine conservation. However, minor to moderate positive, indirect impacts on this segment of society may also occur in scenarios where the action alternatives provide equivalent or improved habitat protection (by shifting from less vulnerable to more vulnerable habitat), even in less area.

Closing new areas

Closing areas that are currently available to fishing will have numerous social impacts across various fisheries and communities. The most direct impacts will be on vessels currently fishing in these areas that will no longer have access due to the closures. The addition of new habitat closed areas would force mobile bottom-tending gear users to modify where and how they fish, having a negative impact on the *Historic and Present Participation* in the affected fisheries. This would also have a negative social impact on the *Size and Demographics* of the affected fisheries because of a probable reduction in fishing opportunity, revenue, and employment. Negative social impacts would be expected in *Life-style/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 in order 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 tables in each sub-regional or regional section identify the communities impacted by each alternative. These communities were selected based on the port of landing or city of registration associated with vessels identified as impacted by the potential new closure areas by the economic analysis of VTR data described in section 4.1.1. For background information on these communities see the Human Communities and the Fishery section of the Affected Environment (Volume 1). In addition to the ports explicitly identified, other ports are impacted but could not be detailed due to confidentiality concerns.

Communities impacted both at the port of landing and city of registration are included because of the differing impacts associated with each community type. Potential impacts related to the port of landing include a loss of landings and revenue that can affect the fisheries infrastructure in the community. The city where the permit is registered is generally where the permit owner resides. Impacts to these communities may be widespread beyond fisheries related aspects of the communities. Permits are often registered in different cities than the ports where the vessels land so the number of vessels cannot be added across community type as this may result in double counting vessels. The communities listed in these tables are not the only communities that will be impacted by the addition of new closed areas. As fishermen change their behavior to attempt to adjust to the lack of access to a closed area there will likely be an impact on vessels currently fishing in areas in close proximity the proposed closed areas.

It is not likely that this action would affect all of these communities to the same extent. Those communities that are more dependent on fishing with the affected gear types would likely have more social 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 section (Volume 1). These indices correspond to different components of social vulnerabilities that may affect communities. For more information on these indices see Jepson and Colburn (2013) or http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/index. The number of vessels impacted is also included in the tables for a general representation of the impact to each community. This is not a representation of the magnitude of impact as each vessel may be impacted differently. 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.

Additional impacts on the *Attitudes, Beliefs, and Values* of fishermen may be more widespread and affect communities not directly impacted by the new closures. Some fishermen generally question the efficacy of habitat closures. In informational interviews conducted by the Council, fishermen commented that natural disturbances such as storms and large-scale oceanic changes have a greater impact on the benthic environment than fishing gear and that small levels of benthic disturbance are beneficial. There are many instances in which fishermen have differing views than those held by ocean and fisheries scientists. A fisherman's view is based largely on personal experience and their own proximal environment, which can be at odds with the larger environment described by fisheries scientists. This continued lack of faith in the science used to direct management decisions could undermine the perceived legitimacy of future management actions and have a negative social impact on the formation of *Attitudes and Beliefs* about management. The impact of revising closed area management strategies on the *Attitudes, Beliefs, and Values* of fishermen is uncertain and is largely related to the level of acceptance and belief in the efficacy of closed area management by stakeholders, which varies considerably.

While the aforementioned impacts are generally negative, there is the potential for positive social impacts derived from closing new areas. These are generally associated with the potential future and long-term benefits created by the improvement of fish stocks generated from new closed areas. 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. For example, vessels that are unable to adapt to new restrictions in the short-term may not be able to benefit from the potential stock increases in the long-term. Additionally, the short-term impacts on markets, processing capability, and other infrastructure during the period of adjustment to new closed areas may be such that these shoreside resources are lost and unable to recover in the future when potential stock increases occur.

Moderate, indirect Positive impacts on the *Attitude, Beliefs, and Values* of the non-fishing public who are concerned with the management of the ocean and living marine resources are expected from the majority of the action alternatives that result in additional area being closed. However, minor, indirect, negative impacts on this segment of society may also occur in these situations if those stakeholders feel that the reduction in size of the footprint of closed areas is too great.

<u>Gear modifications and exemptions</u>

Several gear modifications are being proposed in the action alternatives. In terms of the social impact assessment, gear modifications affect *changes in occupational opportunities and community infrastructure* and *Attitudes, Beliefs and Values* the most. Gear modifications can compromise business planning for shoreside support services and impose an economic burden on a large number of vessels. The social impacts likely to result from changes to gear restrictions are related to the cost for vessels to comply with and the ability of gear suppliers to adapt to the new gear restrictions. If the new gear required is not readily available, gear suppliers must order the gear well in advance of the effective date of the new regulation. In addition, new gear requirements can sometimes leave gear suppliers with a significant amount of the "old gear" that may no longer be marketable if it cannot be used in the fishery anymore (or in other fisheries). This results in a more significant loss of income for the gear suppliers.

Gear modifications place an additional economic burden on all affected fishing vessels. The ability to adapt to the new gear regulations will depend on vessels' current economic situation and ability to cover the short-term costs of the gear. If the new gear requirement is significantly different from current gear requirements, it is likely that the most marginal vessels will not be able to cover the costs of the new gear and will be forced to seek alternative fisheries or stop fishing altogether. For the vessels that can cover the short-term costs of the gear, long-term impacts are related more to the loss of revenues from fishing that may occur because of the new gear. For example, the ground cable modifications may affect the catch per unit effort of affected vessels. Thus a vessel may have to increase effort, such as longer tows or more tows to achieve the same amount of catch. Over the long-term, this may result in more significant economic impacts and, ultimately, more severe dislocation of vessels in the fishery.

Modifications to daily routines can make long-term planning difficult. New gear and equipment must be ordered months in advance resulting in changes to daily routines when these modifications cannot be met in a time and cost efficient manner. Additionally, the gear modifications will have differing impacts on vessels depending on their size class. According to informational interviews held by the Council, the requirement that bottom trawl vessels use ground cables modified with elevating disks was estimated by participants to have a more significant impact on smaller vessels that may not have enough horse power to pull the gear through rugged bottom. In contrast, the requirement for shorter ground cables or eliminating ground cables entirely may have greater impacts on larger vessels that are more difficult to operate with smaller cables.

The gear modification and exemptions apply differently to different fisheries with varying levels of restriction. Option 2 would exempt hydraulic clam dredges, while the gear restrictions (Options 3 and 4) would only apply to bottom trawl vessels. The differing levels of restrictions on different fisheries could have a negative social impact, exacerbating conflicts between fisheries and negatively affecting the *Social Structures and Organizations* of a community, as well as having a negative impact on formation of *Attitudes and Beliefs* about management if users of particular gear types feel they are being unfairly restricted in comparison to others.

The magnitude and nature of the impacts of the gear restrictions under consideration in the Omnibus Amendment will depend on the cost and catch efficiency of the new gear, the current availability of the new gear, and vessels' choices as to whether or not to fish in the areas where the new gear is required. There are potential long-term positive social impacts of gear restrictions if they have significant benefits on habitat conservation, resulting in higher, sustained levels of catch; however these benefits are highly uncertain.

The impacts on the *Attitudes, Beliefs, and Values* of the non-fishing public concerned about marine conservation from the alternatives that would implement gear modifications or restrictions instead of closures are likely to be indirect and moderately negative. It is likely that this would equivalent to the impacts from removing the closed areas, but without the mitigation that smaller, better sited closures would be just as or more effective.

4.1.2.2 ***Groundfish spawning alternatives***

Although the purposes of these actions differ (i.e., protecting habitat for groundfish and other stocks versus protecting spawning groundfish, respectively), the general social impacts of the groundfish spawning protection alternatives are similar to those associated with habitat management alternatives. Additional social impacts specific to the groundfish spawning protection alternatives generally impact the *Attitudes, Beliefs, and Values* of fishermen. Negative impacts on *Attitudes, Beliefs, and Values* may be based on perceptions of differing levels of impact to particular gear types or fisheries. For example, the spawning protection areas are identified to improve groundfish spawning protection; however the restrictions impact a wide range of vessels capable of catching groundfish, including those where groundfish may not be the primary target and where retention and sale of groundfish is prohibited. This may cause resentment among fishermen using gear types that are capable of catching groundfish and will be affected by the restrictions, but do not target groundfish and are thus unlikely to benefit from future groundfish spawning improvement, negatively affecting the *Social Structures and Organizations* of a community.

The Options to exempt recreational fishing may also have impacts on *Attitudes, Beliefs, and Values* of fishermen. These are likely to be positive impacts on the recreational fishery and negative impacts on the commercial fishery. These differing impacts may also affect the *Social Structures and Organizations* of a community. The social impacts of the proposed alternatives that include recreational fisheries are difficult to discern, in part because many participants are not associated with a primary or secondary port group; passengers on party/charter vessels come from a wide area and are often not specifically associated with a fishing community.

There may also be positive impacts on the *Attitudes, Beliefs, and Values* of members of the groundfish fishery related to the shift in management from a focus on mortality closures, which are viewed as no longer necessary due to output controls in the fishery, to spawning protection. However, some members of the fishery that participated in informational interviews conducted by the Council mentioned that due to these output controls there is no need for additional spawning protection.

Indirect, moderate positive impacts on the *Attitude, Beliefs, and Values* of the non-fishing public who are concerned with the management of the ocean and living marine resources are expected from the spawning alternatives that improve fisheries management and improve the likelihood of successful rebuilding of culturally and historically important species, such as cod. Moderate, negative indirect impacts would be expected if the general belief was that management has missed an opportunity to protect fish stocks and other marine resources.

4.2 Habitat management alternatives

4.2.1 Eastern Gulf of Maine

Tables and figures related to analysis of the economic and social impacts of the eastern Gulf of Maine habitat management alternatives are provided below. Discussion of impacts is provided under a separate heading for each alternative.

Figure 15 – Machias HMA average annual revenue by gear over the time period identified. Average annual total revenue: 2005 - 2014 = $ 609,897; 2010 - 2014 = $ 721,546; 2012 - 2014 = $ 916,242

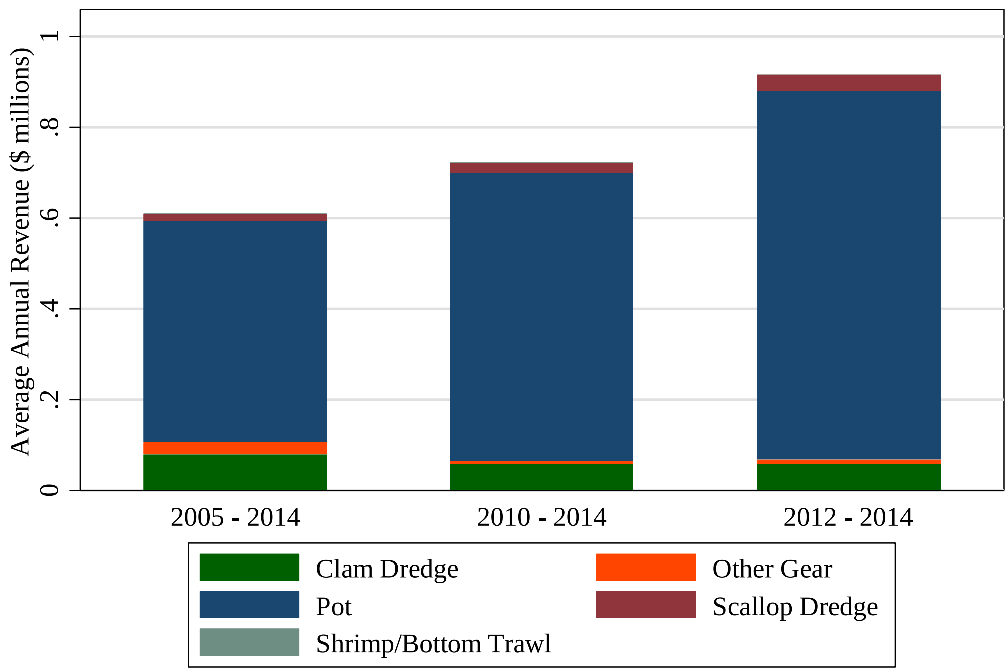


Figure 16 – Large Eastern Maine HMA average annual revenue by gear. Average annual total revenue: 2005 - 2014 = $ 2,272,051; 2010 - 2014 =$ 2,853,703; 2012 - 2014 = $ 3,017,613

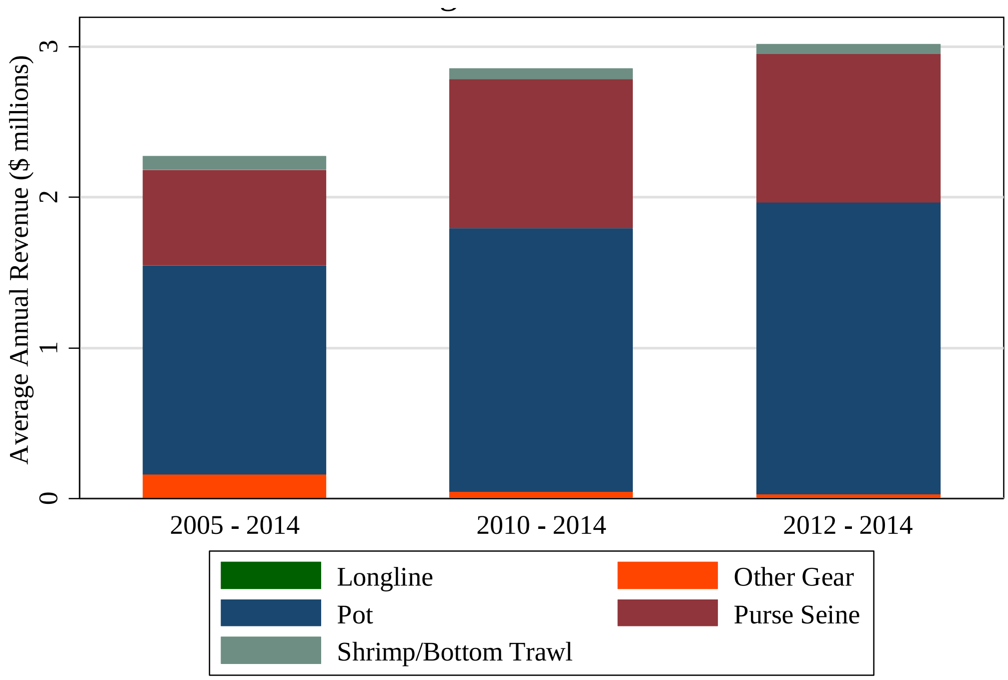


Figure 17 – Small Eastern Maine HMA average annual revenue by gear over the time period identified. Average annual total revenue: 2005 - 2014 = $ 631,772; 2010 - 2014 =$ 680,293; 2012 - 2014 = $ 703,931

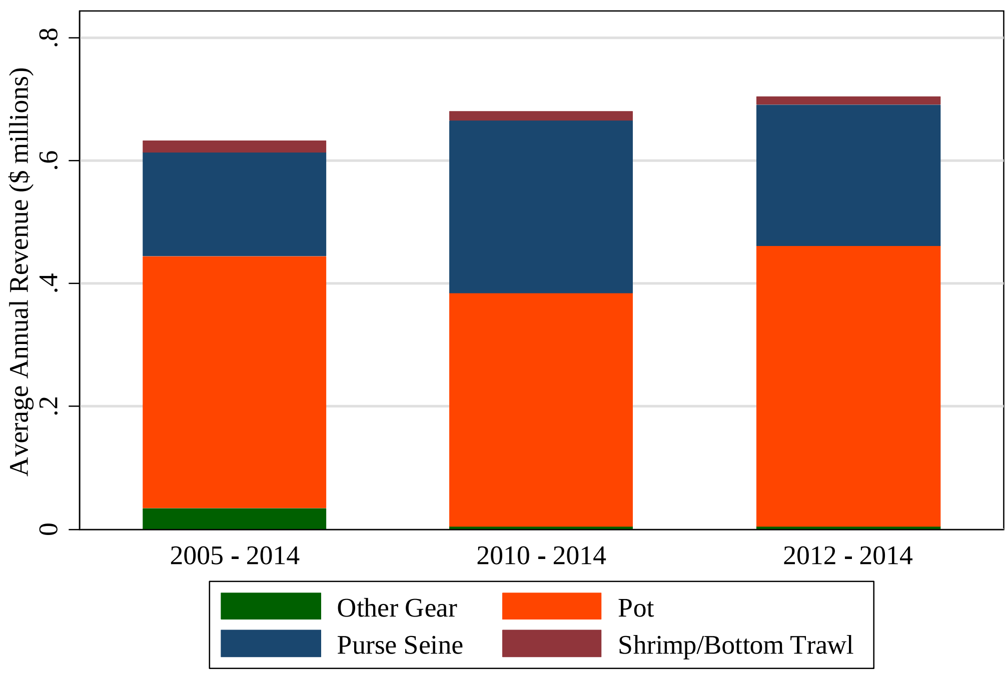


Figure 18 – Toothaker Ridge HMA revenue by gear, as a percentage of the total average revenue over the time period identified. Average annual total revenue: 2005 - 2014 = $ 798,260; 2010 - 2014 = $ 823,271; 2012 - 2014 = $ 881,972

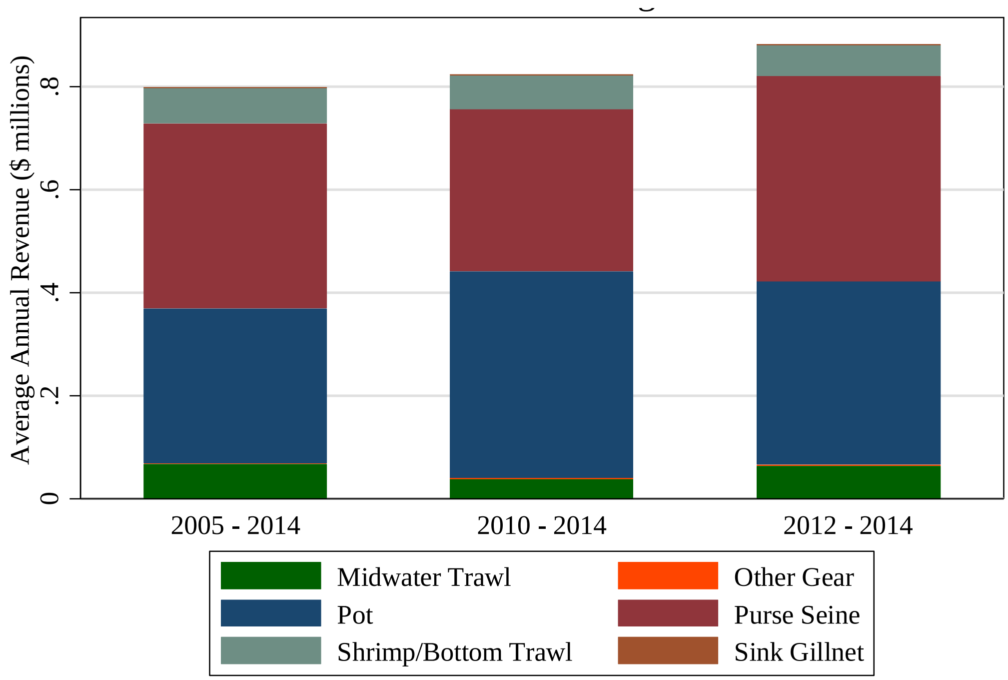


Table 37 – Mobile bottom-tending gear revenues potentially impacted by the areas included in the Eastern Gulf of Maine Habitat Alternatives. All variables represent annual estimates. Blanks indicate no data for the time period. Vessel sizes: S < 50 ft, 50 ft <= M < 70 ft, L >= 70 ft, U= unknown vessel characteristics. Note: Midwater Trawl results for 2012 – 2014 are not presented due to data confidentiality requirements.

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
Machias (Alts 2 and 3)	Clam Dredge	ALL	79,395	70,834	49,468	168,542	324	12	848	2005 - 2014
	Clam Dredge	ALL	59,207	69,268	38,579	105,095	324	11	667	2010 - 2014
	Clam Dredge	ALL	59,273	72,401	53,605	105,095	324	10	667	2012 - 2014
	Scallop Dredge	ALL	16,063	8,590	17,793	52,858	565	9	113	2005 - 2014
	Scallop Dredge	ALL	22,379	11,847	22,739	52,858	3,388	8	124	2010 - 2014
	Scallop Dredge	ALL	34,957	40,165	20,996	52,858	11,847	10	159	2012 - 2014
	Shrimp/Bottom Trawl	ALL	1,084	1,007	847	2,427	16	8	21	2005 - 2014
	Shrimp/Bottom Trawl	ALL	1,339	1,550	917	2,427	190	7	24	2010 - 2014
	Shrimp/Bottom Trawl	ALL	1,536	1,550	898	2,427	632	9	25	2012 - 2014
Large Eastern Maine (Alt 2)	Shrimp/Bottom Trawl	L	25,458	23,641	18,307	67,228	6,027	12	57	2005 - 2014
	Shrimp/Bottom Trawl	L	33,331	24,903	22,555	67,228	8,439	15	76	2010 - 2014
	Shrimp/Bottom Trawl	L	45,017	42,920	21,240	67,228	24,903	17	97	2012 - 2014
	Shrimp/Bottom Trawl	M	41,179	37,293	25,286	81,638	9,846	15	96	2005 - 2014
	Shrimp/Bottom Trawl	M	22,382	23,883	12,315	38,306	9,846	10	61	2010 - 2014
	Shrimp/Bottom Trawl	M	16,574	10,406	11,171	29,469	9,846	10	55	2012 - 2014
	Shrimp/Bottom Trawl	S/U	25,666	21,413	21,886	74,381	2,728	13	111	2005 - 2014
	Shrimp/Bottom Trawl	S/U	17,193	11,822	17,556	44,442	2,728	10	91	2010 - 2014
	Shrimp/Bottom Trawl	S/U	5,812	2,884	5,206	11,822	2,728	6	42	2012 - 2014
	Longline	ALL	2,671	1,456	2,772	8,390	0	5	22	2005 - 2014
	Longline	ALL	4,489	3,690	2,927	8,390	695	5	29	2010 - 2014
	Longline	ALL	4,181	3,459	3,898	8,390	695	4	18	2012 - 2014
	Purse Seine	ALL	632,527	674,377	451,811	1,303,009	3,269	6	99	2005 - 2014
	Purse Seine	ALL	989,036	988,160	282,094	1,303,009	700,101	6	109	2010 - 2014
	Purse Seine	ALL	980,690	988,160	260,804	1,237,678	716,231	5	108	2012 - 2014
Small	Shrimp/Bottom Trawl	L	5,148	4,749	4,259	14,951	247	9	40	2005 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
Eastern Maine (Alt 3)	Shrimp/Bottom Trawl	L	6,786	5,261	5,486	14,951	247	10	49	2010 - 2014
	Shrimp/Bottom Trawl	L	9,675	8,813	4,902	14,951	5,261	12	66	2012 - 2014
	Shrimp/Bottom Trawl	M	8,004	6,696	4,738	14,542	1,275	12	63	2005 - 2014
	Shrimp/Bottom Trawl	M	5,826	5,489	5,239	14,542	1,275	7	32	2010 - 2014
	Shrimp/Bottom Trawl	M	3,033	2,232	2,268	5,593	1,275	7	28	2012 - 2014
	Shrimp/Bottom Trawl	S/U	5,025	3,122	5,404	17,530	355	10	70	2005 - 2014
	Shrimp/Bottom Trawl	S/U	3,415	2,093	4,510	11,224	355	7	50	2010 - 2014
	Shrimp/Bottom Trawl	S/U	1,253	398	1,518	3,006	355	5	24	2012 - 2014
	Purse Seine	ALL	169,673	119,008	184,668	625,825	590	6	66	2005 - 2014
	Purse Seine	ALL	279,750	222,857	207,285	625,825	86,136	6	82	2010 - 2014
	Purse Seine	ALL	228,929	222,857	58,589	290,318	173,612	5	78	2012 - 2014
Toothaker Ridge (Alt 3)	Shrimp/Bottom Trawl	L	10,725	9,663	7,435	25,600	2,350	19	97	2005 - 2014
	Shrimp/Bottom Trawl	L	15,907	14,115	6,823	25,600	8,314	24	145	2010 - 2014
	Shrimp/Bottom Trawl	L	19,809	19,711	5,743	25,600	14,115	26	177	2012 - 2014
	Shrimp/Bottom Trawl	M	23,717	22,283	9,099	40,847	12,321	21	189	2005 - 2014
	Shrimp/Bottom Trawl	M	21,021	19,254	6,519	29,749	13,276	17	133	2010 - 2014
	Shrimp/Bottom Trawl	M	20,760	19,254	8,339	29,749	13,276	16	110	2012 - 2014
	Shrimp/Bottom Trawl	S/U	34,031	31,700	15,854	57,724	10,672	24	327	2005 - 2014
	Shrimp/Bottom Trawl	S/U	28,351	27,048	12,860	44,400	10,672	19	232	2010 - 2014
	Shrimp/Bottom Trawl	S/U	20,335	23,283	8,577	27,048	10,672	13	118	2012 - 2014
	Purse Seine	ALL	358,987	219,524	379,247	1,232,128	18,348	8	94	2005 - 2014
	Purse Seine	ALL	314,599	236,281	293,196	788,542	18,348	9	88	2010 - 2014
	Purse Seine	ALL	396,249	236,281	341,657	788,542	163,923	7	99	2012 - 2014
	Sink Gillnet	ALL	1,681	1,621	929	2,843	221	10	25	2005 - 2014
	Sink Gillnet	ALL	1,987	2,451	879	2,843	871	11	26	2010 - 2014
	Sink Gillnet	ALL	2,204	2,546	862	2,843	1,224	10	27	2012 - 2014
	Midwater Trawl	ALL	68,163	2,995	122,059	369,327	0	4	15	2005 - 2014
	Midwater Trawl	ALL	39,555	744	85,149	191,828	0	3	5	2010 - 2014
	Midwater Trawl	ALL	-	-	-	-	-	-	-	2012 - 2014

Table 38 – Fishing effort (in hours fished), and individuals fishing in areas currently open to fishing within the areas included in the eastern Gulf of Maine alternatives, estimated from VMS polls using the approach of Records and Demarest (2013). Total effort and individuals are the annual average across all years identified, while the remaining statistics are calculated at the individual level. Note that some year/gear combinations are not presented due to data confidentiality requirements.

Area	Gear	Years	Total Effort	Individuals	Mean Effort	Median Effort	SD Effort
Large Eastern Maine (Alt 2)	Bottom Trawl	2005 - 2012	19.30	11.88	1.63	0.12	5.12
	Bottom Trawl	2008 - 2012	12.21	9.20	1.33	0.20	2.80
	Bottom Trawl	2010 - 2012	3.42	6.67	0.51	0.04	1.01
	LA Scallop	2005 - 2012	0.04	0.75	0.05	0.01	0.08
Machias (Alts 2 and 3)	GC Scallop	2005 - 2012	5.37	1.13	4.77	2.17	7.70
Small Eastern Maine (Alt 3)	Bottom Trawl	2005 - 2012	0.29	2.63	0.11	0.01	0.27
	Bottom Trawl	2008 - 2012	0.22	1.60	0.14	0.00	0.33
Toothaker Ridge (Alt 3)	Bottom Trawl	2005 - 2012	187.77	17.88	10.50	0.23	24.48
	Bottom Trawl	2008 - 2012	213.33	15.20	14.03	2.04	24.98
	Bottom Trawl	2010 - 2012	200.55	12.67	15.83	3.10	27.52
	Shrimp Trawl	2005 - 2012	18.79	2.75	6.83	2.69	9.16
	Shrimp Trawl	2008 - 2012	25.87	3.60	7.19	2.43	9.95
	Shrimp Trawl	2010 - 2012	29.86	4.00	7.46	2.43	9.63

Table 39 – Party/charter recreational fishing revenue associated with the areas included in the eastern Gulf of Maine alternatives. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual revenue is the mean annual revenue, individuals represents the average number of permit holders fishing in the area, and anglers represents to average number of anglers per year. All other statistics are estimates at the trip level.

Area	Years	Annual Revenue	Individuals	Anglers	Mean Revenue	Median Revenue	SD_Revenue
Large Eastern Maine (Alt 2)	2006 - 2014	972	0	6	2,187	1,971	2,207
	2010 - 2014	-	-	-	-	-	-
	2012 - 2014	-	-	-	-	-	-

Table 40 – Total number of vessels conducting mobile bottom-tending gear trips in 2012 in currently open portions of the eastern Gulf of Maine alternatives. Vessels are grouped by port of landing or city of registration, provided that location included at least three vessels. Cities/ports with less than three vessels each were included in the state totals only.

Eastern Gulf of Maine		Alternative 2		Alternative 2 (Option 5)		Alternative 3	
State	**Community**	**Port**	**City**	**Port**	**City**	**Port**	**City**
MA		**25**	**9**	**28**	**13**	**35**	**15**
	Boston	11		11		14	
	Gloucester	14		15	3	21	
	New Bedford	3	3	5	4	6	3
ME		**34**	**47**	**103**	**113**	**59**	**70**
	Addison				3		
	Beals		6	9	13		6
	Bremen						3
	Boothbay Harbor					3	
	Bucks Harbor			3			
	Friendship					4	4
	Harpswell				3		
	Jonesport	12	3	27	13	12	3
	Machiasport			3	3		
	New Harbor					3	
	Northeast Harbor			3	3		
	Port Clyde	6	3	8	3	8	3
	Portland	8	7	13	7	18	10
	Rockland			6			
	South Bristol		3		4	8	5
	Stonington			7	4		
	Tenants Harbor			5	5		
	Vinalhaven			8	8		
	Westbrook		3		3		3
	Winter Harbor		4	4	6		4
	Newington			6			

Table 41 – Landing port and associated mobile bottom-tending gear revenues in 2012 potentially impacted by the areas included in the eastern Gulf of Maine Alternatives. Ports with less than 3 vessels each were included in the state totals only.

Eastern Gulf of Maine				
	Alternative	**2**	**2**	**3**
	Option	**1,2,3,4**	**5**	**1,2,3,4**
State	**Port**	**Total Revenue**	**Total Revenue**	**Total Revenue**
MA	**Total**	**73,418.59**	**73,418.59**	**54,324.21**
	BOSTON	8,132.20	8,132.20	11,094.55
	GLOUCESTER	58,342.19	58,342.19	38,161.21
	NEW BEDFORD	6,944.19	6,944.19	5,068.45
ME	**Total**	**104,748.24**	**1,377,373.79**	**120,561.39**
	FRIENDSHIP			2,510.71
	JONESPORT	87,119.85		74,230.26
	PORT CLYDE	11,193.57	25,566.04	28,829.75
	PORTLAND	1,970.05	11,283.61	9,030.02
	ROCKLAND		826772.98	
	SOUTH BRISTOL			683.50
	VINALHAVEN		9570.68	
	WINTER HARBOR		88278.23	

4.2.1.1 *Alternative 1 (No Action/No Habitat Management Areas)*

There are currently no year-round closed areas in this sub-region. The groundfish resource impacts discussion (Volume 5) indicates that there is some expectation that recent restoration projects in Eastern Maine will help rejuvenate groundfish populations in this sub-region. However, there is high uncertainty regarding the overall cause of reductions in groundfish populations, and thus whether the restoration projects will ultimately prove successful. Therefore, the current no action alternative is expected to have a neutral economic impact, with a possibility of moderately negative impacts if synergies between restoration and conservation actions are not capitalized upon. Alternative 1 would result in mainly neutral non-economic social impacts as it would maintain the status quo. All other alternatives are compared to No Action in the sections that follow.

4.2.1.2 *Alternative 2*

Alternative 2 would designate two new habitat management areas, the Large Eastern Maine HMA and the Machias HMA.

Figure 15 and Figure 16 identify the major gears currently fishing in the vicinity of the Machias and Large Eastern Maine management alternatives. Pots are the primary gear type in the Machias HMA, highlighting the importance of lobster in this area of the Gulf of Maine. This result is despite the fact that lobster landings are underrepresented in the federal VTR database. Note that the “other gear” category in Machias includes other dredges (i.e. not clam or scallop dredge) which would potentially be affected by the area management alternatives. However, for confidentiality purposes these gears could not be broken out separately. Although pots still account for over 50% of the average revenue in the Large Eastern Maine area, purse seine in particular represents another significant fishery in the area. In the Large Eastern Maine area, the “other gear” category includes other dredges, clam dredges, and scallop dredges, which would potentially be affected by the area management alternatives but cannot be detailed for privacy purposes.

Table 37 provides a more detailed view of mobile bottom-tending gear use. In Machias, the fishery with the most potential revenue displacement is the clam fishery. The annual revenue metric is high, despite the average revenue displaced per trip being $89 (8% of an average trip’s revenue). This can be explained by the fact that the Machias alternative abuts productive clam beds to the south (see for instance the 44th SAW Assessment Report Appendix A8, Stock Assessment for Ocean Quahog in Maine Waters), and although there is evidence of clam fishery activity, the majority of the clam activity in the vicinity, as represented by the logbook data, appears to occur outside of the Machias management area. This interpretation is bolstered by the existence of the Maine PSP closure, for which the exemption encompasses only a small portion of the Machias and Large Eastern Maine areas. Scallop dredge revenue seems to follow a similar pattern, with an average revenue displacement per trip of $220 (17% of an average trip’s revenue) between 2012 and 2014. The shrimp/bottom trawl revenues potentially displaced are minimal in Machias.

In the Large Eastern Maine area, the shrimp and bottom trawl gears represent the most revenue potentially displaced by Alternative 2, with vessels of all categories plying these waters although there does seem to be a downward trend through time. The average revenue impacted per trip for shrimp/bottom trawl vessels larger than 70 ft is estimated to be $463 (2% of an average trip's revenue), for vessels between 50 and 70 ft it is $303 (2% of an average trip's revenue), and for vessels smaller than 50 ft it is $138 (3% of an average trip's revenue). Although not insignificant amounts, when compared to other areas under consideration in this amendment the trawl revenue in Large Eastern Maine seems to represent fishing on the edges of more productive fishing grounds as opposed to the area being a center of fishing. The total combined bottom & shrimp trawl revenue expected to be displaced by Alternative 2 is an average of $22,467 over the 2012 – 2014 period. This represents 0.07% of the average annual revenue reported in VTR for these two gear types for generated from the Gulf of Maine, Georges Bank, and Southern New England during 2012 (see section 4.5 of Volume 1 for relevant statistical areas and magnitude of total revenue). Total impacted clam revenue represents 0.1% of the average total revenue reported in clam log books in 2012 – 2014 within the Gulf of Maine, Georges Bank, and Southern New England areas.

Table 38 presents the VMS analysis of fishing effort in Machias and Large Eastern Maine, which seem to bear out the VTR analysis of Table 37. Historically, some small amount of general category scalloping has occurred within the boundaries of Machias, while Large Eastern Maine shows low amounts of bottom trawl and scallop fishing.

Table 39 summarizes the recreational fishing reported within Alternative 2. For the most recent period data has been suppressed due to data confidentiality requirements. Limited party and charter recreational fishing activity occurs in these areas.

In summary, Option 1 (closure to mobile bottom-tending gears) has a relatively small impact on the total revenues being generated from the waters of the Machias and Large Eastern Maine HMA, with a complete exclusion of mobile bottom-tending gears affecting less than 5% (between $163,168 and $188,715 annually) of the total revenue generated in these areas between 2012 and 2014. Option 2 as written exempts only hydraulic clam dredges from the management areas. Although the clam logbook data does not include a gear categorization, Stevenson et al. (2004) indicates that the clam fishery in Machias, which would benefit most from this exemption, is actually prosecuted with the dry clam dredge and thus would not qualify for the exemption.

The short term impacts of Alternative 2, with Option 1 or 2, are thus expected to be slightly negative, with neither Machias nor Large Eastern Maine reported to be centers of mobile bottom-tending gear activity. In the long run, slightly positive impacts are expected through expected increases in groundfish productivity (see Volume 5, Section 2.1), though as noted these impacts are less certain and smaller than those expected from management areas in other sub-regions. The magnitude of these impacts is expected to be similar to Alternative 3, given the similar level of habitat protection afforded by each alternative (see section 3.2.1.2). Although discounting plays a role in whether the net benefits are ultimately positive or negative, the low short-term negative impacts, and low long-term positive impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

Options 3 and 4 would primarily exempt fishermen dredging in Machias, and thus 99% of the revenue potentially displaced by area management (see Table 37). However, as discussed in section 3.1.2.3, both the costs borne by trawl fishermen and the benefits of gear restrictions defined in these Options in terms of habitat conservation are highly uncertain. What information exists indicates that Option 3 would be expected to decrease catch rates for some species, meaning more effort, and thus a higher cost, would be needed to catch the same quantity of fish. Additionally, fishermen would be faced with the cost of buying new/converting nets to meet the new requirements. This, coupled with the expected uncertain impact on seabed habitats identified in section 3.2.1.2, indicates that Options 3 and 4 would be expected to induce a slightly negative impact as compared to Alternative 1/No Action.

Option 5 adds the restriction of gear capable of catching groundfish to the mobile bottom-tending gear restrictions of Option 1. The analysis of Option 1 is equally valid in describing the expected impact of Option 5 on mobile bottom-tending gear. Table 37 presents the additional impact expected for non-mobile gear capable of catching groundfish. Purse seine is the largest category of gear exempted from Option 1 that would be impacted by Option 5, and accounts for over 99% of the additional revenue expected to be displaced in the last 3 year period. Between 2012 and 2014 the average revenue per trip for purse seine vessels within the Large Eastern Maine area is calculated at $9,109, with the impact concentrated on 5 permit holders averaging just over 21 trips a year. The Large Eastern Maine area thus seems to be a relatively important center of seine net fishing for a small number of fishermen. It should be noted that this concentration of seine net effort looks to have been fairly recent and is generated by the herring fishery, with revenue estimates much lower in the longer time horizons investigated. Although some longline fishing occurs in the area, it is at a much smaller scale as indicated in Table 37, with an average trip-level revenue displacement estimated to be $232 between 2012 and 2014. This suggests that the Large Eastern Maine area is not a center of fishing effort with this gear. Option 5 is not expected to impact any additional fishing effort within Machias, beyond what has already been detailed in Option 1. However, the ‘other gear’ category in both Machias (Table 37) and Large Eastern Maine (Table 37) include both mobile bottom-tending gear and gear capable of catching groundfish, which cannot be detailed due to confidentiality issues. In aggregate, Option 5 would be expected to displace between $1,148,039 and $1,173,586 annually, or 29-30% of all the revenue generated between 2012 and 2014 from the waters proposed to be regulated under Option 5. Given these additional affected revenues, Alternative 2 with Option 1 or 2 plus Option 5 is expected to have greater short term impacts, i.e. moderately to slightly negative in the short term, and slightly positive in the long term.

The social impacts of the eastern Gulf of Maine habitat alternatives would most heavily impact port communities in Maine based on the location of registration of affected vessels (Table 40). With the exception of Portland, most of these communities are smaller coastal communities that have high levels of engagement and reliance on commercial fishing and have limited economic opportunities outside of fishing and relatively high social vulnerability indices (see tables in Volume 1 Fishing Communities section). Many of these communities are heavily dependent on lobstering. While lobster gear would not be affected by these closures, other gear types that allow fishermen in these areas to diversify their harvest would be impacted, thus reducing their level of resilience to future impacts by reducing their diversification. Although Portland is a larger community with a more diverse economy and less reliance on commercial fishing, diversity of fishing opportunities has declined in recent years. The social impacts related to port of landing are concentrated in Boston, Massachusetts. None of the identified communities would benefit from the clam dredge exemption (Option 2) as it does not apply to dry dredges which are typically used in this area (Stevenson et al 2004). Communities in downeast Maine using scallop dredges would benefit from the gear modification options 3 and 4. However, due to confidentiality concerns these communities are not detailed in the analysis. Option 5 would have larger negative impacts particularly on communities in Maine with high levels of vulnerability and particularly high indicators of commercial fishing dependence (see tables in Volume 1, Section 4.6).

The short-term social impacts of Alternative 2, Options 1-4 in comparison to Alternative 1/No Action are expected to be slightly negative, although slightly less negative than the impacts associated with Alternative 3. The social impacts of Alternative 2, Option 5 are expected to have more negative impacts than Options 1-4. Positive social impacts are possible in the long-term, if new closed areas effectively increase fish populations and there are spillover benefits in open fishing grounds.

4.2.1.3 *Alternative 3 (Preferred Alternative)*

Alternative 3 would designate three new habitat management areas: the Small Eastern Maine HMA, the Machias HMA, and the Toothaker Ridge HMA.

Figure 15, Figure 17, and Figure 18 present the major gear types fishing in the vicinity of the Alternative 3 management areas. Although the overall pattern of gear usage is similar, the Small Eastern Maine area encompasses roughly 23-28% of the revenue associated with the Large Eastern Maine area in Alternative 2. Again, purse seine and lobster pots are the dominant gear types in the Small Eastern Maine area. This result is despite the fact that lobster landings are underrepresented in the Federal VTR database. The “other gear” category in the Small Eastern Maine alternative includes dredges which would be subject to options being considered within Alternative 3 but cannot be detailed due to confidentiality concerns. The entirety of the Small Eastern Maine area falls within the Maine Mahogany Clam PSP closure, meaning that depending on the current occurrence of biotoxin in the area, clam fishing can be restricted. Machias is discussed under Alternative 2. Toothaker Ridge is dominated by purse seine and lobster pot gear. “Other gear” includes clam dredges, scallop dredges, and other dredges, which would be subject to management Options being considered within Alternative 3 but cannot be detailed due to data confidentiality requirements.

Table 37 provides a more detailed view of the mobile bottom-tending gears used in these three areas. Machias is discussed under Alternative 2. In the Small Eastern Maine area, the shrimp and bottom trawl gears represent the most revenue potentially displaced by Alternative 3, Option 1, with vessels of all categories plying these waters although there does seem to be a downward trend through time. The average impacted revenue per trip for shrimp/bottom trawl vessels > 70 ft is estimated to be $146 (less than 1% of an average trip’s revenue), for vessels between 50 and 70 ft it is $108 (less than 1% of an average trip’s revenue), and for vessels smaller than 50 ft it is $53 (1% of an average trip’s revenue). Although not insignificant amounts, this trawl revenue in Small Eastern Maine seems to represent fishing on the edges of more productive fishing grounds as opposed to centers of fishing themselves. This result is mirrored within the boundaries of

Toothaker Ridge, where average revenue displaced per trip for shrimp/bottom trawl vessels > 70 ft is estimated to be $112 (0.5% of an average trip's revenue), for vessels between 50 and 70 ft it is $189 (1.7% of an average trip's revenue), and for vessels smaller than 50 ft it is $173 (4.4% of an average trip's revenue). However, the total of 404 bottom trawl trips estimated to overlap the boundaries of Toothaker Ridge suggests that this area abuts much more productive fishing grounds than other areas in this sub-region, though it is not a major center of fishing itself. The shrimp and bottom trawl revenue expected to be displaced by alternative 3 Option 1 represents 0.07% of the average annual revenue reported for these two gear types in the VTR between 2010 – 2012 (see section 4.5 of Volume 1 for relevant statistical areas and total revenue magnitude).

Table 38 presents the VMS analysis of fishing effort in Machias, Small Eastern Maine, and Toothaker Ridge, which seem to bear out the VTR analysis of Table 37. Small Eastern Maine has had minimal bottom trawl effort within its boundaries. Bottom trawl effort within Toothaker Ridge is somewhat more pronounced than either Machias or Small Eastern Maine, a result consistent with the VTR analysis of these areas. The median is much smaller than the mean effort, suggesting that a few individuals utilize this area more intensively than the majority of individuals fishing in the area. Shrimp trawl effort is also estimated to fall within Toothaker Ridge, though at relatively low levels. Although there have historically been some recreational trips whose VTR location place them within the Small Eastern Maine and Toothaker Ridge areas, this information cannot be presented due to data confidentiality requirements.

A complete exclusion of mobile bottom-tending gear, as per Option 1, would affect roughly $170,631, or 8% of the total revenue generated from the waters surrounding the areas in the most recent three year period (2012 – 2014). This mainly affects bottom trawl fishermen in the vicinity of Toothaker Ridge, and clam dredge fishermen around Machias. As noted above, clam dredging in this area is prosecuted with the dry clam dredge and thus would not qualify for the Option 2 exemption.

The short-term impacts of Alternative 3 are thus expected to be slightly negative, with none of the areas reported to be centers of mobile bottom-tending gear activity. In the long-term, slightly positive impacts are expected through expected increases in groundfish productivity (see Volume 5, Section 2.1) though as noted these impacts are less certain and smaller than those expected from management areas in other sub-regions, and smaller than the positive impacts associated with Alternative 2. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the short-term slightly negative impacts, and long-term slightly positive impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

Options 3 and 4 would primarily exempt fishermen dredging in Machias, and thus a substantial portion of the revenue potentially displaced by area management. However, as discussed under Alternative 2, both the costs and the benefits of gear restrictions are highly uncertain. Preliminary studies indicate that Option 3 (groundcables on elevated disks) would be expected to decrease CPUE for some species, meaning more effort, and thus a higher cost, would be needed to catch the same quantity of fish, and fishermen would be faced with the cost of buying new/converting nets to meet the new requirements. This, coupled with the expected uncertain impact on seabed habitats identified in section 3.2.1.3, indicates that both Options 3 and 4 would be expected to induce a slightly negative impact as compared to Alternative 1/No Action.

The short-term social impacts of Alternative 3 (all gear restriction options) in comparison to the Alternative 1/No Action are expected to be slightly negative, and slightly more negative in comparison to Alternative 2 (all gear restriction options). See the Alternative 2 discussion for further details. Positive social impacts are possible in the long-term, if new closed areas effectively increase fish stocks and there are spillover benefits in open areas.

The Council's preferred alternative is to designate the Small Eastern Maine HMA only, with Option 1. Compared to the full Alternative 3 that also includes the Machias and Toothaker Ridge HMAs, the preferred alternative is expected to have a smaller magnitude of impacts (but still slightly negative) in the short-term, and a smaller magnitude of impacts (but still slightly positive) over the long-term.

4.2.2 Central Gulf of Maine

Tables and figures related to analysis of the economic and social impacts of the central Gulf of Maine habitat management alternatives are provided below. Discussion of impacts is provided under a separate heading for each alternative.

In 2013, the Habitat Plan Development Team indicated that Platts Bank was being fished for scallops, in a departure from previous time periods. The scallop resource in the Gulf of Maine tends to have episodic recruitment and periods of higher productivity, so such a shift in the importance of scallop beds in the region is not unusual. In order to investigate this issue, the VTR analysis was re-run, focused solely on scallop dredge fishing in the Platts Bank area. Figure 19 and Figure 20 present the results of this analysis. Individuals are ranked from largest to smallest impact, in terms of revenue estimated to have been generated from Platts Bank, and are summarized in groups of five, to ensure confidentiality. As can be seen, 90% of the total scallop revenue estimated to have been generated within Platts Bank was generated by the top 5 individuals. Figure 20 illustrates the average trip level revenue estimated to have fallen within the Platts Bank area. The average trip level revenue does not differ between groups to the extent that the total revenue per group does. This indicates that the difference in the revenue generated by groups is driven primarily by the number of trips taken to Platts Bank. In fact, the top 5 individuals encompass 65% of the total trips to Platts Bank. It is clear that, although a total of 61 individuals have some portion of their revenue estimated to have been derived from Platts Bank, the majority of the impact from Alternative 3 rests with a very few individuals. The analyses in the following sections now factor in this new phenomenon. There is, however, an overall decrease in the number of individuals identified as exposed to the Platts Bank management area. This is due to a slight change in the manner in which the VTR data was mapped. The 2012 – 2014 data uses raster grids instead of polygons, which has increased the stability and speed of the mapping algorithms. Some spatial detail is lost when translating from polygons to grids. Although this does not affect the overall conclusions of the analysis, it does change the number of individuals and trips exposed to the area (see Table 42).

Figure 19 – Scallop fishing revenue within the vicinity of Platts Bank in 2013. Individuals are ranked from largest to smallest impact, in terms of revenue estimated to have been generated from Platts Bank, and are summarized in groups of five, to ensure confidentiality. A total of $42,373 is estimated to have been generated by scallop dredges in Platts Bank within the calendar year 2013.

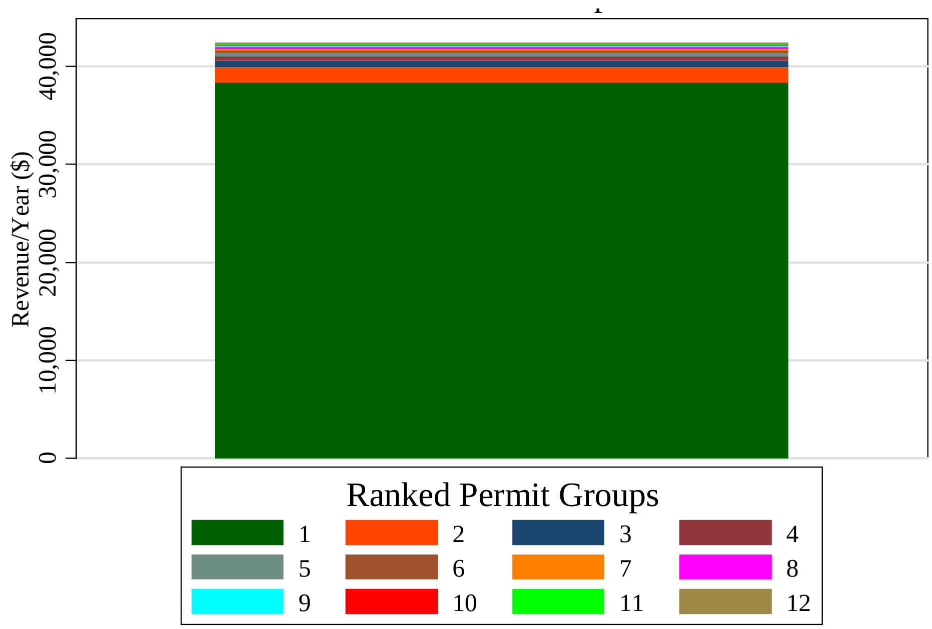


Figure 20 – Average trip-level scallop fishing revenue within the vicinity of Platts Bank, by ranked permit group. Individuals are ranked from largest to smallest impact, in terms of revenue estimated to have been generated from Platts Bank, and are summarized in groups of five, to ensure confidentiality.

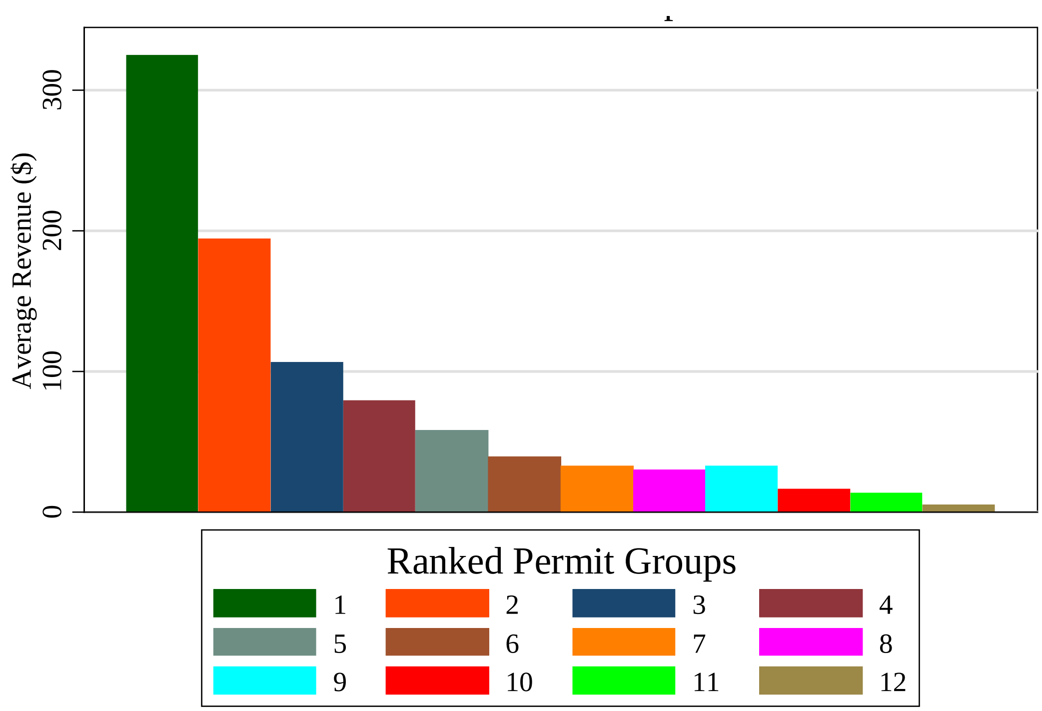


Figure 21 – Jeffreys Bank Modified HMA average annual revenue in the currently open portion of the area by gear, over the time period identified. Average annual total revenue: 2005 - 2014 = $ 430,410; 2010 - 2014 = $ 204,158; 2012 - 2014 = $ 229,430

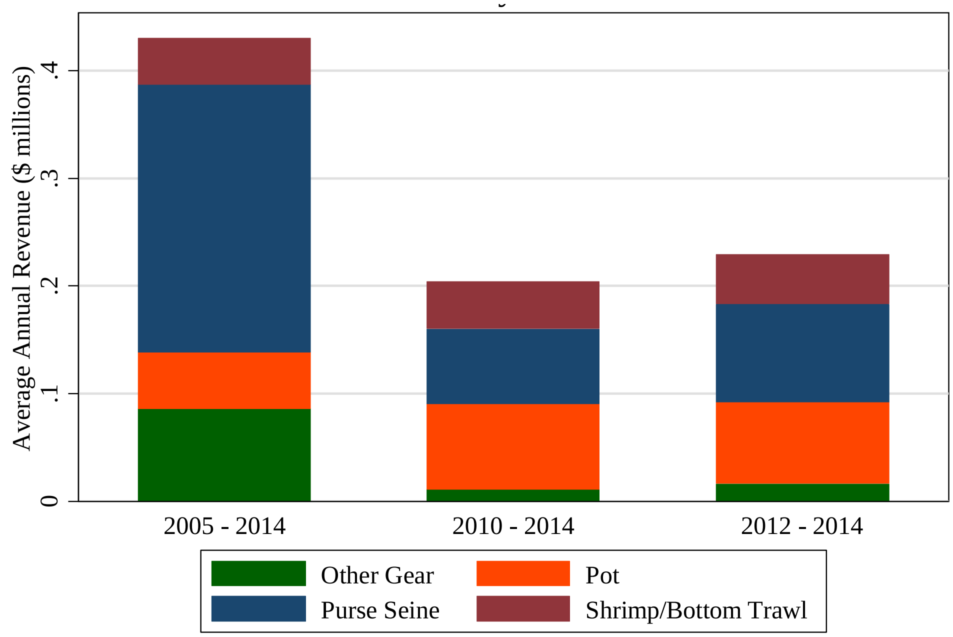


Figure 22 – Platts Bank HMA revenue in the currently open portion of the area by gear, as a percentage of the total average revenue over the time period identified. Average annual total revenue: 2005 - 2014 = $ 243,428; 2010 - 2014 = $ 282,438; 2012 - 2014 = $ 351,062

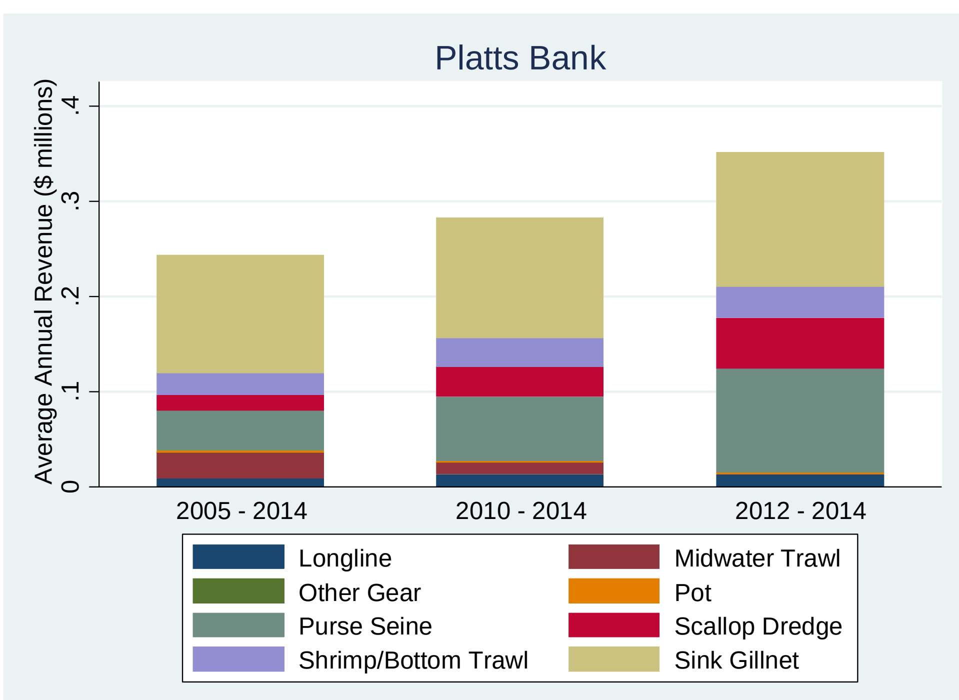


Table 42 – Mobile bottom-tending gear revenues potentially impacted by the areas included in the central Gulf of Maine Habitat Alternatives that are currently open to fishing. All variables represent annual estimates. Blanks indicate no data for the time period. Vessel sizes: S < 50 ft, 50 ft <= M < 70 ft, L >= 70 ft, U = unknown vessel characteristics.

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Indivi duals	Trips	Years
Jeffreys Bank (open portion of modified area, Alts 3 and 4)	Shrimp/Bottom Trawl	L	11,088	7,097	10,937	40,228	2,505	22	144	2005 - 2014
	Shrimp/Bottom Trawl	L	17,249	13,619	13,117	40,228	7,985	26	213	2010 - 2014
	Shrimp/Bottom Trawl	L	22,776	14,482	15,120	40,228	13,619	28	265	2012 - 2014
	Shrimp/Bottom Trawl	M	14,952	14,041	7,272	24,697	5,669	19	133	2005 - 2014
	Shrimp/Bottom Trawl	M	13,547	11,361	6,675	23,437	6,320	15	88	2010 - 2014
	Shrimp/Bottom Trawl	M	15,493	16,720	8,624	23,437	6,320	15	93	2012 - 2014
	Shrimp/Bottom Trawl	S/U	17,151	16,290	8,526	32,356	2,881	12	95	2005 - 2014
	Shrimp/Bottom Trawl	S/U	13,490	14,743	9,175	27,024	2,881	8	63	2010 - 2014
	Shrimp/Bottom Trawl	S/U	8,561	7,483	6,288	15,319	2,881	6	46	2012 - 2014
Platts Bank (Alt 3)	Shrimp/Bottom Trawl	L	8,918	7,051	5,722	19,138	638	30	268	2005 - 2014
	Shrimp/Bottom Trawl	L	13,400	13,585	4,209	19,138	7,415	37	414	2010 - 2014
	Shrimp/Bottom Trawl	L	15,723	14,447	2,989	19,138	13,585	39	490	2012 - 2014
	Shrimp/Bottom Trawl	M	11,676	11,354	3,643	17,501	4,290	28	230	2005 - 2014
	Shrimp/Bottom Trawl	M	13,802	12,659	2,848	17,501	11,352	23	260	2010 - 2014
	Shrimp/Bottom Trawl	M	14,999	16,140	3,228	17,501	11,356	21	294	2012 - 2014
	Shrimp/Bottom Trawl	S/U	3,080	3,067	1,089	4,703	1,066	22	128	2005 - 2014
	Shrimp/Bottom Trawl	S/U	2,920	2,770	1,496	4,703	1,066	13	89	2010 - 2014
	Shrimp/Bottom Trawl	S/U	2,846	2,770	1,820	4,703	1,066	11	77	2012 - 2014
	Scallop Dredge	ALL	15,723	-	33,161	80,727	-	2	20	2005 - 2014
	Scallop Dredge	ALL	31,445	-	43,084	80,727	-	3	39	2010 - 2014
	Scallop Dredge	ALL	52,409	76,499	45,436	80,727	-	5	65	2012 - 2014

Table 43 – Fishing Effort (in hours fished), and individuals fishing in areas currently open to fishing within the central Gulf of Maine Alternatives, estimated from VMS polls using the approach of Records and Demarest (2013). Total effort and individuals are the yearly means, while the statistics are calculated at the individual level. Note that shrimp trawl effort is unreported due to data confidentiality requirements.

Area	Gear	Years	Total Effort	Individuals	Mean Effort	Median Effort	SD Effort
Jeffreys Bank	Bottom Trawl	2005 - 2012	99.44	18.38	5.41	0.12	13.75
	Bottom Trawl	2008 - 2012	117.99	16.40	7.19	0.41	15.95
	Bottom Trawl	2010 - 2012	88.97	14.67	6.07	0.33	14.09
Platts Bank	Bottom Trawl	2005 - 2012	3.81	14.13	0.27	0.01	0.59
	Bottom Trawl	2008 - 2012	3.02	11.40	0.26	0.01	0.61
	Bottom Trawl	2010 - 2012	2.04	12.33	0.17	0.01	0.41

Table 44 – Party/charter recreational fishing revenue associated with Platts Bank and Cashes Ledge. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual revenue is the mean annual revenue, Individuals represents the average number of permit holders fishing in the area, and Anglers represents the average number of anglers per year. All other statistics are estimates at the trip level. The Cashes Ledge area refers to both the current groundfish and habitat closures.

Area	Years	Annual Revenue	Individuals	Anglers	Mean Revenue	Median Revenue	SD Revenue
Platts Bank	2006 - 2014	23,892	3	161	1,387	1,342	606
	2010 - 2014	15,414	2	104	1,606	1,566	759
	2012 - 2014	-	-	-	-	-	-
Cashes Ledge	2006 - 2014	84,118	5	504	4,137	3,726	2,618
	2010 - 2014	90,907	4	555	3,607	2,781	2,262
	2012 - 2014	94,888	4	611	3,272	2,643	2,195

Table 45 – Current Cashes Ledge groundfish and habitat closures: Average value per haul (calendar year 2007 - 2011) within a 10 nautical mile buffer, and percent of total haul revenue this value represents. NEFOP and ASM observer landings data.

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bottom Trawl	Total Hauls	299	273	509	152	74	66	130	156	145	302	157	221
	Cod	$51	$55	$64	$92	$26	$12	$20	$9	$19	$46	$34	$42
		3%	3%	4%	5%	2%	1%	2%	1%	2%	4%	3%	2%
	Redfish	$45	$107	$59	$59	$112	$56	$220	$139	$166	$93	$148	$226
		3%	6%	4%	3%	10%	4%	17%	13%	16%	8%	14%	12%
	Pollock	$321	$362	$578	$694	$225	$443	$293	$293	$181	$388	$173	$155
		21%	19%	34%	40%	20%	34%	23%	27%	18%	35%	16%	8%
	Plaice	$227	$172	$139	$141	$98	$93	$118	$149	$171	$160	$211	$131
		15%	9%	8%	8%	9%	7%	9%	13%	17%	14%	20%	7%
	Witch Flounder	$160	$300	$241	$232	$132	$48	$63	$52	$48	$76	$63	$352
		10%	16%	14%	13%	12%	4%	5%	5%	5%	7%	6%	19%
	White Hake	$150	$145	$92	$118	$196	$240	$179	$150	$181	$141	$120	$144
		10%	8%	5%	7%	18%	18%	14%	14%	18%	13%	11%	8%
	Monkfish	$485	$608	$370	$313	$234	$253	$258	$249	$236	$176	$241	$679
		32%	33%	22%	18%	21%	19%	20%	23%	23%	16%	23%	37%
	Lobster	$53	$79	$65	$67	$54	$146	$100	$43	$9	$8	$13	$68
		3%	4%	3%	4%	5%	12%	8%	4%	1%	1%	1%	3%
Fixed Gillnet	Total Hauls	96	27	86	53	73	52	149	110	103	64	65	
	Cod	80	43	37	91	98	63	106	130	98	96	128	
		9%	5%	5%	13%	18%	8%	14%	18%	14%	17%	17%	
	Haddock	16	6	9	22	5	4	4	2	2	6	8	
		2%	1%	1%	3%	1%	1%	1%	0%	0%	1%	1%	
	Redfish	12	14	13	6	9	35	16	7	11	14	21	
		1%	2%	2%	1%	2%	5%	2%	1%	2%	3%	3%	
	Pollock	591	653	558	478	57	129	215	305	335	209	420	
		70%	80%	71%	69%	10%	17%	29%	42%	48%	38%	55%	
	White Hake	37	55	73	21	283	423	193	143	103	83	76	
		4%	7%	9%	3%	51%	57%	26%	20%	15%	15%	10%	
	Lobster	$32	$37	$17	$4	$44	$37	$69	$10	$22	$7	$7	
		4%	5%	2%	1%	8%	5%	9%	1%	3%	1%	1%	
Separator Trawl	Total Hauls						32				19		
	Cod						$41				$38		

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
							3%				4%		
	Haddock						$32				$69		
							2%				7%		
	Redfish						$1,200				$83		
							77%				8%		
	Pollock						$78				$669		
							5%				64%		
	White Hake						$70				$124		
							4%				12%		

Table 46 – Jeffreys Bank Habitat Closure Area: Average value per bottom trawl haul (calendar year 2007 - 2011) within a 10 nautical mile buffer, and percent of total haul revenue this value represents. NEFOP and ASM observer landings data.

	Month									
	Jan-Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Hauls		***9***	***29***	***84***	***100***	***37***	***22***	***35***	***51***	***98***
Atlantic cod		$103	$151	$64	$82	$70	$31	$24	$20	$19
		9%	19%	6%	7%	6%	3%	2%	1%	1%
Atlantic halibut		$118	$5	$6	$6	$6	$19	$0	$8	$9
		11%	1%	1%	1%	1%	2%	0%	0%	0%
Acadian redfish		$4	$9	$24	$15	$64	$46	$36	$51	$65
		0%	1%	2%	1%	5%	5%	3%	3%	4%
Pollock		$124	$33	$23	$35	$40	$112	$2	$5	$10
		11%	4%	2%	3%	3%	11%	0%	0%	1%
American plaice		$41	$89	$62	$61	$143	$89	$75	$174	$80
		4%	11%	5%	5%	12%	9%	6%	9%	5%
Witch flounder		$222	$327	$678	$573	$190	$228	$276	$165	$282
		20%	41%	60%	51%	16%	23%	22%	9%	16%
White hake		$43	$20	$35	$73	$259	$76	$88	$66	$93
		4%	3%	3%	6%	22%	8%	7%	4%	5%
Monkfish		$228	$153	$231	$255	$409	$387	$725	$1,315	$1,103
		21%	19%	20%	23%	34%	39%	59%	71%	62%
American lobster		$209	$5	$5	$3	$0	$2	$0	$39	$105
		19%	1%	0%	0%	0%	0%	0%	2%	6%

Table 47 – Total number of vessels conducting mobile bottom tending gear trips in 2012 in currently open portions of the central Gulf of Maine alternatives. Vessels are grouped by port of landing or city of registration, provided that location included at least three vessels. Cities/ports with less than three vessels each were included in the state totals only.

Central Gulf of Maine		Alternative 3		Alternative 4	
State	Community	Port	City	Port	City
MA		**61**	**38**	**39**	**19**
	Boston	17		15	
	Gloucester	28	11	22	7
	New Bedford	21	22	8	7
ME		**37**	**44**	**23**	**22**
	Harpswell		4		
	Port Clyde	6	3	6	3
	Portland	28	11	19	10
	South Bristol		4		4
	Westbrook		3		3

Table 48 – Landing port and associated mobile bottom-tending gear revenues in 2012 potentially impacted by the areas included in the central Gulf of Maine Alternatives. Ports with less than 3 vessels each were included in the state totals only.

	Alternative	3	4
State	Port	Total Revenue	Total Revenue
MA	**Total**	**82,625.75**	**55,596.50**
	BOSTON	20,126.69	5,468.58
	GLOUCESTER	40,172.87	29,436.69
	NEW BEDFORD	22,305.47	20,691.23
ME	**Total**	**39,423.29**	**22,606.23**
	PORT CLYDE	17,629.72	16,983.74
	PORTLAND	20,609.52	5,534.27

Table 49 – Sum of 2012 party/charter recreational fishing revenue associated with the central Gulf of Maine Alternatives. Ports with less than 3 vessels each were included in the state totals only.

State	Number of vessels	Total trip value
MA	**4**	**62,779.73**

4.2.2.1 *Alternative 1 (No Action, Preferred Alternative)*

Alternative 1/No Action in the central Gulf of Maine region includes the Jeffreys Bank and Cashes Ledge Habitat Closure Areas and the Cashes Ledge Groundfish Closure Area. Given the length of time over which the Cashes Ledge and Jeffreys Bank areas have been closed (since 2002 and 2003, respectively), the expectation is that benefits afforded by these areas are already flowing, but additional benefits of these conservation measures are expected to accrue in the future. Despite current, direct costs to the fleet in terms of fishing displacement, Alternative 1/No Action is expected to induce slight positive economic impacts due to the protection of habitats supporting juvenile groundfish that are susceptible to fishing disturbance.

Alternative 1/No Action would result in mainly neutral social impacts as it would maintain the status quo. However, if current benefits to groundfish are being realized (as mentioned above) there may be ongoing slightly positive impacts associated with Alternative 1/No Action.

All other alternatives are compared to No Action in the sections that follow.

4.2.2.2 *Alternative 2 (No Habitat Management Areas)*

This alternative would remove the current Cashes Ledge and Jeffreys Bank Habitat Closure Areas, and the Cashes Ledge Groundfish Closure Area, and would not designate any additional habitat management areas in the region. The economic benefits arising from removing management areas in the central Gulf of Maine are expected to arise from two main sources: 1) increasing fishing revenue or 2) decreasing the costs of fishing. Generally the underlying reasoning for removing management areas is providing fishermen more flexibility and options in when and how to fish. The economic costs of removing management areas are likely to arise from impacts on fish productivity, impact on non-targeted species, and gear interactions and effort displacement from other fisheries. The analysis in this section qualitatively explores the likelihood of both these costs and benefits, and generates an overall expected impact of the no management area alternative both in the short and long term.

Table 45 and Table 46 identify all species that contribute at least 5% of haul-level revenues in any given month from areas within 10 nautical miles of the current Cashes Ledge and Jeffreys Bank combined groundfish and habitat closures. Pollock in particular seems to be an important species across all gear types for Cashes Ledge, while witch flounder consistently generates a large portion of revenues associated with hauls surrounding Jeffreys Bank. In the vicinity of Cashes Ledge, white hake and redfish generate a substantial amount of revenue for the fixed gillnet and separator trawl gears respectively in the late spring and early summer months. Observed bottom trawl trips in the vicinity of both Cashes Ledge and Jeffreys Bank also generate substantial revenue from monkfish. Given that witch flounder are overfished and overfishing is occurring, no positive benefit is likely to be generated by fishing for this species in a reopened Jeffreys Bank. Pollock, monkfish, redfish, and white hake are not overfished, and are not subject to overfishing. Some small increase in revenue is likely to be generated by allowing additional targeting of these species within currently closed areas. However, the analysis conducted for the sector exemptions within Framework 48 of the Northeast Multispecies FMP indicate that Cashes Ledge hosts neither larger individuals nor higher densities of monkfish, white hake, redfish, or pollock, as compared to currently open waters. Higher densities of these species inside versus outside the closed area could have led to higher catch per unit effort, and thus lower costs of fishing through increased efficiency. Higher densities could also indicate a substantial segment of the biomass might currently be unavailable to the fishery, i.e. locked away in the closed area, which could help explain the fact that the catch limits for some of these species are not being fully harvested. Further, although managed under an annual catch limit, larger monkfish, white hake, redfish, or pollock inside the closure could allow fishermen capture price premiums associated with larger fish. Given that neither higher densities nor larger individuals seem to be concentrated within the currently closed portions of the Central Gulf of Maine, the benefits of removing management areas are likely to be relatively small. The Managed Species (4.2) and Fishing Communities (4.6) sections of Affected Environment in Volume 1 seems to reaffirm this result for monkfish, white hake, redfish, and pollock in the existing Jeffreys Bank and Cashes Ledge management areas.

Although both Jeffreys Bank and Cashes Ledge are relatively near shore, particularly compared to areas on Georges Bank, their size and productivity suggests that, if opened, only local effort is likely to flow into their waters. Given the information presented in this document, access to Cashes Ledge and Jeffreys Bank is expected to displace current effort, as opposed to generating additional effort in the groundfish fishery.

Table 44 presents the party/charter fishing revenue estimates for Cashes Ledge. Recreational fishing on Jeffreys Bank is not detailed due to confidentiality concerns. VTR data suggest that a small number of individuals are using Cashes Ledge relatively intensively, with an average gross annual revenue of $13,456 being generated per recreational vessel operating in the area. Increased fishing gear interactions and potential displacement of existing recreational fishing effort within the Cashes Ledge closure are other potential costs of reopening the area with this alternative. The increased costs accruing to the recreational fishery, due to congestion from an influx of commercial gear, depend on the flow of effort into the area, and the gear conflict avoidance measures taken by both recreational fishermen and groundfish/mobile bottom-tending gear fishermen. This effect is likely to be slightly negative, given the recreational fishing currently reported within the Cashes Ledge closure.

In the short-term, Alternative 2 is expected to generate slightly positive economic impacts when compared to Alternative 1/No Action, as groundfish and mobile bottom-tending gear fishermen gain additional flexibility in when and how they are allowed to fish. However, in the long-term, slightly negative impacts are expected when compared to Alternative 1/No Action, due to the lack of protection for habitat supporting juvenile groundfish and susceptible to fishing disturbance. Given the length of time over which Cashes Ledge and Jeffreys Bank areas have been closed, and thus the expectation that any benefits afforded by these areas are already flowing, the overall impact of Alternative 2 is expected to be slightly negative. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the sort-term slightly negative impacts, and long-term slightly positive impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

The short-term social impacts of Alternative 2 in comparison to Alternative 1/No Action are expected to be slightly positive as fishermen would gain access to new fishing areas. There are potential long-term moderately negative social impacts if benefits to fish populations from the

Cashes Ledge closure area are lost. There may be some indirect, slightly negative social impacts to stakeholders concerned with ocean conservation who are particularly supportive of maintaining the Cashes Ledge closure.

4.2.2.3 *Alternative 3 (Preferred Alternative)*

Alternative 3 would modify the boundaries of the current Jeffreys Bank and Cashes Ledge Habitat Closures, and designate three new habitat management areas: Ammen Rock, Fippennies Ledge, and Platts Bank.

Historical average annual revenue associated with the Modified Jeffreys Bank HMA (portion currently open) and the Platts Bank HMA are presented in Figure 21 and Figure 22. The currently open area of the Modified Jeffreys Bank has supported a substantial amount of revenue derived from gears that would not be displaced by this alternative, although the proportion derived from bottom/shrimp trawls has increased in the most recent 3 year period. However, during 2010-2012 the open portions of Jeffreys Bank generated only about half of the longer run average revenue (Figure 21). Platts Bank revenue has similarly been dominated by gear that would not be displaced by this alternative. Table 42 presents more detailed information for the bottom/shrimp trawl fishery, with these two gears being combined due to data confidentiality requirements. The only vessels in these gear types potentially presenting an upward trend in revenue (trips) is the over 70 ft vessels, with a 46% (42%) difference between the three year and five year average on Jeffreys Bank, and a 42% (42%) difference between the three and five year average on Platts Bank. The bottom trawl per-trip revenue in currently open waters of the Modified Jeffreys Bank HMA expected to be affected by this alternative is $108 (0.5% of an average trip's revenue) for vessels over 70 ft, $146 (0.9% of an average trip's revenue) for vessels between 50 and 70 ft, and $226 (1.8% of an average trip's revenue) for vessels < 50 ft. On Platts Bank, these values are $35 (0.2% of an average trip's revenue) for vessels >= 70 ft, $60 (0.4% of an average trip's revenue) for vessels between 50 and 70 ft, and $33 (0.3% of an average trip's revenue) for vessels < 50 ft. Scallop dredges have been active around Platts Bank within both the 2013 and 2014 calendar years, generating an average of $806 (39% of an average trip's revenue) over the 2012-2014 period. These relatively low numbers in Platts Bank are explained at least in part by the size of the proposed areas. Nevertheless, the analysis suggests that the impacts of area closure considered here are likely relatively small, with 0.07% of the 2010 – 2012 average annual shrimp and bottom trawl revenue generated from currently open waters expected to be impacted by the Central Gulf of Maine Alternative 3 (see section 4.5 of Volume I for total revenue numbers and statistical areas).

Table 43 presents VMS effort estimates for the currently open areas of Modified Jeffreys Bank and for Platts Bank. Of the two areas, Modified Jeffreys Bank is associated with the majority of the estimated effort, consistent with the VTR analysis in Table 42. The larger mean as compared to the median of the distribution suggests that a few fishermen use this area more intensively.

A complete exclusion of mobile bottom-tending gear, as per Option 1, would affect between $132,809 in gross revenue (23% of the total) generated from the open waters surrounding the Modified Jeffreys Bank and Platts Bank areas in the most recent three year period (2012-2014). This works out to be $100 per affected trip, again suggesting that although the areas are fished, the center of bottom/shrimp trawl and scallop activity in the central Gulf of Maine is outside of the management areas being considered within Alternative 3. The total area currently closed to a combination of gear capable of catching groundfish, and mobile bottom-tending gear under Alternative 1 is substantially larger than the total area under consideration in Alternative 3. Thus, Alternative 3 opens more water to fishing than Alternative 1/No Action, particularly to gillnet and longline fishermen. Relative to Alternative 1/No Action, groundfish stocks are likely to face a negative impact (see Volume 5, Section 2.1). Thus, the short-term economic impact of Alternative 3, Option 1 is likely to be slightly positive when compared to no action, but the long-term benefit is expected to be slightly negative when compared to the same. Conversely, the short-term economic benefit of Alternative 3, Option 1 is likely to be smaller than Alternative 2, which would open all of the current management areas, but the positive long term economic impact is likely to be larger than Alternative 2. Both the short and long-term impacts of Alternative 3, Option 1 are expected to be negligibly different than Alternative 4, Option 1. Given the lack of clam dredge effort in this portion of the Gulf of Maine, Alternative 3, Option 2 is expected to have the same impacts as Alternative 3, Option 1. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the short-term slightly positive impacts, and long-term slightly negative impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of the gear restrictions (Options 3 and 4) are highly uncertain. Available data indicate that Option 3 would be expected to decrease CPUE for some species, meaning more effort, and thus a higher cost, would be needed to catch the same quantity of fish. Additionally, fishermen would be faced with the cost of buying new/converting nets to meet the new requirements. This, coupled with the expected negative impact on seabed habitats identified in section 3.2.2.3, indicates that both Option 3 and 4 would be expected to induce a slightly negative impact, as compared to Alternative 1/No Action.

The social impacts of the Alternatives 3 and 4 would most heavily impact landing ports in Maine as well as Boston, Gloucester, and New Bedford, Massachusetts. New Bedford and Boston have high social vulnerability index scores and New Bedford and Gloucester have high levels of dependence on commercial fishing (see table in Volume 1, section 4.6). Impacts to communities where permit owners reside are concentrated in mid-coast and southern Maine (Table 47). With the exception of Portland and Westbrook, these communities all have the highest level of dependence on commercial fishing. None of the identified communities included vessels using hydraulic clam dredges or scallop dredges and therefore they would not benefit from the clam dredge exemption (Option 2) or the gear modification Options (Option 3, 4).

While Alternative 3 may open up more total area to fishing than Alternative 1/No Action, it will have a negligible impact on the size and demographic characteristics of the fishery given that it is likely to only impact local fishing effort. The impacts associated with modifying current closed areas and adding additional closures will likely have a negative impact on the size and demographic characteristics of the fishery as well as potential negative impacts on the attitudes, beliefs and values of fishermen, therefore the short-term non-economic social impacts of Alternative 3 in comparison to the no action alternative are expected to be slightly negative and slightly more negative than Alternative 4. In particular, the modification of Jeffreys Bank and the addition of the Platts Bank closed areas will have a large impact on fishing vessels from the midcoast Maine area. These vessels are highly dependent on groundfish in these areas. Moderately positive social impacts are possible in the long-term, if new closed areas effectively increase fish populations and there are spillover benefits into open areas.

4.2.2.4 *Alternative 4*

Alternative 4 would modify the boundaries of the current Jeffreys Bank and Cashes Ledge Habitat Closures, and designate a new habitat management area on Ammen Rock.

Historical average annual revenue associated with currently open areas of the Modified Jeffreys Bank management area is presented in Figure 21, Table 42 (VTR), Table 43 (VMS), and Table 44 (recreational fishing), and a discussion of expected impacts can be found above under Alternative 3.

A complete exclusion of mobile bottom-tending gear, as per Option 1, would affect between $46,830 - $62,950 in gross revenue (20-27% of the total) generated from the open waters surrounding the Modified Jeffreys Bank area in the most recent three year period (2012 – 2014). As with Alternative 3, the total area currently closed to a combination of gear capable of catching groundfish and mobile bottom-tending gear under Alternative 1 is substantially larger than that under consideration in Alternative 4. Thus, Alternative 4 opens more water to fishing than Alternative 1/No Action, particularly to gillnet and longline fishermen. As compared to Alternative 1/No Action, groundfish themselves are likely to face a negative impact (see Volume 5). Thus, the short-term economic impact of Alternative 4, Option 1 is likely to be slightly positive when compared to Alternative 1, but the long-term impact is expected to be slightly negative when compared to the same. Conversely, the short-term economic impact of Alternative 4, Option 1 is likely to be smaller than Alternative 2, but the long term economic impact is likely to be larger than Alternative 2. Both the short and long-term impacts of Alternative 4, Option 1 are expected to be negligibly different than Alternative 3, Option 1. Given the lack of clam dredge effort in this portion of the Gulf of Maine, and that clam resources are not known to occur in the central Gulf of Maine, Alternative 4, Option 2 is expected to have the same impacts as Alternative 4, Option 1. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the short-term slightly positive impacts, and long-term slightly negative impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of the gear restrictions (Options 3 and 4) are highly uncertain. However, given what information is known, Alternative 4, Options 3 and 4 would be expected to induce a slightly negative impact as compared to Alternative 1/No Action.

As with Alternative 3, while Alternative 4 may open up more total area to fishing than Alternative 1/No Action, it will have a negligible social impact on the size and demographic characteristics of the fishery given that it is likely to only impact local fishing effort. The impacts associated with modifying current closed areas and adding additional closures will likely have a negative impact on the size and demographic characteristics of the fishery as well as potential negative impacts on the attitudes, beliefs and values of fishermen, therefore the short-term non-economic social impacts of Alternative 4 in comparison to the no action alternative are expected to be slightly negative and slightly less negative than Alternative 3. In particular, the modification of Jeffreys Bank will have a large impact on fishing vessels from the midcoast Maine area. These vessels are highly dependent on groundfish in this area. Moderate positive social impacts are possible in the long-term, if adjustments to closed areas effectively increase fish populations and there are spillover benefits in open areas. There may be some indirect, slightly negative social impacts to stakeholders concerned with ocean conservation who are particularly supportive of maintaining the current Cashes Ledge closure.

4.2.3 Western Gulf of Maine

Tables and figures related to analysis of the economic impacts of the western Gulf of Maine habitat management alternatives are provided below. Discussion of impacts is provided under a separate heading for each alternative.

Note that the expected economic impact to the shrimp trawl fishery is based on historical data, when in actuality the impact to this fishery during the 2016 season, and potentially further into the future, is expected to be neutral in all alternatives given that the fishery is currently under a moratorium (see http://www.asmfc.org/species/northern-shrimp).

Figure 23 – Large Bigelow Bight HMA average annual revenue by gear, over the time period identified. Note that three gear types are not reported for data confidentiality requirements. Average annual total revenue: 2005-2014 = $ 6,254,381; 2010-2014 = $ 6,813,374; 2012-2014 = $ 5,490,922

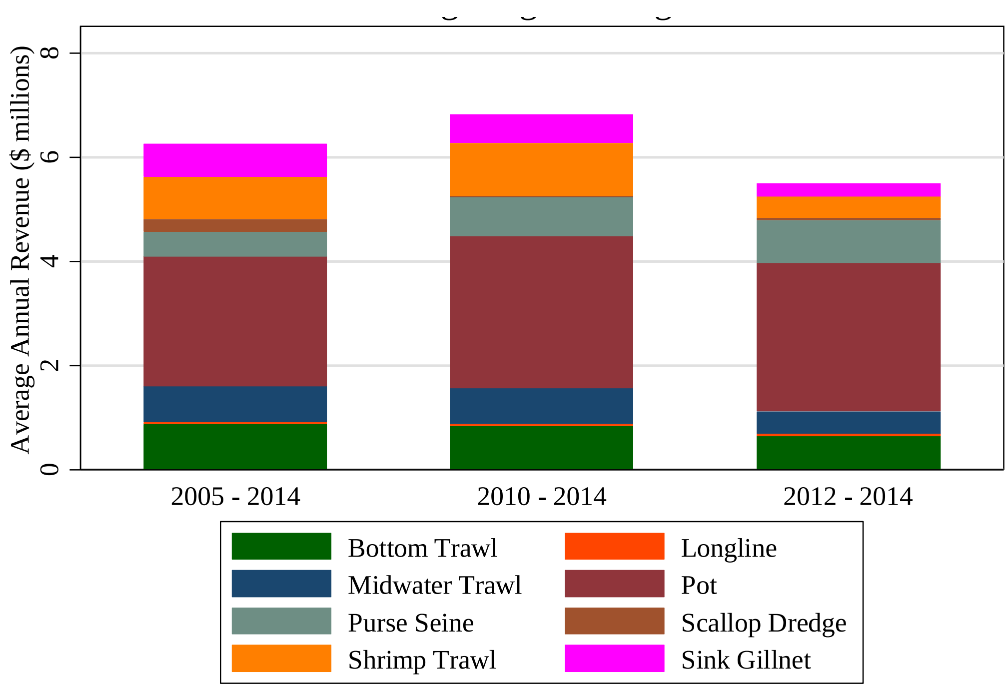


Figure 24 – Small Bigelow Bight HMA average annual commercial fishing revenue by gear, over the time period identified. Note that two gear types are not reported for data confidentiality requirements. Average annual total revenue: 2005-2014 = $ 2,910,542; 2010-2014 = $ 2,874,766; 2012-2014 = $ 2,878,682

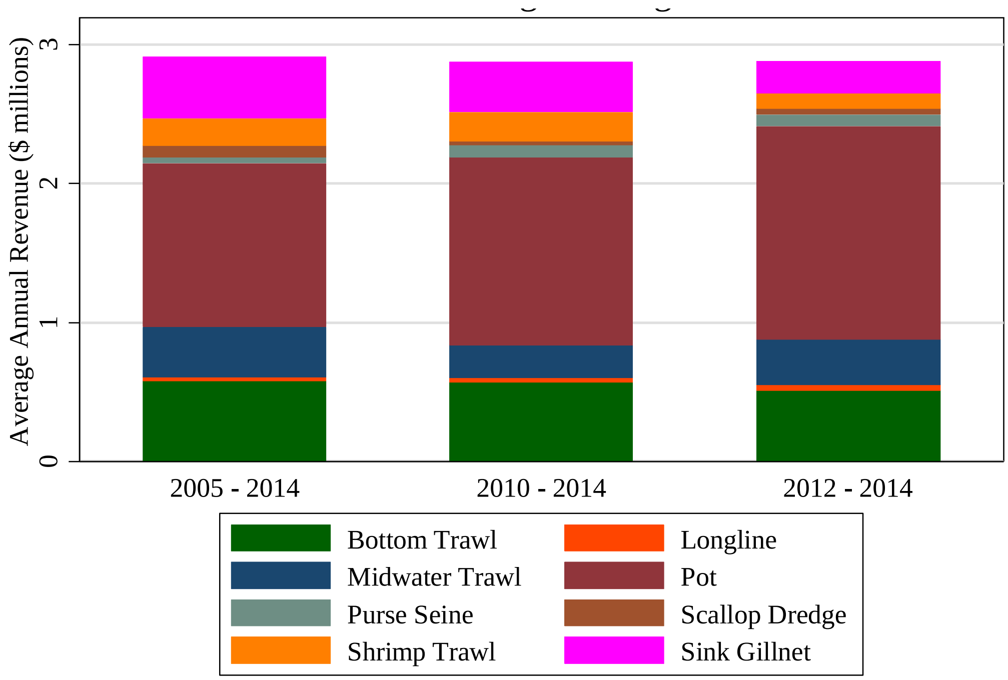


Table 50 – Mobile bottom-tending gear revenues potentially impacted by the areas included in western Gulf of Maine Habitat Alternatives 3, 4, and 5. All variables represent annual estimates. Vessel sizes: S < 50 ft, 50 ft <= M < 70 ft, L >= 70 ft, U = unknown vessel characteristics. Dashes indicate information dropped due to data confidentiality requirements. Note: Large/Unknown Shrimp Trawl data suppressed in 2012 – 2014 due to data confidentiality requirements.

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
Bigelow Bight Large (Alts 3 and 4)	Bottom Trawl	L/U	136,412	91,357	106,919	344,961	41,565	34	345	2005 - 2014
	Bottom Trawl	L/U	153,497	102,473	93,643	281,832	67,812	40	483	2010 - 2014
	Bottom Trawl	L/U	147,218	92,011	117,205	281,832	67,812	41	511	2012 - 2014
	Bottom Trawl	M	285,780	288,442	122,447	538,907	118,952	39	608	2005 - 2014
	Bottom Trawl	M	303,567	350,086	174,156	538,907	118,952	32	586	2010 - 2014
	Bottom Trawl	M	209,614	143,229	136,548	366,662	118,952	30	578	2012 - 2014
	Bottom Trawl	S	446,615	481,450	152,123	677,644	192,125	55	1,141	2005 - 2014
	Bottom Trawl	S	379,361	434,450	174,625	557,443	192,125	43	797	2010 - 2014
	Bottom Trawl	S	301,637	196,526	185,882	516,259	192,125	40	752	2012 - 2014
	Scallop Dredge	ALL	243,048	7,715	707,844	2,256,200	1,347	20	174	2005 - 2014
	Scallop Dredge	ALL	31,908	11,628	33,596	82,841	6,383	16	192	2010 - 2014
	Scallop Dredge	ALL	48,121	49,893	35,639	82,841	11,628	19	257	2012 - 2014
	Shrimp Trawl	L/U	65,149	32,337	80,348	219,255	0	3	44	2005 - 2014
	Shrimp Trawl	L/U	106,847	147,246	99,715	219,255	0	3	53	2010 - 2014
	Shrimp Trawl	L/U	-	-	-	-	-	-	-	2012 - 2014
	Shrimp Trawl	M	278,608	240,238	232,581	759,329	0	15	321	2005 - 2014
	Shrimp Trawl	M	345,878	333,167	326,654	759,329	0	14	307	2010 - 2014
	Shrimp Trawl	M	130,739	59,052	177,776	333,167	0	10	140	2012 - 2014
	Shrimp Trawl	S	468,898	502,346	342,839	1,066,776	14,076	48	830	2005 - 2014
	Shrimp Trawl	S	543,222	522,337	473,233	1,066,776	14,076	45	764	2010 - 2014
	Shrimp Trawl	S	226,671	143,600	264,118	522,337	14,076	34	367	2012 - 2014
Bigelow Bight Small (Alt 5)	Bottom Trawl	L/U	84,562	51,083	70,213	199,147	23,435	31	304	2005 - 2014
	Bottom Trawl	L/U	99,018	57,906	79,866	199,147	23,435	36	414	2010 - 2014
	Bottom Trawl	L/U	100,438	57,906	85,757	199,147	44,260	41	495	2012 - 2014
	Bottom Trawl	M	176,265	162,041	107,535	417,614	62,409	35	494	2005 - 2014
	Bottom Trawl	M	191,483	120,904	151,377	417,614	62,409	29	493	2010 - 2014
	Bottom Trawl	M	139,632	81,982	117,212	274,504	62,409	30	539	2012 - 2014
	Bottom Trawl	S	317,541	333,669	120,888	473,871	160,292	45	897	2005 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
	Bottom Trawl	S	280,598	173,007	155,212	473,871	160,292	36	635	2010 - 2014
	Bottom Trawl	S	269,057	173,007	177,489	473,871	160,292	35	671	2012 - 2014
	Scallop Dredge	ALL	83,558	6,481	210,650	678,423	1,167	16	159	2005 - 2014
	Scallop Dredge	ALL	28,772	9,833	34,367	82,264	1,167	12	179	2010 - 2014
	Scallop Dredge	ALL	45,448	44,248	36,231	82,264	9,833	14	245	2012 - 2014
	Shrimp Trawl	OTHER	84,102	79,947	56,822	200,482	0	7	140	2005 - 2014
	Shrimp Trawl	OTHER	88,969	88,552	77,750	200,482	0	7	156	2010 - 2014
	Shrimp Trawl	OTHER	51,937	35,571	61,769	120,241	0	6	82	2012 - 2014
	Shrimp Trawl	S	106,396	106,300	78,511	288,207	9,421	22	282	2005 - 2014
	Shrimp Trawl	S	117,458	110,188	105,528	288,207	9,421	20	287	2010 - 2014
	Shrimp Trawl	S	58,909	57,119	50,407	110,188	9,421	17	164	2012 - 2014

Table 51 – Fishing effort (in hours fished), and individuals fishing in areas currently open to fishing within the western Gulf of Maine Alternatives 3, 4, and 5, estimated from VMS polls using the approach of Records and Demarest (2013). Total effort and individuals are the yearly means, while the other statistics are calculated at the individual level. Note that some year/gear combinations are not presented due to data confidentiality requirements.

Area	Gear	Years	Total Effort	Individuals	Mean Effort	Median Effort	SD Effort
Bigelow Bight Large (Alts 3 and 4)	Bottom Trawl	2005 - 2012	2,192.86	81.876	26.78	6.80	48.13
	Bottom Trawl	2008 - 2012	2,065.51	81	25.50	7.15	42.04
	Bottom Trawl	2010 - 2012	1,680.96	82	20.50	6.99	30.84
	GC Scallop	2005 - 2012	8.69	6	1.45	0.41	2.59
	GC Scallop	2008 - 2012	7.74	4.6	1.68	0.46	2.81
	GC Scallop	2010 - 2012	9.58	5.33	1.80	0.59	2.97
	LA Scallop	2005 - 2012	2.84	5.38	0.53	0.03	1.48
	LA Scallop	2008 - 2012	1.53	3.2	0.48	0.05	1.07
	LA Scallop	2010 - 2012	1.43	2.33	0.61	0.03	1.52
	Shrimp Trawl	2005 - 2012	3,101.23	41.13	75.41	47.60	79.52
	Shrimp Trawl	2008 - 2012	3,987.73	46.8	85.21	58.98	85.73
	Shrimp Trawl	2010 - 2012	5,102.96	52	97.51	66.70	93.46
Bigelow Bight Small (Alt 5)	Bottom Trawl	2005 - 2012	1,680.90	55.38	30.35	9.00	52.53
	Bottom Trawl	2008 - 2012	1,574.23	56.00	28.11	9.76	43.80
	Bottom Trawl	2010 - 2012	1,389.55	61.67	22.53	9.70	32.84
	GC Scallop	2005 - 2012	8.46	5.38	1.57	0.57	2.70
	GC Scallop	2008 - 2012	7.41	4.40	1.69	0.39	2.87
	GC Scallop	2010 - 2012	9.04	5.00	1.81	0.57	3.07
	LA Scallop	2005 - 2012	1.97	3.38	0.58	0.03	1.59
	LA Scallop	2008 - 2012	1.50	2.80	0.54	0.05	1.13
	LA Scallop	2010 - 2012	1.42	2.33	0.61	0.03	1.51
	Shrimp Trawl	2005 - 2012	979.19	18.88	51.88	27.79	63.18
	Shrimp Trawl	2008 - 2012	1,251.65	22.60	55.38	27.79	68.69
	Shrimp Trawl	2010 - 2012	1,656.72	27.33	60.61	27.09	76.30

Table 52 – Party/charter recreational fishing revenue associated with the areas included in the western Gulf of Maine habitat alternatives. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual revenue is the mean annual revenue, individuals represents the average number of permit holders fishing in the area, and anglers represents the average number of anglers per year. All other statistics are estimates at the trip level.

Area	Years	Annual Revenue	Individuals	Anglers	Mean Revenue	Median Revenue	SD Revenue
WGOM (Alt 1)	2006 - 2014	4,422,526	94	33,613	2,230	1,118	2,098
	2010 - 2014	3,947,579	82	30,575	2,072	1,118	1,929
	2012 - 2014	3,951,228	65	30,716	2,037	1,118	1,915
Bigelow Bight Large (Alts 3 and 4)	2006 - 2014	1,039,767	37	9,501	2,110	1,705	1,683
	2010 - 2014	855,178	31	7,885	2,080	1,705	1,612
	2012 - 2014	715,702	25	6,928	1,885	1,492	1,529
Bigelow Bight Small (Alt 5)	2006 - 2014	752,624	31	7,554	1,977	1,535	1,670
	2010 - 2014	651,601	27	6,510	2,043	1,705	1,654
	2012 - 2014	558,733	21	5,876	1,896	1,577	1,594
Stellwagen Large (Alts 3 and 6)	2006 - 2014	2,027,623	64	11,628	2,421	1,118	2,636
	2010 - 2014	1,768,807	55	10,062	2,228	1,118	2,411
	2012 - 2014	1,769,332	42	10,023	2,187	1,118	2,375
Stellwagen Small (Alts 4 and 5)	2006 - 2014	1,745,337	53	9,539	2,431	1,118	2,715
	2010 - 2014	1,534,858	45	8,410	2,224	1,118	2,457
	2012 - 2014	1,558,295	34	8,575	2,220	1,118	2,420
Jeffreys Ledge (Alts 4 and 5)	2006 - 2014	2,296,994	45	21,423	2,138	1,790	1,601
	2010 - 2014	2,123,252	39	20,247	1,992	1,641	1,495
	2012 - 2014	2,152,099	33	20,606	1,942	1,535	1,502

Table 53 – Western Gulf of Maine [Groundfish] Closure Area: Average value per haul (calendar year 2007 - 2011) within a 10 nautical mile buffer, and percent of total haul revenue this value represents. NEFOP and ASM observer landings data.

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bottom Trawl	Total Hauls	1,256	1,357	1,432	686	540	354	528	608	648	734	824	951
	Cod	$245	$349	$368	$302	$616	$365	$313	$499	$648	$739	$523	$489
		17%	20%	23%	21%	33%	27%	30%	44%	58%	54%	45%	34%
	Haddock	$17	$97	$126	$7	$76	$48	$16	$24	$39	$39	$25	$26
		1%	5%	8%	0%	4%	4%	2%	2%	3%	3%	2%	2%
	Redfish	$41	$81	$69	$86	$82	$60	$28	$20	$22	$22	$23	$29
		3%	5%	4%	6%	4%	4%	3%	2%	2%	2%	2%	2%
	Pollock	$240	$327	$268	$357	$565	$359	$204	$256	$140	$140	$115	$204
		17%	18%	17%	25%	30%	27%	20%	23%	12%	10%	10%	14%
	Monkfish	$278	$280	$205	$135	$116	$101	$98	$77	$70	$90	$127	$160
		19%	16%	13%	9%	6%	8%	9%	7%	6%	7%	11%	11%
	Witch Flounder	$182	$161	$115	$116	$65	$38	$56	$44	$64	$116	$84	$126
		13%	9%	7%	8%	3%	3%	5%	4%	6%	8%	7%	9%
	Plaice	$133	$131	$110	$93	$57	$102	$129	$79	$52	$102	$118	$118
		9%	7%	7%	6%	3%	8%	12%	7%	5%	7%	10%	8%
	White Hake	$157	$210	$187	$257	$226	$167	$106	$71	$52	$79	88	90
		11%	12%	12%	18%	12%	13%	10%	6%	5%	6%	8%	6%
	Lobster	$76	$87	$53	$52	$58	$63	$46	$17	$5	$5	29	56
		5%	5%	3%	4%	3%	5%	4%	2%	0%	0%	3%	4%
Longline	Total Hauls	67	120	323		62							24
	Cod	$550	$377	$122		$241							$447
		91%	92%	40%		41%							90%
	Haddock	$50	$31	$176		$307							$34
		8%	7%	58%		53%							7%
Fixed Gillnet	Total Hauls	799	610	649	95	402	709	848	979	966	926	828	761
	Cod	$483	$306	$178	$289	$489	$450	$559	$661	$642	$765	$826	$649
		45%	48%	43%	66%	74%	26%	51%	58%	61%	60%	52%	36%
	Haddock	$6	$24	$60	$4	$3	$6	$3	$3	$3	$34	$5	$5
		1%	4%	15%	1%	0%	0%	0%	0%	0%	3%	0%	0%
	Pollock	$458	$121	$6	$106	$22	$861	$217	$173	$230	$329	$659	$1,014
		43%	19%	1%	24%	3%	50%	20%	15%	22%	26%	41%	57%
	Yellowtail	$35	$117	$127	$11	$5	$2	$1	$0	$0	$0	$0	$1

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		3%	18%	31%	2%	1%	0%	0%	0%	0%	0%	0%	0%
	Spiny Dogfish	$-	$-	$-	$-	$15	$48	$143	$76	$2	$0	$0	$-
						2%	3%	13%	7%	0%	0%	0%	
	Monkfish	$13	$1	$0	$1	$24	$49	$66	$59	$45	$45	$54	$45
		1%	0%	0%	0%	4%	3%	6%	5%	4%	4%	3%	2%
Separator Trawl	Total Hauls				25		19		11	4			
	Cod				$367		$875		$1,344	$907			
					23%		47%		66%	63%			
	Haddock				$7		$130		$9	$7			
					0%		7%		0%	1%			
	Redfish				$312		$241		$89	$279			
					20%		13%		4%	19%			
	Pollock				$626		$474		$466	$182			
					39%		26%		23%	13%			
	Lobster				$127		$18		$6	$13			
					8%		1%		0%	1%			
Handline	Total Hauls	175	57	22									9
	Cod	$125	$93	$111									$84
		100%	100%	100%									99%

Table 54 – Total number of vessels by port of landing or city of registration associated with at least three vessels conducting mobile bottom tending gear trips in 2012 in currently open portions of the western Gulf of Maine potentially impacted by the management alternatives.

Western Gulf of Maine		Alternative 3 and 4 (Bigelow Large)		Alternative 5 (Bigelow Small)	
State	**Community**	**Port**	**City**	**Port**	**City**
MA		**108**	**78**	**103**	**71**
	Boston	18		17	
	Gloucester	65	33	61	31
	New Bedford	26	25	25	23
	Newburyport	4		3	
	Rockport	3	3		3
ME		**67**	**74**	**32**	**44**
	Boothbay Harbor	4			

Western Gulf of Maine		Alternative 3 and 4 (Bigelow Large)		Alternative 5 (Bigelow Small)	
	Cundys Harbor	3			
	Harpswell	7	11		
	New Harbor	3			
	Port Clyde	6	3		
	Portland	40	13	25	11
	South Bristol	7	5		4
	Westbrook		3		3
NH		**21**	**20**	**18**	**18**
	Hampton		4		4
	Portsmouth	7		6	
	Rye	5		4	
	Seabrook	10	5	9	5

Table 55 – Landing port and associated mobile bottom-tending gear revenues in 2012 potentially impacted by the areas included in the western Gulf of Maine Alternatives. Ports with less than 3 vessels each were included in the state totals only.

Western Gulf of Maine			
	Alternative	**3, 4**	**5**
	Option	**1,2,3,4**	**1,2,3,4**
State	**Port**	**Total Revenue**	**Total Revenue**
MA	**Total**	**653,435.28**	**535,726.45**
	BOSTON	143,868.81	89,810.25
	GLOUCESTER	399,297.95	343,299.98
	NEW BEDFORD	22,010.60	15,382.77
	NEWBURYPORT	71,167.46	70,902.88
	ROCKPORT	15,055.53	
ME	**Total**	**1,005,469.21**	**99,662.30**
	BOOTHBAY HARBOR	6,513.74	
	CUNDYS HARBOR	96,926.02	
	HARPSWELL	105,828.25	
	NEW HARBOR	3,800.90	
	PORT CLYDE	5,531.18	

	PORTLAND	557,148.00	41,009.42
	SOUTH BRISTOL	6,078.00	
NH	**Total**	**637,716.61**	**604,648.48**
	PORTSMOUTH	126,095.49	102,841.13
	RYE	196,199.01	186,481.79
	SEABROOK	313,662.48	313,565.92

Table 56 – Total number of vessels conducting party/charter recreational fishing trips in 2012. Vessels are grouped by port of landing or city of registration, provided that location included at least three vessels. Cities/ports with less than three vessels each were included in the state totals only.

Western Gulf of Maine		Alternative 2 (current WGOM)		Alternative 3		Alternative 4 and 7		Alternative 5		Alternative 6	
State	**Community**	**Port**	**City**	**Port**	**City**	**Port**	**City**	**Port**	**City**	**Port**	**City**
MA		**62**	**62**	**59**	**57**	**61**	**60**	**61**	**60**	**55**	**54**
	Boston			3		3		3			
	Gloucester	13	6	13	6	13	6	13	6	13	6
	Marshfield	23	10	23	10	23	10	23	10	23	10
	Newburyport	5	4	5	4	7	5	7	5		3
	Plymouth	3	3	4	3	3	3	3	3	4	3
	Salisbury	4				4		4			
	Scituate	6		4		4		4		4	
ME		**17**	**15**	**8**	**8**	**17**	**16**	**15**	**14**		
	Ogunquit		3				3		3		
	Portland	3				4					
	Saco	4				3		3			
	Wells	5				5		5			
NH		**24**	**24**	**23**	**24**	**27**	**28**	**27**	**28**	**9**	**9**
	Hampton	7	5	7	5	7	5	7	5		
	Hampton Falls		3		3		3		3		3
	Portsmouth					3		3			
	Rye	8	5	7	4	10	6	10	6		
	Seabrook	7		7		7		7		5	

Table 57 – Sum of 2012 party/charter recreational fishing revenue associated with the western Gulf of Maine Alternatives. Ports with less than 3 vessels each were included in the state totals only.

Western Gulf of Maine						
Alternative		**1**	**3**	**4**	**5**	**6**
State	**Port**	**Value**	**Value**	**Value**	**Value**	**Value**
MA	**Total**	**2,089,428.64**	**1,816,700.08**	**1,957,535.32**	**1,956,417.58**	**1,683,875.31**
	BOSTON		4843.54	4843.54	4,843.54	
	GLOUCESTER	950,451.58	929400.81	863826.73	863,826.73	929,400.81
	MARSHFIELD	489,756.41	481000.78	369971.94	369,971.94	481,000.78
	NEWBURYPORT	57,377.32	43964.44	87556.30	86,438.56	
	PLYMOUTH	150,336.03	151453.77	150336.03	150,336.03	151,453.77
	SALISBURY	357,490.51		418407.34	418,407.34	
	SCITUATE	17,883.84	12667.72	8010.47	8,010.47	12,667.72
ME	**Total**	**743,661.90**	**216714.95**	**871334.3**	**693,547.50**	**19,687.80**
	PORTLAND	21,030.15		29979.15		
	SACO	11,782.85		15959.05	3,877.90	
	WELLS	107,089.70		120811.5	89,788.30	
NH	**Total**	**1,523,076.50**	**461,032.00**	**1,908,577.00**	**1,908,236.00**	**63,340.75**
	HAMPTON	349,951.25	239,637.75	579,870.50	579,870.50	
	PORTSMOUTH			26,598.00	26,598.00	
	RYE	137,423.00	70,160.75	204,429.50	204,088.50	
	SEABROOK	1,007,996.00	149,443.25	1,097,679.00	1,097,679.00	56,520.75

4.2.3.1 *Alternative 1 (No Action, Preferred Alternative)*

This alternative maintains the existing Western Gulf of Maine Closure Area and Habitat Closure Area, with a modified boundary of the groundish closure area as preferred. Alternative 1/No Action 1 is expected to induce moderately positive economic impacts, mainly accrued to the groundfish fishery, through the protection of both groundfish habitat and spawning grounds. Alternative 1/No Action would result in mainly neutral social impacts as it would maintain the status quo. A detailed discussion of no action vs. no habitat management areas (Alternative 2) is provided below. All other alternatives are compared to No Action in the sections that follow.

The Council's preferred alternative modifies the eastern boundary of the Western Gulf of Maine Closure Area, eliminating a portion of the groundfish closure that is roughly 5 nautical miles wide east to west and 60 nautical miles long north to south. The concept of an exemption area for this same easternmost section of the groundfish closure was analyzed in Framework Adjustment 48 to the Northeast Multispecies FMP, and the analyses developed for that framework assessed the potential biological, habitat, and economic impacts associated with allowing sector groundfish vessels access to fish in the area. Note that Framework 48 evaluated this area as a sector exemption area, while the proposal here is to change the boundary and allow any types of fishing into the area, subject to other overlapping management areas and constraints, which include fishing for groundfish in May within 30-minute block 138, and a common pool closure of block 123 during March, under the preferred alternative. In other words, most of the area would be open to most fishing most of the year. While via Framework 48 the Council approved the exemption areas as potential sector requests, sector fishing activities within this particular exemption area have not been authorized to date in the annual sector regulations.

Relevant to the impacts of this boundary change are recent adjustments to catch limits, especially lower catch limits for Gulf of Maine cod, and the evolving redfish exemption program. The redfish exemption program allows for fishing with 5.5 mesh, subject to various requirements. A report from the REDNET research project shows relatively high fishing effort and catches along the eastern boundary of the Western Gulf of Maine Closure Area (see Page 23, Figure 13 here: http://s3.amazonaws.com/nefmc.org/6.-REDNET_Component2_final-report.pdf). Although there has been limited participation in the redfish exemption program to date, participation could increase in the future. Both cod and redfish were caught in waters east of this area between 2007 and 2012 (see revenue summary table below).

The tables in the economic impacts section of Framework 48 are updated below (Table 59) to include just the buffer area that would be reopened under the preferred alternative, rather than using a buffer around the entire Western Gulf of Maine Closure Area. This was done to remove tows west of the closure, which are likely to be less similar to tows in areas east of the 'sliver' area. For practical purposes, in assessing fishing effort in areas adjacent to the 'sliver' area, the portion of the buffer inside the Western Gulf of Maine Closure Area has been closed for many years to various types of fishing effort, so the tables shown below summarize revenues from areas to the north, south, and east of the sliver only. The results of this analysis are presented below for species that, on average across all months, comprised 5% or more of revenues in any gear type. Blue and green shading is used to show the gradient of values from low (white) to high (blue or green) revenue or percent of revenue per haul.

The full list of species analyzed included monkfish, cod, cusk, winter flounder, witch flounder, yellowtail flounder, American plaice, unclassified flounders, haddock, red hake, white hake, unclassified red or white hake, halibut, redfish, pollock, black seabass, shad, spiny dogfish, winter skate, bluefin tuna, porbeagle shark, whiting, lobster, and scallop. All observed hauls and sets between calendar year 2007 and 2012 with latitude and longitude for haul and set beginning and/or end points were included in the analysis. Although some longline and shrimp trawl hauls occurred within the 10 nautical mile buffer, this information cannot be reported due to confidentiality issues.

As shown in Table 58, trawls were used during 2007-2012 in the waters surrounding the sliver area to catch and land primarily monkfish, cod, witch flounder, plaice, white hake, redfish, and pollock. Gillnet and separator trawl revenues were dominated by cod, white hake, and pollock. For both gillnets and separator trawls, some months had fewer than three tows, and for separator trawls in particular, overall sample sizes are fairly small.

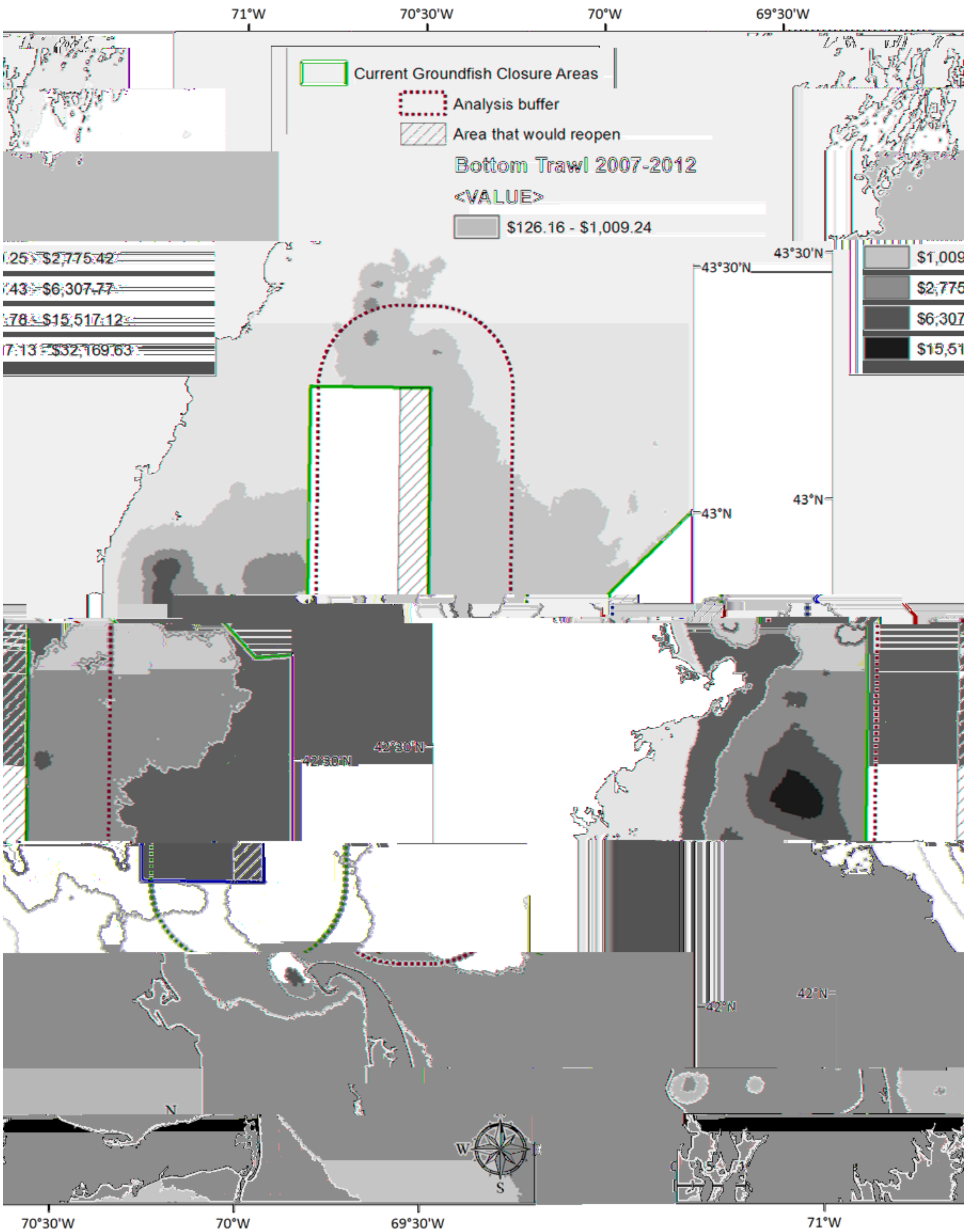
The first chart below (Map 24) shows the VTR reported spatial distribution of bottom trawl (standard and separator/Ruhle trawls combined) revenues during this same period, indicating that they were concentrated along the southeastern corner of the sliver area. The map was generated using the statistical analysis developed in NOAA Technical Memorandum NMFS-NE-229 (DePiper 2014) and used throughout this amendment in order to more rigorously represent the spatial footprint of VTR trips. The second chart (Map 25) shows gillnet (sink and pelagic combined) VTR revenue over the same time period using the same approach, and suggests that most gillnet revenue is generated off of the northeastern corner of the sliver area.

Shifting the boundary west by approximately five nautical miles could reduce steam times by an hour or so per day, which could make it possible for vessels currently fishing west of the closure to fish on the eastern side of it on a more routine basis. However, given that the low Gulf of Maine cod TAC proposed as part of Framework 53 is likely to severely restrict groundfish fishing in the area surrounding the WGOM sliver, the economic benefits afforded by fishermen's access to this area of the ocean are likely to be small to negligible. A two tailed test for the proportion of hauls catching cod on the east versus the west side of the WGOM closure is significant at the 5% level for bottom trawl (p-value = 0.00), but not for gillnet hauls (p-value = 0.81) This means that catch rates of cod are significantly lower on the eastern versus western side of the WGOM closure for observed bottom trawl trips, but not for gillnet trips. A nonparametric two-tailed Wilcoxon rank-sum test indicates that, at the 5% level, the median value derived from cod on hauls on the western side of the closure is significantly higher than the eastern side for both bottom trawls (p-value = 0.00) and gillnet hauls (p-value = 0.00). This means that cod is a higher proportion of the landed revenue on the western side of the closure than the eastern side of the closure. This analysis indicates that, given the constraining role cod is likely to play in the groundfish fishery for the foreseeable future, there is some benefit to opening areas with a lower catch rate of cod, versus other species, to fishermen. Nevertheless, as previously stated, the economic benefit would likely be small to negligible in magnitude. Therefore, the preferred alternative is expected to have similar economic impacts relative to the No Action alternative as currently configured, i.e. moderately positive over both the short and long term.

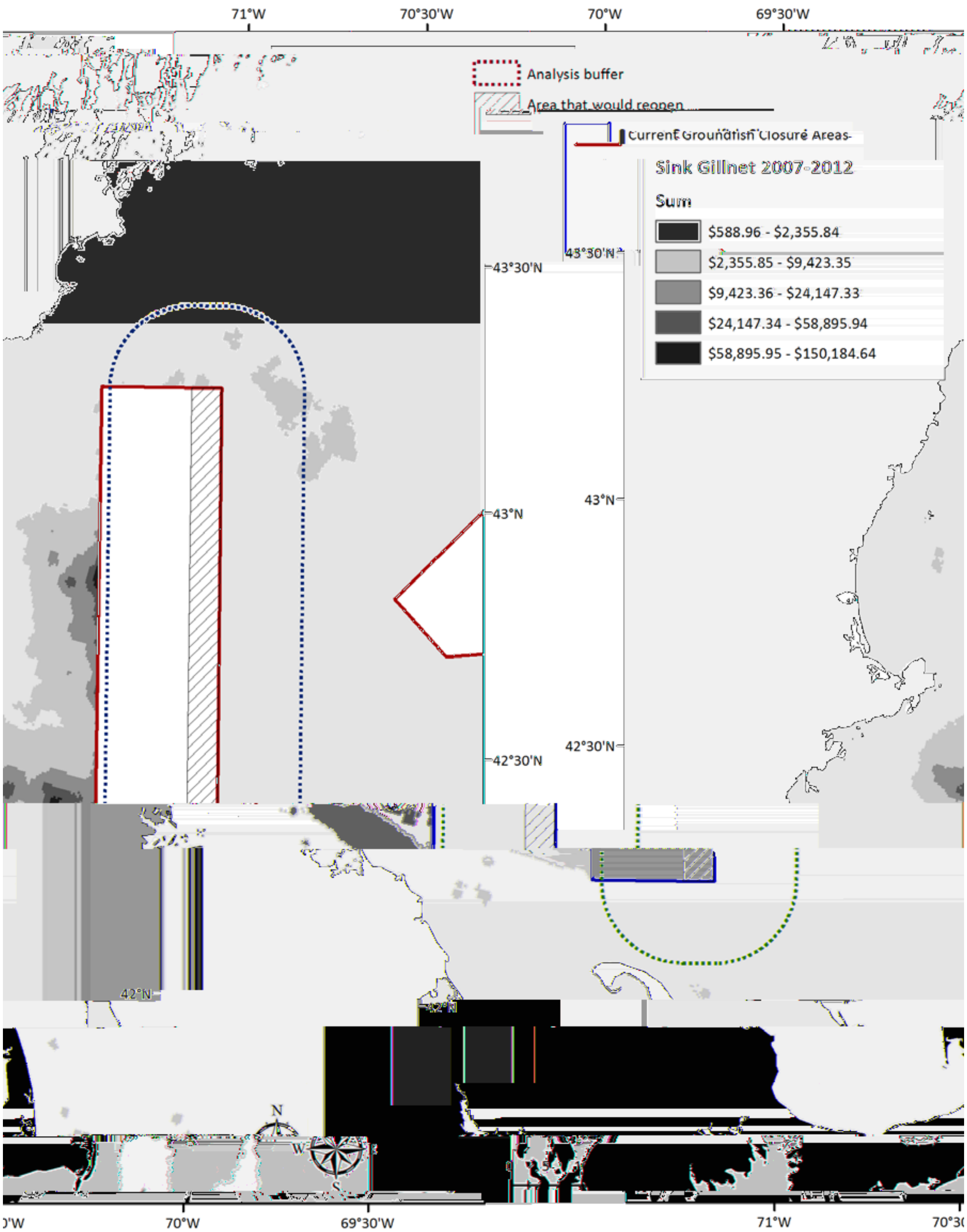
Table 58 – Average revenue per haul by species and gear type within a 10 nm buffer around the eastern sliver of the WGOM Closure Area, time period 2007-2012. Blue and green shading is used to show the gradient of values within each gear type from low to high revenue (white to blue) or percent of revenue (white to green).

Gear	Month	Number of hauls	Total average revenue per haul	Average revenue by species (may not sum to total as only major species are shown) Monkfish	Cod	Witch Flounder	Plaice	White Hake	Redfish	Pollock
Bottom OT	1	915	$ 1,637	$ 377	$ 124	$ 227	$ 181	$ 216	$ 55	$ 293
	2	1120	$ 1,937	$ 339	$ 318	$ 192	$ 158	$ 254	$ 98	$ 394
	3	1098	$ 1,667	$ 267	$ 329	$ 145	$ 139	$ 243	$ 90	$ 348
	4	655	$ 1,454	$ 141	$ 283	$ 120	$ 95	$ 269	$ 90	$ 373
	5	423	$ 1,891	$ 147	$ 358	$ 73	$ 68	$ 288	$ 104	$ 669
	6	240	$ 1,341	$ 138	$ 55	$ 34	$ 135	$ 246	$ 88	$ 516
	7	373	$ 1,099	$ 124	$ 188	$ 56	$ 171	$ 148	$ 39	$ 281
	8	325	$ 1,061	$ 104	$ 130	$ 39	$ 137	$ 111	$ 35	$ 436
	9	331	$ 1,015	$ 84	$ 381	$ 24	$ 97	$ 77	$ 39	$ 247
	10	400	$ 1,209	$ 109	$ 421	$ 28	$ 177	$ 135	$ 39	$ 230
	11	372	$ 1,035	$ 187	$ 100	$ 77	$ 247	$ 187	$ 48	$ 134
	12	492	$ 1,344	$ 281	$ 112	$ 172	$ 218	$ 173	$ 52	$ 155
Bottom OT	1	915	100%	23%	8%	14%	11%	13%	3%	18%
	2	1120	100%	17%	16%	10%	8%	13%	5%	20%
	3	1098	100%	16%	20%	9%	8%	15%	5%	21%
	4	655	100%	10%	19%	8%	7%	19%	6%	26%
	5	423	100%	8%	19%	4%	4%	15%	5%	35%
	6	240	100%	10%	4%	3%	10%	18%	7%	38%
	7	373	100%	11%	17%	5%	16%	13%	4%	26%
	8	325	100%	10%	12%	4%	13%	10%	3%	41%
	9	331	100%	8%	38%	2%	10%	8%	4%	24%
	10	400	100%	9%	35%	2%	15%	11%	3%	19%
	11	372	100%	18%	10%	7%	24%	18%	5%	13%
	12	492	100%	21%	8%	13%	16%	13%	4%	12%
Average monthly percent of revenue by species				13%	17%	7%	12%	14%	5%	24%
Fixed Gillnet	3	16	$ 228	$ 4	$ 55	$ -	$ 4	$ 6	$ 1	$ 150
	4	62	$ 498	$ 2	$ 307	$ 2	$ 6	$ 4	$ 9	$ 159
	6	121	$ 2,022	$ 25	$ 268	$ 1	$ 3	$ 473	$ 8	$ 1,161
	7	89	$ 621	$ 16	$ 290	$ 1	$ 3	$ 97	$ 1	$ 107
	8	74	$ 1,275	$ 48	$ 370	$ 2	$ 1	$ 409	$ 2	$ 404
	9	70	$ 1,541	$ 11	$ 503	$ 1	$ 0	$ 369	$ 10	$ 627
	10	64	$ 1,137	$ 14	$ 487	$ 1	$ 0	$ 158	$ 7	$ 456
	11	34	$ 966	$ 17	$ 391	$ 1	$ 0	$ 72	$ 7	$ 469
	12	28	$ 873	$ 10	$ 297	$ 1	$ 0	$ 31	$ 7	$ 505
Fixed Gillnet	3	16	100%	2%	24%	0%	2%	3%	0%	66%
	4	62	100%	0%	62%	0%	1%	1%	2%	32%
	6	121	100%	1%	13%	0%	0%	23%	0%	57%
	7	89	100%	3%	47%	0%	0%	16%	0%	17%
	8	74	100%	4%	29%	0%	0%	32%	0%	32%
	9	70	100%	1%	33%	0%	0%	24%	1%	41%
	10	64	100%	1%	43%	0%	0%	14%	1%	40%
	11	34	100%	2%	41%	0%	0%	7%	1%	49%
	12	28	100%	1%	34%	0%	0%	4%	1%	58%
Average monthly percent of revenue by species				2%	36%	0%	0%	14%	1%	43%
Separator OT	4	25	$ 1,587	$ 21	$ 367	$ 34	$ 33	$ 32	$ 312	$ 626
	6	10	$ 1,044	$ 47	$ 28	$ 2	$ 39	$ 13	$ 192	$ 647
	9	3	$ 651	$ -	$ 4	$ 2	$ 12	$ 39	$ 372	$ 196
Separator OT	4	25	100%	1%	23%	2%	2%	2%	20%	39%
	6	10	100%	4%	3%	0%	4%	1%	18%	62%
	9	3	100%	0%	1%	0%	2%	6%	57%	30%
Average monthly percent of revenue by species				2%	9%	1%	3%	3%	32%	44%

Map 24 – Spatial distribution of bottom trawl VTR revenues near the WGOM Closure Area, sum over the period 2007-2012. The buffer area used for the analysis is the oblong shape with dotted outline. No groundfishing was allowed in the groundfish closures (solid outline) during this time period. The eastern portion that would reopen is hatched.



Map 25 – Spatial distribution of sink gillnet VTR revenues near the WGOM Closure Area, 2007-2012. The buffer area used for the analysis is the oblong shape with dotted outline. No groundfishing was allowed in the groundfish closures (solid outline) during this time period. The eastern portion that would reopen is hatched.



4.2.3.2 *Alternative 2 (No Habitat Management Areas)*

This alternative would remove the current Western Gulf of Maine Habitat Closure Area and the Western Gulf of Maine Groundfish Closure Area, and would not designate any additional habitat management areas in the region.

Table 53 presents the haul-level revenue generated by species caught on observed trips in the area within a 10 nautical mile buffer of the combined Western Gulf of Maine Groundfish and Habitat Closure Areas. A substantial amount of effort occurs within this 10 nautical mile buffer, for a varied mix of gear types. Cod and pollock account for a substantial portion of the revenue across all gear types. The Gulf of Maine cod stock is overfished, and overfishing is occurring, and thus in the short term, no significant increases in revenue are expected to result from targeting this species under Alternative 2. Pollock is not overfished, and overfishing is not occurring. In addition, the analyses conducted for both Framework 48 to the Northeast Multispecies FMP and this action suggest the Western Gulf of Maine closures contain substantial pollock biomass. Access to this biomass would likely provide some increased revenue, but the analysis in Framework 50 for the Northeast Multispecies FMP highlights that only 33% of the total annual catch entitlement was caught in 2010, and 50% in 2011, suggesting that if a lack of access to biomass because of area closure has been a limiting factor for pollock landings in the Gulf of Maine, it is probably not the only factor. Haddock also plays an important role for longline fishermen in the vicinity of the Western Gulf of Maine closures. However, this is likely due to a selectivity issue as opposed to biomass availability, given that this pattern is not repeated across other gear types capable of catching haddock. Nonetheless, some increases in haddock landings and revenue would be expected.

At a combined 883 square nautical miles, the Western Gulf of Maine closures amount to a large portion of the inshore western Gulf of Maine. Opening this area up to fishing is likely to decrease the costs of fishing for some commercial groundfish and mobile bottom-tending gear fishermen, who will not need to travel as far in order to access open fishing grounds. Maps in the large mesh multispecies fishery section of Volume 1 as well as Map 24 and to a lesser extent Map 25 above indicate that a substantial amount of effort currently occurs very near to the area boundaries. Statistical area 514 in particular generates the largest annual landings for multispecies bottom trawl, gillnet, and longline gears, though separator trawls are more active in other statistical areas. Some of this effort would redistribute into the current closure if Alternative 2 is chosen.

Table 52 presents the revenue from recreational charter and party vessels whose VTR points fall within the boundaries of the existing closures. A large number of permit holders, and a substantially larger number of anglers on party/charter trips, currently ply these waters. Table 56 lists communities associated with recreational trips in these areas in 2012, which are likely to experience impacts from Alternative 2. These recreational charter and party permits are mainly associated with communities in Massachusetts although there are some from southern Maine and New Hampshire (Table 56).

Increased fishing gear interactions and potential displacement of existing recreational fishing effort within the existing closures are other potential costs of this alternative. The increased costs accruing to the recreational fishery, due to congestion from an influx of commercial gear, depend on the flow of effort into the area, and the gear conflict avoidance measures taken by both recreational fishermen and commericial fishermen. This effect is likely to be negative, given the substantial recreational fishing currently reported within the Western Gulf of Maine closure areas.

When compared to Alternative 1/No Action, Alternative 2 is expected to induce moderate positive economic impacts in the short-term, and moderate negative impacts in the long-term, the latter due to its negative impact on groundfish species (see Volume 5 section 2.2.3.2). The magnitude of the short-term positive benefits are expected to be substantially larger than Alternatives 1, 3, 4, 5, 6, or 8. Conversely, the long-term negative impacts would be substantially larger in magnitude than Alternatives 1, 3, 4, 5, 6, or 8. The discount rate and time horizon before costs begin to accrue will play an important role on the overall magnitude and sign of the net benefits due to Alternative 2. The lower the discount rate, and shorter the time horizon before the costs of area management begin to accrue, the more likely the overall impact will be negative. However, given that the No Action Alternative 1 is expected to be producing short-term benefits with the same general magnitude as those derived from Alternative 2, but with positive long-term benefits, the net benefits of Alternative 2 are expected to be lower than Alternative 1.

The short-term social impacts of Alternative 2 in comparison to Alternative 1/No Action are expected to be highly positive as fishermen would gain access to new relatively large and accessible fishing area. There are potential long-term highly negative social impacts if benefits to fish populations from the Western Gulf of Maine Habitat and Groundfish Closure Areas are lost.

4.2.3.3 *Alternative 3*

Alternative 3 would modify the boundaries of the current Western Gulf of Maine Habitat Closure Area to create the Large Stellwagen HMA, and designate the Large Bigelow Bight HMA. The Western Gulf of Maine Groundfish Closure Area would be removed.

Figure 23 illustrates the diverse, and relatively stable, assemblage of fishing gears used to fish the waters of the Large Bigelow Bight area. The most obvious change between 2005 and 2012 is the substantial decrease in scallop dredge revenue in the most recent three year period. Table 50 indicates that the difference in scallop landings across time is explained by a single year (2008) with $2,256,200 in revenue, skewing the distribution. Bottom trawl and shrimp trawl revenues are much more stable across time. The VTR analysis estimates that within the bottom trawl fleets, area management in Large Bigelow Bight would affect a mean revenue of $288 (2% of an average trip's revenue) per trip for vessels > 70 ft, $364 (4% of an average trip's revenue) per trip for vessels between 50 ft and 70 ft, and $400 (21% of an average trip's revenue) per trip for vessels < 50 ft. In total, Large Bigelow Bight is expected to impact 0.9% of average annual bottom trawl revenue recorded in VTR between 2010 and 2012. The shrimp trawl fishery would be affected to an even greater extent, with a mean trip revenue of $2,350 (58% of an average trip's revenue) for vessels >70 ft, $936 (44% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $618 (38% of an average trip's revenue) for vessels < 50 ft. The displaced revenue accounts for 34% of all shrimp trawl revenue reported within the VTR for 2010 – 2012 (see section 4.5 of Volume I for magnitude and statistical areas used). Given that the Large Bigelow Bight area abut New Hampshire state waters, in which there is a complete ban on mobile gear fishing, including all otter trawls (http://www.gencourt.state.nh.us/rules/state_agencies/fis600.html), the impact on New Hampshire fishermen in particular is likely to be acute. The ongoing closure of the shrimp fishery means that in the short term this closure would not have any additional effect on shrimp trawl revenues, but this could change in the long-run.

Table 51 presents the VMS analysis for effort estimated to fall within the Large Bigelow Bight management area. Neither the general category nor the limited access scallop estimates of effort reflect the revenue spike estimated for 2008 through the VTR analysis. Bottom trawl effort seems to be on a downward trend in the area, with the 2010-2012 average 23% lower than the 2005-2012 average. This steep a downward trajectory is apparent in the VTR analysis for vessels < 70 ft in length, although the average number of trips is only down 6% over the same time periods across all vessel sizes. Additonal analysis would be necessary in order to ascertain whether the difference between VMS and VTR results are significant. Conversely, the shrimp trawl shows a marked increase in effort estimated to fall within the Large Bigelow Bight area, with an increase of 65% in the mean annual effort when comparing 2010-2012 to the full 2005-2012 series average. This is consistent with the VTR analysis, which indicates a 59% increase over the same time periods. However, the more recent VTR data presents a decline in revenue generated from bottom trawls within the Large Bigelow Bight area. Although some discrepancies exist between the VTR and VMS analysis, they paint a similar broad picture, with both indicating the importance of Large Bigelow Bight to bottom and shrimp trawl fishermen in particular.

Table 52 details the recreational fishing revenue generated from the Large Bigelow Bight and Large Stellwagen areas. There is significant charter and party boat fishing in both areas, with a substantial number of angler trips and permitted vessels reported in the areas although there does seem to be a downward trend across time. To the extent that mobile bottom-tending gear crowds out recreational effort, an exclusion of these gear types would benefit the recreational fishery in the Large Bigelow Bight area. However, longline and gillnet effort is expected to flow into the Western Gulf of Maine Groundfish Closure Area. To the extent that recreational and commercial gear interactions would increase due to this effort displacement, the recreational fishery is expected to experience negative impacts. Given the relative amount of recreational fishing reported within the Western Gulf of Maine closure (Table 52), the net impact to the recreational fishery is likely to be moderately negative for all Options, when compared to Alternative 1/No Action. The negative impact to the recreational fishery is expected to be smaller than Alternative 2 and 6, but larger than Alternatives 4 and 5. These impacts are associated with trips that land in or have permits registered in towns in Massachusetts, southern Maine, and New Hampshire (Table 56).

A complete exclusion of mobile bottom-tending gear, as per Option 1, would affect $1,114,143 in gross revenue (20% of the total) generated from Large Bigelow Bight in the most recent three year period (2012-2014). The Alternative 2 discussion above indicates that the economic benefits arisising from the removal of the Western Gulf of Maine closures was likely to derive from the decreased cost of commercial fishing, as opposed to increases in gross revenue. Statistical area 514, overlapping the Stellwagen Large portion of the Western Gulf of Maine closure, generates the largest annual landings for multispecies bottom trawl, gillnet, and longline gears, though separator trawls are more active in other statistical areas. This, in turn, suggests that more effort is concentrated around the Stellwagen Large, versus the more northerly portion of the western Gulf of Maine closures. The Large Bigelow Bight HMA is closer inshore, and larger than, the area around Jeffreys Ledge that would opened under Alternative 3. Coupled with the importance of the Large Bigelow Bight area to bottom trawl and shrimp trawl fishermen, this indicates that Alternative 3, Option 1 is, in the short-term, likely to generate moderate negative economic impacts to bottom trawl and shrimp trawl fishermen, when compared to Alternative 1/No Action. Conversely, Alternative 3, Option 1 is likely to generate positive economic benefits for gillnet and longline fishermen, who will gain more flexibility in where and when they can fish, likely translating into a decreased cost of fishing. The net impact across all commercial gear and recreational fleet, is expected to be moderately negative in the short-term given the relative size of each of the fleets. Moderate positive economic benefits are expected in the long-term for all large mesh groundfish fishermen, when compared to Alternative 1/No Action, due to the expected highly positive impact of Alternative 3 on large mesh groundfish stocks (see Volume 5). The magnitude of the negative short-term impacts are expected to be larger than Alternatives 1, 2, and 8 (which are expected to have positive impacts), and commesurate options in Alternative 6, and smaller than Alternatives 4 and 5. Conversely, the positive long-term benefits are expected to be larger than Alternatives 1 , 2, 5, 6, and 8 and negligibly different from Alternative 4. The discount rate and time horizon before benefits begin to accrue will play an important role on the overall magnitude and sign of the net benefits due to Alternative 3. The lower the discount rate, and shorter the time horizon before the benefits of area management begin to accrue, the more likely the overall impact will be positive. However, given that the Alternative 1/No Action is expected to be producing positive short-term benefits with positive long-term benefits with the same general magnitude as Alternative 3, the net benefits of Alternative 3 are expected to be lower than Alternative 1.

Option 2 is expected to have the same economic outcomes as Option 1, given the fact that the southern portion of the Large Bigelow Bight area falls within a PSP closure that was in effect until recently, and no clam revenue is estimated to have been generated from the northern portion between 2005 and 2014. While this PSP closure for clams was lifted in December 2014, this change is not likely to lead to any significant amount of clamming in the area in the future, given the historical survey and fishery data available (see section 4.3.8 of Volume I for an overview of the distribution and fishery, and 79 FR 38274 in the Federal Register for expected impacts due to the PSP closure removal).

As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. Given what is known, Options 3 and 4 would be expected to induce a moderate negative impact as compared to Alternative 1/No Action.

The social impacts of implementing the Large Bigelow Bight HMA would affect ports of landing and city of registration from Maine to Massachusetts (Table 55). None of the identified communities included vessels using clam dredges so would not benefit from the clam dredge exemption (Option 2), and limited or no hydraulic clam dredging is likely to occur in the western Gulf of Maine. Many of the communities identified have vessels using scallop dredges and would benefit from the gear modification Options (Options 3 and 4). Analysis of the impacts of the modification of the current Western Gulf of Maine Habitat Closure Area into the Large Stellwagen HMA is difficult due to the fact that this area is currently closed.

The short-term social impacts of Alternative 3 in comparison to Alternative 1/No Action are expected to be moderately negative, slightly less negative than Alternative 4, but more negative than Alternative 5. The addition of the Large Bigelow Bight HMA would most likely have negative social impacts on smaller vessels that are more likely to fish inshore and cannot easily adapt to fishing in other areas or easily access the areas of the Western Gulf of Maine closure that would be opened. The access to the northern part of the Western Gulf of Maine closure may have positive social impacts on larger vessels. Positive social impacts are possible in the long-term, if new closed areas effectively increase fish populations and there are spillover benefits in open areas. However, due to the geographic range of the Large Bigelow Bight area it may be difficult for smaller vessels to adapt in the near-term. Additionally, fishermen commented during informational interviews conducted by the Council that this area would disproportionately impact the shrimp fishery as well as voicing concerns about the current impact of fixed gears in this area and how this may increase if mobile gears are restricted thus limiting the benefits to habitat in the area.

4.2.3.4 *Alternative 4*

Alternative 4 would modify the boundaries of the current Western Gulf of Maine Habitat Closure Area to create the Small Stellwagen and Jeffreys Ledge HMAs, and designate the Large Bigelow Bight HMA.

Fishing activity in the Large Bigelow Bight area is discussed under Alternative 3 above (Figure 23, Table 50 – VTR, Table 51 – VMS, Table 52 – recreational). Given the relative amount of recreational fishing reported within the Western Gulf of Maine Groundfish Closure Area (Table 52), the impact to the recreational fishery is likely to be negative for all Options, when compared to Alternative 1/No Action. The negative impact to the recreational fishery is expected to be smaller than Alternatives 2, 3, and 6, but larger than Alternatives 5 and 8. Table 56 lists communities associated with recreational trips in these areas in 2012, which are likely to experience these impacts. In particular towns in Massachusetts, southern Maine, and New Hampshire are associated with trips that land in or have permits registered in these communities.

As discussed under Alternative 3, a complete exclusion of mobile bottom tending gear, as per Option 1, would affect $1,114,143 in gross revenue (20% of the total) generated from Large Bigelow Bight in the most recent three year period (2012-2014). The combination of Large Bigelow Bight, Small Stellwagen, and Jeffreys Ledge are thus expected to induce negative economic impacts in the short run for shrimp and bottom trawl under Option 1, when compared to Alternative1/No Action, Alternative 2, and Alternative 8. The magnitude is expected to be larger than Alternatives 3, 5, and 6. Conversely, Alternative 4 is expected to induce positive economic benefits to gillnet and longline fishermen, by opening currently closed areas to fishing and decreasing interactions between static and mobile gears, which is expected to decrease the costs of fishing compared to Alternatives 1, 2, and 8 and commesurate Options in Alternatives 3, 5, and 6. As compared to Alternative 1/No Action, moderate negative impacts are expected in the short-term, due to the relative size of each of the fishing fleets affected, with moderate positive long-term benefits expected. The discount rate and time horizon before benefits begin to accrue will play an important role on the overall magnitude and sign of the net benefits due to Alternative 4. The lower the discount rate, and shorter the time horizon before the benefits of area management begin to accrue, the more likely the overall impact will be positive. However, given that the No Action Alternative 1 is expected to be producing positive short-term benefits with positive long-term benefits with the same general magnitude as Alternative 4, the net benefits of Alternative 4 are expected to be lower than Alternative 1.

Option 2 is expected to have the same economic outcomes as Option 1, given the fact that the southern portion of the Large Bigelow Bight area falls within the current PSP closure, and no clam revenue is estimated to have been generated from the northern portion between 2005 and 2012. As noted previously, this PSP closure has been lifted (79 FR 38274) but clam dredging is not expected to increase substantially in this area in the future.

As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. Given what is known, Options 3 and Option 4 would be expected to induce negative impacts as compared to no action.

The addition of the Large Bigelow Bight HMA would most likely have negative social impacts on smaller vessels that are more likely to fish inshore and cannot easily adapt to fishing in other areas or easily access the areas of the Western Gulf of Maine closure that would be opened. The access to the northern part of the Western Gulf of Maine closure may have positive social impacts on larger vessels. Analysis of the impacts of the modification of the current Western Gulf of Maine habitat closure to create the Small Stellwagen and Jeffreys Ledge Habitat Management Areas is difficult due to the fact that these areas are currently closed. However, positive social impacts related to the modification of the WGOM closure are less likely to benefit the small vessels which will be highly impacted by the Large Bigelow Bight HMA. The social impacts of Alternative 4 in comparison to the no action alternative are expected to be moderately negative. Moderate positive social impacts are possible in the long-term, if new closed areas effectively increase fish populations and there are spillover benefits in open areas.

4.2.3.5 *Alternative 5*

Alternative 5 would also modify the boundaries of the Western Gulf of Maine Habitat Closure Area to create the Small Stellwagen and Jeffreys Ledge HMAs, and designate the Small Bigelow Bight HMA.

Figure 24 identifies the fishing gear active in Small Bigelow Bight, and their relative share of total revenue. In total, the Small Bigelow Bight encompasses 52% of the revenue generated from Large Bigelow Bight, with a relatively larger share of the revenue generated using bottom trawl, midwater trawl, and sink gillnet in the smaller area. Table 50 details the revenue generated by gears potentially impacted by this alternative. This revenue represents 60% of what is generated within Large Bigelow Bight with the same gear, although a larger portion is contributed by bottom trawl (77%) as opposed to shrimp trawl (27%). The Small Bigelow Bight area is an important bottom trawl fishing ground. Average revenue for vessels >70 ft is $203/trip (1% of an average trip's revenue), for vessels between 50 and 70 ft it is $260/trip (3% of an average trip's revenue), and vessels < 50 ft it is $400/trip (22% of an average trip's revenue), substantially lower than the Large Bigelow Bight area. Nevertheless, the VTR analysis estimates that 93% of bottom trawl trips potentially impacted by the Large Bigelow Bight area between 2012 and 2014 would still be impacted by the Small Bigelow Bight management area to some extent. Overall, the affected bottom trawl revenue represents 0.5% of the total bottom trawl revenue reported through VTR in the Gulf of Maine, Georges Bank and Southern New England (see section 4.5 of Volume I for statistical areas used and magnitude of total). This is compared to only 27% of the shrimp trawl trips from Large Bigelow Bight estimated to be also impacted by the Small Bigelow Bight alternative, representing 7.7% of the 2010 – 2012 average annual shrimp trawl revenue reported within the VTR for relevant statistical areas (see section 4.5 of Volume I). The average trip revenue displaced on affected shrimp trawl trips is $358 (27% of an average trip's revenue) for vessels < 50 ft, and $631 (34% of an average trip's revenue) for all other vessels. These results are again backed up by the VMS analysis presented in Table 51, which estimates that the Bottom and Shrimp Trawl effort in Small Bigelow Bight are respectively 83% and 32% of what falls within the boundary of Large Bigelow Bight. Combined, this suggests that the Small Bigelow Bight excludes the most intensively fished grounds for shrimp trawl, but still encapsulates a large portion of the bottom trawl fishing grounds associated with Large Bigelow Bight HMA. A general discussion of the Western Gulf of Maine closure can be found in Alternative 2, and provides a sense of the benefits and costs associated with the Small Stellwagen and Jeffreys Ledge HMAs.

Table 52 represents the recreational fishing effort reported within Small Bigelow Bight, which encompasses 78% of the revenue, and 85% of the angler trips associated with Large Bigelow Bight. This suggests that Small Bigelow Bight is an important center for recreational fishing. Nevertheless, to the extent that recreational and commercial gear interactions would increase due to the displacement of gillnet and longline effort into areas of the Western Gulf of Maine closure currently closed to these gear types, the recreational fishery is expected to experience negative impacts. Table 52 also shows the recreational effort reported within the boundaries of the Small Stellwagen and Jeffreys Ledge areas. Longline and gillnet effort is expected to flow into the Western Gulf of Maine Groundfish Closure Area. To the extent that recreational and commercial gear interactions would increase, the recreational fishery is expected to experience negative impacts in this area. Although the Stellwagen and Jeffreys Ledge areas will continue to be exclusion zones for mobile bottom-tending gear, given the relative amount of recreational fishing reported within the Western Gulf of Maine Closure Area (Table 52), the net impact to the recreational fishery is likely to be negative for all Options, when compared to Alternative 1. The magnitude of this negative impact is expected to be larger than that of Alternatives 4 and 8, but smaller than Alternatives 2, 3, or 6. Table 79 lists the communities associated with recreational trips in these areas in 2012, which are likely to experience these impacts.

A complete exclusion of mobile bottom tending gear, as per Option 1, would affect $665,425 in gross revenue (23% of the total) generated from Small Bigelow Bight in the most recent three year period (2012-2014). Alternative 5 Option 1 is likely to induce negative impacts to the shrimp trawl fishery as compared to Alternative 1. These impacts are expected to be lower than Alternative 3 and Alternative 4, in particular given that the Small Bigelow Bight area seems to exclude the most productive shrimp grounds, but substantially larger in magnitude than Alternatives 1, 2, and 6. A substantial portion of the current Western Gulf of Maine Closure Area falling within statistical area 514 would continue to remain closed to bottom trawl fishing, meaning that Alternative 5 is expected to induce a neutral to slightly negative short-term impact for fishermen using bottom trawls when compared to Alternative 1. This short-term negative impact is expected to be substantially larger than Alternatives 2 (which has expected positive impacts) and 6, and smaller than Alternatives 3 and 4. Alternative 5 is expected to induce moderate positive economic benefits to the gillnet and longline fishermen, by opening currently closed areas to fishing and decreasing interactions between static and commercial mobile gear, which is expected to decrease the costs of fishing slightly compared to Alternatives 1-4, 6, and 8. However, the cumulative economic impacts in the short-term are expected to be moderately negative, when compared to no action, due to the relative size of the fishing fleets under management. In the long-term, a moderately positive benefit is expected from Alternative 5, Option 1 when compared to Alternative 1/No Action, due to increased protection for groundfish habitat (see section 2.2.3.5 of Volume 5). The discount rate and time horizon before benefits begin to accrue will play an important role on the overall magnitude and sign of the net benefits due to Alternative 5. The lower the discount rate, and shorter the time horizon before the benefits of area management begin to accrue, the more likely the overall impact will be positive. However, given that the No Action Alternative 1 is expected to be producing positive short-term benefits with positive long-term benefits with the same general magnitude as Alternative 5, the net benefits of Alternative 5 are expected to be lower than Alternative 1. Option 2 is expected to have the same economic outcome as Option 1, for reasons noted in the discussion of Alternatives 3 and 4.

As discussed previously both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. Options 3 and 4 would be expected to induce a moderately negative impact as compared to Alternative 1/No Action.

Analysis of the social impacts of Alternative 5 is difficult due to the fact that the Small Stellwagen and Jeffreys Ledge HMAs are currently closed, however positive social impacts related to the modification of the Western Gulf of Maine Habitat Closure Area are less likely to benefit the small vessels which will be highly impacted by the Small Bigelow Bight HMA. The implementation of the Small Bigelow Bight HMA will likely have moderately negative social impacts, particularly affecting smaller vessels that are not able to adapt and fish further offshore; however these impacts will be less significant in comparison to the impacts associated with the Larger Bigelow Bight HMA included in Alternatives 3 and 4, particularly because many of the communities in Maine that would be impacted by the large Bigelow Bight HMA will not be impacted by this smaller area. Moderate positive social impacts are possible in the long-term, if new closed areas effectively increase fish populations and there are spillover benefits in open areas. Overall, the social impacts of Alternative 5 in comparison to Alternative 1/No Action are expected to be moderately negative.

4.2.3.6 *Alternative 6*

Alternative 6 would modify the boundaries of the Western Gulf of Maine Habitat Closure Area to create the Large Stellwagen HMA.

The Large Stellwagen area lays within statistical area 514, which generates the largest annual landings for multispecies bottom trawl, gillnet, and longline gears of any statistical area. A large portion of the current Western Gulf of Maine Habitat Closure Area within statistical area 514 would remain closed to bottom trawl fishing under Alternative 6 Option 1. Nevertheless, Alternative 6 Option 1 is expected to generate moderate positive economic benefits for fishermen using bottom trawls, when compared to Alternative 1, due to the fact that Alternative 6 is a subset of the area currently closed under Alternative 1. The short-run positive impact is expected to be substantially smaller than Alternative 2, and substantially larger than Alternatives 3 (of which this is a subset), 4, 5, and 8 given the relative size of the closures in each. The other fisheries/gears currently active within the Gulf of Maine have centers of effort outside of this statistical area. Shrimp trawl would likely see a slightly positive impact from Alternative 6 when compared to Alternative 1/No Action, in the event that the fishery is reopened. This impact is expected to be substantially smaller than Alternative 2 and substantially larger than Alternatives 3, 4, 5, and 8 which all include areas seemingly more productive for shrimp fishermen. Gillnet and longline fishermen are expected to experience moderately positive economic impacts when compared to Alternatives 1 and 8 due to the increase in area open to these gear types. The magnitude of this impact is negligibly smaller than what would be expected from Alternatives 3, 4, and 5, given that slightly higher fishing costs might arise from more interactions between gear types under Alternative 6. Thus, the magnitude of the positive economic impacts to longline and gillnet fishermen is expected to be negligibly larger than Alternative 2.

Table 52 details the recreational fishing reported to occur within the Stellwagen Large area. Although this effort will continue to be shielded from gear interactions with bottom trawls, the influx of gillnet and longline effort in this area, in addition to the removal of exclusions against mobile bottom-tending gear and gear capable of catching groundfish in the northern portion of the current Western Gulf of Maine closures is expected to induce moderately negative impacts to the recreational fishery when compared to Alternative 1/No Action. The magnitude of this impact is expected to be larger than Alternatives 3-5 and 8, but smaller than Alternative 2. Table 56 lists communities associated with recreational trips in these areas in 2012, which are likely to experience these impacts.

Across all fisheries, the short-term impacts are expected to be slightly positive when compared to Alternative 1/No Action, given the relative size of the fleets under management. In the long term, slightly negative impacts are expected when compared to Alternative 1, given the decreased protection for groundfish habitat (see section see section 2.2.3.6 of Volume 5). Although discounting plays a role in whether the net benefits are ultimately positive or negative, the sort-term slightly positive impacts, and long-term slightly negative impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign. Option 2 is expected to have the same economic outcome as Option 1, for reasons outlined in the discussions of the economic impacts for Alternative 3 and 4.

As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. Both Options 3 and 4 would be expected to induce a moderate negative impact as compared to no action.

The short-term non-economic social impacts of Alternative 6 are expected to be moderately positive. Minimal social impacts are associated with fishing vessels adapting to the new boundaries of the Large Stellwagen HMA due to its proximity in overall size and location of the current habitat closure. There are potential long-term negative social impacts if benefits to fish populations from the Western Gulf of Maine Habitat and Groundfish Closure Areas are lost.

4.2.3.7 *Alternatives 7A and 7B (7A Preferred Alternative)*

Alternative 7 would implement roller gear size restrictions for all trawl vessels as a habitat management measure in the western Gulf of Maine in the existing Inshore Roller Gear Restricted Area (Alternative 7A) or a modified roller gear area (Alternative 7B). This alternative can be implemented in addition to any of the other six alternatives and is analyzed as an add-on measure and not as a standalone alternative.

When **coupled with the preferred alternative** (No Action Alternative 1), Alternative 7A is expected to have neutral impacts in both the short-term and long-term, as it continues current area management regulations. When coupled with Alternatives 2-6 or 8, Alternative 7A is not expected to change the net impact conclusions, as Alternative 7A would hold constant across all alternatives and is very similar to the existing roller gear restriction except that it would apply to all trawl vessels, not only Northeast multispecies vessels.

Given the smaller area encompassed by the roller gear restriction in Alternative 7B, which is for the most part a sub-set of Alternative 7A, the induced inefficiency by changing from what is ostensibly an optimal gear configuration is no larger, and likely smaller, than the inefficiency induced by the restrictions in the Alternative 7A area. Therefore the cost of Alternative 7B to bottom trawl fishermen is expected to be smaller than 7A. Conversely, what habitat conservation the gear restriction induces is also likely to be smaller than 7A, given that it protects a smaller amount of area susceptible to fishery impacts. Coupling Alternative 7B with any other alternative in the western Gulf of Maine would follow the general comparison of benefits between those alternatives and the status quo. This is a result of a relatively small impact expected from Alternative 7B when compared to the much larger impacts associated with Alternatives 1 – 6 and 8.

The social impacts of Alternative 7 will depend upon the other spatial alternatives selected. Generally, if implemented in conjunction with one of the other spatial management alternatives, Alternative 7 is expected to have neutral social impacts.

4.2.3.8 *Alternative 8 (preferred)*

Alternative 8 is identical to the Alternative 1/No Action in terms of impacts for all gears save shrimp trawl, which would be exempted within the northwest section of the Western Gulf of Maine Habitat Closure. The discussion of Alternative 1 and 2 present the expected benefits and costs of Alternative 1. The shrimp fishery section of Volume 1 includes a map of the historical effort distribution for shrimp trawls, as self-reported within the dealer and VTR databases. Statistical Area 513, in which the exemption area discussed within Alternative 8 falls, has the highest concentration of northern shrimp landings reported within the dealer reports. The VTR points also suggest a substantial amount of effort self-reported around the exemption area of Alternative 8, particularly in the January to March timeframe. Together, this suggests that an exemption for shrimp trawls within the area would provide some benefit for shrimp trawls seasonally, through the ability to follow the shrimp biomass offshore. However, the fishery description in Volume 1 suggests that the majority of the fishery (92% of trips) is prosecuted in-shore in waters shallower than 55 fathoms.

The current northern shrimp fishery moratorium means that the short-run impacts of Alternative 8 are expected to be neutral, with respect to Alternative 1/No Action. Given the high uncertainty in the future prospects for the northern shrimp fishery due to the stock collapse, the long-term impacts are highly uncertain, and could be neutral, or slightly positive.

The social impacts of Alternative 8 would likely be positive compared to the No Action Alternative; however, there may be some slight negative impacts to *Social Structures and Organizations* due to differing levels of restrictions on different fisheries.

4.2.4 Georges Bank

Tables and figures related to analysis of the social and economic impacts of the Georges Bank habitat management alternatives are provided below. Discussion of impacts is provided under a separate heading for each alternative.

Figure 25 – Northern Edge HMA (Alternatives 3 and 4) average annual revenue by gear, over the time period identified. Note that one gear type is not reported for data confidentiality requirements. Average annual total revenue: 2005 - 2014 = $ 949,330; 2010 - 2014 = $ 1,406,977; 2012 - 2014 = $ 1,636,247

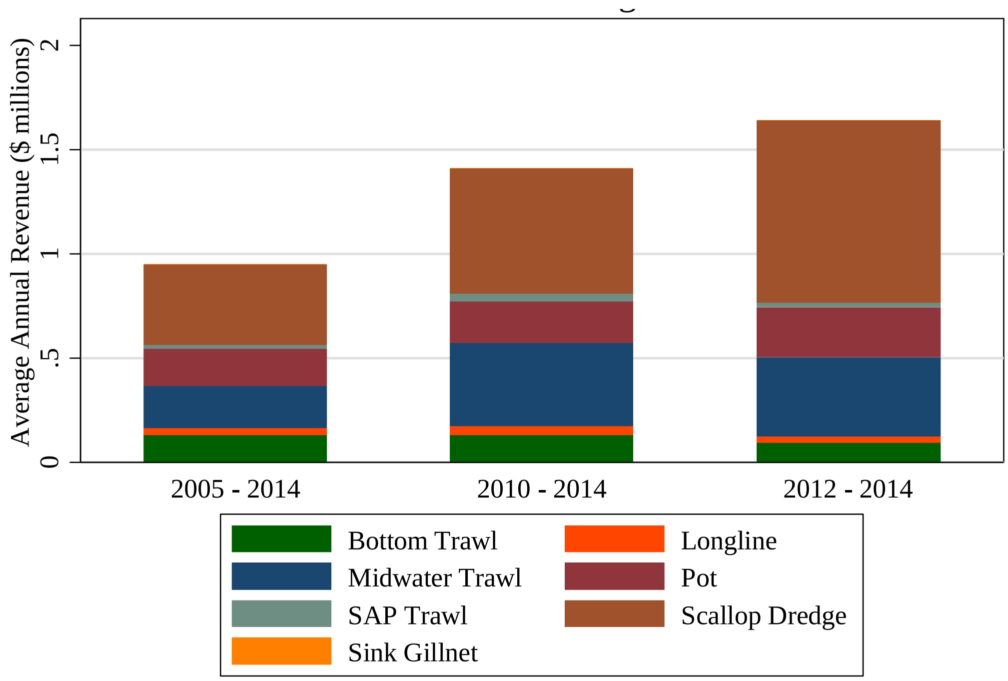


Figure 26 –Georges Shoal Gear Modification Area (Alternative 4) average annual revenue by gear, over the time period identified. Note that one gear type is not reported for data confidentiality requirements. Average annual total revenue: 2005 - 2014 = $ 4,005,306; 2010 - 2014 = $ 5,524,334; 2012 - 2014 = $ 6,060,388

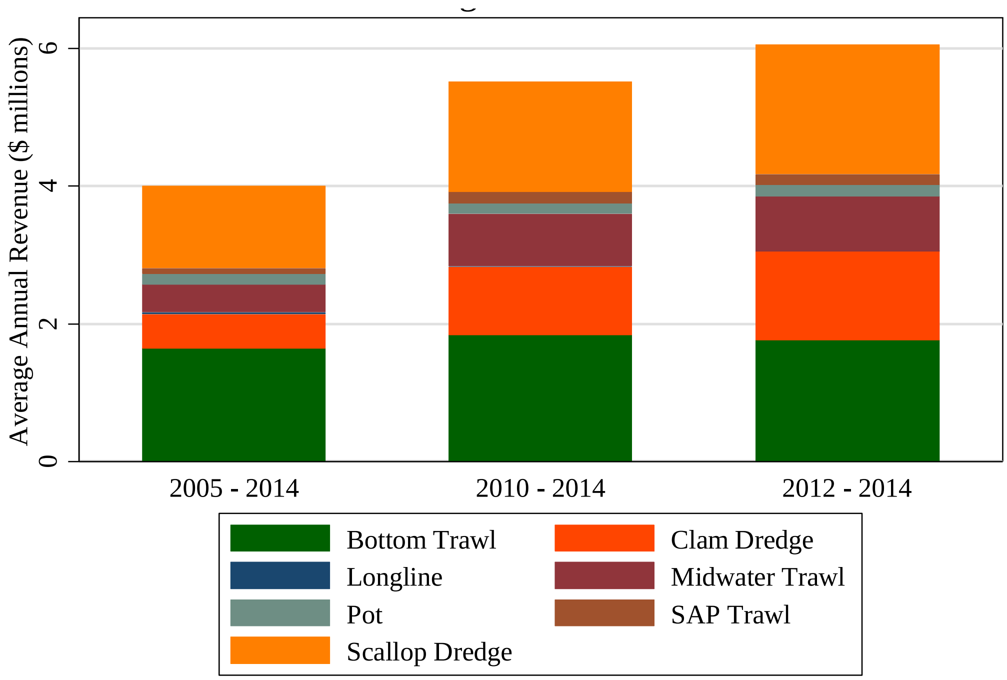


Figure 27 – Northern Georges Gear Modification Area (Alternative 5) revenue by gear, as a percentage of the total average revenue over the time period identified. Note that two gear types are not reported for data confidentiality requirements. Average annual total revenue: 2005 - 2014 = $ 21,481,061; 2010 – 2014 = $ 29,361,960 ; 2012 – 2014 = $ 32,696,392

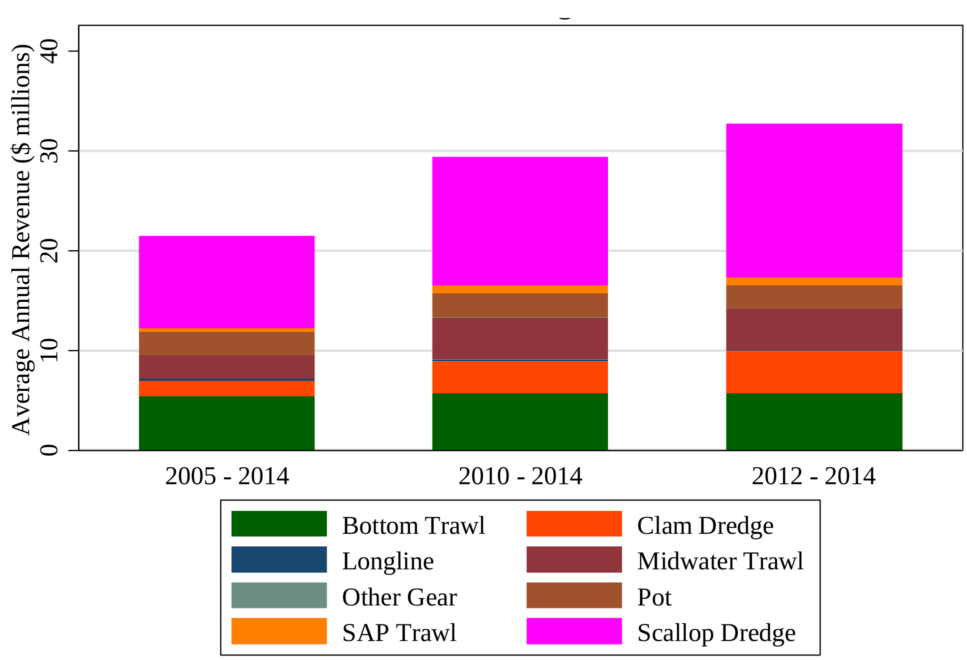


Figure 28 – Georges Shoal 1 MBTG closure HMA (Alternative 5) revenue by gear, as a percentage of the total average revenue over the time period identified. Note that three gear types are not reported for data confidentiality requirements. Average annual total revenue: 2005 - 2014 = $ 2,177,691; 2010 – 2014 = $ 2,975,335; 2012 – 2014 = $ 3,485,110

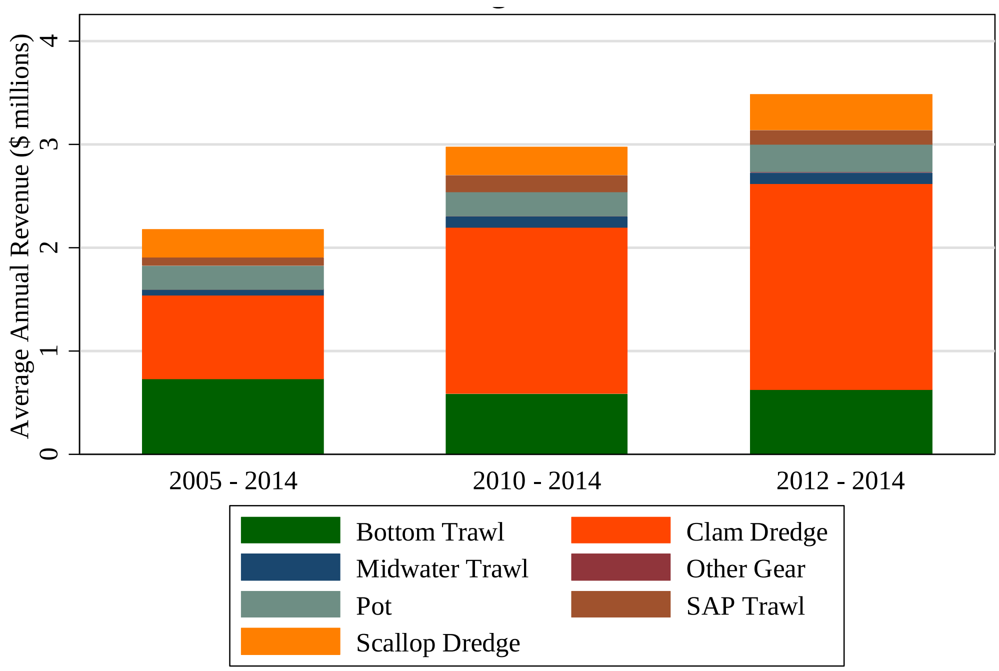


Figure 29 – EFH Expanded 1 HMA (Alternative 6A) revenue by gear, as a percentage of the total average revenue over the time period identified. Average annual total revenue: 2005 - 2014 = $ 6,893,719; 2010 – 2014 = $ 9,154,497; 2012 – 2014 = $ 11,004,482

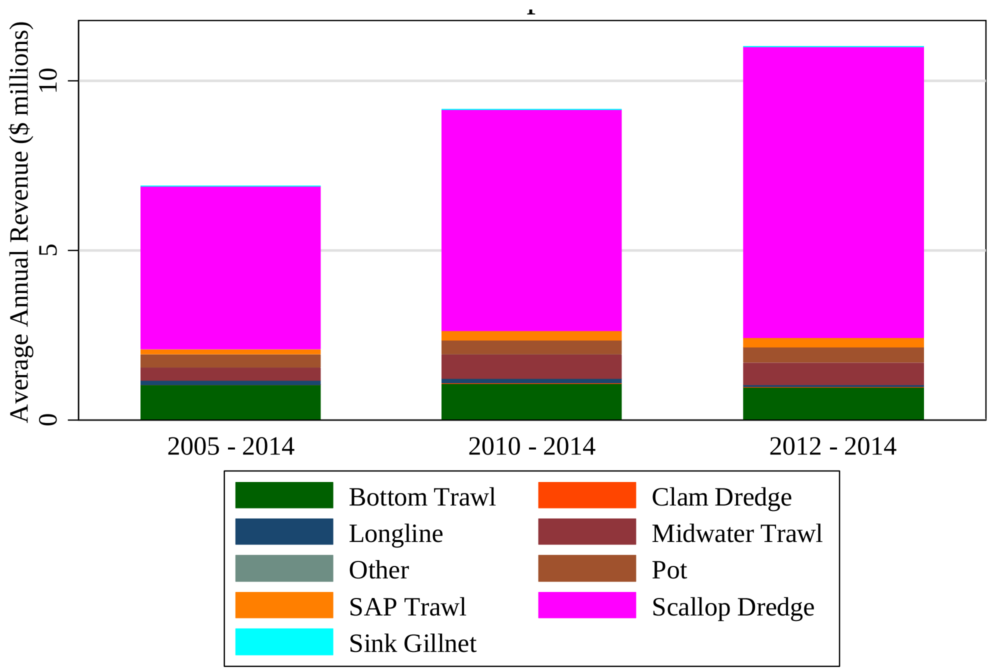


Figure 30 – Georges Shoal 2 MBTG/EFH South MBTG (Alternative 7) revenue by gear, as a percentage of the total average revenue over the time period identified. Average annual total revenue: 2005 - 2014 = $ 3,178,650; 2010 – 2014 = $ 4,388,426; 2012 – 2014 = $ 5,306,839

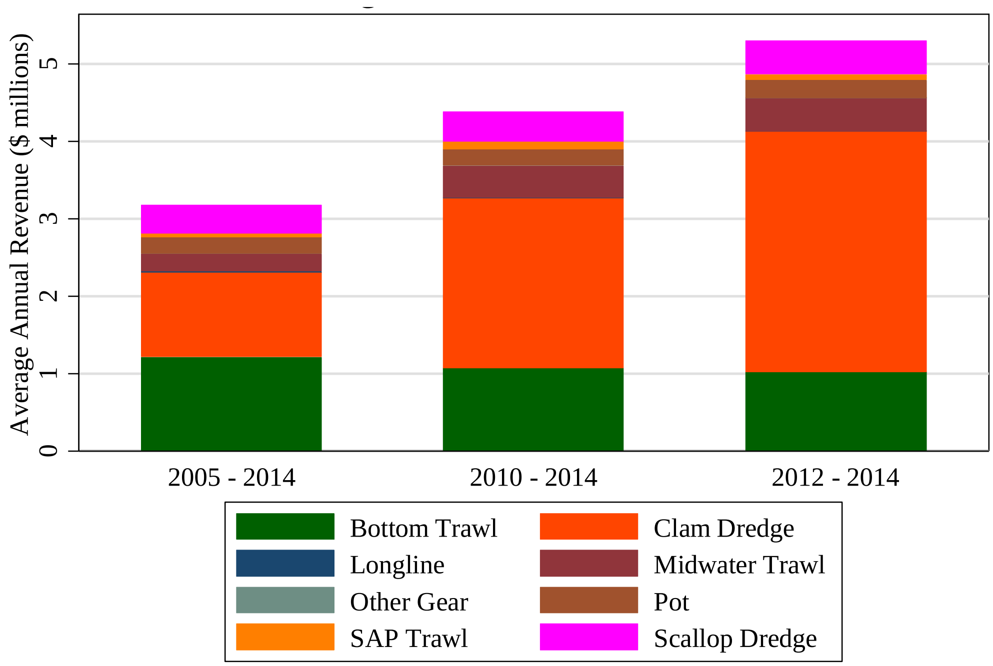


Figure 31 – Northern Georges MBTG HMA (Alternative 8) revenue by gear, as a percentage of the total average revenue over the time period identified. Average annual total revenue: 2005 - 2014 = $ 22,495,645; 2010 – 2014 = $ 29,931,768; 2012 – 2014 = $ 32,303,187

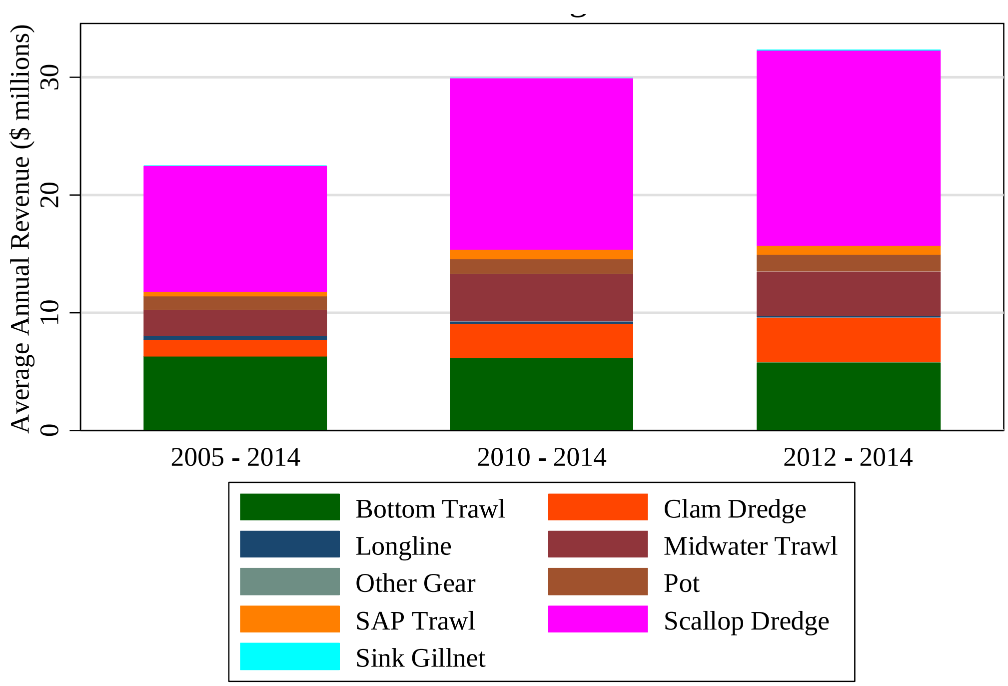


Figure 32 – Alternative 9 Western MBTG HMA revenue by gear, as a percentage of the total average revenue over the time period identified. Average annual total revenue: 2005 – 2014 = $3,877,906; 2010 – 2014 = $4,728,752; 2012 – 2014 = $5,127,713.

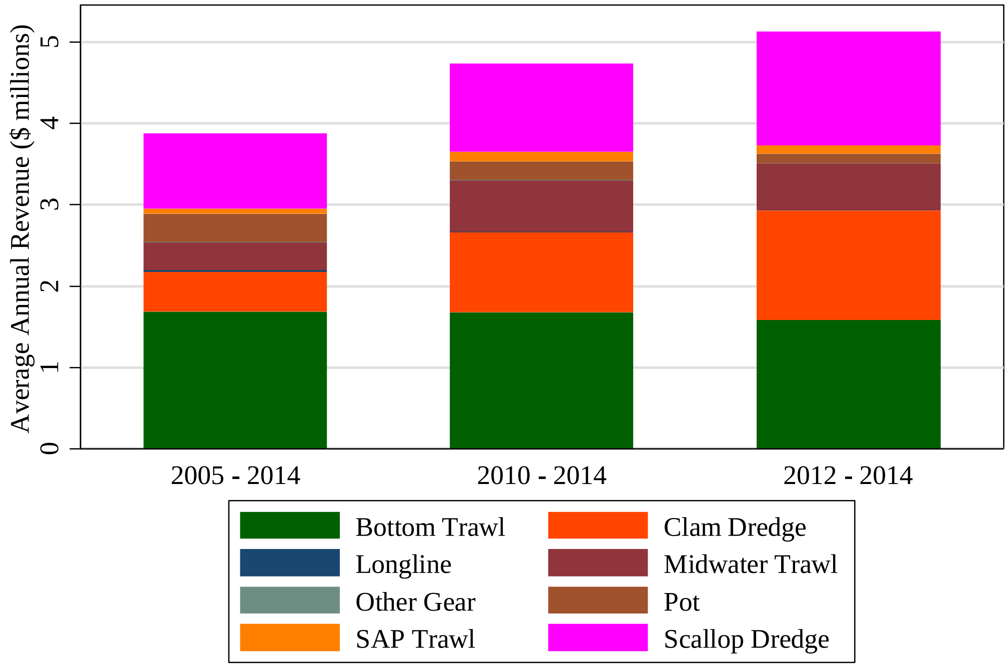


Figure 33 – Alternative 9 mortality closure revenue by gear, as a percentage of the total average revenue over the time period identified. Average annual total revenue: 2005 – 2014 = $ 2,281,134; 2010 – 2014 = $ 3,201,684; 2012 – 2014 = $4,193,130. Note: Clam Dredge revenue is excluded due to data confidentiality requirements.

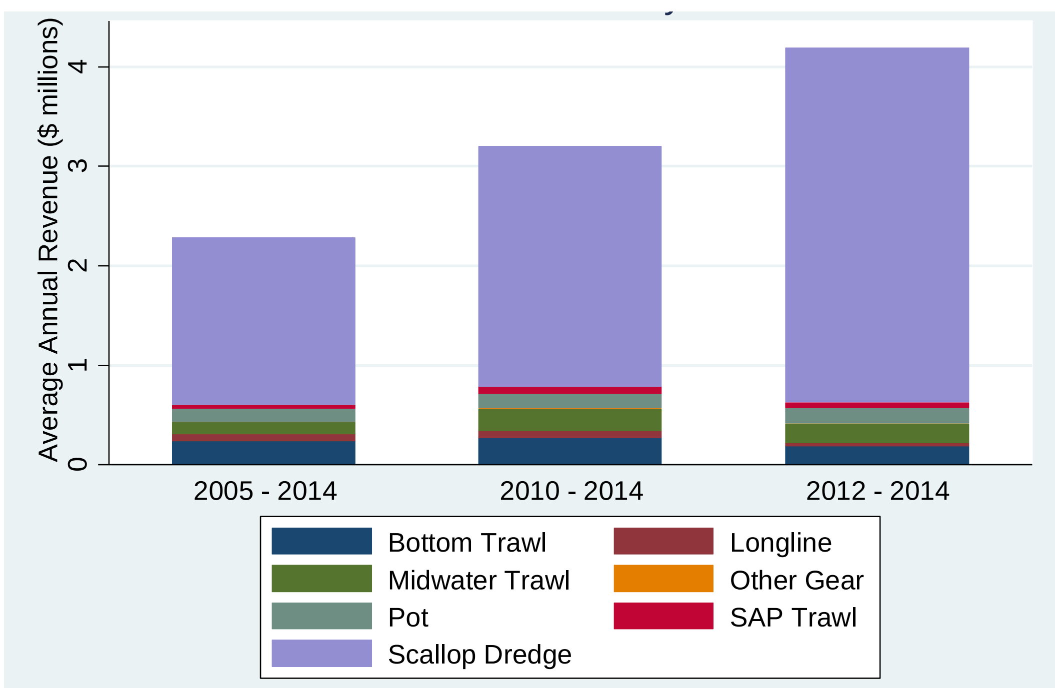


Table 59 – Mobile bottom-tending gear in currently open portions of the areas included in the Georges Bank habitat alternatives. All variables represent annual estimates. Vessel sizes: S < 50 ft, 50 ft <= M < 70 ft, L >= 70 ft, U = unknown vessel characteristics. Dashes represent data suppressed due to data confidentiality requirements.

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
Northern Edge (Alts 3 and 4)	Bottom Trawl	L	111,513	99,017	55,043	199,617	41,662	80	547	2005 - 2014
	Bottom Trawl	L	122,599	120,088	49,586	176,300	71,829	63	604	2010 - 2014
	Bottom Trawl	L	89,192	75,659	26,825	120,088	71,829	58	654	2012 - 2014
	Bottom Trawl	OTHER	20,111	15,421	17,730	63,660	940	17	62	2005 - 2014
	Bottom Trawl	OTHER	9,725	10,356	6,261	18,485	940	12	52	2010 - 2014
	Bottom Trawl	OTHER	6,548	8,348	4,959	10,356	940	11	43	2012 - 2014
	SAP Trawl	ALL	19,344	1,768	27,344	77,560	-	21	107	2005 - 2014
	SAP Trawl	ALL	38,688	41,286	27,328	77,560	3,536	21	107	2010 - 2014
	SAP Trawl	ALL	23,336	25,185	18,943	41,286	3,536	19	102	2012 - 2014
	Scallop Dredge	L	364,066	187,796	445,117	1,476,898	93,089	38	55	2005 - 2014
	Scallop Dredge	L	562,871	250,422	585,620	1,476,898	93,089	37	51	2010 - 2014
	Scallop Dredge	L	823,615	820,512	651,736	1,476,898	173,436	38	54	2012 - 2014
	Scallop Dredge	OTHER	19,538	9,163	28,327	89,238	611	4	5	2005 - 2014
	Scallop Dredge	OTHER	32,177	12,680	37,009	89,238	1,356	3	4	2010 - 2014
	Scallop Dredge	OTHER	46,751	49,661	44,013	89,238	1,356	3	4	2012 - 2014
Georges Shoal Gear Mod Area (Alt 4)	Bottom Trawl	L	1,511,337	1,538,260	501,498	2,197,205	398,001	87	976	2005 - 2014
	Bottom Trawl	L	1,717,737	1,690,509	356,895	2,197,205	1,333,905	72	1,074	2010 - 2014
	Bottom Trawl	L	1,653,493	1,429,370	473,281	2,197,205	1,333,905	67	1,099	2012 - 2014
	Bottom Trawl	OTHER	133,893	134,644	50,009	218,178	47,099	23	129	2005 - 2014
	Bottom Trawl	OTHER	124,589	126,833	52,295	178,570	47,099	16	106	2010 - 2014
	Bottom Trawl	OTHER	110,326	105,308	65,879	178,570	47,099	14	85	2012 - 2014
	SAP Trawl	L	76,795	13,605	113,444	303,069	-	23	173	2005 - 2014
	SAP Trawl	L	153,589	98,949	119,217	303,069	27,210	23	173	2010 - 2014
	SAP Trawl	L	137,628	82,605	145,928	303,069	27,210	22	157	2012 - 2014
	SAP Trawl	M	2,847	0	5,320	15,963	0	2	9	2005 - 2014
	SAP Trawl	M	5,694	4,971	6,589	15,963	0	2	9	2010 - 2014
	SAP Trawl	M	-	-	-	-	-	-	-	2012 - 2014
Northern Georges Gear Mod Area (Alt 5)	Bottom Trawl	L	4,912,928	4,636,202	1,704,140	7,693,870	1,606,149	90	1,149	2005 - 2014
	Bottom Trawl	L	5,319,440	4,548,730	1,699,423	7,693,870	3,919,625	75	1,253	2010 - 2014
	Bottom Trawl	L	5,387,408	4,548,730	2,022,070	7,693,870	3,919,625	68	1,268	2012 - 2014
	Bottom Trawl	OTHER	502,881	502,049	221,663	936,752	153,205	25	159	2005 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
	Bottom Trawl	OTHER	382,911	355,355	179,303	630,842	153,205	17	129	2010 - 2014
	Bottom Trawl	OTHER	309,452	305,233	158,399	469,918	153,205	15	101	2012 - 2014
	SAP Trawl	ALL	405,768	63,426	635,259	1,754,666	0	28	204	2005 - 2014
	SAP Trawl	ALL	811,536	431,300	704,540	1,754,666	126,852	28	204	2010 - 2014
	SAP Trawl	ALL	770,939	431,300	865,425	1,754,666	126,852	26	183	2012 - 2014
Georges Shoal 1 Mobile Bottom Tending Gear Closure (Alt 5)	Bottom Trawl	L	663,602	653,316	353,248	1,450,060	152,958	83	915	2005 - 2014
	Bottom Trawl	L	533,672	549,057	248,705	763,590	152,958	64	888	2010 - 2014
	Bottom Trawl	L	590,747	549,057	156,228	763,590	459,592	67	1,058	2012 - 2014
	Bottom Trawl	OTHER	68,663	50,713	47,671	172,837	20,306	20	118	2005 - 2014
	Bottom Trawl	OTHER	48,405	43,098	37,803	113,120	20,306	13	76	2010 - 2014
	Bottom Trawl	OTHER	36,201	43,098	12,079	43,250	22,254	13	76	2012 - 2014
	ClamDredge	ALL	808,259	0	1,108,363	2,783,302	0	1	32	2005 - 2014
	ClamDredge	ALL	1,616,518	1,985,020	1,063,413	2,783,302	0	2	59	2010 - 2014
	ClamDredge	ALL	1,990,936	1,985,020	789,425	2,783,302	1,204,485	4	94	2012 - 2014
	SAP Trawl	ALL	80,013	6,445	137,546	337,477	-	25	165	2005 - 2014
	SAP Trawl	ALL	160,026	61,361	162,979	337,477	12,890	25	165	2010 - 2014
	SAP Trawl	ALL	133,764	50,954	177,420	337,449	12,890	25	173	2012 - 2014
	Scallop Dredge	ALL	274,746	306,711	182,492	509,051	-	52	74	2005 - 2014
	Scallop Dredge	ALL	277,785	329,548	215,890	507,034	-	48	62	2010 - 2014
	Scallop Dredge	ALL	353,126	440,534	211,614	507,034	111,811	50	65	2012 - 2014
EFHExpanded 1/EFH Expanded 2 (Alts 6A and 6B)*	Bottom Trawl	L	931,452	864,257	395,884	1,503,428	366,423	85	711	2005 - 2014
	Bottom Trawl	L	1,014,051	945,672	420,216	1,503,428	477,176	66	749	2010 - 2014
	Bottom Trawl	L	921,149	782,843	526,920	1,503,428	477,176	61	791	2012 - 2014
	Bottom Trawl	M	13,934	-	27,170	81,468	-	12	50	2005 - 2014
	Bottom Trawl	M	27,868	17,230	34,288	81,468	-	12	50	2010 - 2014
	Bottom Trawl	M	46,447	40,641	32,510	81,468	17,230	12	50	2012 - 2014
	Bottom Trawl	Other	81,811	88,186	69,817	200,779	0	24	97	2005 - 2014
	Bottom Trawl	Other	30,577	0	45,329	101,006	0	16	88	2010 - 2014
	SAP Trawl	ALL	140,374	16,843	217,013	611,509	0	23	137	2005 - 2014
	SAP Trawl	ALL	280,748	186,938	238,120	611,509	33,687	23	137	2010 - 2014
	SAP Trawl	ALL	277,378	186,938	299,339	611,509	33,687	22	125	2012 - 2014
	Scallop Dredge	ALL	4,823,632	3,271,818	4,054,825	########	946,927	44	65	2005 - 2014
	Scallop Dredge	ALL	6,527,212	4,623,601	5,217,039	########	1,957,893	42	59	2010 - 2014
	Scallop Dredge	ALL	8,571,482	9,731,920	6,116,495	########	1,957,893	45	64	2012 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
Georges Shoal 2 MBTG (Alt 7)	Bottom Trawl	L	1,101,917	1,096,331	223,187	1,546,930	825,968	95	1,176	2005 - 2014
	Bottom Trawl	L	986,455	993,253	145,990	1,196,402	825,968	75	1,178	2010 - 2014
	Bottom Trawl	L	965,887	875,290	201,150	1,196,402	825,968	67	1,173	2012 - 2014
	Bottom Trawl	OTHER	113,032	122,202	39,089	160,383	45,860	24	150	2005 - 2014
	Bottom Trawl	OTHER	90,962	77,853	39,088	140,202	45,860	16	117	2010 - 2014
	Bottom Trawl	OTHER	64,108	68,610	16,465	77,853	45,860	14	89	2012 - 2014
	ClamDredge	ALL	1,098,350	16,838	1,569,647	4,246,770	0	1	35	2005 - 2014
	ClamDredge	ALL	2,196,338	1,939,114	1,590,469	4,246,770	31,861	2	65	2010 - 2014
	ClamDredge	ALL	3,102,489	3,121,583	1,153,947	4,246,770	1,939,114	4	119	2012 - 2014
	SAP Trawl	ALL	46,907	7,686	71,663	188,993	0	27	193	2005 - 2014
	SAP Trawl	ALL	93,814	66,474	77,810	188,993	15,371	27	193	2010 - 2014
	SAP Trawl	ALL	79,814	35,077	95,064	188,993	15,371	26	179	2012 - 2014
	Scallop Dredge	L	350,503	355,299	169,477	716,416	105,840	52	76	2005 - 2014
	Scallop Dredge	L	372,356	342,985	226,873	716,416	105,840	47	61	2010 - 2014
	Scallop Dredge	L	418,512	433,281	305,556	716,416	105,840	52	68	2012 - 2014
	Scallop Dredge	OTHER	12,688	10,172	10,179	37,029	2,333	5	7	2005 - 2014
	Scallop Dredge	OTHER	14,206	9,413	13,459	37,029	2,333	3	4	2010 - 2014
	Scallop Dredge	OTHER	19,761	14,353	15,299	37,029	7,901	3	4	2012 - 2014
Northern Georges MBTG (Alt 8)	Bottom Trawl	L	5,702,111	5,249,393	1,676,830	8,973,559	3,947,560	95	1,168	2005 - 2014
	Bottom Trawl	L	5,721,436	5,706,156	1,619,763	7,900,309	4,018,368	75	1,206	2010 - 2014
	Bottom Trawl	L	5,413,104	4,320,634	2,159,279	7,900,309	4,018,368	67	1,215	2012 - 2014
	Bottom Trawl	OTHER	578,168	582,273	248,391	965,065	139,713	25	157	2005 - 2014
	Bottom Trawl	OTHER	403,115	450,723	176,740	607,152	139,713	17	124	2010 - 2014
	Bottom Trawl	OTHER	319,233	332,834	173,122	485,153	139,713	14	95	2012 - 2014
	ClamDredge	ALL	1,448,242	1,236	1,953,560	4,473,876	0	1	30	2005 - 2014
	ClamDredge	ALL	2,896,385	2,951,854	1,828,690	4,473,876	1,970	2	56	2010 - 2014
	ClamDredge	ALL	3,842,700	4,452,206	1,074,518	4,473,876	2,602,016	4	103	2012 - 2014
	SAP Trawl	L	404,988	76,075	592,989	1,535,082	0	25	189	2005 - 2014
	SAP Trawl	L	809,975	570,229	617,368	1,535,082	152,150	25	189	2010 - 2014
	SAP Trawl	L	752,487	570,229	709,252	1,535,082	152,150	24	171	2012 - 2014
	SAP Trawl	M	18,110	0	34,488	102,064	0	3	10	2005 - 2014
	SAP Trawl	M	36,220	24,221	43,084	102,064	0	3	10	2010 - 2014
	Scallop Dredge	L	10,086,808	7,669,945	6,789,934	22,232,899	1,719,386	56	87	2005 - 2014
	Scallop Dredge	L	13,738,520	13,300,000	7,797,395	22,232,899	4,439,168	51	73	2010 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
	Scallop Dredge	L	15,832,537	20,825,543	9,892,007	22,232,899	4,439,168	58	84	2012 - 2014
	Scallop Dredge	OTHER	557,826	583,252	340,843	987,159	124,267	7	9	2005 - 2014
	Scallop Dredge	OTHER	758,233	904,071	283,339	987,159	302,816	4	6	2010 - 2014
	Scallop Dredge	OTHER	731,349	904,071	373,438	987,159	302,816	5	6	2012 - 2014
Alternative 9 MBTG closures**	Bottom Trawl	L	1,403,292	1,534,421	571,335	2,265,894	3,351	81	907	2005 - 2014
	Bottom Trawl	L	1,286,648	1,462,607	678,107	1,924,986	3,351	55	793	2010 - 2014
	Bottom Trawl	L	1,486,367	1,329,633	384,976	1,924,986	1,204,481	66	1,131	2012 - 2014
	Bottom Trawl	OTHER	138,707	146,448	43,035	186,613	44,958	23	126	2005 - 2014
	Bottom Trawl	OTHER	128,713	149,903	56,946	186,613	44,958	14	87	2010 - 2014
	Bottom Trawl	OTHER	102,349	98,301	59,519	163,790	44,958	14	88	2012 - 2014
	Clam Dredge	ALL	495,249	415	779,546	2,392,928	0	1	29	2005 - 2014
	Clam Dredge	ALL	990,442	831,069	868,486	2,392,928	545	2	53	2010 - 2014
	Clam Dredge	ALL	1,335,997	831,069	915,631	2,392,928	783,995	3	98	2012 - 2014
	SAP Trawl	ALL	59,726	9,713	84,865	236,576	-	24	155	2005 - 2014
	SAP Trawl	ALL	119,453	123,802	85,360	236,576	19,425	24	155	2010 - 2014
	SAP Trawl	ALL	104,624	57,871	115,879	236,576	19,425	23	166	2012 - 2014
	Scallop Dredge	L	894,271	923,688	635,469	2,231,898	147,212	47	72	2005 - 2014
	Scallop Dredge	L	1,040,389	1,018,994	853,063	2,231,898	161,703	41	58	2010 - 2014
	Scallop Dredge	L	1,340,417	1,476,123	966,507	2,231,898	313,229	51	74	2012 - 2014
	Scallop Dredge	OTHER	35,457	34,444	26,389	90,842	0	6	8	2005 - 2014
	Scallop Dredge	OTHER	43,290	45,450	33,156	90,842	0	4	5	2010 - 2014
	Scallop Dredge	OTHER	55,164	45,450	31,949	90,842	29,198	4	5	2012 - 2014
Alternative 9 mortality closure***	Bottom Trawl	L	196,108	169,112	132,217	459,443	95	71	505	2005 - 2014
	Bottom Trawl	L	211,402	214,847	157,449	459,443	95	48	479	2010 - 2014
	Bottom Trawl	L	182,765	169,112	80,302	269,018	110,165	60	695	2012 - 2014
	Bottom Trawl	OTHER	21,822	21,974	12,279	44,662	1,917	17	62	2005 - 2014
	Bottom Trawl	OTHER	15,130	12,541	11,356	30,959	1,917	11	47	2010 - 2014
	Bottom Trawl	OTHER	7,698	8,637	5,374	12,541	1,917	12	46	2012 - 2014
	SAP Trawl	ALL	36,347	2,701	52,960	134,693	0	20	104	2005 - 2014
	SAP Trawl	ALL	72,694	70,695	54,846	134,693	5,403	20	104	2010 - 2014
	SAP Trawl	ALL	57,945	33,739	67,959	134,693	5,403	20	107	2012 - 2014
	Scallop Dredge	L	1,594,447	856,742	1,830,236	6,233,866	290,053	38	55	2005 - 2014
	Scallop Dredge	L	2,285,435	978,545	2,483,522	6,233,866	290,053	35	49	2010 - 2014
	Scallop Dredge	L	3,386,192	3,223,933	2,770,111	6,233,866	700,778	39	56	2012 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
	Scallop Dredge	OTHER	89,432	38,792	109,368	309,814	1,465	4	5	2005 - 2014
	Scallop Dredge	OTHER	131,437	97,604	138,202	309,814	3,814	3	4	2010 - 2014
	Scallop Dredge	OTHER	184,268	239,177	160,219	309,814	3,814	3	4	2012 - 2014

*6A and 6B are different areas but have the same areas currently open to fishing with mobile bottom-tending gears

** Western HMA, Eastern HMA is currently closed to mobile bottom-tending gears

*** The mortality closure in Alternative 9 and the Reduced Impact HMA in Alternative 10 are different, but have the same areas currently open to fishing with mobile bottom-tending gears

Table 60 – Fixed gear use in currently open portions of the areas included in the Georges Bank habitat alternative 9 areas. All variables represent annual estimates. Vessel sizes: S < 50 ft, 50 ft <= M < 70 ft, L >= 70 ft, U = unknown vessel characteristics.

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
Alt 9 MBTG closures	Longline	ALL	26,582	23,587	26,138	73,116	1	6	40	2005 - 2014
	Longline	ALL	8,431	1,166	14,353	33,498	1	4	14	2010 - 2014
	Longline	ALL	393	12	670	1,166	1	4	7	2012 - 2014
	Midwater Trawl	L	338,858	139,681	365,050	946,224	4,752	10	76	2005 - 2014
	Midwater Trawl	L	628,982	755,386	297,570	946,224	198,989	11	121	2010 - 2014
	Midwater Trawl	L	579,559	755,386	329,900	784,302	198,989	12	131	2012 - 2014
	Other Gear	ALL	3,573	2,290	3,589	11,165	60	4	12	2005 - 2014
	Other Gear	ALL	5,828	5,758	3,878	11,165	1,966	4	14	2010 - 2014
	Other Gear	ALL	3,347	2,317	2,095	5,758	1,966	5	19	2012 - 2014
	Pot	ALL	341,862	326,194	207,741	712,683	113,820	19	337	2005 - 2014
	Pot	ALL	219,247	125,323	139,261	406,824	113,820	18	363	2010 - 2014
	Pot	ALL	119,496	119,345	5,753	125,323	113,820	20	468	2012 - 2014
Alt 9 mortality closure	Longline	ALL	73,203	73,245	60,756	180,001	33	6	34	2005 - 2014
	Longline	ALL	73,778	83,086	76,080	180,001	33	6	23	2010 - 2014
	Longline	ALL	27,900	580	47,794	83,086	33	6	15	2012 - 2014
	Midwater Trawl	L	112,260	4,868	193,851	573,385	-	6	24	2005 - 2014
	Midwater Trawl	L	218,830	222,736	236,916	573,385	902	7	37	2010 - 2014
	Midwater Trawl	L	192,978	4,647	329,448	573,385	902	7	30	2012 - 2014
	Other Gear	ALL	1,752	836	2,297	7,935	168	4	12	2005 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
	Other Gear	ALL	2,390	761	3,144	7,935	621	3	13	2010 - 2014
	Other Gear	ALL	702	722	72	761	621	4	19	2012 - 2014
	Pot	ALL	136,036	152,299	39,045	169,705	52,017	16	313	2005 - 2014
	Pot	ALL	148,074	162,188	25,895	169,705	115,271	16	328	2010 - 2014
	Pot	ALL	152,293	162,188	23,946	169,705	124,985	18	435	2012 - 2014

Table 61 – Fishing effort (in hours fished), and individuals fishing in the areas included in the Georges Bank habitat alternatives, estimated from VMS polls using the approach of Records and Demarest (2013). Total effort and individuals are the annual average across all years identified, while the remaining statistics are calculated at the individual level.

Area	Gear	Years	Total Effort	Individuals	Mean Effort	Median Effort	SD Effort
Northern Edge (Alts 3 & 4)	Bottom Trawl	2005 - 2012	1,588.36	55.13	28.81	15.61	36.60
	Bottom Trawl	2008 - 2012	1,993.90	61.40	32.47	16.80	40.69
	Bottom Trawl	2010 - 2012	1,833.09	56.00	32.73	15.54	44.76
	GC Scallop	2005 - 2012	5.09	1.75	2.91	1.25	3.66
	GC Scallop	2008 - 2012	5.59	2.00	2.80	1.25	3.97
	GC Scallop	2010 - 2012	7.81	2.33	3.35	1.24	4.68
	LA Scallop	2005 - 2012	264.00	27.88	9.47	2.85	14.39
	LA Scallop	2008 - 2012	286.45	26.60	10.77	4.07	15.29
	LA Scallop	2010 - 2012	286.15	23.00	12.44	4.07	18.15
Georges Shoal Gear Mod Area (Alt 4)	Bottom Trawl	2005 - 2012	6,404.36	102.75	62.33	20.53	89.84
	Bottom Trawl	2008 - 2012	5,796.35	88.80	65.27	17.38	97.99
	Bottom Trawl	2010 - 2012	4,997.69	76.33	65.47	9.57	114.94
Northern Georges Gear Mod Area (Alt 5)	Bottom Trawl	2005 - 2012	21,520.40	118.13	182.18	96.81	217.90
	Bottom Trawl	2008 - 2012	21,117.03	102.80	205.42	89.02	259.43
	Bottom Trawl	2010 - 2012	18,542.35	92.33	200.82	60.42	284.34
	GC Scallop	2005 - 2012	376.31	4.13	91.23	104.28	59.76
	GC Scallop	2008 - 2012	488.13	5.60	87.17	95.88	63.48
	GC Scallop	2010 - 2012	533.59	4.67	114.34	129.55	63.98
	LA Scallop	2005 - 2012	7,913.12	59.63	132.71	115.83	113.83
	LA Scallop	2008 - 2012	7,238.48	54.40	133.06	117.30	100.60
	LA Scallop	2010 - 2012	6,529.49	53.33	122.43	113.30	87.36
Georges Shoal 1 MBTG (Alt 5)	Bottom Trawl	2005 - 2012	1,171.44	89.50	13.09	2.41	24.40
	Bottom Trawl	2008 - 2012	722.82	78.80	9.17	1.76	17.79

Area	Gear	Years	Total Effort	Individuals	Mean Effort	Median Effort	SD Effort
	Bottom Trawl	2010 - 2012	492.78	68.00	7.25	0.92	14.13
	GC Scallop	2005 - 2012	0.01	1.88	0.01	0.00	0.02
	GC Scallop	2008 - 2012	0.01	2.40	0.00	0.00	0.01
	LA Scallop	2005 - 2012	3.41	19.13	0.18	0.00	0.41
	LA Scallop	2008 - 2012	1.41	11.20	0.13	0.00	0.34
	LA Scallop	2010 - 2012	0.44	10.33	0.04	0.00	0.14
EFH Expanded 1/EFH Expanded 2 (Alts 6A and 6B)*	Bottom Trawl	2005 - 2012	5,658.43	62.00	91.26	54.72	101.17
	Bottom Trawl	2008 - 2012	6,950.99	67.20	103.44	56.55	115.25
	Bottom Trawl	2010 - 2012	6,688.26	63.33	105.60	54.22	126.74
	GC Scallop	2005 - 2012	214.48	4.13	51.99	27.81	60.23
	GC Scallop	2008 - 2012	286.98	5.60	51.25	23.55	63.34
	GC Scallop	2010 - 2012	283.42	4.67	60.73	23.55	72.12
	LA Scallop	2005 - 2012	4,873.66	51.50	94.63	72.98	91.01
	LA Scallop	2008 - 2012	4,258.48	48.80	87.26	58.76	89.30
	LA Scallop	2010 - 2012	3,652.78	47.67	76.63	47.95	80.97
Georges Shoal 2 MBTG (Alt 7)	Bottom Trawl	2005 - 2012	1,580.55	91.13	16.77	1.91	30.68
	Bottom Trawl	2008 - 2012	1,009.65	77.60	12.28	1.50	24.49
	Bottom Trawl	2010 - 2012	631.30	67.67	8.49	0.83	20.68
	GC Scallop	2005 - 2012	0.06	1.75	0.04	0.00	0.11
	GC Scallop	2008 - 2012	0.02	2.40	0.01	0.00	0.02
	GC Scallop	2010 - 2012	0.02	1.67	0.01	0.00	0.03
	LA Scallop	2005 - 2012	2.50	17.88	0.14	0.00	0.43
	LA Scallop	2008 - 2012	0.86	13.20	0.06	0.00	0.25
	LA Scallop	2010 - 2012	0.59	13.00	0.05	0.00	0.09
Northern Georges (Alt 8)	Bottom Trawl	2005 - 2012	25,941.72	116.88	221.96	127.26	250.39
	Bottom Trawl	2008 - 2012	26,712.59	101.40	263.44	126.42	298.50
	Bottom Trawl	2010 - 2012	23,417.56	90.67	258.28	103.38	318.73
	GC Scallop	2005 - 2012	364.57	4.63	78.83	88.40	63.96
	GC Scallop	2008 - 2012	482.57	6.40	75.40	53.62	68.10
	GC Scallop	2010 - 2012	533.51	6.00	88.92	105.39	74.44
	LA Scallop	2005 - 2012	7,752.32	73.75	105.12	84.47	114.19
	LA Scallop	2008 - 2012	7,082.82	61.80	114.61	106.30	102.70
	LA Scallop	2010 - 2012	6,416.55	64.67	99.23	89.58	91.14
Alternative 9 MBTG closures**	Bottom Trawl	2005 - 2012	6013.98	93.38	61.21	16.10	92.27
	Bottom Trawl	2008 - 2012	5541.26	81.00	63.26	10.54	99.82

Area	Gear	Years	Total Effort	Individuals	Mean Effort	Median Effort	SD Effort
	Bottom Trawl	2010 - 2012	4527.78	70.67	56.60	3.22	109.03
	GC Scallop	2005 - 2012	0.24	2.13	0.11	0.01	0.24
	GC Scallop	2008 - 2012	0.21	2.80	0.08	<0.01	0.18
	LA Scallop	2005 - 2012	76.87	30.75	2.45	0.04	15.52
	LA Scallop	2008 - 2012	9.82	23.00	0.41	0.02	1.30
	LA Scallop	2010 - 2012	5.45	19.67	0.27	0.02	0.84
Alternative 9 Mortality closure/Alternative 10 Reduced Impact HMA***	Bottom Trawl	2005 - 2012	1453.61	51.00	28.50	12.54	38.25
	Bottom Trawl	2008 - 2012	1939.63	56.80	34.15	16.19	43.01
	Bottom Trawl	2010 - 2012	1819.13	50.33	36.14	19.26	44.32
	GC Scallop	2005 - 2012	104.17	2.88	36.23	5.47	53.82
	GC Scallop	2008 - 2012	164.14	3.80	43.20	20.37	56.97
	GC Scallop	2010 - 2012	228.51	4.00	57.13	20.36	67.76
	LA Scallop	2008 - 2012	2599.74	39.60	65.65	36.75	76.28
	LA Scallop	2010 - 2012	2439.80	35.67	68.41	41.38	74.93

* 6A and 6B are different areas but have the same areas currently open to fishing with mobile bottom-tending gears
** Western HMA, Eastern HMA is currently closed to mobile bottom-tending gears
*** The mortality closure in Alternative 9 and the Reduced Impact HMA in Alternative 10 are different, but have the same areas currently open to fishing with mobile bottom-tending gears

Table 62 – Closed Area I: Average value per haul (calendar year 2007-2011) within a 10 nautical mile buffer, and percent of total haul revenue this value represents. NEFOP and ASM observer landings data.

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bottom Trawl	Total Hauls	444	680	641	478	304	1,222	1,293	1,342	1,336	1,410	1,187	445
	Cod	$171	$370	$405	$480	$220	$176	$175	$146	$178	$203	$ 164	$143
		19%	26%	41%	43%	16%	13%	17%	15%	21%	22%	17%	12%
	Haddock	$173	$606	$404	$309	$937	$920	$313	$202	$163	$208	$ 214	$310
		19%	43%	40%	28%	66%	66%	31%	21%	19%	22%	22%	25%
	Yellowtail	$49	$11	$0	$5	$34	$9	$31	$61	$64	$76	$45	$36
		5%	1%	0%	0%	2%	1%	3%	6%	7%	8%	5%	3%
	Lobster	$166	$151	$106	$101	$35	$67	$64	$57	$39	$39	$69	$118

		Month											
		Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
		18%	11%	11%	9%	2%	5%	6%	6%	5%	4%	7%	10%
	Winter Skate	$40	$16	$5	$18	$14	$22	$35	$49	$51	$44	$40	$9
		4%	1%	0%	2%	1%	2%	3%	5%	6%	5%	4%	1%
	Scallops	$46	$21	$0	$5	$24	$12	$27	$44	$16	$18	$14	$3
		5%	1%	0%	0%	2%	1%	3%	5%	2%	2%	1%	0%
	Winter Flounder	$11	$3	$1	$2	$20	$33	$174	$166	$94	$98	$203	$71
		1%	0%	0%	0%	1%	2%	17%	17%	11%	11%	21%	6%
	Witch Flounder	$58	$45	$22	$51	$20	$25	$30	$69	$80	$74	$76	$235
		6%	3%	2%	5%	1%	2%	3%	7%	9%	8%	8%	19%
	Monkfish	$76	$117	$29	$61	$17	$33	$43	$46	$61	$73	$72	$148
		8%	8%	3%	6%	1%	2%	4%	5%	7%	8%	7%	12%
	Plaice	$44	$31	$9	$37	$43	$55	$61	$67	$75	$52	$59	$98
		5%	2%	1%	3%	3%	4%	6%	7%	9%	6%	6%	8%
Ruhle Trawl	Total Hauls					13	94						
	Cod					$7	$187						
						0%	9%						
	Haddock					$2,065	$1,718						
						99%	86%						
	Yellowtail					$5	$32						
						0%	2%						
Fixed Gillnet	Total Hauls						128	196	129	211	93	40	30
	Cod						$128	$247	$431	$256	$677	$612	$292
							20%	47%	74%	55%	86%	71%	67%
	Haddock						$38	$56	$15	$16	$ 10	$14	$9
							6%	11%	3%	3%	1%	2%	2%
	Pollock						$4	$25	$49	$24	$ 13	$23	$56
							1%	5%	8%	5%	2%	3%	13%
	Lobster						$40	$17	$14	$14	$12	$51	$8
							6%	3%	2%	3%	2%	6%	2%
	Winter Skate						$336	$110	$44	$120	$45	$143	$31
							52%	21%	8%	26%	6%	16%	7%
	Skate						$10	$28	$0	$8	$14	$-	$-
							2%	5%	0%	2%	2%		
	Spiny Dogfish						$73	$29	$6	$0	$-	$-	$-

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
							11%	6%	1%	0%			
Separator Trawl	Total Hauls	26	15		18	45	204	142	46	115	89	27	11
	Cod	$151	$408		$99	$ 144	$171	$33	$106	$67	$139	$173	$20
		9%	56%		3%	8%	7%	3%	11%	8%	12%	10%	4%
	Haddock	$1,083	$166		$2,868	$1,578	$2,277	$933	$465	$564	$751	$1,055	$350
		65%	23%		92%	87%	88%	91%	49%	67%	63%	62%	66%
	Redfish	$25	$1		$56	$0	$4	$3	$36	$23	$27	$122	$9
		1%	0%		2%	0%	0%	0%	4%	3%	2%	7%	2%
	Pollock	$259	$63		$6	$23	$31	$9	$7	$116	$37	$45	$6
		15%	9%		0%	1%	1%	1%	1%	14%	3%	3%	1%
	Yellowtail	$1	$-		$25	$17	$4	$7	$51	$5	$78	$1	$13
		0%			1%	1%	0%	1%	5%	1%	7%	0%	2%
	Lobster	$89	$9		$36	$5	$16	$10	$5	$2	$4	$17	$42
		5%	1%		1%	0%	1%	1%	1%	0%	0%	1%	8%
Longline	Total Hauls									31			
	Cod									$321			
										79%			
	Haddock									$65			
										16%			
	Redfish									$1			
										0%			

Table 63 – Closed Area II: Average value per haul (calendar year 2007 - 2011) within a 10 nautical mile buffer, and percent of total haul revenue this value represents. NEFOP and ASM observer landings data.

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bottom Trawl	Total Hauls	758	85	449	1,560	1,332	1,024	517	835	659	652	798	1,107
	Cod	$57	$247	$227	$327	$137	$129	$60	$96	$68	$45	$64	$144
		5%	17%	13%	17%	8%	11%	4%	7%	6%	3%	5%	8%
	Haddock	$193	$53	$584	$949	$798	$372	$237	$412	$371	$332	$493	$684
		16%	4%	34%	49%	47%	30%	16%	29%	31%	25%	35%	37%
	Yellowtail flounder	$438	$95	$28	$190	$341	$203	$338	$186	$154	$245	$215	$397
		36%	7%	2%	10%	20%	17%	23%	13%	13%	18%	15%	22%

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Scallop	$167	$34	$40	$62	$105	$61	$121	$62	$65	$122	$43	$168
		14%	2%	2%	3%	6%	5%	8%	4%	5%	9%	3%	9%
	Winter flounder	$96	$31	$34	$92	$156	$247	$495	$315	$157	$225	$357	$249
		8%	2%	2%	5%	9%	20%	34%	22%	13%	17%	25%	14%
	Witch flounder	$15	$70	$39	$31	$48	$45	$18	$50	$66	$91	$41	$13
		1%	5%	2%	2%	3%	4%	1%	4%	6%	7%	3%	1%
	Winter skate	$117	$82	$141	$53	$22	$37	$19	$35	$155	$100	$52	$50
		10%	6%	8%	3%	1%	3%	1%	2%	13%	7%	4%	3%
	White hake	$6	$188	$78	$29	$7	$2	$2	$5	$7	$5	$15	$9
		0%	13%	4%	2%	0%	0%	0%	0%	1%	0%	1%	1%
	Lobster	$48	$412	$394	$103	$21	$61	$84	$149	$56	$62	$56	$22
		4%	29%	23%	5%	1%	5%	6%	11%	5%	5%	4%	1%
	Monkfish	$38	$80	$99	$40	$25	$39	$52	$44	$76	$86	$49	$49
		3%	6%	6%	2%	1%	3%	4%	3%	6%	6%	3%	3%
Separator Trawl	Total Hauls	151	29	80	179	78	73	33	17	54	29	140	159
	Cod	$109	$91	$159	$516	$189	$31	$6	$19	$31	$71	$129	$193
		5%	4%	5%	18%	6%	2%	1%	1%	2%	7%	7%	8%
	Haddock	$1,915	$689	$2,567	$1,686	$2,554	$1,580	$956	$1,223	$1,319	$648	$1,401	$1,988
		83%	30%	87%	60%	83%	88%	84%	94%	84%	66%	73%	82%
	Pollock	$145	$337	$17	$13	$4	$9	-	$2	$21	$16	$130	$37
		6%	14%	1%	0%	0%	1%		0%	1%	2%	7%	2%
	Yellowtail flounder	$28	$28	$9	$153	$127	$19	$107	$2	$8	$17	$70	$52
		1%	1%	0%	5%	4%	1%	9%	0%	1%	2%	4%	2%
	Lobster	$28	$184	$91	$176	$1	$68	$9	$16	$19	$5	$13	$5
		1%	8%	3%	6%	0%	4%	1%	1%	1%	1%	1%	0%
	Monkfish	$9	$16	$17	$16	$2	$22	$14	$8	$27	$55	$5	$6
		0%	1%	1%	1%	0%	1%	1%	1%	2%	6%	0%	0%
	Winter flounder	$32	$6	$26	$167	$191	$29	$13	$0	$0	$-	$119	$93
		1%	0%	1%	6%	6%	2%	1%	0%	0%		6%	4%
	Witch flounder	$4	$35	$7	$19	$0	$18	$5	$18	$93	$60	$19	$6
		0%	1%	0%	1%	0%	1%	0%	1%	6%	6%	1%	0%
	White hake	$24	$881	$32	$43	$-	$6	$-	$3	$18	$74	$10	$40
		1%	38%	1%	2%		0%		0%	1%	8%	1%	2%
Longline	Total Hauls					79	103						

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Cod					386	275						
						30%	23%						
	Haddock					881	900						
						69%	76%						
Ruhle Trawl	Total Hauls		6		30	50	49						
	Cod		$14		$567	$73	$5						
			3%		25%	2%	0%						
	Haddock		$325		$1,416	$2,994	$969						
			74%		62%	96%	94%						
	Yellowtail flounder		$95		$193	$41	$15						
			21%		9%	1%	1%						

Table 64 – Recreational revenue estimated within a 10 nautical mile buffer of Closed Area I and Closed Area II, which are currently closed to recreational groundfishing. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual revenue is the mean annual revenue, individuals represents the average number of permit holders fishing in the area, and anglers represents the average number of anglers per year. All other statistics are estimates at the trip level. Dashes indicate data censored due to data confidentiality requirements.

Area	Years	Annual Revenue	Individuals	Anglers	Mean Revenue	Median Revenue	SD Revenue
CAIIbuffer	2006 - 2012	-	-	-	-	-	-
CAIIbuffer	2008 - 2012	-	-	-	-	-	-
CAIIbuffer	2010 - 2012	-	-	-	-	-	-
CAIbuffer	2006 - 2012	75,245.64	9.86	409.71	2,002.74	1,117.74	2,394.29
CAIbuffer	2008 - 2012	74,863.38	9.2	406.2	2,354.19	1,117.74	2,604.09
CAIbuffer	2010 - 2012	58,266.78	7.67	320	2,427.78	1,117.74	2,555.87

Table 65 – Total number of vessels conducting mobile bottom tending gear trips in 2012 in currently open portions of the Georges Bank alternatives. Vessels are grouped by port of landing or city of registration, provided that location included at least three vessels. Cities/ports with less than three vessels each were included in the state totals only. See updated Alternative 9 information below.

Georges Bank		Alternative 3		Alternative 4		Alternative 5		Alternative 6		Alternative 7		Alternative 8	
State	Community	Port	City	Port	City	Port	City	Port	City	Port	City	Port	City
CT										3			
MA		124	87	140	98	135	94	131	90	137	94	154	104

Georges Bank		**Alternative 3**		**Alternative 4**		**Alternative 5**		**Alternative 6**		**Alternative 7**		**Alternative 8**	
State	**Community**	**Port**	**City**	**Port**	**City**	**Port**	**City**	**Port**	**City**	**Port**	**City**	**Port**	**City**
	Boston	9		11				9		11		11	
	Fairhaven		13		16		15		14		14		17
	Gloucester	24	7	24	8	24	9	24	8	23	8	24	8
	New Bedford	96	60	107	64	103	61	101	60	104	62	121	70
	Peabody		3		3				3		3		3
ME		**3**	**19**	**4**	**20**	**5**	**20**	**3**	**19**	**4**	**20**	**5**	**21**
	Portland	3	10	4	9	5	10	3	9	4	10	5	10
	Westbrook		3		3		3		3		3		3
NC			**6**		**6**		**4**		**6**		**3**		**6**
NJ			**7**		**7**	**3**	**11**		**8**	**4**	**14**	**4**	**16**
	Atlantic City										3		3
	Cape May		5		5		5		5		8		10
NY					**3**		**3**		**3**		**3**		**4**
RI		**4**	**8**	**6**	**12**	**7**	**12**	**6**	**12**	**8**	**12**	**9**	**12**
	Newport												
	Point Judith	4		6		6	6	7		6		7	
	Wakefield		4		6				6		6		6

Georges Bank Alternative 9			**Number of vessels**	
State	**Community**	**Revenue**	**Port**	**City**
CT				
MA		9,047,051	**156**	**108**
	Boston	75,166	11	
	Chatham	17,987	3	
	Fairhaven			16
	Gloucester	208,405	28	10
	New Bedford	8,677,761	111	65
	Peabody			3
ME		2,251	**8**	**24**
	Portland	1,240	6	10

Georges Bank Alternative 9			Number of vessels	
State	**Community**	**Revenue**	**Port**	**City**
	Westbrook			3
NC				**6**
NJ		18,459	**3**	**11**
	Atlantic City			3
	Cape May			5
NY				5
RI		17,812	**6**	**12**
	Point Judith	17,812	6	
	Wakefield			6

Table 66 – Landing port and associated mobile bottom-tending gear revenues in 2012 potentially impacted by the areas included in the Georges Bank Alternatives. Ports with less than 3 vessels each were included in the state totals only. * Changes in revenue for Option 2 only listed for ports with 3 or more vessels affected by Option 2 gear exemption.

Georges Bank										
	Alternative	**3**	**4**	**4**	**5**	**6**	**7**	**7**	**8**	**8**
	Option	**1,2,3,4**	**1,3,4**	**2***	**1,2,3,4**	**1,2,3,4**	**1,3,4**	**2***	**1,3,4**	**2***
St	**Port**	**Total Revenue**	**Total Revenue**	**Total Revenue**	**Total Revenue**	**Total Revenue**	**Total Revenue**	**Total Revenue**	**Total Revenue**	**Total Revenue**
CT	**Total**						**2,388.16**	**2,388.16**	**4,969.66**	**4,969.66**
MA	**Total**	**1,996,388.26**	**7,352,247.91**	**6,562,938.17**	**34,748,073.92**	**10,240,151.05**	**2,328,392.56**	**1,694,767.54**	**24,606,613.56**	**23,793,007.84**
	BOSTON	15476.29	113,248.71	113,248.71	485,793.65	74,945.05	74,332.11	74,332.11	353,365.90	353,365.90
	GLOUCESTER	52169.25	302,620.60	302,620.60	1,149,381.30	210,895.34	113,913.03	113,913.03	986,496.78	986,496.78
	NEW BEDFORD	1,926,169.86	6,904,162.00	6,114,852.26	32,869,126.84	9,909,203.94	2,126,266.42	1,494,875.55	23,081,159.42	22,269,086.80
ME	**Total**	**106.74**	**915.27**	**915.27**	**4,586.95**	**721.39**	**1,172.33**	**1,172.33**	**5,038.75**	**5,038.75**
	PORTLAND	106.74	915.27	915.27	4,586.95	721.39	1,172.33	1,172.33	5,038.75	5,038.75
NJ	**Total**				**174,349.40**	**1,245.51**	**20,270.13**	**20,270.13**	**37,251.99**	**37,251.99**
RI	**Total**	**1357.83**	**15,008.36**	**15,008.36**	**79,520.28**	**11,945.81**	**9,901.40**	**9,901.40**	**65,581.86**	**65,581.86**
	POINT JUDITH	1357.83	15,008.36	15,008.36	74,860.47	11,945.81	6,406.42	6,406.42	64,307.43	64,307.43

Table 67 – Sum of 2012 party/charter recreational fishing revenue associated with the Closed Area I buffer. Ports with less than 3 vessels each were included in the state totals only.

State	Number of Vessels	Revenue
MA	6	36,140.26

4.2.4.1 *Alternative 1 (No Action)*

The no action habitat management alternative in the Georges Bank region includes the Closed Area I and Closed Area II habitat and groundfish closure areas. See Alternative 2 below for general discussions of the economic impacts of removing these closures. In summation, the economic impact of Alternative 1/No Action is expected to be highly negative. Although the groundfish fishery is gaining some benefits from no action management areas in Georges Bank, these benefits are not expected to surpass the substantial cost of current management to the scallop fishery (see Volume 5, section 6.2.2 for a detailed description of yield in these areas, and model comparisons between no action and access to existing closures). Alternative 1 would result in mainly neutral social impacts as it would maintain the status quo. Given the vulnerability in the groundfish fishery, benefits to groundfish may be felt more acutely than lost potential benefits to the scallop fishery, resulting in neutral social impacts overall. All other alternatives are compared to No Action in the sections that follow. No Action is not preferred.

4.2.4.2 *Alternative 2 (No Habitat Management Areas)*

This alternative would remove the current Closed Area I and Closed Area II Habitat Closure Areas and would not designate any additional habitat management areas in the region. The Closed Area I and Closed Area II groundfish closures would also be removed on a year round basis, subject to selection of Georges Bank Spawning Alternative 2 or 3 (Alternative 3 is preferred for spawning). This is not a preferred alternative.

Table 62 and Table 63 represent the species contributing substantially to the revenue of hauls within a 10 nautical mile buffer of the current Closed Area I and Closed Area II management areas. In the vicinity of Closed Area I, cod and haddock are the dominant species across all gear types, with winter skate important to sink gillnet revenue as well. Haddock and cod again play an important role across all gear types in the waters around Closed Area II. In addition, yellowtail flounder, winter flounder, and lobster generate substantial revenue for generic bottom trawl, while Ruhle trawl lands some quantity of yellowtail flounder in the winter and early spring. Georges Bank cod and Georges Bank yellowtail flounder are overfished, and overfishing is occurring, and thus Alternative 2 is unlikely to generate any significant benefits from these two stocks. Georges Bank winter flounder is overfished which would limit any benefits from this stock in the near term. However, Georges Bank haddock is not overfished, and overfishing is not occurring. Furthermore, the analysis in Northeast Multispecies Framework 48 suggested that a substantial concentration of haddock exist within Closed Area II, which could lead to additional flexibility in terms of higher revenue generated and lowered costs due to increased CPUE of haddock. The analysis within Framework 48 also indicated that cod, haddock, and winter flounder within the boundaries of Closed Area II are likely larger than the surrounding areas open to fishing and thus could generate additional revenue both from decreasing the ratio of unwanted bycatch (undersized fish), and capitalizing on any price premium on larger individuals that might exist in the marketplace. The magnitude of this benefit is uncertain, and depends on the size and duration of the increase in catch per unit effort (CPUE) for this species, as well as the ratio of large/small individuals, which cannot be quantified to any level of confidence. However, it is logical to expect that effort will flow into the reopened closed until CPUE equates inside and outside the currently closed areas, and thus the benefits could be transitory. Given the status of cod and winter flounder, positive impacts associated with the ability to catch larger size fish would primarily come from haddock.

It should be noted that Special Access Programs allow access to the southern portions of Closed Area II below latitude 41° 30’ and the northern portion above latitude 42° 10’ for haddock fishing between May 1 and December 31 and May 1 and January 31 respectively. Thus, the magnitude of the benefit generated from additional access to this species depends on the relative concentration of haddock in the areas and times not currently open to groundfish fishing.

Additional landings of non-target stocks could provide economic benefits to the groundfish fishery if existing closures reopen.[5] Lobster consistently appears as an important non-target species for hauls surrounding Closed Area I and Closed Area II. This general trend is particularly true for bottom trawls. A large amount of offshore lobster pot effort is concentrated in Closed Area II, perhaps due to a greater abundance of lobster in the area, and/or the lower levels of gear conflict. If the lobster pots are utilized in this area due to decreased gear interactions, then groundfish fishermen would not likely see any increase in revenue associated with lobster landings by accessing these areas. If, however, the concentration of lobster pot effort in Closed Area II indicates locally high lobster abundance, then groundfish fishermen could benefit from access to these areas due to higher catch rates. Closed Area II is the area most likely to provide this benefit to fishermen, if it exists.[6] A similar argument can be made for scallops in Closed Area I and II. Both of these closed areas are subject to significant effort from the scallop fishery, and to the extent that groundfish fishermen will gain access to areas with high scallop biomass, they could expect increased fishing revenue. These benefits are likely to only be slightly positive in magnitude, given the current fishing allowed through exemptions to the area.

Other fisheries may derive benefits as well. Although there are potential benefits associated with increased access to the skate complex, the target stocks for the fishery, winter and little skate, have widespread distribution across the bank and access to the current closures in particular may not be beneficial (see Volume 5, section 5). A more thorough economic analysis of access to Closed Area I and Closed Area II for the LA and GC scallop fishermen can be found in Volume 5, section 6. Although successful exploratory fishing for surfclam and ocean quahog has recently been conducted on Georges Bank, the portions of Georges Bank recently reopened to the clam fishery fall outside Closed Areas I and II, and thus Alternative 2 is not expected to benefit the surfclam/ocean quahog fishery.

Increased fishing gear interactions and potential displacement of existing fishing effort using non-groundfish/non-mobile bottom tending gear within Closed Area I and Closed Area II are other potential costs of this alternative. For example, it has already been noted that Closed Area II currently supports a large amount of lobster pot fishing. The increased costs accruing to the

[5] The following analysis depends on fishermen currently landing less than the permitted amount of non-groundfish species. If, instead, fishermen are already landing the entirety of their permitted landings, then the effect of changes described below are likely neutral.

[6] However, note that there is an agreement between sector trawl fishermen and the offshore lobster industry that prevents trawling within Closed Area II between June 15 and October 31, which appears to be the time of highest lobster abundance in Closed Area II. This agreement would therefore limit economic benefits associated with incidental catches. See section 17 of Volume 5 for additional discussion of lobsters in Closed Area II.

lobster pot fishery due to gear conflicts, for example losses of pots if strings are trawled or dredged over, depend on the flow of effort into the area, and the gear conflict avoidance measures taken by both lobstermen and groundfish or scallop fishermen. If, for example, mobile gear fishermen take pains in avoiding pot strings, then these costs are expected to be minimal. However, the lobster pot/mobile gear interaction is likely to be idiosyncratic, given that there is no manner to ensure due care is taken in avoidance by either groundfish fishermen or lobstermen. This effect is likely to be slightly negative, given the magnitude of mobile bottom-tending gear effort currently surrounding Closed Area II. Recreational groundfishing is currently prohibited from Closed Area I and Closed Area II. Table 64 details the recreational fishing within a 10 nautical mile buffer of Closed Area I and Closed Area II, which indicates very little recreational fishing currently occurs in the vicinity of these closures. Given the distance these areas are from shore and the lack of substantial current recreational effort in the vicinity, recent data suggest that it is unlikely that allowing recreational fishing in either Closed Area I or Closed Area II would result in substantial recreational effort redistributing into these areas. This in turn suggests that Alternative 2 would result in neutral to slightly positive impacts for the recreational fishery.

In the short term, Alternative 2 is expected to generate high positive impacts when compared to Alternative 1/No Action, as all fishermen gain additional flexibility in when and how they are able to fish, and biomass of scallops in the closed areas would be accessible. High positive impacts are also expected in the long term, and are mainly driven by the scallop fishery. Although the groundfish fishery is expected to experience negative economic impacts over the long term when compared to the status quo, given expected negative impacts on groundfish stocks resulting from removal of management areas, these impacts are not expected to surpass the additional positive benefits accrued to the scallop fishery. The positive impact of this alternative is larger in magnitude than all other alternatives under consideration within this sub-region.

The short-term social impacts of Alternative 2 in comparison to the no action alternative are expected to be positive as fishermen would gain access to new fishing areas. There are likely to be negative impacts in the form of gear conflict with existing lobster effort in these areas. There are also potential long-term negative social impacts if benefits to fish populations from the current closed areas are lost. Given the vulnerability in the groundfish fishery, long-term negative impacts to groundfish may be acutely felt.

4.2.4.3 *Alternative 3*

Alternative 3 would remove the current Closed Area I Habitat Closure Areas and would modify the Closed Area II Habitat Closure to create the Northern Edge HMA. The Closed Area I and Closed Area II groundfish closures would also be removed on a year-round basis, subject to selection of Georges Bank Spawning Alternative 2 or 3. This is not a preferred alternative.

Scallop dredges and bottom trawl generate the largest revenue from the portions of Northern Edge HMA currently open to fishing (Figure 25). Closed Area II and its surrounding areas have long been important for vessels > 70 ft in both of these fisheries (Table 59). Mean bottom trawl revenue per trip is $136 (less than 1% of an average trip's revenue) for this vessel class in the Northern Edge HMA. Scallop revenue per trip for vessels > 70 ft is substantially higher at

$15,159 (5% of an average trip's revenue). SAP trawl revenue displacement is estimated to be $230 per trip (2% of an average trip's revenue). For the previous three year period (2010-2012), the average annual revenue within the currently open sections of the Northern Edge HMA is 0.2% of the bottom trawl, 1.1% of total SAP trawl, and 0.3% of the scallop dredge revenue for 2012 from the Georges Bank, Gulf of Maine, and Southern New England statistical areas (see section 4.5 of Volume 1 for total VTR revenue estimates in 2012, and relevant statistical areas). The small size of the Northern Edge area currently open to fishing makes interpretation of the VTR analysis somewhat uncertain, as the average annual number of trips that are estimated to spend at least of a portion of their time in the area is high, but the overall revenue estimated to fall in the area is low. This result could indicate either that the area is on the outskirts of more productive grounds, or that the area actually falls within an important center of fishing and the low revenue estimates are a result of the very small sliver of this area that is currently open to fishing. Given other information available (see the maps in sections 4.3.1 (large mesh groundfish) and 4.3.5 (scallops) of Volume 1, which details the current distribution of effort around Closed Area II), it is likely that this area is an important fishing ground, for both bottom trawl and scallop dredge fishermen. As Table 59 indicates, 60% of all revenues currently generated from open areas of Northern Edge HMA would be affected by mobile bottom-tending gears. This is equal to $989,429 annually in the years 2012 - 2014.

A complete exclusion of mobile bottom-tending gear, as per Option 1, would be expected to displace $989,429, given the VTR analysis. The full impact of this alternative on the scallop fishery is expected to be on the order of two magnitudes larger than what is estimated through the VTR analysis. This disparity results from the fact that the majority of the Northern Edge area falls within the borders of the Closed Area II Habitat Closure Area, and thus is currently closed to scallop dredges. As compared to No Action, the impact on bottom trawl fishermen is expected to be neutral in the short run, but negative in the long run. This is because Alternative 3 would provide additional access to areas not currently open to fishing within the current borders of Closed Area II, but the portion of the Northern Edge currently open to fishing that would close to mobile bottom tending gear under Alternative 3 seems to be an important, but small, area of concentrated fishing effort.

Increased fishing gear interactions and potential displacement of existing fishing effort using non-groundfish/non-mobile bottom tending gear within the exemption areas are other potential costs of this alternative. Interactions with the lobster fishery are discussed under Alternative 2.

In the short-term, Alternative 3, Option 1 is expected to induce a highly positive impact, mainly accrued by the scallop fishery compared to Alternative/No Action. The bottom trawl fishery is expected to experience moderately negative impacts in the long-term when compared to Alternative 1/No Action, but the impact will likely be outweighed by the increase in economic surplus expected to be generated from the scallop fishery. Given the fact that the existing Closed Area II Habitat Closure Area and the Northern Edge HMA are relatively similar in terms of their overlap with scallop biomass, the short term benefit to the scallop fishery is likely to be generated from access to the northern portion of Closed Area I, which contained roughly 4.3% of the short term yield (based on scallop resource conditions is 2013; see section 6.2.2 of Volume 5). While this is a small percentage of scallop yield relative to the entire scallop fishery, scallops are very valuable relative to other resources harvested on Georges Bank. Over the long term, this area has contained a smaller fraction, 0.2-2.4%, of scallop yield, but biomass has built up in the closed area over time. The longer term benefits are thus expected to be moderately positive, but are more uncertain as they depend to some extent on the expected impact of Alternative 3, Option 1 on groundfish productivity (see Volume 5, section 2).

Alternative 3, Option 2 is expected to have a neutral effect on the surfclam and ocean quahog fishery, when compared to Alternative 1/No Action. There is no clam dredge revenue shown in the open portions of Alternative 3 (Table 59). Additionally, most of the Northern Edge HMA does not fall within the PSP closure exemption area, i.e. even if Closed Area II, which prohibits clam dredging, is made seasonal under this alternative, most of the HMA would still be within the PSP closure.

As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. What information exists indicates that Option 3 would be expected to decrease CPUE for some species, meaning more effort, and thus a higher cost, would be induced to catch the same quantity of fish. Additionally, fishermen would be faced with the cost of buying new/converting nets to meet the new requirements. This, coupled with the expected negative impact on seabed habitats identified in 3.2.4.3, indicates that Options 3 and 4 would be expected to have a highly positive impact as compared to Options 1 and 2, although marginally smaller overall due to the long-term impact on the groundfish fishery.

There are positive non-economic social impacts associated with Alternative 3 and the access gained to new fishing areas. Many of these benefits relate to the scallop fishery. Many of the identified communities, particularly New Bedford and Fairhaven, Massachusetts and Cape May, New Jersey include vessels using scallop dredges which would benefit from gear modification Options 3 and 4. New Bedford has relatively high indicators of social vulnerability and indicators demonstrate Cape May is vulnerable to gentrification. Both towns have high levels of dependence on commercial fishing (see table in the Human Community section 4.6 of Volume 1). There may be negative long-term impacts if benefits to fish populations from the current closures are lost. Given the current vulnerability in the groundfish fishery, impacts to groundfish may be felt more acutely than impacts to the scallop fishery.

4.2.4.4 *Alternative 4*

Alternative 4 would remove the current Closed Area I Habitat Closure Areas and would modify the Closed Area II Habitat Closure to create the Northern Edge HMA. The Georges Shoal Gear Modification Area would also be designated. The Closed Area I and Closed Area II groundfish closures would also be removed on a year round basis, subject to selection of Georges Bank Spawning Alternative 2 or 3. This is not a preferred alternative.

Table 59 overviews the current revenue being generated within currently open areas of Alternative 4. Scallop dredge and bottom trawl generate the largest revenues. Closed Area II and its surrounding areas have long been important for vessels > 70 ft in both of these fisheries, as highlighted by Table 59. Mean bottom trawl revenue estimated to be impacted per trip is $1,505 (8% of an average trip's revenue) for this largest vessel class in Georges Shoal Gear Modification Area and $1,298 (7% of an average trip's revenue) for all other vessel classes.

Average impacted revenue estimated for SAP trawl trips equals $875 (6% of an average trip's revenue) for vessels >70 ft, though the revenues associated with vessels between 50 and 70 ft cannot be disclosed due to data confidentiality requirements. Discussion of the Northern Edge impacts can be found in Alternative 3. For the previous three year period (2010-2012), the average annual combined revenue within the Alternative 4 areas represents 1.9% of the bottom trawl, 4.1% of SAP trawl, and 0.3% of scallop dredge revenue for 2012 from the Georges Bank, Gulf of Maine, and Southern New England statistical areas (see section 4.5 of Volume 1 for total VTR revenue estimates in 2012, and relevant statistical areas). As Table 59 indicates, 38% (over $2,890,000) of all revenues currently generated from Northern Edge HMA and Georges Shoal GMA would be affected by mobile bottom-tending gear closure.

Table 61 presents the VMS analysis for the Georges Shoal GMA, which identifies the importance of this area for bottom trawl fishermen. This is apparent in terms of both hours and individuals fishing within the bounds of the Georges Shoal GMA.

There is no recreational fishing currently reported within the boundaries of Northern Edge. Although some recreational fishing has been reported within the boundaries of the Georges Shoals GMA, this information is not presented due to data confidentiality requirements.

See the discussion of Alternative 3 for a full description of the impacts expected from a Northern Edge HMA. The Georges Shoal GMA is expected to induce uncertain impacts to both the trawl fisheries and habitat very similar to those associated with Option 3 and 4 in Alternative 3. Therefore, the cumulative impacts of both areas combined are expected to be highly positive when compared to No Action in both in the long and short-term. These positive benefits mainly accrue to the scallop dredge fishery, which gains access to areas of scallop biomass off-limits to them in No Action Alternative 1, within CAI. Despite these overall benefits, the groundfish fishery is expected to experience slightly negative impacts in the short-term and and marginally negative impacts in the long-term. The positive benefits are expected to be smaller than consistent Options in Alternative 3, given the additional inefficiency induced by gear restrictions with no clear habitat benefits, as well as Alternatives 2, 5, 7, and 6B, but larger than Alternatives 6A and 8.

The social impacts associated with the Northern Edge HMA are discussed in Alternative 3. The social impacts of the Georges Shoal GMA are uncertain due to the uncertain effects of the gear modification on the habitat and catch rates.

4.2.4.5 *Alternative 5*

Alternative 5 would remove the Closed Area I and II Habitat Closure Areas and establish the Georges Shoal mobile-bottom tending gear HMA and establish the Large Georges Shoal Gear Modification Area (GMA). The Closed Area I and II groundfish closures would also be removed on a year round basis, subject to selection of Georges Bank Spawning Alternative 2 or 3 (spawning Alternative 3 is preferred). Habitat Alternative 5 is not a preferred alternative.

Figure 27 and Figure 28 illustrate the gears currently employed within the boundaries of the Northern Georges GMA and Georges Shoal 1 Mobile Bottom Tending Gear areas being considered in Alternative 5. Revenue generated within the Northern Georges GMA is dominated by scallop dredge and bottom trawl fishermen, while in the Georges Shoal 1 Mobile Bottom Tending Gear area, clam dredge and bottom trawl are the two most prolific revenue sources (see Table 59 for details). Note that the bottom trawl and SAP trawl revenues associated with the Georges Shoal 1 Mobile Bottom Tending Gear HMA are also contained within the totals for the Northern Georges GMA, as the mobile bottom-tending gear closure is a subset of the larger gear modification area. Though double counting, the results are presented in this way because the management options for the areas are different. Mean revenue per trip in the Northern Georges GMA is $4,248 (23% of an average trip's revenue) for bottom trawl vessels > 70 ft, and $3,054 (18% of an average trip's revenue) for all other bottom trawl vessel classes. SAP trawl trips in the area generate similar mean revenue, with $4,198 per trip across all vessel types. The Georges Shoal 1 Mobile Bottom Tending Gear area encapsulates a much smaller portion of the trawl revenue, with a mean per trip revenue of $558 for vessels > 70 ft (3% of an average trip's revenue), and $478 per trip (3% of an average trip's revenue) for other vessel classes of bottom trawls, and SAP trawl per trip revenue estimated to be $770for across all vessel types. The VTR analysis suggests that the MBTG area encapsulates 12% of the revenue generated by SAP and bottom trawls combined in the Northern Georges GMA.

The mean revenue per trip from clam dredge activity estimated to fall within the Georges Shoal Mobile Bottom Tending Gear area is $21,256 over the last three year period (Table 59). Due to the Georges Bank Paralytic Shellfish Poisoning area closure in effect in the area until 2013, the true value of this area to the surfclam and ocean quahog fishery is higher than what can be gleaned from the VTR analysis of past effort. Conversely, the mean scallop dredge revenue per trip is only $5,405, suggesting that the most productive scallop beds in this part of Georges Bank do not fall within the Georges Shoal 1 Mobile Bottom Tending Gear area. For the previous three year period (2010-2012), the average annual revenue in these areas accounts for 5.4% of bottom trawl, 17.6% of SAP trawl, 0.1% of scallop, and 11% of clam dredge revenue for 2012 from the Georges Bank, Gulf of Maine, and Southern New England statistical areas (see section 4.5 of Volume 1 for total VTR revenue estimates in 2012, and relevant statistical areas).

These general results are mirrored by the VMS analysis (Table 61). Bottom trawl effort is particularly high in the Northern Georges GMA, and only 3% of this effort is estimated to fall within the Mobile Bottom Tending Gear area. The VMS analysis also indicates that both general category and limited access scallop effort in the Mobile Bottom Tending Gear area is low relative to the surrounding waters. Similar to the VTR analysis, the Northern Georges GMA and Georges Shoal 1 Mobile Bottom Tending Gear area double count the effort estimates, and thus effort cannot be summed across areas.

Although there have been some recreational trips reported within the boundaries of the Large Georges Shoal Area, this information is not presented due to data confidentiality requirements.

Given the above discussion, and the lack of scallops falling within the mobile bottom tending gear area, Alternative 5 is expected to generate highly positive net impacts in both the short and long-term when compared to No Action. These benefits accrue mainly to the scallop fishery, and are generated despite expected moderately negative impacts in the groundfish and clam fisheries. The groundfish negative impact is due to expected long-run negative impacts on groundfish habitat, while the surfclam and ocean quahog fisheries face both short run and long run displacement of effort from productive fishing grounds. The positive net benefits are expected to be smaller in magnitude than Alternative 2, mainly due to the inefficiency induced in the groundfish fishery with negative to neutral impacts on groundfish habitat (see Volume 5). The magnitude of the positive benefits are expected to be larger than commensurate Options in Alternatives 3 and 4, primarily due to the larger positive benefits expected for the scallop fishery.

The social impacts of Alternative 5 in comparison to Alternative 1/No Action are highly uncertain given the potential tradeoffs between decreased catch rates and increased fishing time when using the modified gear. There are likely to be negative impacts from gear conflicts created by opening the current closures, particularly with lobster gear in Closed Area II. However there are also positive impacts to other gear types gaining access to these previously closed areas, particularly the scallop fishery. Given these uncertainties, it is likely that the social impacts of Alternative 5 will be somewhat negative. Given the vulnerability in the groundfish fishery negative impacts to groundfish may be felt more acutely than lost benefits to the scallop fishery.

4.2.4.6 ***Alternative 6A and 6B***

Alternative 6 would remove the current Closed Area I Habitat Closure Areas and would modify the Closed Area II Habitat Closure in one of two wasy. Alternative 6A extends the area further west (are EFH Expanded 1), and Alternative 6B also extends the area west but removes an 8 nm corridor along the EEZ (area EFH Expanded 2). The Closed Area I and II groundfish closures would also be removed on a year round basis, subject to selection of Georges Bank Spawning Alternative 2 or 3 (Alternative 3 is preferred). Alternatives 6A and 6B are not preferred.

Figure 29 illustrates the gears currently employed within the currently open sections of Alternatives 6A and 6B. Given that the majority of this alternative falls within the current Closed Area II Habitat Closure Area, Options A and B are equal in regards to current effort by mobile bottom tending gear. Similar to the spatially overlapping Northern Edge HMA, scallop dredge and bottom trawl are the most prolific gears. Table 59 provides more detail for the mobile bottom tending gear currently fishing within the open area of Alternative 6. Between 2012 and 2014, scallop dredge trips are estimated to have generated an average of $134,631 per trip to this area (47% of an average trip's revenue), across all vessel categories. Per trip, large bottom trawl vessels are estimated to have generated an average of $1,164 (6% of an average trip's revenue), while all other bottom trawl vessel categories generated a lower trip average of $923 (6% of an average trip's revenue). SAP trawl trips of all vessel categories combined estimated to have generated an average of $2,225. Combined, the revenue expected to be impacted represents 1.0% of bottom trawl, 4.7% of SAP trawl, and 2.6% of scallop average annual revenue reported in the VTR between 2010 and 2012 (see section 4.5 of Volume I for total 2012 VTR revenue and statistical areas of relevance). Although some clam dredge activity was estimated to have occurred within the bounds of Alternative 6, confidentiality issues keep this data from being presented at the gear level. The majority of the clam dredging that has occurred on Georges Bank in the last three years seems to have fallen outside of the bounds of the Alternative 6A and B areas.

The economic impact to the scallop fishery is explored in Volume 5, section 6.2.2. Maps of scallop dredge survey catch indicate that the area of Alternative 6 currently open to scallop fishing has historically been a concentration of substantial biomass. These analyses suggest that

6A would generate moderately negative impacts to the scallop fishery when compared to Alternative 1/No Action, and this impact is expected to greatly outweigh any long-term benefits to the groundfish fishery from conservation measures. Given this, Alternative 6A is expected to induce overall moderately negative impacts in the sort term, and highly negative impacts in the long term, when compared to Alternative 1/No Action.

Alternative 6B is expected to generate highly positive benefits for the scallop fishery in both the short-term and long-term when compared to Alternative 1/No Action, given the relative long-term yield estimates of the areas presented in Volume 5, section 6. Positive benefits are also expected for the groundfish fishery in the short-term, although the long-term impact is expected to be negative due to Alternative 6B's expected impact on groundfish habitat (see Volume 5, section 2). The overall impact from Alternative 6B, Options 1 and 2 are thus expected to be highly positive in both the short-term and long-term, with the majority of the benefits accruing to the scallop fishery.

Recent clam dredging activity is estimated to have been concentrated outside of the boundaries of Alternative 6, and the majority of the area encapsulated by Alternative 6 falls within an area that is still closed under the Georges Bank PSP closure. Therefore, Options 1 and 2 are expected to generate impacts negligibly different from one another, for both Alternative 6A and Alternative 6B.

As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. What information exists indicates that Option 3 would be expected to decrease CPUE for some species, meaning more effort, and thus a higher cost, would be induced to catch the same quantity of fish. Additionally, fishermen would be faced with the cost of buying new/converting nets to meet the new requirements. This, coupled with the expected negative impact on seabed habitats, indicates that Options 3 and 4 would be expected to have a larger negative impact for bottom trawl fishermen as compared to Options 1 and 2 of 6A. However, Options 3 and 4 would allow the scallop dredge fishery to operate within the area, which means that the aggregate effects are expected to be highly positive when compared to Options 1 and 2. Options 3 and 4 would also be expected to lead to somewhat larger positive benefits than Options 1 and 2 of 6B.

The social impacts of Alternative 6A are expected to be moderately negative. This is mainly due to the economic impacts on the scallop industry described above. These impacts are concentrated on vessels associated with communities in Massachusetts, particularly New Bedford, which has indicators of high levels of fishing dependence and relatively high levels of social vulnerability (see Affected Environment table). The short term impacts to the groundfish industry are expected to be positive, however there may be negative, long term impacts if benefits to fish populations from the current closures are lost. Given the current vulnerability in the groundfish fishery, impacts to the groundfish industry may be felt more acutely than impacts to the scallop fishery resulting in overall short-term, non-economic social impacts that are less negative than those described in the economic analysis above.

The social impacts of Alternative 6B are expected to be positive. In the short term, there will be positive impacts to both the scallop and groundfish fishery as they gain access to new fishing areas. The long term social impacts on the groundfish fishery are expected to be negative given the expected impacts on groundfish habitat.

4.2.4.7 *Alternative 7*

Alternative 7 would remove the current Closed Area I Habitat Closure and modify the Closed Area II Habitat Closure to create the EFH South HMA, and would also create the new Georges Shoal 2 Mobile Bottom Tending Gear HMA. The Closed Area I and II groundfish closures would also be removed on a year round basis, subject to selection of Georges Bank Spawning Alternative 2 or 3 (Alternative 3 is preferred). Alternative 7 is not preferred, although the Georges Shoal 2 HMA is part of the preferred alternative (Alternative 10).

Figure 30 highlights revenue generated in Alternative 7 areas currently open to fishing, as a proportion of the total revenue. The majority of revenue is generated by fishermen employing clam dredges, with a substantial portion of revenue also being generated by bottom trawl, scallop dredge, and midwater trawl fishermen. Table 59 details the mobile bottom-tending gear revenues in the vicinity of the Georges Shoal 2 HMA that would be affected by Alternative 7. Bottom trawl vessels > 70 ft. in length generate the bulk of the revenue being generated by the areas encompassed by Alternative 7, with average trip revenue estimated to be $824 (4% of an average trip's revenue) in the 2012-2014 period. At $718 (4% of an average trip's revenue), smaller bottom trawl vessels generated similar impacted trip revenue during the same time period, but average a much lower number of trips per year. This is intuitive given both of these areas are a long distance from shore. The average trip revenue is much higher for scallop dredge boats, with an average of $6,273 (2% of an average trip's revenue) for vessels > 70 ft. and $4,560 (2% of an average trip's revenue) for all other vessel categories. For the previous three year period (2010-2012), the average annual revenue in these areas accounts for 0.9% of bottom trawl, 1.8% of SAP trawl, 10.4% of clam dredge, and 0.2% of scallop dredge revenue for 2012 from the Georges Bank, Gulf of Maine, and Southern New England statistical areas (see section 4.5 of Volume 1 for total VTR revenue estimates in 2012, and relevant statistical areas). Given the scallop revenue estimated to fall within some of the other alternatives within Georges Bank, the relatively low revenue estimated to be impacted by Alternative 7 suggests that this area is not a major center of scallop fishing. The revenue displacement estimated for the SAP trawl vessels is not insubstantial, with an average trip revenue of $445 (2% of an average trip's revenue) across all vessel classes. Nevertheless, comparatively fewer trips by fishermen utilizing this gear are expected to be impacted to a much lesser extent than more traditional bottom trawl gears.

The Georges Shoal 2 area encompassed a substantial amount of clam dredging over the past three years (Table 59). Due to the Georges Bank Paralytic Shellfish Poisoning area closure, past revenues from the VTR/clam logbook analysis may under-represent the future revenue generating potential of this area to the surfclam and ocean quahog fishery. The mean revenue per trip from clam dredge activity estimated to fall within the Georges Shoal Mobile Bottom Tending Gear area is $26,145 (56% of an average trip's revenue) over the last three year period.

The VMS analysis in Table 61 shows a relatively steep drop-off in bottom trawl fishing effort within the bounds of the Georges Shoal 2 area in the 2010 – 2012 period, when compared to longer-run averages. Additionally, the analysis suggests almost no scallop effort expended in the area by either limited access or general category permitted vessels. Comparing the results of

Table 59 and Table 61 across areas indicates that the Georges Shoal 2 area seems to avoid the most heavily fished portions of Georges Bank. The Scallop PDT's analysis presented in Volume 5, section 6 indicates that Georges Shoal 2 encapsulates only 0-2 MT (median/mean, close to 0.0%) of the total scallop long-term yield, which further bolsters this conclusion.

The entirety of the EFH South HMA falls within the current Closed Area II Habitat Closure. Currently, no mobile bottom tending gear fishing is permitted within this area. However, the scallop PDT has provided an analysis of the fishery yield potential of this area, which suggests that this area does not host a substantial portion of the Georges Bank scallop biomass (10-23 MT median/mean long-term yield, 0.0-0.1% of the total yield for the scallop resource). Given the information available, Alternative 7 is expected to induce highly positive impacts when compared to Alternative 1, No Action. These benefits are expected to be smaller than Alternative 2 and 5, but larger than all other alternative s in this sub-region.

The social impacts of Alternative 7 are expected to be moderately positive in the short term as fishermen gain access to new fishing areas. Given the expected impact on groundfish habitat (Volume 5) it is likely that the long term social impact on the groundfish industry will be moderately negative.

4.2.4.8 *Alternative 8*

Alternative 8 would remove the current Closed Area I Habitat Closure and expand the Closed Area II Habitat Closure significantly to create the Northern Georges HMA. The Closed Area I and II groundfish closures would also be removed on a year-round basis, subject to selection of Georges Bank Spawning Alternative 2 or 3 (Alternative 3 is preferred). Alternative 8 is not preferred.

Figure 31 presents the revenue generated within the portions of the Northern Georges Bank HMA currently open to fishing. Scallop dredge dominates the revenue, with bottom trawl also generating a substantial percentage. Table 59 presents a more detailed overview of the mobile bottom tending gear that would be impacted by Alternative 8. Bottom trawl vessels > 70 ft. encompass 94% of the revenue for this gear, with average trip revenue impacted estimated at $4,455 (24% of an average trip's revenue) in 2012 – 2014. All other bottom trawl vessels average slightly less revenue per trip during the same time period, with $3,372 (20% of an average trip's revenue) estimated to be affected by Alternative 8, but with many fewer trips to the area. For all vessel sizes, annual average bottom trawl revenue between 2010-2012 represent 5.3% of the average annual revenue for the gear type during 2012 (combining GOM, GB, SNE statistical areas) The per trip SAP trawl revenue impacted is similar across all vessel categories, with vessels > 70 ft. averaging $4,393 (30% of an average trip's revenue) and all other categories averaging $3,045 (14% of an average trip's revenue). Annual average SAP trawl revenue between 2010-2012 corresponds to 15.4% of 2012 annual SAP trawl revenue (combining GOM, GB, and SNE statisistical areas). Scallop vessels > 70 ft. generate 95% of the scallop revenue expected to be impacted by Alternative 8 in the 2012-2014 period, with average trip revenue impacted estimated to be $187,889 (70% of an average trip's revenue). All other categories of scallop dredge vessels fishing in the area would be expected to have $129,062 (72% of an average trip's revenue) displaced per trip. For all vessel sizes, annual average revenue between

2010-2012 represents 6.5% of the total scallop dredge revenue for 2012 as reported in VTRs (combining GOM, GB, and SNE statistical areas).

The Northern Georges Bank HMA hosted a substantial amount of the exploratory fishing conducted by the surfclam and ocean quahog fishery over the past three years, as represented by the clam dredge revenue (Table 59). As noted above, the VTR analysis under-represents the future revenue generating potential of this area to the surfclam and ocean quahog fishery. The mean revenue per trip from clam dredge activity estimated to fall within the Northern Georges HMA is $37,187 (80% of an average trip's revenue) over 2012 – 2014. The total clam revenue impacted represents 11.4% of average annual revenue within the clam logbooks between 2010 and 2012 for relevant statistical areas.

Table 61 presents the VMS analysis for the Northern Georges Bank HMA area, which supports the VTR analysis in terms of importance of the area to both bottom trawl and scallop dredge fishing. The analysis indicates that a large number of limited access scallop and bottom trawl fishermen intensively utilize the Northern Georges Bank area, as seen by the average annual individuals and mean individual annual effort in Table 61. A much smaller number of general category scallop vessels seem to be active in the area, although those individuals also seem to utilize the area relatively intensively. The Scallop PDT's analysis indicates that Northern Georges MBTG HMA encapsulates somewhere between 11.3% (mean estimate) and 4.8% (median estimate) of the total scallop long-term yield, an amount much larger than any of the other alternatives in this sub-region.

Although there has been some recreational fishing historically reported in the Northern Georges Bank HMA, confidentiality issues preclude its presentation.

Alternative 8 is expected to cumulatively induce highly negative impacts both in the short and long run. The magnitude of this impact is expected to be larger than any other alternative under consideration. Although the majority of this impact is expected to accrue to the scallop fishery, the impact of Alternative 8 on the groundfish fishery is expected to be negative, when compared to No Action Alternative 1, given the neutral to slightly negative impact on the groundfish stocks themselves expected from this alternative (see Volume 5 section 2.1.2.4.8). The impact on the clam fishery is also expected to be negative.

The social impacts of Alternative 8 will be concentrated on vessels associated with communities in Table 66. Given the expected economic impacts to the scallop and clam fishery as well as the neutral or slightly negative impacts to juvenile groundfish habitat (see Volume 5) it is likely that in both the short and long term the social impacts of Alternative 8 will be moderately negative. There may be some indirect, slightly positive social impacts to stakeholders concerned with ocean conservation who are supportive of the larger areas associated with this alternative.

4.2.4.9 *Alternative 9*

Revenue estimates for the areas are provided in Figure 32 (Eastern and Western MBTG Closures), Figure 33 (Mortality Closure), Table 59 (MBTG VTR), Table 60 (Fixed gear VTR), and Table 61 (MBTG VMS).

The estimates of potentially displaced revenue from the two MBTG areas are generated from the Western area, as the Eastern area falls within a portion of CAII currently closed to mobile bottom-tending gear fishing year-round. The revenue is generated predominantly by bottom trawl, followed by scallop dredge (Table 59). More recently clam dredge has generated an increasing portion of the total revenue, due to dredging in what had previously been a PSP closure on Georges Bank. Similar to other alternatives on Georges Bank, the bottom trawl revenue in the Western MBTG area is generated predominantly by larger vessels (Table 59), with average trip-level revenue of $1,315 (7% of an average trip's revenue). Other bottom trawl vessel classes have similar exposure levels in this area, with $1,163 in average trip-level revenue potentially displaced (7% of an average trip's revenue). Although a smaller share of the total revenue generated in the Western MBTG area, large vessels using scallop dredges generate a substantially higher amount of revenue at the trip level at $18,127 per trip on average (6% of an average trip's revenue). Other scallop dredge vessel classes generate an average of $11,033 (6% of an average trip's revenue). Vessels using clam dredges are estimated to have generated an average trip level revenue of $13,633 from the Western MBTG area (29% of an average trip's total revenue). Vessels using SAP trawl have also seen an increase in activity in the Western MBTG area in recent years, with average trip revenues of $630 being generated (4% of an average trip's total revenue).

Scallop dredge dominates the revenue generated from the portion of the proposed Alternative 9 mortality closure which is currently open to fishing, with bottom trawl also generating a substantial portion of the total revenue (Table 59). The trip level revenue generated by large vessels using scallop dredges is estimated to be $60,110 (21% of an average trip's total revenue), with all other vessel classes generating an average trip revenue of $46,067 (24% of an average trip's total revenue). Large vessels generate the majority of the bottom trawl revenue in the Alternative 9 mortality closure, with the average trip revenue of $263 (1% of an average trip's total revenue). The low trip level revenue and relatively high number of trips estimated to have occurred in the portion of the Alternative 9 currently open to fishing indicates either the area is adjacent to more lucrative fishing grounds, or that the area is too small to encompass the entirety of a vessel's trip. However, the haul distribution information presented in Volume 1, Section 4.3.1.2 indicates that this is likely to be an important fishing ground, and the area size contributes to the relatively low estimate of trip level exposure. The other vessel categories using bottom trawl are estimated to generate an average trip revenue of $167 (1% of an average trip's total revenue) within the proposed mortality closure. SAP trawl and longline vessels in the same area are estimated to generate a trip average of $540 (4% of an average trip's total revenue) and $1,860 (35% of an average trip's total revenue) within the proposed mortality closure. The 'other gear' category is a combination of purse seine and sink gillnet, and thus would be affected by the designation of a mortality closure. These combined gears generate a trip average $49 (1% of a trip's total revenue) from the area.

The VMS analysis (Table 61) is consistent with the VTR analysis, in that bottom trawl effort is substantially greater than scallop effort in the Western MBTG area, while the scallop fishery is estimated to have higher activity in the portion of the mortality closure currently open to fishing.

A complete exclusion of mobile bottom tending gear in the Western MBTG area and the area of the mortality closure as proposed in Alternative 9 that is currently open to fishing would be expected to displace 89% of the total revenue generated within these areas, equal to an annual average of $8,278,623. Of this, an average of $3,570,461 has been generated by scallop dredges in the currently open area of the proposed mortality closure between 2012 and 2014. The Western MBTG area is similar in size and position to the Georges Shoal 2 MBTG area, with which it overlaps somewhat, and the VTR analysis presents similar levels of exposure to the two areas. However, the Western MBTG area has substantially more bottom trawl effort as evidenced by VMS. The portion of the Alternative 9 mortality closure currently open to fishing is roughly 65% larger in size than the Northern Edge area of Alternative 3 and 4, with which it overlaps somewhat, and the VTR presents a similar ratio in terms of bottom trawl and SAP trawl revenue exposure. The VMS analysis indicates the bottom trawl effort expenditure in these two areas is much more similar, while both the VMS and VTR indicate substantially more revenue and effort for the scallop fishery in the mortality closure of Alternative 9.

Alternative 9 is expected to generate highly positive impacts both in the short and long term when compared to Alternative 1/No Action. These benefits accrue mainly to the scallop fishery, and are expected to be smaller than comparable options for Alternative 7 and Alternative 2, but larger than all other alternatives on Georges Bank, primarily due to the lack of scallop biomass in the areas under consideration. However, both the short and long term impacts on the groundfish fishery are uncertain and likely heterogeneous across species and gears, due to differential impacts on habitat and the groundfish resource (see section 3.2.4.9 of this volume and section 2.2.4.9 of Volume 5). Alternative 9 would be expected to generate relatively moderate negative impacts in both the short and long term to the clam fishery when compared to Alternative 1/No Action given there is no proposed exemption for clam dredges, but these impacts are expected to be greatly outweighed by the positive benefits accruing to the scallop fishery.

The social impacts of Alternative 9 are expected to be slightly positive in the short term as fishermen gain access to new fishing areas but lose access to others. Given the expected impact on groundfish habitat (Volume 5) it is likely that the long term social impact on the groundfish industry will be slightly negative.

4.2.4.10 *Alternative 10 (preferred)*

Alternative 10 would remove the current Closed Area I Habitat Closure, modify the Closed Area II Habitat Clousre, and create the Georges Shoal 2 area to the west. Overlapping the CAII Habitat Closure, a ‘reduced impact’ HMA would be created in the north and a mobile bottom-tending gear closure HMA in the south. The Closed Area I and II groundfish closures would also be removed on a year-round basis, subject to selection of Georges Bank Spawning Alternative 2 or 3 (3 is preferred). Georges Shoal 2 would have a one-year exemption for hydraulic dredges, that could be extended in a trailing framework adjustment for a portion or all of the area. The alternative also includes a seasonal closure for scallop dredges from June 15-October 31 within Closed Area II north of 41° 30’ N. Alternative 10 is the preferred alternative for habitat protection.

The Georges Shoal 2 Mobile Bottom Tending Gear HMA is described in section 4.2.4.7, while the Alternative 9 mortality closure is described in section 4.2.4.9, which also includes a comparison of the Georges Shoal 2 HMA and Western HMA, the single largest difference between Alternative 9 and 10. A description of the current fishing estimated to occur within the areas encompassed by Alternative 10 can be found in Figure 30, Figure 33, Table 59, Table 60, and Table 61, while exposed communities are presented in Table 66. Under the assumption that the clam dredge exemption in the Georges Shoal 2 HMA continues into the future beyond the one-year initial exemption, and scallop revenue is reallocated chronologically but not fully displaced from the Reduced Impact HMA, a complete exclusion of mobile bottom tending gear in the currently open areas of Alternative 10 is expected to impact $1,806,637, 19% of the total revenue generated within the affected waters. If the clam exemption is not extended past the first year of area management, the exclusion would be expected to displace $4,909,126 which is 52% of the total revenue with Alternative 10. A full estimate of the impacts on the scallop fishery due to implementation of Alternative 10 is presented in Volume 5, section 6.2.

Alternative 10 is expected to generate highly positive impacts both in the short and long term when compared to Alternative 1/No Action. Benefits accrue mainly to the scallop fishery and are expected to be smaller than comparable Options of Alternative 9 and Alternative 7, as well as Alternative 2, but are larger than all other alternatives under consideration. However, both the short and long term impacts on the groundfish fishery are uncertain and likely heterogeneous across species and gears, due to differential impacts on habitat and gear restrictions (see section 3.2.4.10 of this volume and section 2.2.4.10 of Volume 5). If the clam exemption is not extended beyond the first year, Alternative 10 would be expected to generate relatively large negative impacts in the long run to the clam fishery when compared to Alternative 1/No Action, but these impacts are expected to be greatly outweighed by the positive benefits accruing to the scallop fishery. However, the Georges Shoal 2 area is likely to provide for less protection for habitat most susceptible to fishery disturbance (see section 3.2.4.7).

The social impacts of Alternative 10 are expected to be slightly positive in the short term as fishermen gain access to new fishing areas but lose access to others. Given the expected impact on groundfish habitat (Volume 5) it is likely that the long term social impact on the groundfish industry will be slightly negative.

4.2.5 Great South Channel/Southern New England

Tables and figures related to analysis of the social and economic impacts of the Great South Channel/Southern New England habitat management alternatives are provided below. Discussion of impacts is provided under a separate heading for each alternative.

Framework 50 of the Northeast Multispecies Fisheries Management Plan permits the landing of Southern New England/Mid-Atlantic winter flounder, worth an estimated $5.2 million, which is a departure from the recent past and thus not represented in the VTR analysis of these sections. Industry has expressed concerns that the Great South Channel HMA (preferred alternative) encapsulates a significant portion of the biomass for this species in southern New England. In order to investigate this claim, revenue generated from observed haul level winter flounder landings prior to Amendment 16, which prohibited landings of Southern New England/Mid-Atlantic Winter Flounder, were compared between the Great South Channel area (Alternative 4) and a 10 nautical mile buffer surrounding Nantucket Lightship. This includes the years 2007 – 2009. A two-tailed test for the equality of variance between the two samples was significant at the 1% level (p-value = 0.0000), meaning that a t-test is inappropriate. Instead, a nonparametric Wilcoxon rank sum test for the equality of the winter flounder revenue distributions between the two areas was conducted. The null hypothesis of equality between the two samples was rejected, again at the 1% level (p-value = 0.0000), with Great South Channel presenting the higher mean haul level revenue of the two areas, by $98. Additionally, a test of proportions was conducted in order to understand whether the proportion of hauls on which winter flounder was caught differed significantly between the two areas. Again, the test was significant at the 1% level, with winter flounder landed on 64% of hauls within the Great South Channel, while the species was landed on only 30% of hauls within Nantucket Lightship. Although there are reasons, including potential shifts in distributions between the historical and current population of Southern New England/Mid-Atlantic winter flounder or differences in density inside Nantucket Lightship versus in a 10 nautical mile buffer surrounding Nantucket Lightship, the analysis above suggests that catch rates are likely to differ significantly between Great South Channel and Nantucket Lightship. These results would hold for the Great South Channel East HMA (Alternative 3), given that the Great South Channel area is nested within this larger area. It is unclear whether this same result holds for the Nantucket Shoals and Nantucket Shoals West areas, and additional analysis would be needed before any conclusion could be made in these areas. These are not preferred alternatives.

Figure 34 – Great South Channel East HMA (Alt 3) annual revenue by gear, over the time period identified. Average annual total revenue: 2005 - 2014 = $ 26,130,258; 2010 – 2014 = $ 37,600,248; 2012 – 2014 = $ 45,834,441

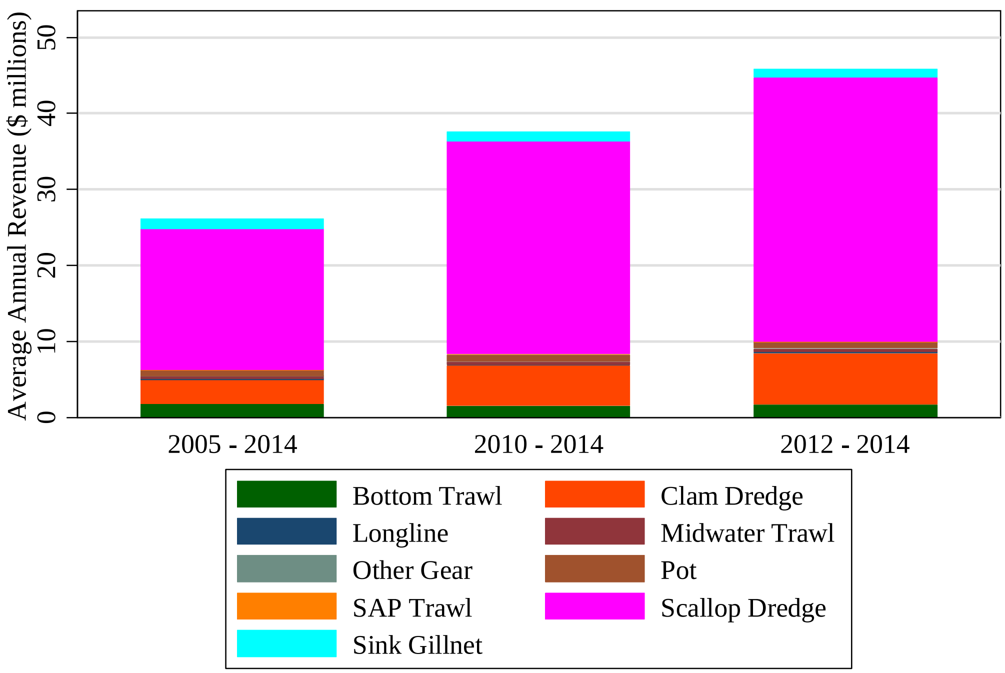


Figure 35 – Cox Ledge HMA (Alts 3-6) average annual revenue by gear, over the time period identified. Note that one gear type is not reported for data confidentiality requirements. Average annual total revenue: 2005 - 2014 = $ 950,453; 2010 – 2014 = $ 1,224,784; 2012 – 2014 = $ 938,278

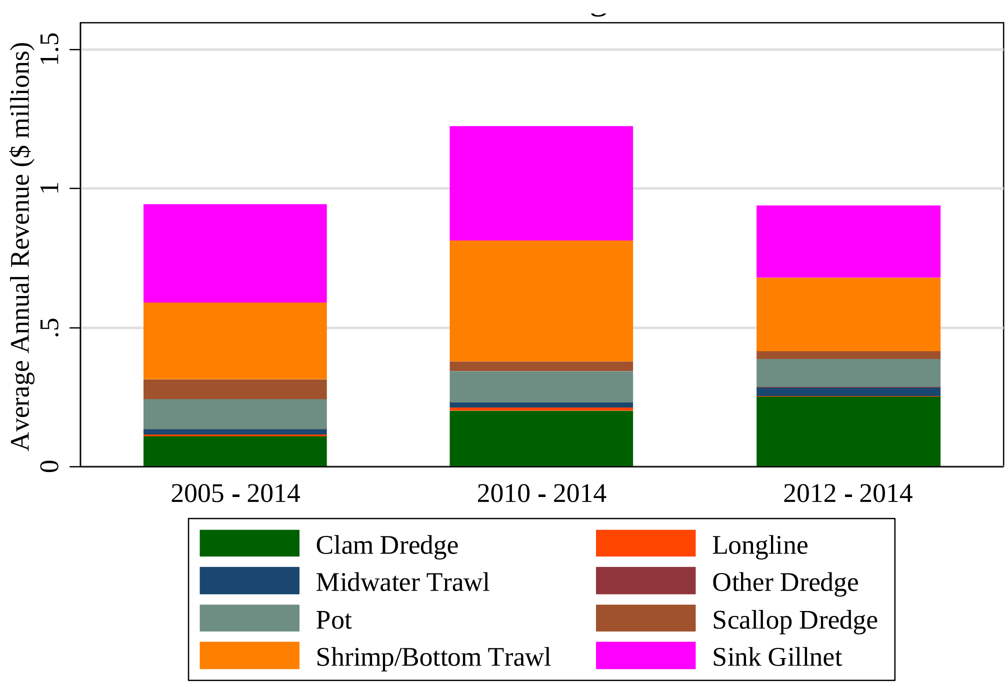


Figure 36 – Great South Channel HMA (Alt 4) average annual revenue by gear, as a percentage of the total average revenue over the time period identified. Average annual total revenue: 2005 - 2014 = $ 13,966,073; 2010 – 2014 = $ 19,922,937; 2012 – 2014 = $ 24,127,177

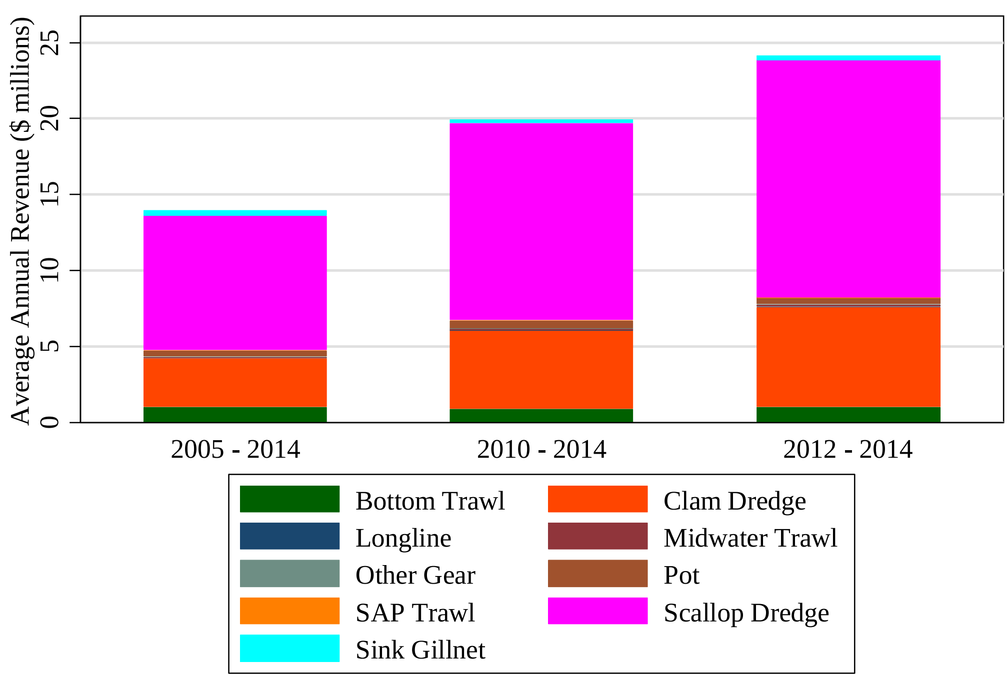


Figure 37 –Nantucket Shoals HMA (Alt 5) average annual revenue by gear, over the time period identified. Average annual total revenue: 2005 - 2014 = $ 9,153,254; 2010 – 2014 = $ 13,414,834; 2012 – 2014 = $ 14,504,619

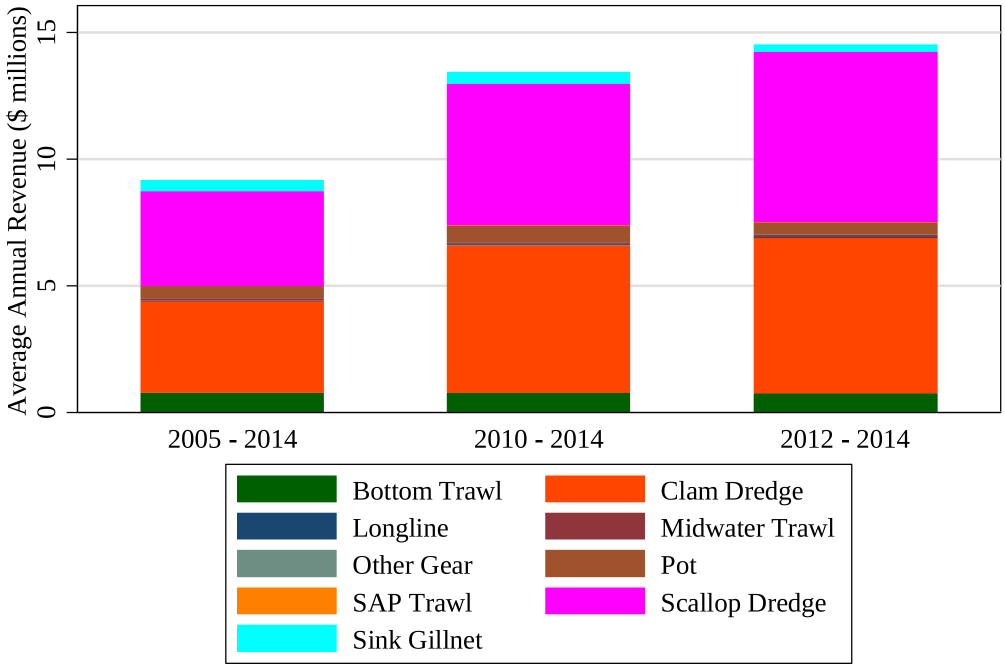


Figure 38 –Nantucket Shoals West HMA (Alt 6) average annual revenue by gear, over the time period identified. Average annual total revenue: 2005 - 2014 = $ 8,866,623; 2010 – 2014 = $ 12,426,407; 2012 – 2014 = $ 15,031,651

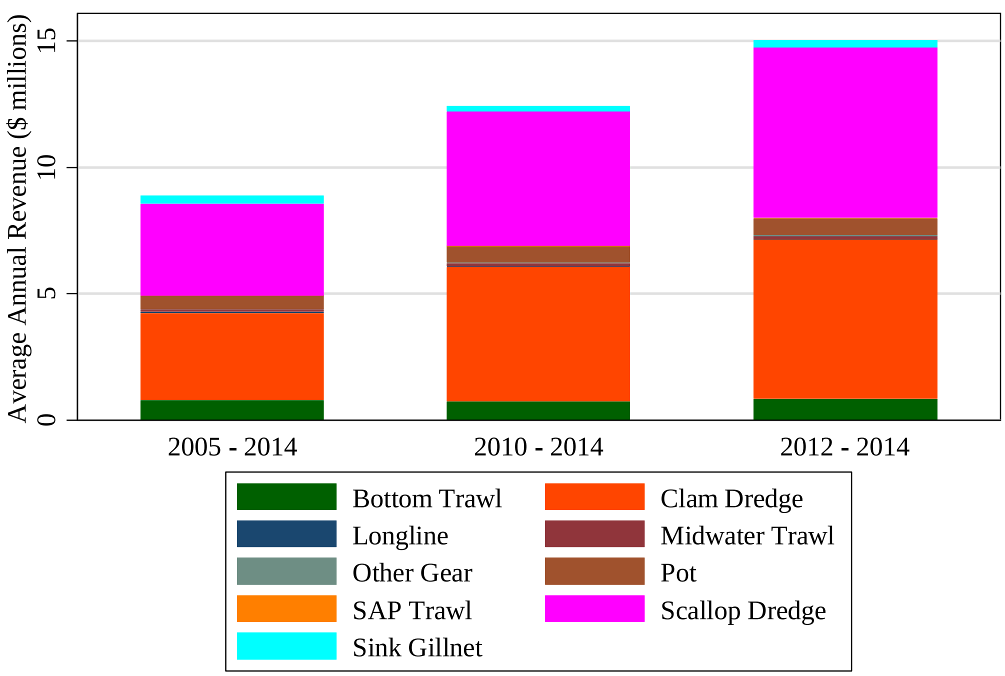


Figure 39 – Great South Channel Gear Modification Area (Alt 6) average annual revenue by gear, over the time period identified. Average annual total revenue: 2005 - 2014 = $ 43,983,976; 2010 – 2014 = $ 65,098,812; 2012 – 2014 = $ 80,207,744

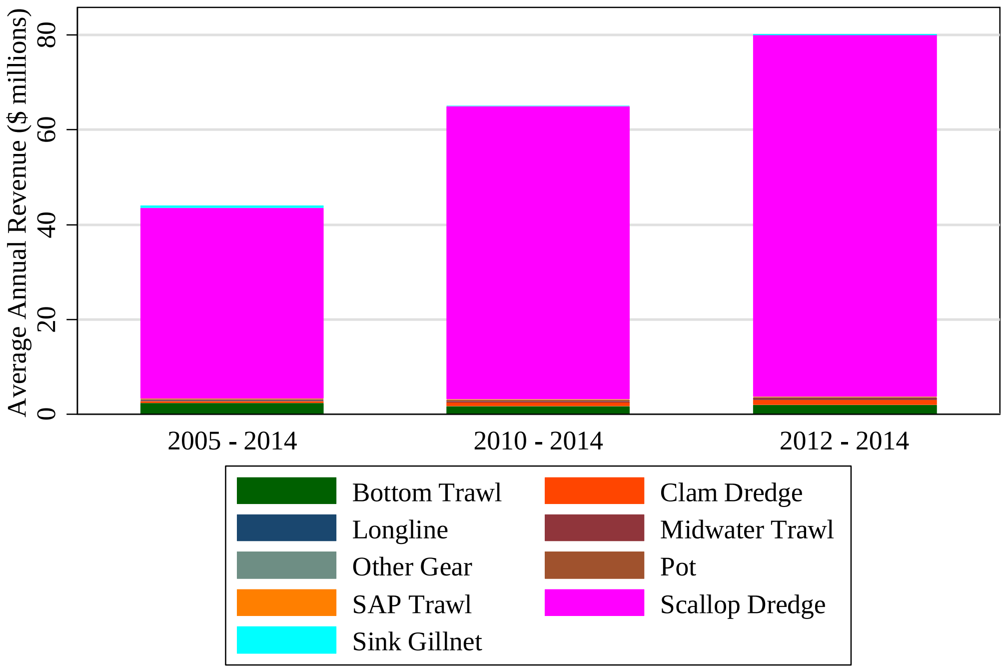


Table 68 – Nantucket Lightship: Average value per haul/set (calendar year 2007 - 2011) within a 10 nautical mile buffer, and percent of total haul revenue this value represents. NEFOP and ASM observer landings data

		Month											
		1	2	3	4	5	6	7	8	9	10	11	12
Bottom Trawl	Total Hauls	93	170	32	142	63	104	23	67	18	9	16	
	Cod	$7	$5	$4	$15	$5	$9	$40	$137	$168	$4	$175	
		1%	0%	0%	1%	1%	1%	9%	26%	24%	1%	52%	
	Haddock	$6	$7	$5	$9	$10	$504	$92	$4	$2	$0	$0	
		1%	1%	0%	1%	1%	49%	21%	1%	0%	0%	0%	
	Yellowtail	$182	$215	$7	$49	$134	$31	$23	$17	$2	$1	$1	
		19%	17%	1%	5%	17%	3%	5%	3%	0%	0%	0%	
	Monkfish	$128	$130	$83	$179	$313	$37	$76	$36	$6	$5	$5	
		14%	11%	8%	18%	40%	4%	17%	7%	1%	1%	2%	
	Winter Skate	$221	$562	$175	$442	$207	$8	$12	$14	$260	$300	$51	
		24%	46%	17%	45%	27%	1%	3%	3%	37%	75%	15%	
	Winter Flounder	$58	$7	$8	$2	$12	$331	$116	$256	$0	$62	$78	
		6%	1%	1%	0%	2%	32%	26%	49%	0%	15%	23%	
	Summer Flounder	$108	$110	$685	$197	$27	$28	$3	$10	$80	$24	$4	
		12%	9%	67%	20%	4%	3%	1%	2%	12%	6%	1%	
	Witch Flounder	$1	$9	$7	$37	$65	$5	$34	$0	$0	$0	$0	
		0%	1%	1%	4%	8%	1%	8%	0%	0%	0%	0%	
	Skate	$38	$101	$50	$45	$1	$0	$0	$0	$167	$0	$3	
		4%	8%	5%	5%	0%	0%	0%	0%	24%	0%	1%	
	Scallop	$186	$82	$3	$3	$0	$4	$0	$1	$0	$0	$0	
		20%	7%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
	Lobster	$1	$1	$0	$0	$2	$29	$44	$39	$2	$3	$18	
		0%	0%	0%	0%	0%	3%	10%	8%	0%	1%	5%	
Fixed Gillnet	Total Hauls	44	71	60	76	156	33						17
	Monkfish	$588	$536	$256	$598	$669	$657						$631

		Month											
		1	2	3	4	5	6	7	8	9	10	11	12
		77%	55%	32%	65%	85%	95%						67%
	Winter Skate	$170	$332	$507	$318	$110	$23						$293
		22%	34%	64%	35%	14%	3%						31%
	Skate	$0	$109	$16	$0	$2	$0						$9
		0%	11%	2%	0%	0%	0%						1%

Table 69 – Mobile bottom-tending gear in currently open portions of the Great South Channel Alternative 3 potentially impacted by the management Options. All variables represent annual estimates. Vessel sizes: S < 50 ft, 50 ft <= M < 70 ft, L >= 70 ft, U = unknown vessel characteristics.

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
Cox Ledge (Alts 3-6)	Clam Dredge	ALL	111,962	86,616	136,581	442,181	984	3	51	2005 - 2014
	Clam Dredge	ALL	201,480	153,413	144,234	442,181	91,732	5	96	2010 - 2014
	Clam Dredge	ALL	254,085	221,219	174,006	442,181	98,855	7	158	2012 - 2014
	Scallop Dredge	L	25,079	21,387	16,058	51,628	1,504	12	90	2005 - 2014
	Scallop Dredge	L	17,551	20,182	9,220	24,487	1,504	12	26	2010 - 2014
	Scallop Dredge	L	15,391	20,182	12,218	24,487	1,504	15	26	2012 - 2014
	Scallop Dredge	M	17,178	10,114	20,618	67,869	11	9	118	2005 - 2014
	Scallop Dredge	M	7,083	2,683	9,825	23,673	11	4	33	2010 - 2014
	Scallop Dredge	M	3,910	2,683	3,916	8,292	754	6	24	2012 - 2014
	Scallop Dredge	S/U	27,650	17,586	33,250	113,251	1,204	14	135	2005 - 2014
	Scallop Dredge	S/U	9,301	9,323	7,473	16,869	1,204	6	52	2010 - 2014
	Scallop Dredge	S/U	9,478	9,323	7,087	16,642	2,470	6	48	2012 - 2014
	Shrimp/Bottom Trawl	L	44,906	46,654	12,205	68,231	27,720	48	470	2005 - 2014
	Shrimp/Bottom Trawl	L	46,258	46,572	6,899	57,101	38,893	50	408	2010 - 2014
	Shrimp/Bottom Trawl	L	48,608	46,736	7,729	57,101	41,987	63	501	2012 - 2014
	Shrimp/Bottom Trawl	M	219,503	136,873	304,230	1,063,016	32,214	49	1,020	2005 - 2014
	Shrimp/Bottom Trawl	M	369,791	196,711	388,647	1,063,016	165,906	48	1,043	2010 - 2014
	Shrimp/Bottom Trawl	M	202,201	196,711	39,328	243,986	165,906	55	1,291	2012 - 2014
	Shrimp/Bottom Trawl	S/U	13,211	6,769	18,874	65,569	4,133	22	288	2005 - 2014
	Shrimp/Bottom Trawl	S/U	21,273	7,877	25,250	65,569	6,460	19	258	2010 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
	Shrimp/Bottom Trawl	S/U	11,013	7,877	6,697	18,703	6,460	23	327	2012 - 2014
Great South Channel East/Extended (Alt 3)	Bottom Trawl	L	1,563,745	1,470,122	827,176	3,279,062	405,329	97	844	1,563,745
	Bottom Trawl	L	1,303,464	1,427,973	373,169	1,624,144	675,446	93	1,041	1,303,464
	Bottom Trawl	L	1,443,201	1,427,973	173,830	1,624,144	1,277,486	97	1,123	1,443,201
	Bottom Trawl	M	175,235	184,483	74,949	314,978	58,429	51	311	175,235
	Bottom Trawl	M	169,122	195,495	62,586	235,919	81,222	46	354	169,122
	Bottom Trawl	M	211,707	203,707	21,367	235,919	195,495	46	407	211,707
	Bottom Trawl	S/U	28,388	23,310	17,801	64,815	12,652	20	237	28,388
	Bottom Trawl	S/U	28,775	18,692	20,720	64,815	15,894	16	205	28,775
	Bottom Trawl	S/U	20,846	18,692	6,311	27,952	15,894	15	200	20,846
	Clam Dredge	ALL	3,224,908	2,210,448	2,613,307	7,429,989	534,663	5	241	2005 - 2014
	Clam Dredge	ALL	5,289,819	5,710,969	2,084,379	7,429,989	2,516,257	10	491	2010 - 2014
	Clam Dredge	ALL	6,701,017	6,962,094	888,751	7,429,989	5,710,969	17	876	2012 - 2014
	SAP Trawl	ALL	50,126	4,970	81,700	220,107	0	12	64	2005 - 2014
	SAP Trawl	ALL	100,252	50,650	93,471	220,107	9,939	12	64	2010 - 2014
	SAP Trawl	ALL	90,152	40,409	113,571	220,107	9,939	8	54	2012 - 2014
	Scallop Dredge	L	15,272,306	11,263,730	13,584,738	42,879,919	1,289,888	170	521	15,272,306
	Scallop Dredge	L	23,579,154	20,100,000	14,324,470	42,879,919	8,655,284	201	603	23,579,154
	Scallop Dredge	L	29,713,495	33,450,478	15,379,287	42,879,919	12,810,088	210	688	29,713,495
	Scallop Dredge	M	1,662,800	1,143,571	1,348,477	4,203,786	239,651	31	342	1,662,800
	Scallop Dredge	M	2,355,133	2,272,598	1,548,677	4,203,786	763,925	28	289	2,355,133
	Scallop Dredge	M	2,860,376	3,613,417	1,839,419	4,203,786	763,925	27	347	2,860,376
	Scallop Dredge	S/U	1,583,350	1,526,144	987,718	3,127,975	204,571	36	886	1,583,350
	Scallop Dredge	S/U	2,085,593	1,760,013	942,466	3,127,975	1,194,299	21	736	2,085,593
	Scallop Dredge	S/U	2,060,088	1,760,013	953,929	3,127,975	1,292,276	23	720	2,060,088
Great South Channel (Alt 4)	Bottom Trawl	L	892,333	863,685	459,937	1,843,042	245,562	94	689	2005 - 2014
	Bottom Trawl	L	749,984	831,580	209,675	904,757	399,283	91	815	2010 - 2014
	Bottom Trawl	L	839,685	895,790	105,037	904,757	718,509	95	889	2012 - 2014
	Bottom Trawl	M	111,536	109,843	51,384	198,527	36,648	43	225	2005 - 2014
	Bottom Trawl	M	116,630	144,533	47,954	156,955	53,029	41	260	2010 - 2014
	Bottom Trawl	M	150,935	151,315	6,219	156,955	144,533	42	310	2012 - 2014
	Bottom Trawl	S/U	7,683	6,288	6,001	18,810	1,938	17	155	2005 - 2014
	Bottom Trawl	S/U	5,516	3,151	4,160	10,640	1,938	14	113	2010 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
	Bottom Trawl	S/U	5,007	2,443	4,885	10,640	1,938	13	103	2012 - 2014
	Clam Dredge	ALL	3,176,465	2,189,882	2,557,691	7,252,632	533,721	5	239	2005 - 2014
	Clam Dredge	ALL	5,199,974	5,653,743	2,032,652	7,252,632	2,504,223	10	488	2010 - 2014
	Clam Dredge	ALL	6,584,604	6,847,438	831,217	7,252,632	5,653,743	17	868	2012 - 2014
	SAP Trawl	ALL	26,411	2,912	42,324	113,735	0	11	55	2005 - 2014
	SAP Trawl	ALL	52,823	29,540	47,818	113,735	5,825	11	55	2010 - 2014
	SAP Trawl	ALL	46,909	21,166	58,379	113,735	5,825	8	43	2012 - 2014
	Scallop Dredge	L	8,002,729	6,071,847	6,307,689	20,012,388	800,514	165	495	2005 - 2014
	Scallop Dredge	L	11,812,050	11,700,000	6,401,746	20,012,388	4,858,787	192	566	2010 - 2014
	Scallop Dredge	L	14,167,154	16,127,123	7,033,115	20,012,388	6,361,951	208	655	2012 - 2014
	Scallop Dredge	M	692,977	466,407	579,221	1,685,922	115,046	29	245	2005 - 2014
	Scallop Dredge	M	1,003,461	1,090,147	662,429	1,685,922	270,928	26	186	2010 - 2014
	Scallop Dredge	M	1,218,743	1,595,360	732,151	1,685,922	374,946	26	214	2012 - 2014
	Scallop Dredge	S/U	168,996	158,847	119,562	358,762	36,888	33	467	2005 - 2014
	Scallop Dredge	S/U	137,525	142,643	83,907	255,195	53,443	18	281	2010 - 2014
	Scallop Dredge	S/U	190,963	175,051	57,939	255,195	142,643	18	275	2012 - 2014
Nantucket Shoals (Alt 5)	Bottom Trawl	L	633,971	587,265	264,801	1,179,726	185,338	94	694	2005 - 2014
	Bottom Trawl	L	603,978	584,302	72,201	726,677	534,485	91	828	2010 - 2014
	Bottom Trawl	L	569,637	584,198	30,591	590,228	534,485	95	878	2012 - 2014
	Bottom Trawl	M	105,990	100,857	41,592	157,206	42,738	44	292	2005 - 2014
	Bottom Trawl	M	133,275	144,569	35,702	157,206	71,013	42	311	2010 - 2014
	Bottom Trawl	M	150,265	155,630	10,687	157,206	137,958	43	354	2012 - 2014
	Bottom Trawl	S/U	18,516	16,098	13,669	51,973	6,824	21	410	2005 - 2014
	Bottom Trawl	S/U	21,976	19,851	17,991	51,973	6,824	18	456	2010 - 2014
	Bottom Trawl	S/U	12,686	9,297	8,106	21,937	6,824	17	377	2012 - 2014
	Clam Dredge	ALL	3,613,113	2,618,179	2,600,480	7,462,844	644,828	5	263	2005 - 2014
	Clam Dredge	ALL	5,802,632	6,302,989	1,657,164	7,462,844	3,066,067	10	544	2010 - 2014
	Clam Dredge	ALL	6,161,416	6,302,989	420,420	6,492,774	5,688,484	17	870	2012 - 2014
	SAP Trawl	ALL	20,337	1,640	33,900	84,396	0	11	53	2005 - 2014
	SAP Trawl	ALL	40,674	19,379	39,392	84,396	3,281	11	53	2010 - 2014
	SAP Trawl	ALL	33,897	14,013	44,062	84,396	3,281	8	39	2012 - 2014
	Scallop Dredge	L	3,306,532	2,628,516	2,753,909	9,044,636	269,546	135	348	2005 - 2014
	Scallop Dredge	L	5,001,315	5,272,270	2,802,078	9,044,636	1,900,083	164	410	2010 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
	Scallop Dredge	L	5,944,741	5,916,525	3,085,883	9,044,636	2,873,064	184	494	2012 - 2014
	Scallop Dredge	M	308,155	249,423	268,665	769,833	48,535	25	178	2005 - 2014
	Scallop Dredge	M	463,113	398,863	298,756	769,833	101,449	22	152	2010 - 2014
	Scallop Dredge	M	605,084	768,586	284,274	769,833	276,834	23	171	2012 - 2014
	Scallop Dredge	S/U	119,291	92,526	83,238	255,234	22,613	31	373	2005 - 2014
	Scallop Dredge	S/U	113,404	86,058	62,425	210,504	63,395	17	236	2010 - 2014
	Scallop Dredge	S/U	145,647	140,379	62,390	210,504	86,058	17	236	2012 - 2014
Great South Channel Gear Mod Area (Alt 6)	Bottom Trawl	L	2,129,153	1,885,682	1,227,459	4,836,469	638,137	96	765	2005 - 2014
	Bottom Trawl	L	1,551,370	1,655,802	460,334	2,100,942	831,890	92	883	2010 - 2014
	Bottom Trawl	L	1,756,386	1,670,421	310,627	2,100,942	1,497,796	93	954	2012 - 2014
	Bottom Trawl	M	137,080	99,407	106,385	339,215	16,297	36	148	2005 - 2014
	Bottom Trawl	M	110,344	94,844	67,658	226,596	57,616	33	164	2010 - 2014
	Bottom Trawl	M	126,352	94,844	88,787	226,596	57,616	36	190	2012 - 2014
	Bottom Trawl	S/U	4,293	2,009	5,006	14,261	163	7	26	2005 - 2014
	Bottom Trawl	S/U	1,367	910	1,750	4,396	163	5	18	2010 - 2014
	Bottom Trawl	S/U	422	192	423	910	163	3	10	2012 - 2014
	SAP Trawl	ALL	80,460	11,300	132,334	372,624	0	13	73	2005 - 2014
	SAP Trawl	ALL	160,921	100,526	152,375	372,624	22,600	13	73	2010 - 2014
	SAP Trawl	ALL	145,808	42,199	196,673	372,624	22,600	9	60	2012 - 2014
Nantucket Shoals West (Alt 6)	Bottom Trawl	L	627,748	624,531	295,870	1,245,328	204,070	98	722	2005 - 2014
	Bottom Trawl	L	554,537	622,661	137,964	626,470	309,470	92	828	2010 - 2014
	Bottom Trawl	L	612,271	622,661	21,380	626,470	587,682	96	892	2012 - 2014
	Bottom Trawl	M	113,608	91,979	51,742	196,526	54,946	47	352	2005 - 2014
	Bottom Trawl	M	137,559	156,064	61,553	196,526	61,953	45	365	2010 - 2014
	Bottom Trawl	M	180,738	189,623	21,645	196,526	156,064	45	403	2012 - 2014
	Bottom Trawl	S/U	30,106	27,970	12,265	47,934	16,506	23	528	2005 - 2014
	Bottom Trawl	S/U	33,200	28,333	11,609	47,934	19,708	20	580	2010 - 2014
	Bottom Trawl	S/U	31,750	27,607	14,562	47,934	19,708	18	529	2012 - 2014
	Clam Dredge	ALL	3,462,377	3,064,663	2,241,511	6,652,201	725,622	5	242	2005 - 2014
	Clam Dredge	ALL	5,326,539	5,853,200	1,399,582	6,652,201	3,674,162	10	490	2010 - 2014
	Clam Dredge	ALL	6,322,307	6,461,520	417,296	6,652,201	5,853,200	17	870	2012 - 2014
	SAP Trawl	ALL	19,845	1,705	32,733	89,188	0	11	51	2005 - 2014
	SAP Trawl	ALL	39,690	20,383	37,766	89,188	3,410	11	51	2010 - 2014

Area	Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
	SAP Trawl	ALL	35,839	14,919	46,558	89,188	3,410	8	39	2012 - 2014
	Scallop Dredge	L	3,180,382	2,660,701	2,689,424	9,126,532	273,143	139	358	2005 - 2014
	Scallop Dredge	L	4,718,331	3,670,374	2,879,868	9,126,532	1,924,669	166	417	2010 - 2014
	Scallop Dredge	L	5,998,870	5,964,589	3,110,663	9,126,532	2,905,490	187	500	2012 - 2014
	Scallop Dredge	M	304,487	250,088	266,539	772,935	48,756	26	178	2005 - 2014
	Scallop Dredge	M	450,922	334,251	304,273	772,935	102,134	22	149	2010 - 2014
	Scallop Dredge	M	606,075	768,695	285,346	772,935	276,595	23	171	2012 - 2014
	Scallop Dredge	S/U	115,899	96,521	88,046	257,792	20,699	31	375	2005 - 2014
	Scallop Dredge	S/U	104,867	92,521	71,977	208,198	20,699	17	234	2010 - 2014
	Scallop Dredge	S/U	146,499	138,779	58,224	208,198	92,521	17	233	2012 - 2014

Table 70 – Fishing Effort (in hours fished), and individuals fishing in areas currently open to fishing within the areas included in the Great South Channel/Southern New England habitat alternatives, estimated from VMS polls using the approach of Records and Demarest (2013). Total Effort and Individuals are the annual average across all years identified, while the remaining statistics are calculated at the individual level. Shrimp Trawl effort is not reported due to data confidentiality requirements.

Area	Gear	Years	Total Effort	Individuals	Mean Effort	Median Effort	SD Effort
Cox Ledge (Alts 3-6)	Bottom Trawl	2005 - 2012	40.57	65.13	0.62	0.06	1.54
	Bottom Trawl	2008 - 2012	40.56	63.80	0.64	0.09	1.56
	Bottom Trawl	2010 - 2012	42.03	65.00	0.65	0.13	1.56
	GC Scallop	2005 - 2012	27.25	12.63	2.16	0.37	4.72
	GC Scallop	2008 - 2012	15.30	10.20	1.50	0.21	2.89
	GC Scallop	2010 - 2012	10.10	4.67	2.16	0.29	3.67
	LA Scallop	2005 - 2012	94.35	53.75	1.76	0.03	6.58
	LA Scallop	2008 - 2012	45.62	34.40	1.33	0.04	4.99
	LA Scallop	2010 - 2012	19.16	28.00	0.68	0.01	3.68
Great South Channel East/Extended (Alt 3)	Bottom Trawl	2005 - 2012	3,802.93	111.63	34.07	0.90	91.14
	Bottom Trawl	2008 - 2012	1,730.40	93.60	18.49	0.88	66.78
	Bottom Trawl	2010 - 2012	1,176.55	80.33	14.65	1.15	45.54
	GC Scallop	2005 - 2012	1,706.94	63.63	26.83	4.07	52.16
	GC Scallop	2008 - 2012	1,470.81	51.80	28.39	1.91	60.91

Area	Gear	Years	Total Effort	Individuals	Mean Effort	Median Effort	SD Effort
	GC Scallop	2010 - 2012	1,776.07	46.00	38.61	2.04	75.55
	LA Scallop	2005 - 2012	13,559.23	283.75	47.79	1.96	101.20
	LA Scallop	2008 - 2012	10,703.60	238.60	44.86	1.19	92.49
	LA Scallop	2010 - 2012	13,548.11	258.33	52.44	1.93	101.09
Great South Channel (Alt 4)	Bottom Trawl	2005 - 2012	1,641.46	105.25	15.60	0.65	49.20
	Bottom Trawl	2008 - 2012	758.79	90.00	8.43	0.62	38.33
	Bottom Trawl	2010 - 2012	349.57	78.00	4.48	0.72	11.64
	GC Scallop	2005 - 2012	80.45	51.25	1.57	0.26	4.36
	GC Scallop	2008 - 2012	57.39	43.00	1.33	0.16	5.07
	GC Scallop	2010 - 2012	53.71	36.33	1.48	0.06	6.83
	LA Scallop	2005 - 2012	2,027.16	271.13	7.48	0.39	29.41
	LA Scallop	2008 - 2012	1,388.10	229.60	6.05	0.33	22.05
	LA Scallop	2010 - 2012	1,401.53	249.00	5.63	0.41	20.12
Nantucket Shoals (Alt 5)	Bottom Trawl	2005 - 2012	666.10	105.00	6.34	0.65	19.27
	Bottom Trawl	2008 - 2012	394.04	90.20	4.37	0.64	14.66
	Bottom Trawl	2010 - 2012	251.70	78.33	3.21	0.71	9.40
	GC Scallop	2005 - 2012	55.58	51.63	1.08	0.15	2.29
	GC Scallop	2008 - 2012	36.84	43.20	0.85	0.07	1.93
	GC Scallop	2010 - 2012	24.22	36.67	0.66	0.02	1.76
	LA Scallop	2005 - 2012	565.24	270.88	2.09	0.25	11.21
	LA Scallop	2008 - 2012	356.67	230.00	1.55	0.19	8.53
	LA Scallop	2010 - 2012	393.38	247.33	1.59	0.23	8.86
Great South Channel Gear Mod Area (Alt 6)*	Bottom Trawl	2005 - 2012	8,869.55	115.38	76.88	2.51	175.30
	Bottom Trawl	2008 - 2012	5,065.59	97.00	52.22	1.21	139.88
	Bottom Trawl	2010 - 2012	2,916.86	84.33	34.59	1.62	95.58
Nantucket Shoals West (Alt 6)	Bottom Trawl	2005 - 2012	693.25	105.50	6.57	0.81	19.25
	Bottom Trawl	2008 - 2012	423.48	91.00	4.65	0.79	14.76
	Bottom Trawl	2010 - 2012	275.85	79.33	3.48	0.90	9.49
	GC Scallop	2005 - 2012	65.37	52.00	1.26	0.22	2.69

Area	Gear	Years	Total Effort	Individuals	Mean Effort	Median Effort	SD Effort
	GC Scallop	2008 - 2012	44.87	43.40	1.03	0.10	2.57
	GC Scallop	2010 - 2012	28.46	36.67	0.78	0.04	2.11
	LA Scallop	2005 - 2012	688.08	275.00	2.50	0.39	11.96
	LA Scallop	2008 - 2012	441.58	234.60	1.88	0.27	9.36
	LA Scallop	2010 - 2012	486.45	252.00	1.93	0.29	9.65

*Because dredge gears would not be regulated in this area, scallop dredge effort estimates are not shown.

Table 71 – Party/charter recreational fishing revenue associated with the areas included in the Great South Channel/Southern New England habitat alternatives. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual Revenue is the mean annual revenue, Individuals represents the average number of permit holders fishing in the area, and Anglers represents to Average number of anglers per year. All other statistics are estimates at the trip level.

Area	Years	Annual Revenue	Individuals	Anglers	Mean Revenue	Median Revenue	SD Revenue
Nantucket Lightship (Alt 1)	2006 - 2014	17,124	3	102	2,569	1,118	2,344
	2010 - 2014	10,544	1	59	4,055	3,912	2,650
	2012 - 2014	-	-	-	-	-	-
CoxLedge (Alts 3-6)	2006 - 2014	95,911	10	887	2,385	2,078	1,783
	2010 - 2014	88,928	9	816	2,257	1,982	1,712
	2012 - 2014	64,696	6	587	2,521	2,142	1,870
Great South Channel East/Extended (Alt 3)	2006 - 2014	65,889	8	373	2,372	1,118	2,498
	2010 - 2014	11,103	4	60	867	931	373
	2012 - 2014	10,246	3	55	878	931	462
Great South Channel (Alt 4)	2006 - 2014	52,979	5	300	2,709	1,118	2,606
	2010 - 2014	8,979	3	48	955	931	366
	2012 - 2014	9,439	2	51	976	1,118	447
NantucketShoals (Alt 5)	2006 - 2014	32,887	6	181	1,444	1,118	1,552
	2010 - 2014	8,458	3	45	961	1,025	192
	2012 - 2014	4,844	2	26	969	1,118	214
Great South Channel Gear Mod Area (Alt 6)	2006 - 2014	77,146	5	428	4,108	5,030	2,957
	2010 - 2014	17,884	3	96	1,720	1,118	1,914
	2012 - 2014	13,599	3	73	1,316	559	1,731
Nantucket Shoals West (Alt 6)	2006 - 2014	48,970	7	267	1,266	931	1,325
	2010 - 2014	23,622	4	127	993	931	635
	2012 - 2014	18,070	3	97	951	1,118	227

Table 72 – Total number of vessels by port of landing or city of registration associated with at least three vessels conducting mobile bottom tending gear trips in 2012 in currently open portions of the Great South Channel/Southern New England Areas potentially impacted by the management alternatives.

Great South Channel/Southern New England		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
State	**Community**	**Port**	**City**	**Port**	**City**	**Port**	**City**	**Port**	**City**
CT		**19**	**11**	**19**	**11**	**19**	**11**	**19**	**11**
	New London	5		5		5		5	
	Stonington	14		14		14		14	
MA		**382**	**237**	**364**	**226**	**337**	**215**	**341**	**216**
	Barnstable	13		13		13		15	
	Boston	18		17		17		18	
	Chatham	13	3	12	3	12	3	12	3
	Chilmark	6		6		6		6	
	Fairhaven	11	34	10	34	10	30	10	3
	Falmouth	4		4		5		5	
	Gloucester	10	15	10	13	27	14	28	14
	Harwich				3		3		
	Harwichport	38		29		6		6	3
	Hyannis	6		6		5		6	
	Mattapoisset			3					
	Nantucket	4		4		10		11	
	New Bedford	281	131	274	128	248	120	254	122
	Peabody		3		3		3		3
	Provincetown	5							
	South Dartmouth		3		3		3		3
	Westport		3		3		3		
	Woods Hole	7		7		6		7	
ME		**5**	**29**	**5**	**27**	**5**	**27**	**5**	**27**
	Portland	5	11	5	11	5	11	5	11
NC		**3**	**34**	**6**	**34**	**6**	**34**	**7**	**35**
	Bayboro		3		3		3		3
	Beaufort	46		4		3		3	
	Hobucken		4		4		4		4
	New Bern		8		8		8		8
	Newport		3		3		3		

Great South Channel/Southern New England		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
State	**Community**	**Port**	**City**	**Port**	**City**	**Port**	**City**	**Port**	**City**
	Oriental		4		4		3		4
	Wanchese		4		4		4		4
NH			**3**		**3**		**3**		**3**
NJ		**7**	**88**	**33**	**86**	**33**	**74**	**36**	**76**
	Barnegat/ Barnegat Light	28	7	7	7	5	4	5	4
	Cape May	9	44	26	44	20	40	21	3
	Cape May Courthouse		8		7		4		41
	Manahawkin		5		5		5		5
	Point Pleasant	19		8		6		7	
NY		**17**	**23**	**19**	**23**	**18**	**23**	**19**	**24**
	Hampton Bays		3		3		3	18	3
	Montauk	16	14	27	14	16	14	16	14
RI		**12**	**59**	**86**	**59**	**84**	**58**	**86**	**59**
	Charlestown		5		5		5		5
	Newport	71		12		10		11	
	North Kingstown		5		5		5		5
	Point Judith/ Narragansett	59	9	71	9	70	9	71	9
	South Kingstown		3		3		3		3
	Wakefield		22		22		21		22
	West Kingston		4		4		4		4
	Westerly		3		3		3		3
VA		**3**	**55**	**58**	**44**	**50**	**35**	**52**	**36**
	Chincoteague	10		3		3		4	
	Gloucester		3		3		3		
	Hampton	25	9	21	9	18	7	18	9
	Newport News	22	11	24	10	20	7	21	7
	Seaford	21	9	10	9	9	8	9	8

Table 73 – Landing port and associated mobile bottom-tending gear revenues in 2012 potentially impacted by the areas included in the Great South Channel/Southern New England Alternatives. Ports with less than 3 vessels each were included in the state totals only. *Changes in revenue for Option 2 only listed for ports with 3 or more vessels affected by Option 2 gear exemption.

Great South Channel/Southern New England

	Alternative	3	3	4	4	5	5	6	6
	Option	1,3,4	2*	1,3,4	2*	1,3,4	2*	1,3,4	2*
State	Port	Total Revenue	Total Revenue	Total Revenue	Total Revenue	Total Revenue	Total Revenue	Total Revenue	Total Revenue
CT	**Total**	**636,902.62**	**636,902.62**	**357,089.62**	**357,089.62**	**154,403.91**	**154,403.91**	**1,477,635.77**	**1,477,635.77**
	NEW LONDON	19,183.65	19,183.65	15,611.45	15,611.45	14,882.74	14,882.74	29,749.33	29,749.33
	STONINGTON	617,718.97	617,718.97	341,478.17	341,478.17	139,521.17	139,521.17	1447,886.44	1,447,886.44
MA	**Total**	**52,870,574.69**	**47,075,645.88**	**28,062,150.93**	**28,062,150.93**	**14,802,230.18**	**89,98,387.84**	**116,762,660.32**	**110,387,142.79**
	BARNSTABLE	40,902.07	40,902.07	10,112.36	10,112.36	13,593.12	13,593.12	65,873.81	65,873.81
	BOSTON	122,347.68	122,347.68	68,521.64	68,521.64	60,149.98	60,149.98	123,145.44	123,145.44
	CHATHAM	1,950,741.68	1,950,741.68	97,881.87	97,881.87	65,297.30	65,297.30	1,366,566.31	1,366,566.31
	CHILMARK	721.05	721.05	687.03	687.03	707.67	707.67	734.64	734.64
	FAIRHAVEN	4,710,293.15	3,485,439.21	2,997,800.08	1,794,812.56	1,903,158.55	688,681.57	7,124,156.10	5,678,720.53
	FALMOUTH	746.63	746.63	714.51	714.51	1,983.33	1,983.33	4,199.00	4,199.00
	GLOUCESTER	200,212.97	200,212.97	81,050.49	81,050.49	54,159.15	54,159.15	499,376.28	499,376.28
	HARWICHPORT	1,515,620.29	1,515,620.29	16,145.52	16,145.52	10,278.20	10,278.20	203,411.63	203,411.63
	HYANNIS	8,357.08	8,357.08	6,670.09	6,670.09	9,917.44	9,917.44	16,290.22	16,290.22
	NANTUCKET	182,374.33	182,374.33	9,581.74	9,581.74	12,691.17	12,691.17	36,522.58	36,522.58
	NEW BEDFORD	42,582,388.02	39,500,216.02	23,278,913.23	20,218,617.26	11,162,449.23	8,061,430.76	105,626,236.38	102,310,490.79
	OTHER BARNSTABLE	1,487,820.15		1,473,548.98		1,487,590.52		1,608,739.24	
	PROVINCETOWN	14,085.88	14,085.88						
	WOODS HOLE	24,896.44	24,896.44	8,652.27	8,652.27	7,509.34	7,509.34	51,375.97	51,375.97
ME	**Total**	**6,866.35**	**6,866.35**	**3,994.39**	**3,994.39**	**4,314.02**	**4,314.02**	**11,473.36**	**11,473.36**
	PORTLAND	6,866.35	6,866.35	3,994.39	3994.39	4,314.02	4,314.02	11,473.36	11,473.36
NC	**Total**	**4,908.27**	**4,908.27**	**4,203.53**	**4203.53**	**2,705.43**	**2,705.43**	**13,525.15**	**13,525.15**
	BEAUFORT	1,971.03	1,971.03	1,649.38	1649.38	819.93	819.93	8,995.88	8,995.88
NJ	**Total**	**501,409.07**	**501,409.07**	**348,304.91**	**348304.91**	**107,942.25**	**107,942.25**	**2,473,429.20**	**2,473,429.20**
	BARNEGAT	100,447.26	100,447.26	78,320.22	78320.22	20,455.38	20,455.38	513,039.24	513,039.24
	CAPE MAY	315,570.64	315,570.64	215,935.20	215935.20	66,903.15	66,903.15	1,624,945.57	1,624,945.57
	POINT PLEASANT	82,997.99	82,997.99	51,656.30	51656.30	18,190.53	18,190.53	333,051.21	333,051.21
NY	**Total**	**46,042.76**	**46,042.76**	**38,284.20**	**38284.20**	**36,080.46**	**36,080.46**	**76,787.39**	**76,787.39**

Great South Channel/Southern New England									
	Alternative	3	3	4	4	5	5	6	6
	Option	1,3,4	2*	1,3,4	2*	1,3,4	2*	1,3,4	2*
State	Port	Total Revenue	Total Revenue	Total Revenue	Total Revenue	Total Revenue	Total Revenue	Total Revenue	Total Revenue
	MONTAUK	45,881.55	45,881.55	38,123.00	38123.00	35,919.25	35,919.25	76,626.18	76,626.18
RI	**Total**	**1,034,312.76**	**1,034,312.76**	**745,835.84**	**745835.84**	**573,331.40**	**573,331.40**	**2,114,869.78**	**2,114,869.78**
	NEWPORT	533,590.09	533,590.09	367,540.95	367540.95	248,596.19	248,596.19	1,206,583.34	1,206,583.34
	POINT JUDITH	492,145.21	492,145.21	369,721.84	369721.84	316,186.55	316,186.55	899,603.70	899,603.70
VA	**Total**	**496,404.51**	**496,404.51**	**389,521.60**	**389521.60**	**82,156.67**	**82,156.67**	**2,432,363.27**	**2,432,363.27**
	CHINCOTEAGUE	700.69	700.69	640.06	640.06	472.34	472.34	1,001.76	1,001.76
	CITY OF SEAFORD	233,041.85	233,041.85	196,726.00	196726.00	45,108.38	45,108.38	703,197.90	703,197.90
	HAMPTON	150,161.09	150,161.09	110,667.98	110667.98	23,924.75	23,924.75	926,964.28	926,964.28
	NEWPORT NEWS	112,500.87	112,500.87	81,487.56	81487.56	12,651.20	12,651.20	801,199.34	801,199.34

Table 74 – Total number of vessels conducting recreational fishing trips in 2012. Vessels are grouped by port of landing or city of registration, provided that location included at least three vessels. Cities/ports with less than three vessels each were included in the state totals only.

		Alternative 1 (Nantucket Lightship)		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
State	Community	Port	City	Port	City	Port	City	Port	City	Port	City
MA	**Total**	**7**	**6**	**5**	**3**	**3**		**7**	**6**	**10**	**8**
NY	**Total**			**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**
	Montauk			3		3		3		3	
RI	**Total**			**5**	**6**	**5**	**6**	**5**	**6**	**5**	**6**
	Point Judith			4		4		4		4	

Table 75 – Sum of 2012 party/charter recreational fishing revenue associated with the Great South Channel/Southern New England Alternatives. Ports with less than 3 vessels each were included in the state totals only.

Alternative		1	3	4	5	6
State	Port	Value	Value	Value	Value	Value

MA	**Total**	**38748.32**	**11,736.27**	**10,059.66**	**35,953.97**	**63,338.60**
NY	**Total**		**4,514.10**	**4,514.10**	**4,514.10**	**4,514.10**
	MONTAUK		4,514.10	4,514.10	4,514.10	4,514.10
RI	**Total**		**55,574.52**	**55,574.52**	**55,574.52**	**55,574.52**
	POINT JUDITH		55,146.20	55,146.20	55,146.20	55,146.20

4.2.5.1 *Alternative 1 (No Action)*

Alternative 1/No Action includes the Nantucket Lightship Habitat Closure Area and the Nantucket Lightship Groundfish Closed Area. Alternative 1 is not preferred. See the Alternative 2 section below for the impacts resulting from no habitat management areas in the Great South Channel/Southern New England sub-region. The expected neutral impact the no action alternative has on seabed habitat suggests that the cumulative economic impact of the current closure is slightly negative to negative both in the short and long run, although there is a high degree of uncertainty in this conclusion. Alternative 1 would result in mainly neutral social impacts as it would maintain the status quo. All other alternatives are compared to No Action in the sections that follow.

4.2.5.2 *Alternative 2 (No Habitat Management Areas)*

Alternative 2 would remove the current Nantucket Lightship Habitat Closure Area and the Nantucket Lightship Groundfish Closed Area, and would not designate any additional habitat management areas in the region. Alternative 2 is not preferred.

Table 68 details the haul level revenue generated from the 10 nautical mile buffer surrounding the Nantucket Lightship groundfish and habitat closures. Monkfish and winter skate represent the dominant species for both bottom trawl and fixed gillnet for the winter and spring months. Bottom trawl also generates substantial revenue from a broad mix of additional species throughout the year. Cod and witch flounder are currently overfished, and overfishing is occurring. The benefits derived for these species are thus likely to be minimal. Framework 50 allows for retention of winter flounder in the Southern New England stock area. Although the analysis of haul level data described above suggests that Nantucket Lightship will generate less benefit from this species when compared to currently open portions of Great South Channel, additional access to this species through Alternative 2 will likely provide a slightly positive benefit to groundfish fishermen. The remaining stocks in Table 68 are not overfished, and overfishing is not occurring. The analyses in Framework 48 indicated that a small positive benefit would be expected from increased access to scallop biomass by bottom trawls, and the skate complex could generate additional benefits to the same individuals but the mechanism for the latter is unclear from the data available. Other species would be expected to provide negligible positive benefits to currently excluded fishermen within Nantucket Lightship. The Scallop PDT has conducted a more extensive analysis of the benefits and costs of area management alternatives for limited access and general category scallop permitted vessels in Great South Channel/Southern New England, including Nantucket Lightship. Currently, there is a major scallop recruitment event occurring within the current Nantucket Lightship Habitat Closure that will have substantial effects on the medium-term benefits (2018 and subsequent fishing years) derived from access to this area (see section 6.2.2.1 of Volume 5). However, assuming that there is a return to long standing patterns of relatively low yield from this area once scallops that are part of the current recruitment event are harvested, the longer-term benefits from Alternative 2 are not expected to be driven by the scallop fishery.

Surfclam and ocean quahog harvesting is currently allowed in the southern portion of the Temporary PSP Closure Area, which would include Nantucket Lightship under Alternative 2. Clam dredges are currently allowed access to the groundfish closures within Nantucket

Lightship, although they are excluded from the habitat closure. The majority of trips within/surrounding Nantucket Lightship are reported on the northern edge of the habitat closure, along Nantucket Shoals, and abut areas currently closed to clam dredging. It is likely that under Alternative 2 some of this effort would displace into areas currently closed to the fishery. However, the extent of this displacement depends on relative catch rates inside versus outside of the Nantucket Lightship Habitat Closure, and is uncertain due to the lack of current effort in the area from which to gauge relative CPUE. Historical reporting (e.g. May 2013 MAFMC Ocean Quahog Information Document, Atlantic Surfclam Information Document) suggests that the waters in and around Nantucket Lightship are relatively productive for both surfclam and ocean quahog, and thus Alternative 2 is likely to provide a slightly positive benefit to the fishery.

Table 71 presents data on party/charter recreational fishing reported within Nantucket Lightship. The data suggests that a small number of recreational businesses fish relatively intensively within the borders of Nantucket Lightship, with each individual generating on the order of $9,400/year in the current closures. This small number of individuals suggests that, although there is potential for increased gear interactions, the impact on the recreational industry is likely to be negative but negligible. Table 73 identifies the communities associated with these trips in 2012. These are all associated with Massachusetts, however due to data confidentiality requirements individual communities are not identified.

Overall, the short-term to medium term impacts of Alternative 2 are expected to be moderately to highly positive, and accrue mainly to the surf clam and ocean quahog and scallop fisheries. In the long run the expected impact is neutral to slightly positive when compared to the status quo, particularly given the slightly negative impact no action has on seabed habitats and the potential that the current closure could be shifting effort onto more susceptible seabed. Any positive benefits accrue mainly to the surfclam and ocean quahog fishery. In the long-term, some negative impacts are expected for the groundfish fishery when compared to the status quo (see Volume 5). However, these negative impacts are potentially outweighed by the positive benefits that would be expected to be generated for the surfclam and ocean quahog fishery. The benefits generated from Alternative 2 are expected to be similar to Alternative 4, larger than Alternatives 3, 5 and 6, and are highly uncertain.

The short-term social impacts of Alternative 2 in comparison to the No Action alternative are expected to be slightly positive as fishermen would gain access to new fishing areas. There are also potential long-term slightly negative social impacts if benefits to fish populations from the current closed areas are lost.

4.2.5.3 *Alternative 3*

Alternative 3 would remove the current Nantucket Lightship Habitat Closure Area and the Nantucket Lightship Groundfish Closed Area, and would designate a new habitat management area to the northeast, i.e. the Great South Channel East HMA. An additional habitat management area would also be designated on Cox Ledge. Alternative 3 is not preferred.

Figure 34 and Figure 35 overview the gear active in the vicinity of Great South Channel East and Cox Ledge. The preponderance of revenue in Great South Channel East is generated by scallop dredge gear, while Cox Ledge has a substantial amount of revenue from both sink gillnet and shrimp/bottom trawl trips. Table 69 provides more details on the mobile bottom-tending gear directly impacted by Alternative 3. In Cox Ledge, the mean impacted revenue per trip for shrimp and bottom trawl vessels between 50 ft and 70 ft, which accounts for 78% of all the trawl revenue in this area, is $157 (2% of an average trip's revenue). This result is likely due at least in part to the fact that Cox Ledge is small enough that it fails to fully encompass shrimp and bottom trawl trips. Additionally, the VTR points suggest that Cox Ledge abuts more productive centers for shrimp and bottom trawl fishing, as opposed to being centers themselves. Mean clam dredge revenue impacted per trip in Cox Ledge is estimated to be $1,608 (8% of an average trip's revenue), with fewer active individuals. This suggests that a small number of individuals are more intensively using the waters around Cox Ledge, although again the small size of these areas likely drives some of the analytical results. Mean scallop dredge revenue per trip is $584 (less than 1% of an average trip's revenue) for vessels > 70 ft, $164 (1% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $496 (13% of an average trip's revenue) for vessels < 50 ft.

The mean scallop dredge revenue from Great South Channel East is estimated to be $43,229 (23% of an average trip's revenue) for vessels > 70 ft, $8,015 (24% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $2,855 (44% of an average trip's revenue) for vessels < 50 ft. Clam dredge is also estimated to be highly active in this area, with a mean per trip revenue impact of $7,650 (89% of an average trip's revenue). Trip revenue from bottom trawls are estimated to be $1,287 (7% of an average trip's revenue) for vessels > 70 ft, $525 (4% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $104 (4% of an average trip's revenue) for vessels < 50 ft, while the revenue for SAP Trawls of all vessel sizes averages $1,669 (10% of an average trip's revenue). The affected revenue represents 13.6% of the scallop dredge, 27.8% of clam dredge, 1.6% of SAP trawl, and 0.8% of bottom trawl average annual revenue reported within VTR and clam logbooks in relevant statistical areas between 2010 and 2012 (see section 4.5 of Volume I for 2012 total VTR revenue estimates and statistical areas of relevance).

Table 70 presents the VMS analysis. Bottom trawl effort is estimated to be minimal within Cox Ledge, and the mean individual effort is just under 40 minutes a year, again lending credence to the assertion that this area is not a center of bottom trawl fishing, although the small size of Cox Ledge again plays a role in the results. Both limited access and general category scallop vessel effort levels that have tapered off over recent history, which is a trend also apparent from the VTR analysis. The limited access and general category effort in Great South Channel East is consistently high, as would be expected given VTR analysis. The impact of Alternative 3 to the scallop industry is discussed in Volume 5, Section 6, which further highlights the large biomass concentration, and high productivity, of scallops within the Great South Channel East area. However, the bottom trawl effort seems to follow a downward trend not witnessed in the VTR analysis, with the 2010 – 2012 annual effort at only 31% of the 2005 – 2012 average. Nevertheless, a substantial amount of bottom trawl effort is still estimated to fall within Great South Channel East.

Table 71 overviews the recreational fishing reported in Cox Ledge and Great South Channel East. Although the revenue reported within Cox Ledge is consistently high across all time periods, the Great South Channel East HMA has seen a decrease of 88% between the 2005 –

2012 and 2010 – 2012 annual revenue, and a decrease of 89% for the number of angler trips. Table 74 identifies the communities associated with these trips in 2012, which are located in Massachusetts, New York, and Rhode Island. Due to confidentiality concerns many individual communities are not identified, however, Montauk, New York is identified as an impacted community, which also has high levels of dependence on recreational fishing (Affected Environment Table, Section 4.6).

Overall, a full exclusion of mobile bottom tending gear, as in Option 1, is expected to impact 94%, or $43,751,594 of the total revenue generated from Great South Channel East and Cox Ledge areas. Scallop dredge in the Great South Channel East area accounts for 74% of this revenue number. Given the discussion in Volume 5, Section 6, it is unlikely that this revenue can be generated from a redistribution of effort to alternate sites, meaning that there will be a highly negative impact to the scallop fishery from Alternative 3. Both the short-term and long-term net impacts of Alternative 3 are thus expected to be highly negative, and concentrated within the scallop fishery. The magnitude of the loss to the scallop fishery is expected to dwarf the expected moderate positive benefits to the groundfish fishery of habitat conservation in this area. Note that in the medium term, high scallop yields are expected to be generated by the existing Nantucket Lightship Habitat Closure Area, which reopens under this alternative (see section 6.2.2.1 of Volume 6). This mitigates negative impacts on that fishery somewhat over that timeframe, but in the longer term there is no particular reason to expect that this large recruitment event would be repeated, and the area has typically produced much lower yields.

Option 2 would exempt $6,955,102 worth of revenue that would otherwise be displaced from the surfclam and ocean quahog fishery. However, when compared to Alternative 1/No Action, both the short run and long run impacts of Option 2 are expected to be highly negative, given the impact on the scallop fishery. The communities of Fairhaven and New Bedford, Massachusetts (at the port of landing level) and Cape May and Manahawkin, New Jersey (at the registered city level) will benefit from hydraulic clam dredge exemptions (Table 72).

As discussed previously both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. What information exists indicates that Option 3 would be expected to decrease CPUE for some species, meaning more effort, and thus a higher cost, would be induced to catch the same quantity of fish. Additionally, fishermen would be faced with the cost of buying new/converting nets to meet the new requirements. However, given the relative value of the fisheries, the exemption to scallop and clam dredges in the area is expected to lead to overall moderately positive impacts from these alternatives for both Options 3 and 4, as compared to no action in both the short and long run. In addition to vessels using hydraulic clam dredges, many vessels in the communities identified in Table 72 use scallop dredges and would also benefit from selection of the gear modification Options (Option 3-4).

The social impacts of Alternative 3 in comparison to Alternative 1/No Action are expected to be moderately negative. Vessels from numerous communities are currently fishing in these areas therefore the negative impacts of these closures would be widespread. Positive social impacts are possible in the long-term, if new closed areas effectively increase fish populations and there are spillover benefits in open areas.

In summary, Alternative 3 is expected to produce outcomes more negative, and more certainly, than commensurate options for all other alternatives being considered for the Great South Channel/Southern New England.

4.2.5.4 *Alternative 4 (preferred)*

Alternative 4 would remove the current Nantucket Lightship Habitat Closure Area and the Nantucket Lightship Groundfish Closed Area, and would designate a new habitat management area further north and east in the Great South Channel. An additional habitat management area would also be designated on Cox Ledge. Alternative 4 is the preferred alternative, with clam dredging allowed in most of the Great South Channel HMA for one year following implementation, except within the northeast corner, and continued exemption in the long term to be determined in a trailing action.

Figure 36 and Figure 35 overview the gear active in the vicinity of Great South Channel and Cox Ledge HMAs. The Great South Channel area is nested within the borders of Great South Channel East area in Alternative 3, and thus the discussion will look to compare the two areas. Similarly to the larger Great South Channel East, revenue associated with Great South Channel HMA is predominantly associated with scallop dredges, although a relatively large proportion is also generated by clam dredge. In Cox Ledge (discussed in detail under Alternative 3), a substantial amount of revenue is generated from both sink gillnet and shrimp/bottom trawl trips. Table 69 provides more details on the mobile bottom-tending gear directly impacted by Alternative 4.

The mean scallop dredge revenue from Great South Channel HMA is estimated to be $21,619 (11% of an average trip's revenue) for vessels > 70 ft, $5,540 (12% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $694 (9% of an average trip's revenue) for vessels < 50 ft. This is respectively 48%, 43%, and 9% of the per-trip revenue for the same vessel categories estimated for Great South Channel East area. Overall, the annual scallop dredge revenue for Great South Channel HMA represents 45% of what is estimated to be derived from Great South Channel East. Nevertheless, the VTR analysis potentially overestimates the revenue generated from vessels employing scallop dredges in Great South Channel. The short and long term scallop yield estimates are much lower for the Great South Channel area as compared to the Great South Channel East area (64-313 median/mean vs. 1,101-4,034 median/mean, or 6-8%; see section 6.2.2.1 of Volume 5). The more spatially refined VMS analysis below sheds additional light on this issue.

Clam dredge is also estimated to be highly active in this area, with a mean per trip revenue impact of $7,583 (89% of an average trip's revenue), with both the per trip and annual revenue representing 98% of that estimated for the larger Great South Channel East area. Impacted trip revenue from bottom trawls are estimated to be $946 (5% of an average trip's revenue) for vessels > 70 ft, $491 (4% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $48 (2% of an average trip's revenue) for vessels < 50 ft, while the revenue for SAP Trawls of all vessel sizes averages $1,083 (6% of an average trip's revenue). For bottom/SAP trawls these revenues are 58%, 71%, 24%, and 52% of the same respective per-trip revenues estimated for Great South Channel East. All told, the bottom/SAP trawl annual revenue encapsulates 59% of the revenue estimated for these gear types in the Great South Channel East HMA. Together, the revenue estimated to be impacted by Alternative 4 represents 5.0% of scallop dredge, 27.5% of clam dredge, 0.3% of SAP trawl, and 0.8% of bottom trawl average annual revenue reported within the VTR and clam logbooks in relevant statistical areas between 2010 and 2012 (see section 4.5 of Volume I for 2012 total VTR revenue estimates and statistical areas of relevance).

Table 70 presents the VMS analysis. As described under Alternative 3, bottom trawl effort is minimal within Cox Ledge, and the area does not appear to be a center of bottom trawl fishing. Both limited access and general category scallop vessels are estimated to have effort levels that have tapered off over recent history, which is a trend also apparent from the VTR analysis. The limited access and general category scallop effort estimated for Great South Channel HMA, respectively at 10% and 3%, is a small fraction of what was estimated for Great South Channel East in Alternative 3. VMS data are likely more representative of the scallop fishing in this area. The Scallop PDT's analyses (Volume 5) indicate that the majority of the scallop biomass in the vicinity does not fall within the bounds of the Great South Channel area being considered within Alternative 4. The bottom trawl effort estimates from VMS align more closely with the VTR estimates, with annual effort estimated to represent 30% of the effort within the encompassing Great South Channel East area. An average individual fishing with bottom trawl is estimated to annually spend 1 hour and 20 minutes within the border of Great South Channel HMA.

Table 71 overviews the recreational fishing reported in Cox Ledge and Great South Channel HMAs. Although the revenue reported within Cox Ledge is consistently high across all time periods, the Great South Channel has seen a decrease of 82% between the 2005 – 2014 and 2012 – 2014 annual revenue, and a decrease of 83% for the number of angler trips. Table 74 identifies the communities associated with these trips in 2012, which are located in Massachusetts, New York, and Rhode Island. Due to northward, as opposed to shifting effort from Great South Channel/Southern New England. This, coupled with the expected clam fishery impacts documented in section 10.2 of Volume 5, suggests that the short-term and long-term economic impacts of Alternative 4 are likely to be highly negative for the clam fishery when compared to Alternative 1/No Action.

Likewise, given the differential seen in historical catches of winter flounder at the haul level presented in the introduction to the Great South Channel/Southern New England section, and the substantial revenue currently generated within the bounds of the Great South Channel area, the net impacts to the bottom trawl fishery are, in the short run, expected to be negative when compared to Alternative 1/No Action. As highlighted in Volume 5 section 2.2.5.4, the impacts of this alternative on groundfish resources as compared to no action are highly uncertain due to a general lack of survey data around Nantucket Shoals, although the habitat seems more susceptible to fishing impacts than the Alternative 1/No Action areas.

Overall, the net short-term impacts are expected to be slightly negative when compared to Alternative 1, and accrue mainly to the bottom/SAP trawl and clam dredge fisheries. In the medium term, high scallop yields are expected to be generated by the existing Nantucket Lightship Habitat Closure Area, which reopens under this alternative (see section 6.2.2.1 of Volume 6). This balances expected negative impacts on other fisheries, but in the longer term there is no particular reason to expect that this large recruitment event would be repeated, and the area has typically produced much lower yields. The long-term net impacts of Alternative 4 are highly uncertain, but expected to be neutral to moderately positive, with a trade-off between the impact on the clam dredge fishery and potential increases in groundfish productivity. The net economic benefits are expected to be on the same order of magnitude as Alternative 2, but larger than Alternatives 3, 5 and 6, with the trade-off being between the clam and groundfish fisheries.

Option 2 is expected to mitigate the impact on the clam dredge fishery, and thus the bulk of the impact on mobile bottom-tending gear. The overall short run net impact is therefore expected to be moderately positive when compared to Alternative 1/No Action. However, Option 2 is also expected to mitigate any long run benefits to the groundfish fishery that might otherwise accrue under Option 1. Thus, the overall long run benefit is expected to be moderately negative to neutral when compared to no action.

As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. What information exists indicates that Option 3 would be expected to decrease CPUE for some species, meaning more effort, and thus a higher cost, would be induced to catch the same quantity of fish. Additionally, fishermen would be faced with the cost of buying new/converting nets to meet the new requirements. Both Option 3 and 4 mitigate the impact on the clam dredge fishery, at the expense of some of the groundfish fishery benefits, for an overall positive short-run impact. Coupled with the expected neutral to moderately negative impacts of these gear restrictions on seabed habitats, this indicates that Options 3 and 4 would be expected to induce a net negative impact as compared to no action in the long run.

The social impacts of Alternative 4 in comparison to the no action alternative are expected to be moderately negative. Vessels from numerous communities are currently fishing in these areas therefore the negative impacts of these closures would be widespread. Many vessels in the communities identified in Table 72 are associated with trips utilizing scallop dredges and would benefit from selection of the gear modification Options (Options 3 and 4). The communities of Fairhaven and New Bedford, Massachusetts (at the port of landing level) and Cape May and Manahawkin, New Jersey (at the registered city level) will benefit from hydraulic clam dredge exemptions. Moderate positive social impacts are possible in the long-term, if new closed areas effectively increase fish populations and there are spillover benefits in open areas.

4.2.5.5 ***Alternative 5***

Alternative 5 would remove the current Nantucket Lightship Habitat Closure Area and the Nantucket Lightship Groundfish Closed Area and would designate a new habitat management area further north on Nantucket Shoals. This Nantucket Shoals HMA overlaps with the areas proposed via Alternatives 3 and 4, but is generally further to the west. Two additional habitat management areas would also be designated on Cox Ledge.

Figure 35 and Figure 37 overview the gear active in the vicinity of Cox Ledge and Nantucket Shoals. Scallop dredge and clam dredge generate the majority of revenue from Nantucket Shoals, while Cox Ledge has a substantial amount of revenue from both sink gillnet and shrimp/bottom trawl trips. Table 69 provides more details on the mobile bottom tending gear directly impacted by the management Options being considered within Alternative 5. Fishing effort in the Cox Ledge HMA is detailed under Alternative 3.

The mean scallop dredge revenue from Nantucket Shoals is estimated to be $12,043 (6% of an average trip's revenue) for vessels > 70 ft, $3,418 (7% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $618 (8% of an average trip's revenue) for vessels < 50 ft. The total scallop dredge revenue estimated to fall within the Nantucket Shoals area is 19% of that of the overlapping Great South Channel East area, and 43% of Great South Channel. Clam dredge is estimated to generate a mean per trip revenue of $7,079 (83% of an average trip's revenue) within Nantucket Shoals, and total revenue is 92% of the Great South Channel East and 94% of the Great South Channel areas. Trip revenue from bottom trawls is estimated to be $648 (3% of an average trip's revenue) for vessels > 70 ft, $429 (3.0% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $34 (2% of an average trip's revenue) for vessels < 50 ft, while the revenue for SAP trawls of all vessel sizes averages $869 (5% of an average trip's revenue). Total combined bottom trawl and SAP trawl revenues are estimated to be 43% of those associated with Great South Channel East, and 74% of that generated from Great South Channel. In total, Alternative 5 is expected to impact 1.8% of scallop dredge, 28.8% of clam dredge, 0.2% of SAP trawl and 0.7% of bottom trawl average annual revenue reported within VTR and clam logbooks in relevant statistical areas between 2010 and 2012 (see section 4.5 of Volume I for 2012 total VTR revenue estimates and statistical areas of relevance).

Table 70 presents the VMS analysis. As noted above, Cox Ledge does not appear to be a center of bottom trawl fishing, and both limited access and general category scallop vessels are estimated to have effort levels that have tapered off over recent history, which is a trend also apparent from the VTR analysis. The limited access scallop effort in Nantucket Shoals is relatively low and is estimated to be 3% of the effort falling within the Great South Channel East, and 28% of that associated with Great South Channel. General category scallop effort is substantially lower, estimated to be 40 minutes per year for the average individual, a level 45% of that estimated for Great South Channel HMA, and 1% of the Great South Channel East HMA. The minimal scallop fishing effort in the Nantucket Shoals HMA is consistent with the scallop PDT analysis (Volume 5). Bottom trawl effort in the Nantucket Shoals HMA is again estimated to be lower than both Great South Channel East and Great South Channel, respectively representing 21% and 72% of the effort associated with the two adjoining areas.

Table 71 overviews the recreational fishing reported in Cox Ledge and Nantucket Shoals. Although the revenue reported within Cox Ledge is consistently high across all time periods, Nantucket Shoals has seen a decrease of 85% between the 2005 – 2014 and 2012 – 2014 annual revenue, and a decrease of 86% for the number of angler trips.

Given the analyses above, a complete exclusion of mobile bottom tending gear, as per Option 1, would be expected to impact the clam fishery most heavily, as this area seems to fall further afield from the centers of groundfish and scallop fishing in the Great South Channel/Southern New England area. In the medium term, high scallop yields are expected to be generated by the existing Nantucket Lightship Habitat Closure Area, which reopens under this alternative (see section 6.2.2.1 of Volume 6). This balances expected negative impacts on other fisheries, but in the longer term there is no particular reason to expect that this large recruitment event would be repeated, and the area has typically produced much lower yields. In the short-term, the impact across all fisheries would be expected to be neutral to slightly negative. The long-term impact on the groundfish fishery is uncertain, but likely slightly positive when compared to No Action given the potential for slightly to moderately positive habitat impacts. Balancing groundfish conservation benefits with negative effects on the clam fishery, overall impacts of this alternative in the long term are expected to be neutral to slightly positive. When compared to some of the other alternatives under consideration, particularly Alternatives 3 and 4, Alternative 5 shifts away from both the most vulnerable habitat in the Great South Channel/Southern New England area and what seems to be higher concentrations of groundfish that would benefit from the conservation measure.

As for Alternative 4, Option 2 is expected to mitigate the impact on the clam dredge fishery, and thus the bulk of the impact on mobile bottom-tending gear. The overall short run net impact is therefore expected to be moderately positive when compared to Alternative 1/No Action. However, Option 2 is also expected to mitigate any long run benefits to the groundfish fishery that might otherwise accrue under Option 1. Thus, the overall long run benefit is expected to be moderately negative to neutral when compared to no action. The impacts are likely to be smaller in magnitude than Alternatives 2 and 4, but larger than 3 and 6.

As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. What information exists indicates that Option 3 would be expected to decrease CPUE for some species, meaning more effort, and thus a higher cost, would be induced to catch the same quantity of fish. Additionally, fishermen would be faced with the cost of buying new/converting nets to meet the new requirements. This, coupled with the expected neutral to negative impact on seabed habitats identified in section 3.2.5.5, indicates that both Option 3 and 4 would be expected to induce a net negative economic impact as compared to No Action in the long-term.

Table 72 identifies the communities associated with these trips in 2012, which are located in Massachusetts, New York, and Rhode Island. Due to confidentiality concerns many individual communities are not identified however Montauk, New York is identified as an impacted community which also has high levels of dependence on recreational fishing (see Table in the Communities section of Volume 1).

The social impacts of Alternative 5 in comparison to Alternative 1/No Action are expected to be moderately negative. Vessels from numerous communities are currently fishing in these areas therefore the negative impacts of these closures would be widespread. Many vessels in the communities identified in Table 72 are associated with trips utilizing scallop dredges and would benefit from selection of the gear modification Options (Options 3 and 4). The communities of Fairhaven and New Bedford, Massachusetts (at the port of landing level) and Cape May and Manahawkin, New Jersey (at the registered city level) would benefit from hydraulic clam dredge exemptions in Option 2. Moderate positive social impacts are possible in the long-term, if new closed areas effectively increase fish populations and there are spillover benefits in open areas.

4.2.5.6 *Alternative 6*

Alternative 6 would remove the current Nantucket Lightship Habitat Closure Area and the Nantucket Lightship Groundfish Closed Area and would designate a new habitat management area further north on Nantucket Shoals (Nantucket Shoals West HMA). An additional area further east in the Great South Channel would be designated as a gear modification area (Great South Channel GMA). Two additional habitat management areas would also be designated on Cox Ledge.

Figure 35, Figure 38, and Figure 39 overview the gears active in the vicinity of Cox Ledge, Nantucket Shoals West, and Great South Channel Gear Modification Area (GMA). Scallop dredge and clam dredge generate the majority of revenue from Nantucket Shoals West, scallop dredge revenue dwarfs the revenue generated from all other gears within the Great South Channel GMA area, and Cox Ledge has a substantial amount of revenue from both sink gillnet and shrimp/bottom trawl trips. Table 69 provides more details on the mobile bottom-tending gear directly impacted by Alternative 6. Revenues in Cox Ledge are described under Alternative 3.

The mean scallop dredge revenue from Nantucket Shoals West is estimated to be $12,017 (6% of an average trip's revenue) for vessels > 70 ft, $3,417 (7% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $629 (9% of an average trip's revenue) for vessels < 50 ft. The total scallop dredge revenue estimated to fall within the Nantucket Shoals West area is 100% of the scallop dredge revenue within Nantucket Shoals, 19% of that of the adjoining Great South Channel East area, and 43% of Great South Channel. Clam dredge is estimated to generate a mean per trip revenue of $7,264 (85% of an average trip's revenue) within Nantucket Shoals West, and total revenue is 3% higher than Nantucket Shoals, 94% of the the Great South Channel East and 96% of the Great South Channel areas. Impacted per-trip revenue from bottom trawls is estimated to be $686 (4% of an average trip's revenue) for vessels > 70 ft, $453 (4% of an average trip's revenue) for vessels between 50 ft and 70 ft, and $60 (3% of an average trip's revenue) for vessels < 50 ft, while the revenue for SAP trawls of all vessel sizes averages $919 (5% of an average trip's revenue). Total combined bottom trawl and SAP trawl revenues are estimated to be 12% higher than Nantucket Shoals, 49% of Great South Channel East, and 83% of Great South Channel. The impacted revenue within the boundaries of the Nantucket Shoals West and Cox Ledge HMAs represents 0.8% of bottom trawl, 31.2% of clam dredge, 0.6% of SAP trawl, and 2.5% of scallop dredge average annual revenue within the VTR and clam logbooks in relevant statistical areas between 2010 and 2012 (see section 4.5 of Volume I for 2012 total VTR revenue estimates and statistical areas of relevance).

The Great South Channel GMA also generates a substantial amount of bottom and SAP trawl revenue. The mean per-trip bottom trawl revenue estimated to fall within the GMA is $1,843 (9% of an average trip's revenue) for vessels > 70 ft, $668 (4% of an average trip's revenue) for vessels between 50 ft and 70 ft, and$42 (less than 1% of an average trip's revenue) for vessels < 50 ft, while the revenue for SAP Trawls of all vessel sizes averages $2,444 (14% of an average trip's revenue). Both the number of individuals and trips estimated to be affected by any gear modifications are relatively high. The impacted revenue within the boundaries of the Greast South Channel GMA represents 1.2% of bottom trawl revenue and 2.6% of SAP trawl revenue reported within VTR in relevant statistical areas between 2010 and 2012 (see section 4.5 of Volume I for 2012 total VTR revenue estimates and statistical areas of relevance).

Table 70 presents the VMS analysis. As noted above, Cox Ledge does not appear to be a center of bottom trawl fishing, and both limited access and general category scallop vessels are estimated to have effort levels that have tapered off over recent history, which is a trend also apparent from the VTR analysis. The limited access scallop effort in Nantucket Shoals West is relatively low, and is estimated to be 4% of the effort falling within the Great South Channel East, 45% of that associated with Great South Channel, and 124% of Nantucket Shoals. General category scallop effort is substantially lower, estimated to be 47 minutes per year for the average individual, a level 1% of the Great South Channel East level, 53% of that estimated for Great South Channel, and 118% of Nantucket Shoals. The minimal scallop fishing effort in the Nantucket Shoals HMA is consistent with the scallop PDT analysis (Volume 5). Bottom trawl effort is estimated to be lower than both Great South Channel East and Great South Channel, respectively representing 23% and 79% of the effort associated with these two areas, although it is 110% of Nantucket Shoals because the Nantucket Shoals west area is overlapping and slightly larger. It is unclear what is driving the difference between the VMS and VTR analysis, with the VTR suggesting that Nantucket Shoals West generates higher bottom/SAP trawl revenue than Great South Channel, and the VMS analysis suggesting that effort is lower in Nantucket Shoals West than Great South Channel. However, it is possible that some of the effort accounted for in the VTR is not in the VMS analysis due to the fact that VMS is not required on all vessels.

The VMS analysis indicates a substantial amount of effort associated with bottom trawls in the Great South Channel GMA, in terms of number of individuals and annual time, although the 2010 – 2012 annual effort estimate is only 33% of the 2005 – 2012 average suggesting a downward trend.

Table 71 overviews the recreational fishing reported in Cox Ledge, Nantucket Shoals West, and Great South Channel GMA areas. Although the revenue reported within Cox Ledge is consistently high across all time periods, both Nantucket Shoals West and Great South Channel GMA have respectively seen decreases of 63% and 82% between the 2005 – 2014 and 2012 –

2014 annual revenue, and a decrease of 64% and 83% for the number of angler trips, which is consistent with the other management alternatives in the area.

Option 1, which would potentially apply a mobile bottom tending gear closure to the Nantucket Shoals West and Cox Ledge areas, would be expected to have the largest impact on the clam dredge and bottom trawl fisheries. In the medium term, high scallop yields are expected to be generated by the existing Nantucket Lightship Habitat Closure Area, which reopens under this alternative (see section 6.2.2.1 of Volume 6). This balances expected negative impacts on other fisheries, but in the longer term there is no particular reason to expect that this large recruitment event would be repeated, and the area has typically produced much lower yields. Given the expected impacts on habitat most susceptible to fishing and groundfish stocks (see EFH impacts section in this volume, and groundfish impacts in Volume 5), Alternative 6 is expected to generate slightly negative impacts in the short run and moderately negative long run when compared to Alternative 1/No Action. These negative impacts accrue mainly to the clam dredge and bottom trawl fisheries. The negative impacts are expected to be larger than commensurate Options in all other Alternatives under consideration for Great South Channel/Southern New England, except for Alternative 3.

Alternatively, Option 2 could be applied to the Nantucket Shoals West and Cox Ledge areas and exempt hydraulic clam dredges from the closure. This is expected to mitigate the impacts on the clam dredge fishery, resulting in moderately positive impacts in the short-run, although the long-run impacts are still expected to be moderately negative given the expected additional impacts on habitat and groundfish stocks, and the costs to the trawl fishery associated with the gear modification area.

If this alternative is selected, the Great South Channel Gear Modification Area would be implemented with either Option 3 or Option 4. As discussed previously, both the costs borne by trawl fishermen and the habitat conservation benefits of gear restrictions defined in Options 3 and 4 are highly uncertain. What information exists indicates that Option 3 would be expected to decrease catch per unit effort for some species, meaning more effort, and thus a higher cost, would be induced to catch the same quantity of fish. Additionally, fishermen would be faced with the cost of buying new/converting nets to meet the new requirements. This, coupled with the expected neutral to negative impact on seabed habitats identified in this volume, indicates that if Option 3 or 4 is applied in the Great South Channel Gear Modification Area, they would be expected to induce a net negative impact as compared to Alternative 1/No Action.

Table 72 identifies the communities associated with these trips in 2012, which are located in Massachusetts, New York, and Rhode Island. Due to confidentiality concerns many individual communities are not identified however Montauk, New York is identified as an impacted community which also has high levels of dependence on recreational fishing (see table in Communities section of Volume 1). The social impacts of Alternative 6 in comparison to the No Action alternative are expected to be moderately negative. Vessels from numerous communities are currently fishing in these areas therefore the negative impacts of these closures would be widespread.

4.3 Spawning management alternatives

4.3.1 Gulf of Maine

Tables and figures related to analysis of the social and economic impacts of the Gulf of Maine spawning management alternatives are provided below. Discussion of impacts is provided under a separate heading for each alternative.

Note that Alternatives 3 (Massachusetts Bay Cod Spawning Protection Area) and 4 (Block 125 during the second half of April) are not considered as standalone alternatives, but rather are intended to be implemented in combination with the regulatory no action alternative, 1A. The analysis below considers the additional benefits of these measures relative to implementing either 1A or 1B on their own.

Figure 40 – Massachusetts Bay Groundfish Spawning Area average annual revenue by gear, Nov. 1 – Jan 31 within each year range given. Note that two gear types are not reported for data confidentiality requirements. Average annual total revenue: 2005 - 2014 = $ 816,663; 2010 – 2014 = $ 1,092,965; 2012 – 2014 = $ 1,416,966

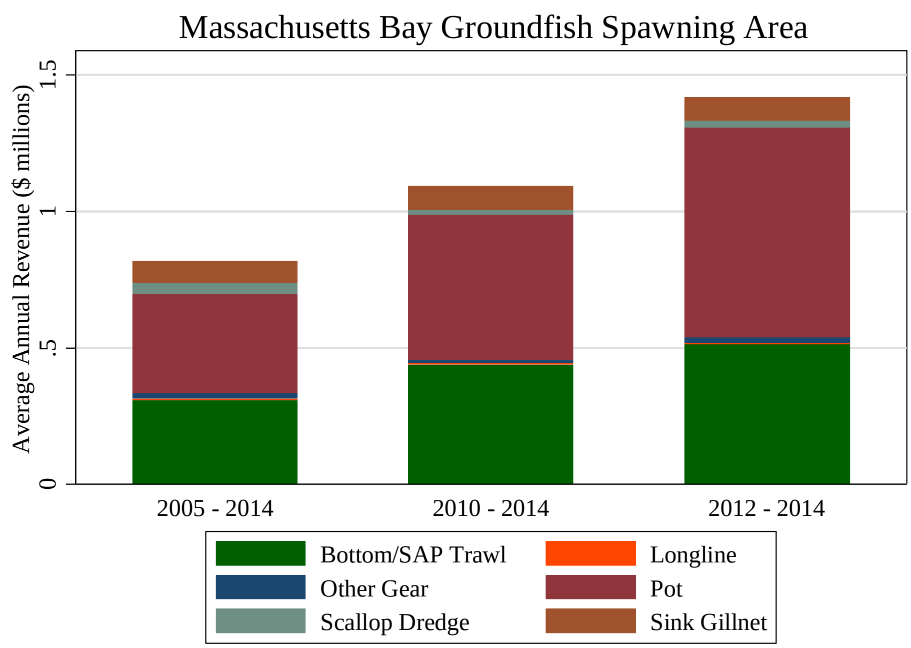


Figure 41 – Average recreational revenue generated within the Massachusetts Bay Spawning Area during Nov. 1 – Jan 31, delineated by whether or not groundfish were caught on a trip.

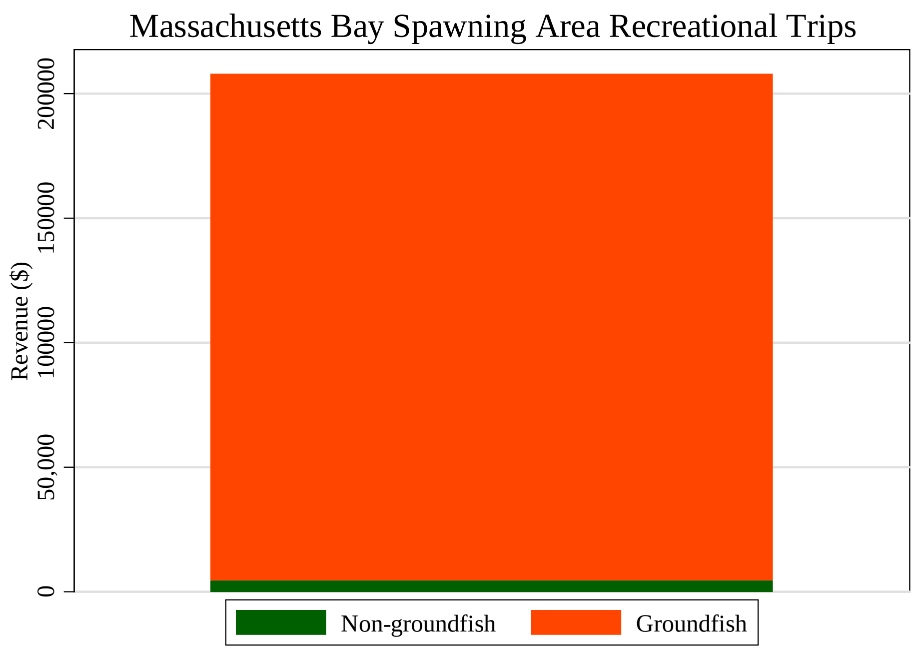


Figure 42 – Recreational revenue estimated to have been generated by trips reported within the GOM Spawning Alternative 2 areas, with groups representing blocks of 5 permits, ranked by the revenue estimated to fall within the areas. Note: Groups do not necessarily consist of the same individuals across years.

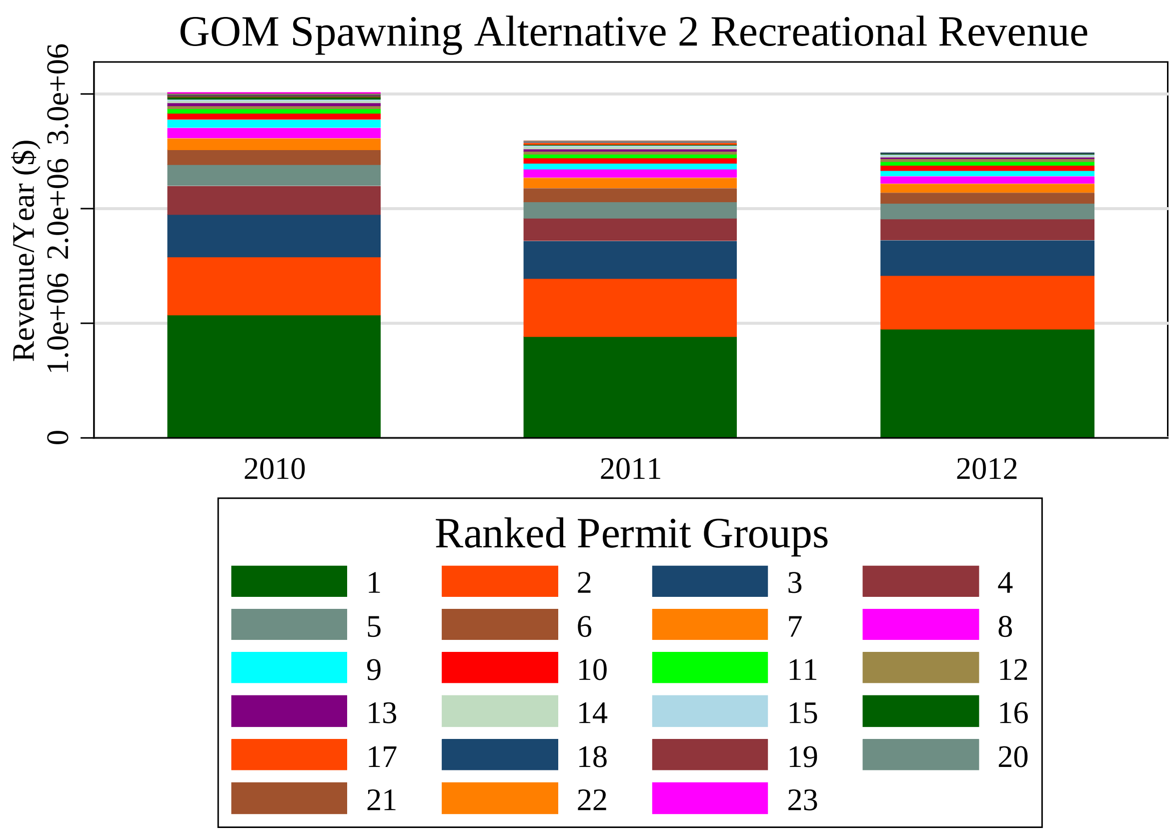


Figure 43 – Percent, averaged across permits, of each ranked group's total revenue (including commercial revenue) estimated to have been generated by recreational trips within the areas of GOM Spawning Alternative 2 during the relevant time periods.

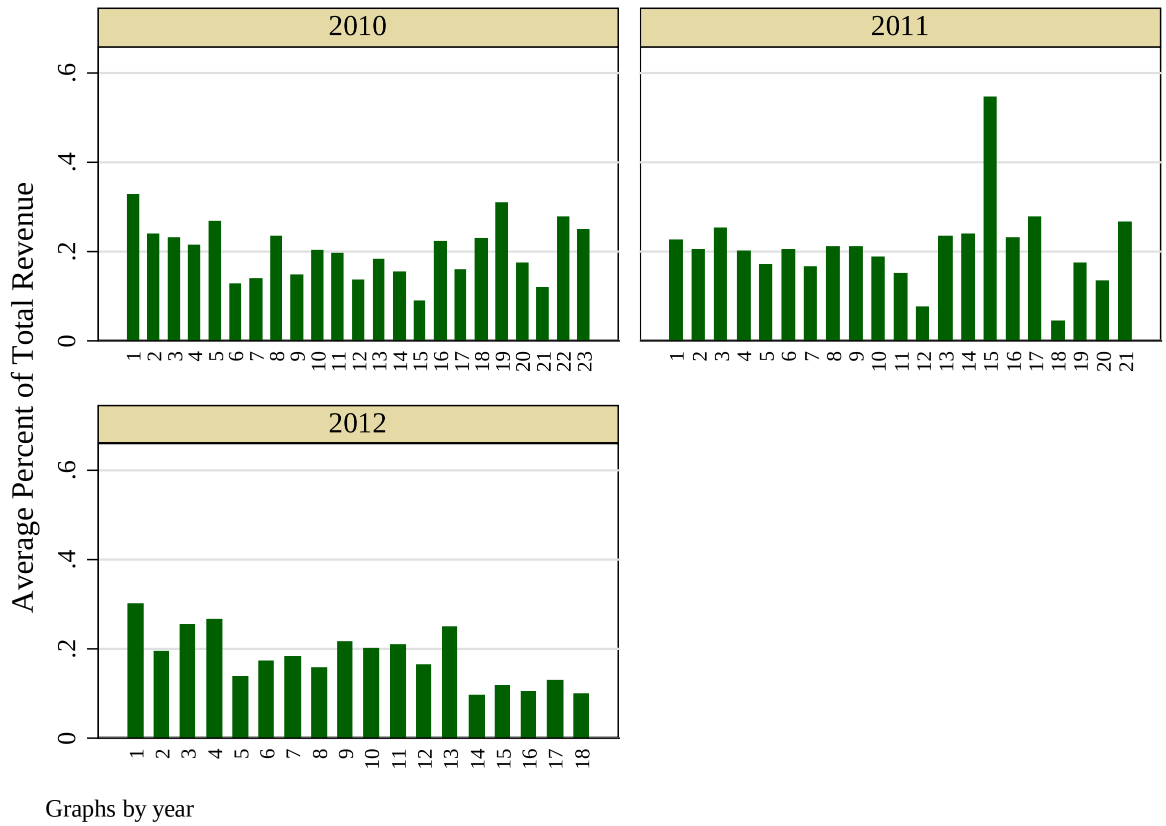


Table 76 – Revenue in currently open portions of the Massachusetts Bay Spawning Area (Alternatives 2 and 3) potentially impacted by the management Options during November 1 - January 31. All variables represent annual estimates. Vessel sizes: S < 50 ft, 50 ft <= M < 70 ft, L >= 70 ft, U = unknown vessel characteristics

Gear	Vessel Size	Mean Revenue	Median Revenue	SD Revenue	Max Revenue	Min Revenue	Individuals	Trips	Years
Bottom/SAP Trawl	L/U	31,424	18,544	32,734	99,572	5,023	29	120	2005 - 2014
Bottom/SAP Trawl	L/U	40,555	23,065	37,914	99,572	5,432	31	143	2010 - 2014
Bottom/SAP Trawl	L/U	26,713	18,553	26,326	56,153	5,432	36	156	2012 - 2014
Bottom/SAP Trawl	M	103,551	91,193	63,894	221,715	24,379	33	268	2005 - 2014
Bottom/SAP Trawl	M	108,849	107,705	85,992	221,715	24,379	22	164	2010 - 2014
Bottom/SAP Trawl	M	71,609	26,915	79,618	163,533	24,379	22	160	2012 - 2014
Bottom/SAP Trawl	S	79,928	69,761	64,039	241,578	16,617	32	380	2005 - 2014
Bottom/SAP Trawl	S	104,704	76,757	85,485	241,578	16,617	22	233	2010 - 2014
Bottom/SAP Trawl	S	107,666	64,802	118,448	241,578	16,617	23	259	2012 - 2014
Longline	ALL	4,986	3,344	6,695	23,230	91	13	70	4,986
Longline	ALL	1,541	1,779	1,195	3,060	91	7	24	1,541
Longline	ALL	956	613	1,078	2,163	91	6	19	956
Scallop Dredge	L	27,578	-	84,986	269,386	-	1	2	2005 - 2014
Scallop Dredge	L	1,279	-	2,860	6,396	-	1	1	2010 - 2014
Scallop Dredge	L	2,132	-	3,693	6,396	-	1	1	2012 - 2014
Scallop Dredge	OTHER	6,419	1,102	15,864	51,328	83	5	11	2005 - 2014
Scallop Dredge	OTHER	1,965	1,596	2,226	5,734	83	4	10	2010 - 2014
Scallop Dredge	OTHER	3,056	1,838	2,322	5,734	1,596	5	11	2012 - 2014
Sink Gillnet	ALL	62,610	63,145	43,710	144,568	16	27	417	2005 - 2014
Sink Gillnet	ALL	52,750	41,906	58,493	144,568	16	15	188	2010 - 2014
Sink Gillnet	ALL	25,759	7,340	38,420	69,920	16	13	170	2012 - 2014

Table 77 – Recreational fishing revenue associated with the GOM Spawning Alternative 2 areas in the relevant time frames being considered for closure. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual revenue is the mean annual revenue, individuals represents the average number of permit holders fishing in the area, and anglers represents the average number of anglers per year. All other statistics are estimates at the trip level.

Area	Years	Annual Revenue	Individuals	Anglers	Mean Revenue	Median Revenue	SD Revenue
MassBay	2006 - 2014	266,115	7	1,429	6,404	5,775	3,903
	2010 - 2014	316,618	6	1,700	6,943	6,706	3,731
	2012 - 2014	268,816	5	1,443	6,893	6,706	3,802
April Rolling	2006 - 2012	839,805	53	5,985	2,524	1,118	2,424
	2008 - 2012	579,920	40	4,203	2,335	1,118	2,208
	2010 - 2012	263,194	19	1,893	2,302	1,118	2,248
May Rolling	2006 - 2012	924,514	47	8,072	2,314	1,790	1,958
	2008 - 2012	798,720	35	6,833	2,393	1,790	2,050
	2010 - 2012	394,849	19	3,444	2,089	1,342	1,843
June Rolling	2006 - 2012	152,493	18	1,103	1,507	895	1,181
	2008 - 2012	109,597	13	803	1,566	1,023	1,125
	2010 - 2012	52,974	6	376	1,528	1,044	1,015

Table 78 – Total number of vessels by port of landing or city of registration associated with at least three vessels conducting trips capable of catching groundfish in 2012 in currently open portions of the Gulf of Maine potentially impacted by the Massachusetts Bay Spawning Area.

State	Community	Port	City
MA		**124**	**99**
	Boston	13	
	Gloucester	70	37
	Manchester		3
	Marshfield	8	3
	New Bedford	19	19
	Plymouth	3	
	Provincetown	4	
	Sandwich	3	
	Scituate	7	7
	Swampscott		3
ME		**3**	**20**
	Portland	3	9
NH		**3**	**4**

Table 79 – Landing port and associated revenues for gear capable of catching groundfish in 2012 in currently open portions of the Gulf of Maine potentially impacted by the Massachusetts Bay Spawning Area. Ports with less than 3 vessels each were included in the state totals only.

State/port	Total revenue
MA total	565,567.10
BOSTON	82,742.82
GLOUCESTER	147,627.10
MARSHFIELD	7,507.21
NEW BEDFORD	18,206.15
PLYMOUTH	46,495.47
PROVINCETOWN	8,706.05
SANDWICH	919.21
SCITUATE	251,750.30
ME total	1,120.66
PORTLAND	1,008.85
NH total	65.63

Table 80 – Total number of permits by port of landing or city of registration associated with at least three permits conducting recreational fishing trips associated with the GOM Spawning Alternative 2 in the relevant time frames being considered for closure.

State	Community	Port	City
MA		**55**	**54**
	Gloucester	9	9
	Marshfield	5	5
	Newburyport	8	8
	Plymouth	4	4
	Rockport	3	3
ME		**11**	**11**
NH		**24**	**25**
	Hampton	5	5

State	Community	Port	City
	Hampton Falls	3	3
	Rye	6	6

4.3.1.1 *Alternative 1A (Regulatory No Action, preferred)*

The regulatory no action alternative considers the spawning protection impacts of (1) the Western Gulf of Maine Closure Area and the Cashes Ledge Closure Area, (2) the Gulf of Maine Cod Protection Closures, which are similar to the long-standing rolling closures, and (3) the Gulf of Maine Cod Spawning Protection Area, also known as the Whaleback area.

To the extent that spawning aggregations increase CPUE and are encompassed within these closed areas, the ongoing cost of the Cod Protection Closures to fishermen are expected to be substantial. In addition, the close proximity of the rolling closures to shore means that many of the impacted fishermen face additional steaming costs in order to reach areas of the ocean open to fishing. Nevertheless, given the expected impact of Alternative 1/No Action on groundfish habitat and productivity, the expected ongoing impact on the fisheries managed is moderately positive.

The social impacts associated with Alternative 1A are expected to be neutral as it would maintain the status quo. There may be some negative impacts on the *Attitudes, Beliefs, and Values* of members of the groundfish fishery related to the lack of flexibility of management as this would maintain current mortality closures, which are seen by some as no longer needed due to output controls in the fishery.

4.3.1.2 *Alternative 1B (Baseline No Action)*

The baseline no action alternative considers the spawning protection impacts of (1) the Western Gulf of Maine Closure Area and the Cashes Ledge Closure Area, (2) the Gulf of Maine Rolling Closures Areas that apply to sector and common pool vessels, and (3) the Gulf of Maine Cod Spawning Protection Area, also known as the Whaleback area.

To the extent that spawning aggregations increase CPUE, the ongoing cost of the former rolling closures to fishermen are expected to be substantial. In addition, the close proximity of the rolling closures to shore means that many of the impacted fishermen face additional steaming costs in order to reach areas of the ocean open to fishing. Nevertheless, given the expected impact of Alternative 1/No Action on groundfish habitat and productivity, the expected ongoing impact on the fisheries managed is moderately positive.

The social impacts associated with Alternative 1B are expected to be neutral to slightly negative as it would revert to a set of rolling closures that are longstanding but were changed via a recent groundfish framework developed by the Council (Northeast Multispecies Framework 53). There may be some negative impacts on the *Attitudes, Beliefs, and Values* of members of the groundfish fishery related to the lack of flexibility of management as this would maintain current mortality closures, which are seen by some as no longer needed due to output controls in the fishery.

4.3.1.3 *Alternatives 2A and 2B*

Alternatives 2A and 2B would remove the common pool rolling closure areas, while maintaining the sector rolling closures (and applying them to all vessels with gear capable of catching groundfish) and adding a spawning area in Massachusetts Bay during the fall/winter. Option B would extend spawning area restrictions to recreational vessels.

Options A and B are equivalent in their impact on commercial fishing. The gear currently employed within the bounds of the Massachusetts Bay Spawning Protection Area during the proposed November 1 to January 31 closure period is illustrated in Figure 40. Of particular interest for this alternative is the large portion of the revenue generated by bottom/SAP trawls and sink gillnet. Table 76 provides more detail about the fishing revenue being generated by these gears. For bottom/SAP trawls, a mean per-trip revenue of $171 (1% of an average trip's revenue) is estimated to fall within the area closure for the > 70 ft vessel category, for vessels between 50 ft and 70 ft the mean per-trip revenue potentially displaced is estimated to be $448 (6% of an average trip's revenue), and for vessels < 50 ft it is $416 (16% of an average trip's revenue). Vessels between 50 ft and 70 ft represent 52% of the total bottom trawl revenue estimated for the Massachusetts Bay Spawning Protection Area. The area is estimated to produce a per-trip revenue of $151 (9% of an average trip's revenue) for vessels fishing with sink gillnets, with a relatively large number of trips estimated to have fished in the area. Less fishing is conducted using longline, which has a mean per-trip impact of $49 (5% of an average trip's revenue), and scallop dredges, for which the < 70 ft vessels average per-trip impact is estimated to be $286 (9 of an average trip's revenue) and the > 70 ft vessels recently producing $2,132 (1% of an average trip's revenue) in the area. Overall, the impact represents 0.3% of bottom/SAP trawl, 0.3% of sink gillnet, 0.03% of longline, and 0.00% of scallop average annual revenue generated from relevant statistical areas between 2010 and 2012 (see section 4.5 of Volume 1 for relevant statistical areas and magnitude of total revenue).

The April – June rolling closures in Alternative 2 are a subset of the current common pool rolling closures. Alternative 2 is thus expected to have a slightly net positive impact on common pool vessels in the short run when compared to Alternative 1/No Action, by increasing their flexibility in fishing location choice. Because these rolling closures already apply to sector vessels (i.e., the majority of groundfish vessels), neutral impacts are expected when compared to Alternative 1/No Action.

Additional year-round habitat closures are being considered for both the central and western Gulf of Maine, which could drastically change the overall impact analyses of this alternative for mobile bottom-tending gear vessels. Nevertheless, as written Alternative 2 would have short-term moderately positive benefits to commercial fishermen, as it would provide access to the current Western Gulf of Maine and Cashes Ledge Closure Areas. However, the long-term impacts are expected to be moderately negative, due to the negative impact on groundfish stocks.

When coupled with the preferred habitat alternatives in the western (Alternative 1, Alternative 7A) and central (Alternative 4) Gulf of Maine, the impacts of Alternative 2A are expected to be neutral to slightly positive in the short-term, when compared to Alternative 1/No Action, with a trade-off between additional flexibility of where and when to fish in the central Gulf of Maine, and the negative impact of the Massachusetts Bay Spawning Protection Area on commercial groundfish fishermen. Conversely the long-term impacts are expected to be neutral to slightly negative, again given the trade-off between decreased long-term benefits in the central Gulf of Maine and increases in groundfish productivity due to the Massachusetts Bay Spawning Protection Area. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the sort-term slightly positive impacts, and long-term slightly negative impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

Alternative 2B may impact recreational groundfish fishing when compared to Alternative 1/No Action (Table 77). The average annual revenue is consistently high, with a small number of permits consistently active in these areas. The five permits with the highest revenue estimated to fall within the Alternative 2 areas in the relevant months account for 36%, 34%, and 38% of the total revenue estimates in 2010, 2011, and 2012 respectively (Table 77). Figure 40 indicates that the vast majority of the revenue generated within the Massachusetts Bay Spawning Protection Area is generated on trips that land groundfish. The existing Gulf of Maine Cod Spawning Protection (Whaleback) Area is expected to have a neutral impact as compared to Alternative 1/No Action, given that the management regime does not change between the two alternatives.

The following discussion assumes a positive correlation between the percentage of revenue a management action affects, and the costs of compliance for an individual fisherman. For example, an individual having 100% of their total annual revenue displaced by a management action is assumed to have a higher cost of compliance than someone with 10% of their revenue impacted. In reality, the cost of compliance depends on an individual's next best alternative to recreational fishing in these areas during the time periods of interest. However, this next best alternative is likely different for each individual, and cannot be readily assessed with the data in hand. On average, the percentage of revenue displaced is assumed to be a good proxy for this unknown cost.

Figure 43 indicates what percentage of each rank group's total revenue, including commercial revenue, would be expected to be displaced by Alternative 2. These percentages are relatively stable across time, with no readily apparent trends. At around 20%, they also tend to be relatively large. This suggests that, in the short-term, Alternative 2B will have highly negative impacts to the recreational fishery when compared to Alternative 1/No Action. In the long-term, impacts are also expected to be negative for the recreational fishery when compared to the Alternative 1/No Action, due to the expected impact on groundfish stocks.

The net impact of Alternative 2B is expected to be negative in the long run when compared to Alternative 1/No Action, given the expected impact on groundfish stocks. However, this determination ultimately depends on what habitat management alternatives are selected in central/western Gulf of Maine, and thus the analysis is highly uncertain in terms of a final determination of net effects.

When coupled with the preferred habitat alternatives in the western (Alternative 1, Alternative 7A) and central (Alternative 4) Gulf of Maine, the impacts of Alternative 2B are expected to be neutral to slightly positive in the short-term, when compared to Alternative 1/No Action, with a trade-off between additional flexibility of where and when to fish in the central Gulf of Maine, and the negative impact of the Massachusetts Bay Spawning Protection Area on commercial and recreational groundfish fishermen. Conversely the long-term impacts are expected to be neutral slightly negative, again given the trade-off between decreased long-term benefits in the central Gulf of Maine and increases in groundfish productivity due to the Massachusetts Bay Spawning Protection Area. All impacts are expected to be slightly larger in magnitude than comparable impacts in Alternative 2A. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the sort-term slightly positive impacts, and long-term slightly negative impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

The social impacts of Alternative 2 in comparison to Alternative 1/No Action are expected to be slightly negative. There may be some positive impacts associated with the overall reduction in closed areas and the resulting flexibility and access this gives some commercial vessels. There may be some negative impacts particularly to smaller vessels that fish inshore due to the implementation of the Massachusetts Bay Spawning Protection Area. This will particularly impact the communities identified in Table 78. Additionally, Option B will have a negative impact on communities involved in recreational fishing.

4.3.1.4 *Alternative 3 (Preferred)*

Alternative 3 would designate the Massachusetts Bay Spawning protection area. The discussion under Alternative 2 reviews the expected impacts of the Massachusetts Bay spawning closure area for gear capable of catching groundfish.

The impact of Alternative 3 is expected to be slightly negative in the short-term, as the Massachusetts Bay spawning closure area is situated in an important center of groundfish fishing. However, given the demonstrated impact fishing has on cod spawning behavior (see section dealing with impact of fishing on cod spawning), the status of the cod stock in the Gulf of Maine (see section dealing with cod stock status), and the economic importance of cod to groundfish fishermen in the Gulf of Maine, the long-run impact of Alternative 3 is expected to be slightly positive when combined with the preferred alternative 1A and compared to either Alternative 1A or Alternative 1B. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the sort-term slightly negative impacts, and long-term slightly positive impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

The short term social impacts of Alternative 3 are expected to be slightly negative, particularly for smaller vessels that fish inshore. This will particularly impact the communities identified in Table 78. Many of these communities have high levels of commercial fishing engagement (See the Communities section of Volume 1). The long term social impacts are expected to be moderately positive if increased protection of spawning groundfish in the Massachusetts Bay Spawning Area leads to increased cod populations. There may be some negative impacts on the *Attitudes, Beliefs, and Values* of members of the groundfish fishery related to the lack of flexibility of management as this would maintain current mortality closures, which are seen as no longer needed due to output controls in the fishery.

4.3.1.5 *Alternative 4 (preferred)*

Alternative 4 is an addition to the Gulf of Maine Cod Protection closures that would reinstate a seasonal closure within Block 125 between April 15 and April 30. Through April 2015, this block was part of the April rolling closure, and the rolling closure exemptions are essentially equivalent to the Cod Protection Closure exemptions. Thus, there is no recent effort data within this block that can be used to quantitatively evaluate the costs of keeping the block as part of the seasonal closure system.

Alternative 4 limits where groundfishing activities can take place during April relative to the regulatory no action, Alternative 1A, which does not include April measures. However, Alternative 4 increases opportunities during April relative to the baseline no action, Alternative 1B, because the closure period is only for two weeks as compared to the previous closure which lasted the entire month.

In the short-term, relative to Alternative 1A, Alternative 4 (when combined with the preferred alternative) may have slight negative economic and social impacts on the groundfish fishery through a loss in fishing opportunities, but long-term benefits are expected to be slightly positive due to expected positive impacts on spring-spawning groundfish stocks. Alternative 4 would have neutral to slightly positive impacts on the groundfish fishery relative to Alternative 1B, given that it provides increased flexibility in fishing opportunities and similar stock protections. Other fisheries subject to the restrictions associated with the alternative on gears capable of catching groundfish, such as the skate and monkfish fisheries, would have similar impacts to the groundfish fishery. Fisheries exempted from both the recent Alternative 1B closure of this area and from Alternative 4 restrictions would see neutral impacts. These include scallop vessels, as well as vessels in the whiting and herring exempted fisheries.

4.3.2 Georges Bank and Southern New England

Tables and figures related to analysis of the social and economic impacts of the Georges Bank spawning management alternatives are provided below. Discussion of impacts is provided under a separate heading for each alternative.

Figure 44 – Recreational revenue estimated to have been generated by trips reported within a 10 nautical mile buffer of CAI and CAII, delineated by whether the trip occurred within a period that would provide access to these areas under Georges Bank Spawning Alternative 2.

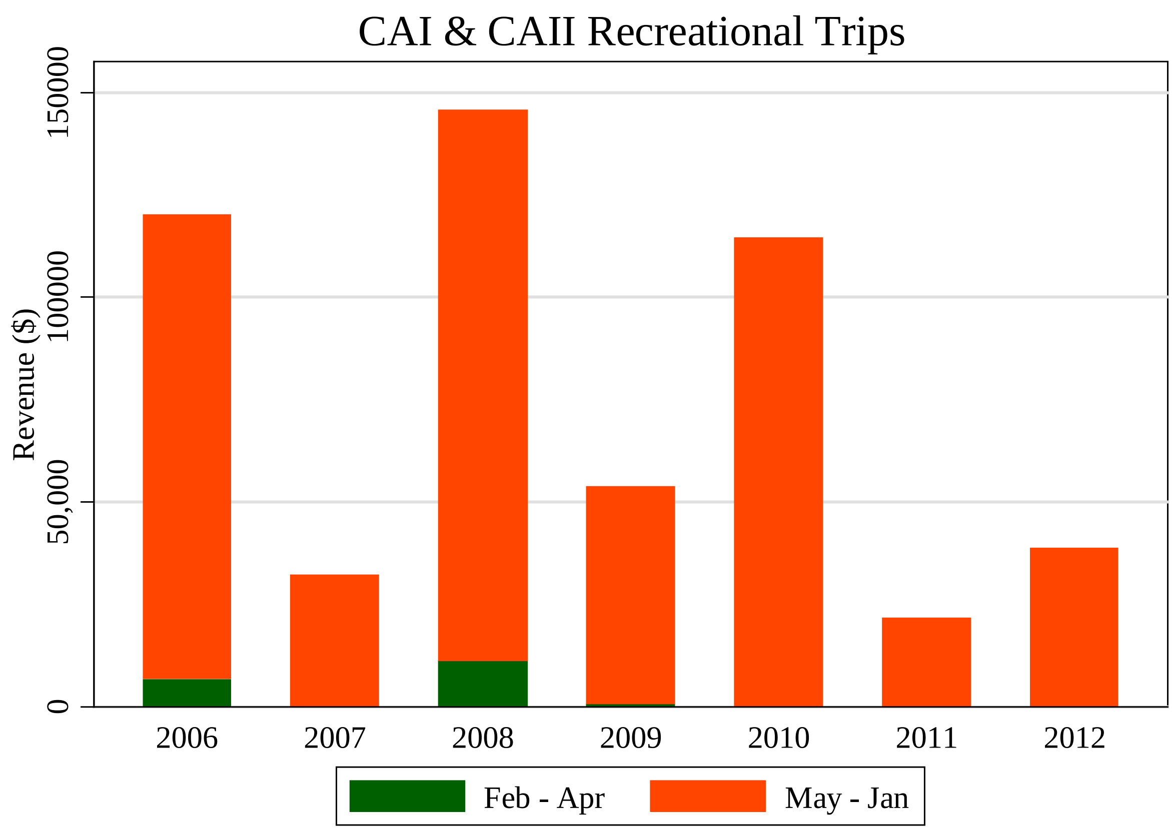


Figure 45 – Recreational revenue estimated to have been generated by trips reported within a 10 nautical mile buffer of CAI and CAII, delineated by whether the trip caught at least one groundfish.

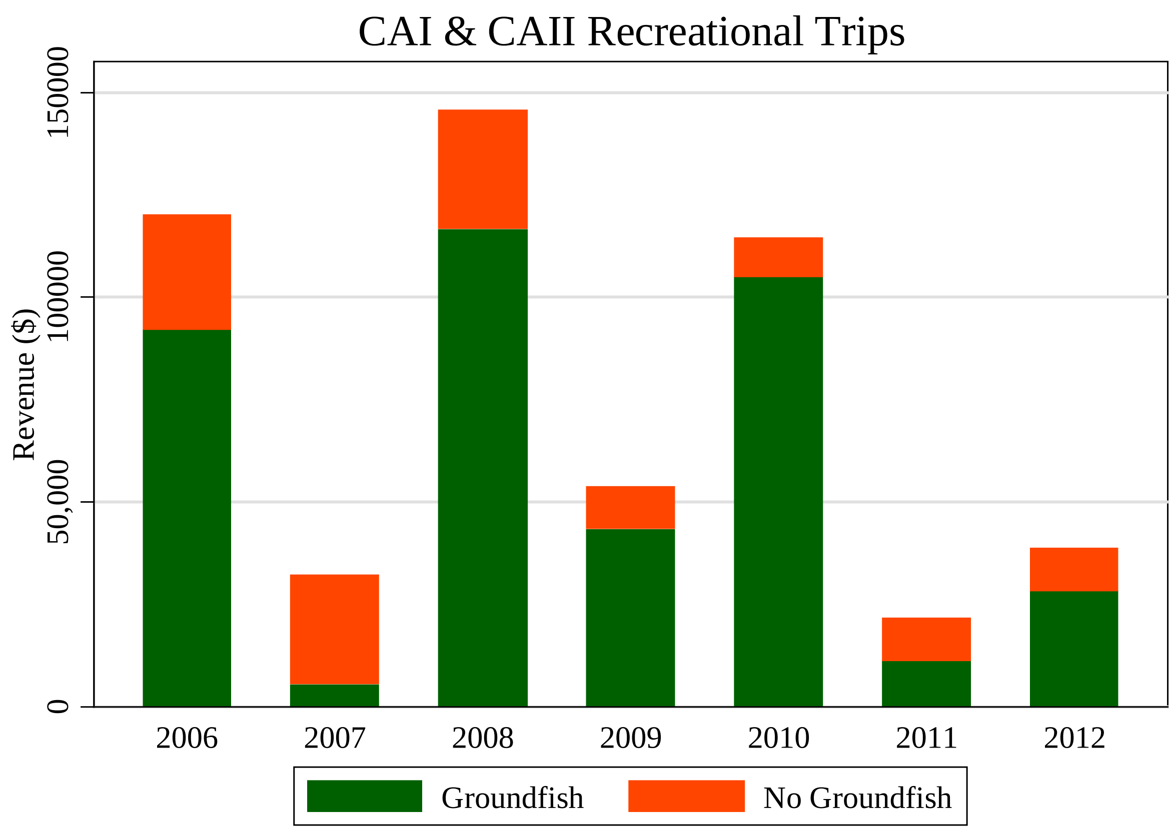


Table 81 – Recreational revenue estimated within a 10 nautical mile buffer of areas within Georges Bank Spawning Alternative 2 currently closed to recreational groundfishing. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual revenue is the mean annual revenue, individuals represents the average number of permit holders fishing in the area, and anglers represents the average number of anglers per year. All other statistics are estimates at the trip level. Dashes indicate data censored due to data confidentiality requirements.

Years	Annual Revenue	Individuals	Anglers	Mean Revenue	Median Revenue	SD Revenue
2006 - 2012	-	-	-	-	-	-
2008 - 2012	-	-	-	-	-	-
2010 - 2012	-	-	-	-	-	-
2006 - 2014	58,524	8	319	2,003	1,118	2,394
2010 - 2014	34,960	5	192	2,428	1,118	2,556
2012 - 2014	12,964	2	73	1,768	1,118	1,891

Table 82 – Total number of Massachusetts permits conducting recreational fishing trips within a 10 nautical mile buffer of Closed Area I (see previous table for revenue estimates). Other states and individual communities could not be identified due to data confidentiality requirements.

Georges Bank		Alternative 2	
State	Community	Port	City
MA		6	5

4.3.2.1 *Alternative 1 (No Action)*

Alternative 1/No Action considers the spawning protections of the existing year round closed areas on Georges Bank and in Southern New England, specifically Closed Area I, Closed Area II, and the Nantucket Lightship Closed Area, as well as the the May Georges Bank Seasonal Closure Area.

Given the expected positive impacts on managed large mesh groundfish through the benefits of current area management to groundfish productivity, there are expected to be positive benefits of Alternative 1/No Action for the groundfish fishery. While there are substantial costs to the scallop fishery of taking no action on habitat management areas, this fishery already has access opportunities within groundfish closed areas, provided they do not overlap with habitat closures. Thus, the overall net economic effects of the No Action spawning alternative on Georges Bank are expected to be slightly to moderately positive, over both the short and long-term. While effort displacement may have slight negative effects in various fisheries, the expected positive groundfish resource impacts are the primary driver associate with net positive effects.

The social impacts associated with Alternative 1/No Action are expected to be neutral as it would maintain the status quo. There may be some negative impacts on the *Attitudes, Beliefs, and Values* of members of the groundfish fishery related to the lack of flexibility of management as this would maintain current mortality closures, assuming they are not removed as a result of the habitat management alternatives selected for the Georges Bank and Great South Channel/Southern New England sub-regions. These year-round closures are seen by some as no longer needed due to output controls in the fishery. Given the current vulnerability in the groundfish fishery, impacts to groundfish may be felt more acutely than impacts to the scallop fishery.

4.3.2.2 *Alternatives 2A and 2B (2B preferred)*

Alternative 2 would retain as spawning closures Closed Area I and Closed Area II during the months of February, March, and the first half of April. Under this alternative, the Nantucket Lightship Groundfish Closed Area and the Georges Bank Seasonal Closures Area would be eliminated.

A general discussion of the benefits of additional access to Closed Area I, Closed Area II, and Nantucket Lightship for the groundfish and recreational fleet can be found in Sections 4.2.4.2 and 4.2.5.2. Volume 5 details the expected economic impact of Alternative 2 to the scallop fishery.

Options A and B are equivalent for commercial fishermen. Alternative 2 would provide additional access to common pool vessels in all current closures, increasing the flexibility of where and when to fish over Alternative 1/No Action, including access to Closed Areas I and II, the Nantucket Lightship Closed Area, and the May Closure, which is expected to have a positive impact in the short-term. Sector vessels would be provided additional access to Closed Area II, by what amounts to an extension of the Eastern US/Canada Haddock SAP season into January, and providing access to the area between latitudes 41° 30' and 42° 10' May – January within a fishing year. Although there is a current SAP in Closed Area I, it only provides exemptions to demersal longline and tub trawl gear, and even then only to northerly portions of Closed Area I. Alternative 2 would provide additional access for other gear capable of catching groundfish, and extend tub trawl and demersal longline access into the southern regions of Closed Area I during the relevant time periods. The Nantucket Lightship Closed Area would be removed, providing additional flexibility of where and when to fish. The May Closure only applies to common pool vessels not under a Handgear A or Handgear B permit, so positive impacts of increased access would be limited to these vessels. In summary, Alternative 2 is expected to produce slightly positive impacts in the short-term when compared to Alternative 1/No Action, primarily from additional access afforded around Closed Area II, assuming that the scallop fishery is exempted from the area. However, ultimately the full impact of this amendment depends on the cumulative impact of all the alternatives chosen, and thus depends greatly on the habitat alternatives chosen.

Table 79 details the recreational fishing reported within a 10 nautical mile buffer around Closed Areas I and II, for which there is no current demersal groundfish recreational exemption. It is clear that there is a very small number of permit holders currently fishing in these buffer areas. The discussions in Sections 4.2.4.1 and 4.2.5.1 indicate that only local groundfish effort is likely to be displaced if and when access to Closed Areas I and II would be granted. Under Alternative 2, Option A, some of this effort would be expected to flow into areas currently closed to recreational fishing. Figure 44 indicates that the majority of the revenue generated by trips surrounding Closed Areas I and II occur during periods in which both of these areas would be open to recreational fishing, and Figure 45 indicates that these trips catch groundfish. A neutral to relatively small positive net benefit to the recreational fishery would be expected from providing access to the closures (Alternative 2A), with the majority of the benefit provided by additional access to Closed Area I. Communities associated with these trips in 2012 are all in Massachusetts (Table 82) however due to confidentiality concerns individual communities are not identified.

Table 71 in the habitat section overviews the recreational fishing currently occurring in the Nantucket Lightship closure. The annual averages suggest a very small number of permit holders report fishing within the bounds of the current closure, particularly in recent years. This suggests that Option B would have a neutral impact on recreational fishermen in the short-term, as recreational fishing is currently allowed in Nantucket Lightship. Although any influx of commercial effort could induce gear conflicts, the relatively small amount of recreational effort historically within the bounds of Nantucket Lightship indicate this interaction would likely be insubstantial.

Ultimately the long-run impacts depend to some extent on the final habitat alternatives selected. Regardless, as written the longer run impacts of Alternative 2 are expected to be slightly positive. The long-run difference between Option A and B are expected to be negligible, given the very small amount of recreational fishing currently reported in and around Closed Area I, Closed Area II, and Nantucket Lightship. The magnitude of these impacts is expected to be slightly smaller than Alternative 3.

The short-term social impacts of Alternative 2 in comparison to Alternative 1/No Action are expected to be positive. There are also potential long-term negative social impacts if benefits to fish populations from the current closed areas are lost. Given the current vulnerability in the groundfish fishery impacts to groundfish may be felt more acutely than impacts to the scallop fishery.

4.3.2.3 *Alternatives 3A and 3B*

Alternative 3 would retain as spawning closures the northern part of Closed Area I and Closed Area II during the months of February, March, and the first half of April. Under this alternative, the Nantucket Lightship Groundfish Closed Area and the Georges Bank Seasonal Closures Area would be eliminated.

A general discussion of the benefits of additional access to Closed Area I, Closed Area II, and Nantucket Lightship for the groundfish and recreational fleet can be found in Sections 4.2.4.2 and 4.2.5.2. Volume 5 details the expected economic impact of Alternative 2 to the scallop fishery. Alternative 2 above discusses the expected impact of seasonal closures for the entirety of Closed Areas I and II. The fishing effort maps in Volume 1 highlight the clustering of observed and reported effort around the northern edge of Closed Area I, indicating that from the perspective of groundfish the additional access afforded by Alternative 3 likely affords only a marginal increase in benefits when compared to No Action.

Options A and B are equivalent for commercial fishermen. Alternative 3 is expected to produce slightly positive impacts in the short-term when compared to Alternative 1/No Action. The magnitude of this benefit is expected to be slightly larger than Alternative 2, given the additional flexibility in where and when to fish. It should be noted that, when compared to Alternative 1/No Action, long-term economic impacts are expected to be negative for the groundfish fishery given Alternative 3’s expected impact on groundfish habitat in particular (see Volume 5). The long-term difference between Options A and B are expected to be negligible, given the very small amount of recreational fishing currently reported in and around Closed Areas I and II, and the expectation that the opening of these areas is likely to only displace local effort.

The short-term social impacts of Alternative 3 in comparison to Alternative 1/No Action are expected to be positive. There are also potential long-term negative social impacts if benefits to fish populations from the current closed areas are lost. Given the current vulnerability in the groundfish fishery impacts to groundfish may be felt more acutely than impacts to the scallop fishery.

4.3.2.4 *Alternatives 2 and 3, Option C*

Option C would exempt scallop dredge vessels from the February through April spawning closures in Closed Areas I and II. Option C could be selected in conjunction with 2A, 2B, 3A, or

3B. Unless restricted by a habitat closure, scallop fishing could be prosecuted throughout the areas during this window. Within these closures, scallops are concentrated in the central portion of Closed Area I and the northern and southern parts of Closed Area II. Impacts of these alternatives to the scallop fishery are detailed in Volume 5. Option C is expected to induce a slightly positive impact on the scallop dredge fleet, by providing additional flexibility in where and when they can fish. The seasonal closures are not expected to bind the number of trips to either Closed Area I or Closed Area II, but is likely to shift effort within the year.

4.4 Dedicated habitat research area alternatives

Many of the general social impacts of the alternatives to designate Dedicated Habitat Research Areas are similar to those discussed earlier regarding the impacts of habitat and spawning management alternatives. Although the purpose of these actions differ (protecting habitat and researching the effects of fishing across habitats respectively) the effects on communities of closing and opening areas to different types of fishing are similar.

Additional social impacts associated with the DHRA alternatives include impacts on *Attitudes, Beliefs, and Values*. Fishermen generally have an inherently different view of the ocean and its fisheries than the views held by ocean/fisheries scientists. Closing access to fishing areas in the name of science and research, which many fishermen consider flawed, could create further mistrust in management. Alternatively, many fishermen feel that scientists know little about the effect of closed areas and gear modifications on habitat and groundfish. Conducting research to better understand these effects may improve the perceptions of spatial management in the future, having positive impacts on the formation of *Attitudes, Beliefs, and Values* about management.

The specific impacts of each alternative will be discussed in the following sections. These are very uncertain and will depend upon the other spatial management alternatives selected.

4.4.1 Alternative 1 (No action)

Currently there are no DHRAs designated in the region. Under Alternative 1/No Action, this would continue and DHRAs would not be designated as part of this amendment. The impact of Alternative 1/No Action ultimately depends on the habitat management alternatives selected. DHRA Alternative 1/No Action is expected to have a neutral to slightly negative impact on fisheries management, as the DHRAs themselves are designed to provide a streamlined process by which scientists can develop the knowledge needed by managers to more effectively and efficiently manage the habitat impacts of fishing.

The social impacts of Alternative 1 are expected to be neutral. There may be positive impacts on the formation of *Attitudes, Beliefs, and Values* about management if new research is conducted to better understand the effect of closed areas and gear modification on habitat and juvenile groundfish, however some of this research could be undertaken in currently closed areas without implementing any DHRAs. Additional types of research work may be facilitated by implementing DHRAs, e.g. mobile gear research in habitat management areas, and this type of research would not generally be possible without the DHRA designation, although there is not an ability to restrict “scientific research on scientific research vessels”.

4.4.2 Alternative 2

Alternative 2 would designate a Dedicated Habitat Research Area in the eastern Gulf of Maine. Gear exclusions, and thus economic impacts, of DHRA Alternative 2 are equivalent to the impacts identified for the Small Eastern Maine HMA in the Eastern GOM Alternative 3. The exclusions would primarily impact shrimp/bottom trawl fishermen, although the revenue estimates, though not insignificant, suggest that the area encompassed by the Eastern Maine DHRA is not a major center of fishing even for these gears.

In comparison to Alternative 1/No Action, short-term impacts are expected to be slightly negative given the above, with long-term slightly positive benefits expected from improved resource management. The magnitude of the long run benefits ultimately depends on the quality and quantity of scientific research being generated from the DHRA. Given the large body of knowledge already accumulated on the area encompassed by Alternative 3 (and detailed in Section 3.4.3), and the historical exclusion of mobile bottom-tending gears from the existing Western Gulf of Maine and Closed Area I habitat closures, the magnitude of the positive benefits generated by Alternative 2 are expected to be smaller than Alternatives 3 and 4. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the sort-term slightly negative impacts, and long-term slightly positive impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

The social impacts of Alternative 2 in comparison to Alternative 1/No Action are expected to be slightly positive. While there may be slightly negative impacts in the short-term particularly to communities in Maine from closing access to this inshore area, the potential benefits of researching this area given current dam removal and restoration projects on the Penobscot River are expected to have moderately positive social impacts in the long-term if there is a better understanding of the interaction between better quality groundfish habitat and improvements in prey availability.

4.4.3 Alternatives 3A, 3B, and 3C (3C preferred)

Alternative 3 would designate the Stellwagen DHRA with a reference area along the southern border (Option A), a reference area shifted five nautical miles north (Option B), or no reference area (Option C).

The reference areas (Options A and B) would exclude recreational groundfish fishing. The analysis below focuses on charter and party vessels for which spatial data at the trip level are available (i.e. Vessel Trip Report data). Although it is highly likely that private vessels will be impacted by the reference area Options that exclude recreational groundfish fishing, there is no data that allows us to gauge the magnitude of this impact either quantitatively or qualitatively.

Option A excludes recreational groundfish fishing from the southern DHRA reference area. Figure 46 summarizes the number of trips in this southern reference area, grouped by whether groundfish were caught on the trip or not. The majority of trips reported to have occurred within the southern reference area land at least one groundfish, which suggests that almost all trips occurring within the reference area would be affected to some extent by this alternative.

Figure 47 presents the total revenue estimated to have been generated from trips within the southern reference area, delineated by a ranked grouping of 5 permit blocks. The graph indicates that the 5 permits with the highest revenue estimated to fall within the southern reference area account for 63% of the total revenue estimates in 2011 and 2012. The revenue in 2010 seems to have been only slightly more diffuse, with 51% of the revenue share generated by the top 5 permits.

Figure 48 indicates the average percentage of each ranked group's total revenue, including commercial revenue, that the recreational revenue within the southern reference area represents. Group 1 generates the highest annual revenue within the reference area, and the percent of total revenue that this fishing represents remains relatively constant 2010 – 2012, between 20-30% of total revenue each year. When 2012 is compared to 2010, there are fewer groups in 2012, and for the groups with the smallest revenue the percentage of total revenue coming from the reference area is lower.

Table 83 presents a longer-term summary of trips falling within the southern reference area. The statistics indicate that a slightly higher number of permit holders are currently using the reference area when compared to the longer-run averages, with an annual average consistently less than 40 permits. However, most of the other statistics are lower in the last three years when compared to longer run averages. In general, there does not seem to be a recent substantial increase in dependence on the reference area from historical patterns.

Taken together, the data suggest that the southern reference area is used intensively, and consistently, by a relatively small number of charter and party permit holders. The recreational revenue generated from the trips in southern reference area catching groundfish is a substantial portion of these individual's total fishing income, and thus the exclusion of these individuals from the reference area is likely to have a highly negative impact for these individuals, when compared to no action, or to a designation of the research area without the reference area (Option C).

Table 86 identifies the communities associated with recreational trips in 2012. These are all associated with Massachusetts, however it should be noted that both Gloucester and Newburyport have a high level of engagement in recreational fishing and are likely to be more affected by these impacts.

Other fisheries are not impacted by the DHRA Alternative 3 Option A, when compared to Alternative 1/No Action. However, given that habitat Alternatives 2 – 7 in the western Gulf of Maine could change area management in that sub-region, the designation of the DHRA could have a broad range of economic impacts depending on the final habitat alternative chosen. A sense of these impacts, and their magnitude, can be gleaned from the economic impacts discussion of western Gulf of Maine habitat Alternative 6, with the caveat that commercial non-mobile bottom tending gear capable of catching groundfish would also be excluded from the DHRA.

In the long-term, benefits are expected to accrue to all groundfish fisheries through more informed, and ostensibly better, management decisions. Option A is thus expected to generate a slightly positive benefit when compared to no action, with concentrated costs accruing to a small number of recreational fishermen in the short-term, and diffuse positive benefits in the form of improved groundfish management in the long-term. The benefits are expected to be larger than Option B, given the higher revenue estimates presented in Table 84 and Figure 50 and Figure 51 for the Option B reference area. However, substantial uncertainty exists regarding both the benefits and costs of these Options, as they ultimately depend on the quality and quantity of scientific research being generated from the DHRA and the ability of fishermen to change their fishing practices/location. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the sort-term slightly negative impacts, and long-term slightly positive impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

The social impacts of Alternative 3 Option A in comparison to Alternative 1/No Action are expected to be positive. However there may be negative impacts related to the recreational fishery which is heavily reliant on this area. This will particularly impact communities on the South Shore of Massachusetts Bay and Cape Cod (Table 86).

Figure 46 – The total number of recreational trips (party and charter) reported within the southern reference area, grouped by whether at least one groundfish was caught on the trip. Total number of permits is 32 in 2010, 36 in 2011, and 42 in 2012.

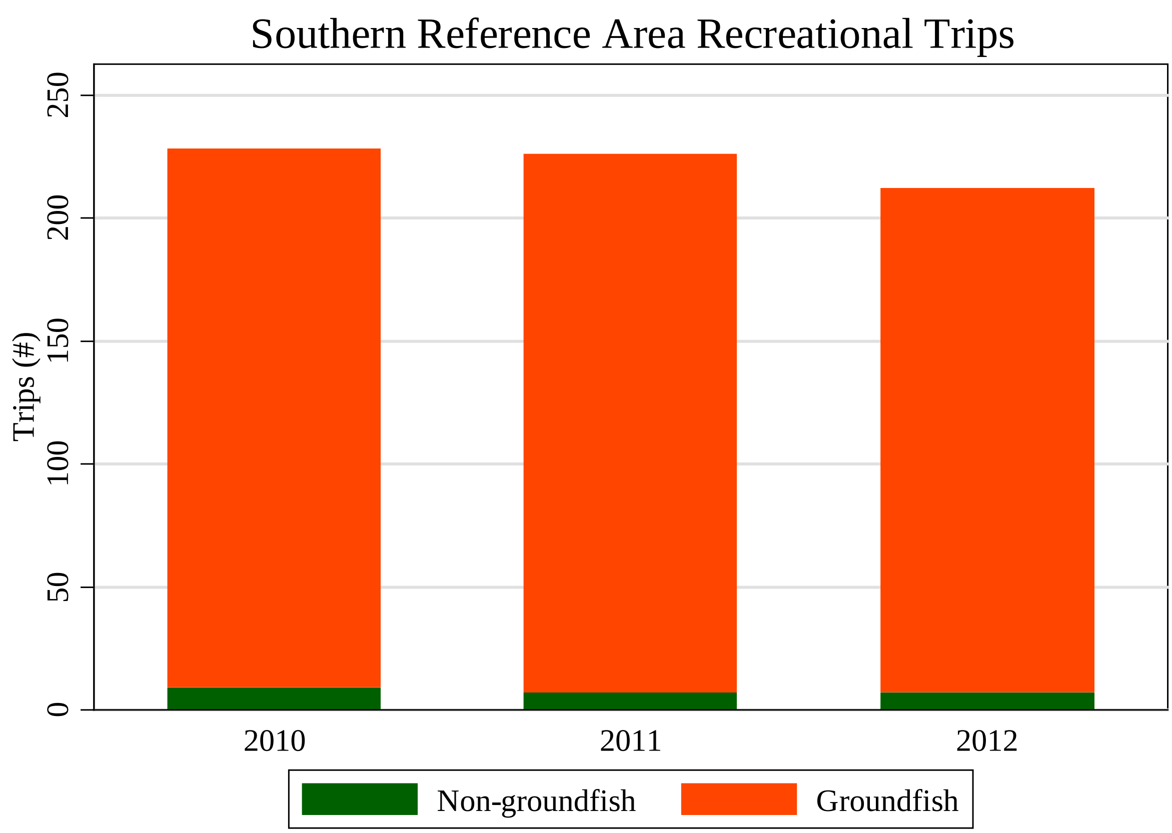


Figure 47 – Recreational revenue estimated to have been generated by trips reported within the southern reference area, with groups representing blocks of 5 permits, ranked by the revenue estimated to fall within the reference area. Note: Groups do not necessarily consist of the same individuals across years. Total number of permits is 32 in 2010, 36 in 2011, and 42 in 2012.

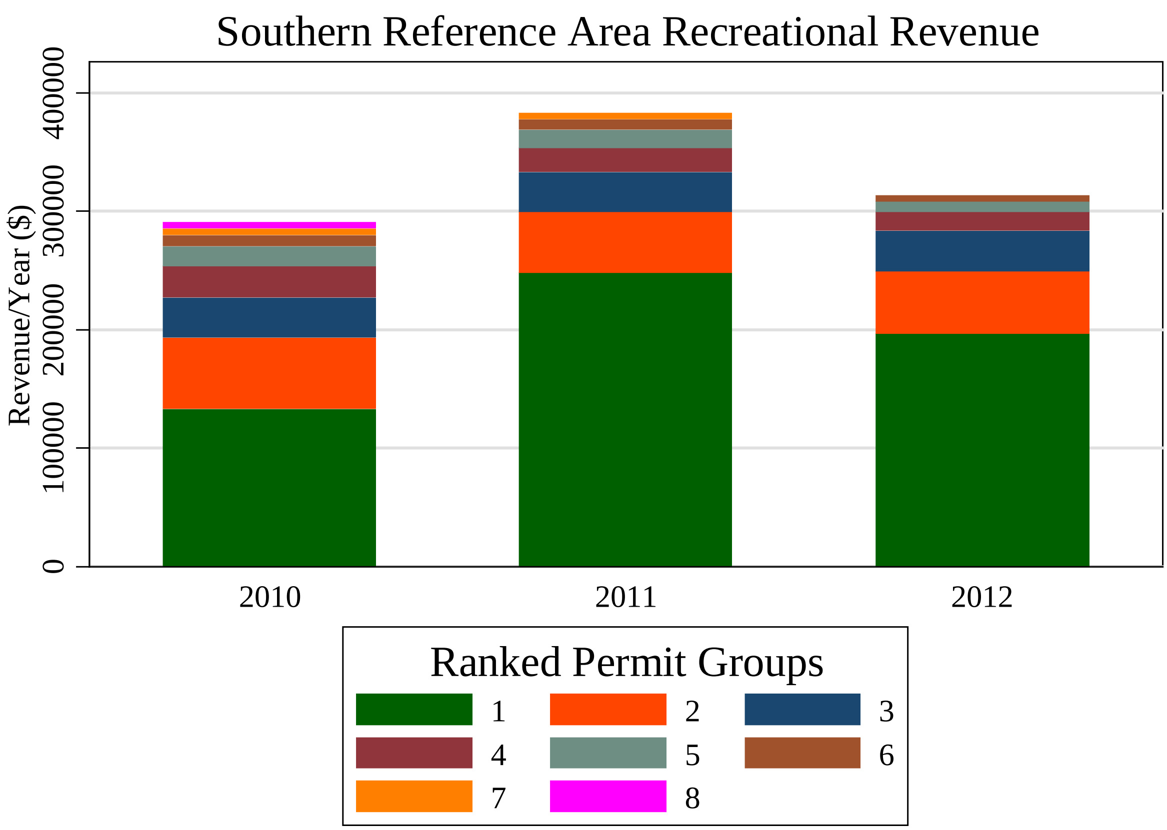


Figure 48 – Percent, averaged across permits, of each ranked group's total revenue (including commercial revenue) estimated to have been generated by recreational trips within the southern reference area. Total number of permits is 32 in 2010, 36 in 2011, and 42 in 2012.

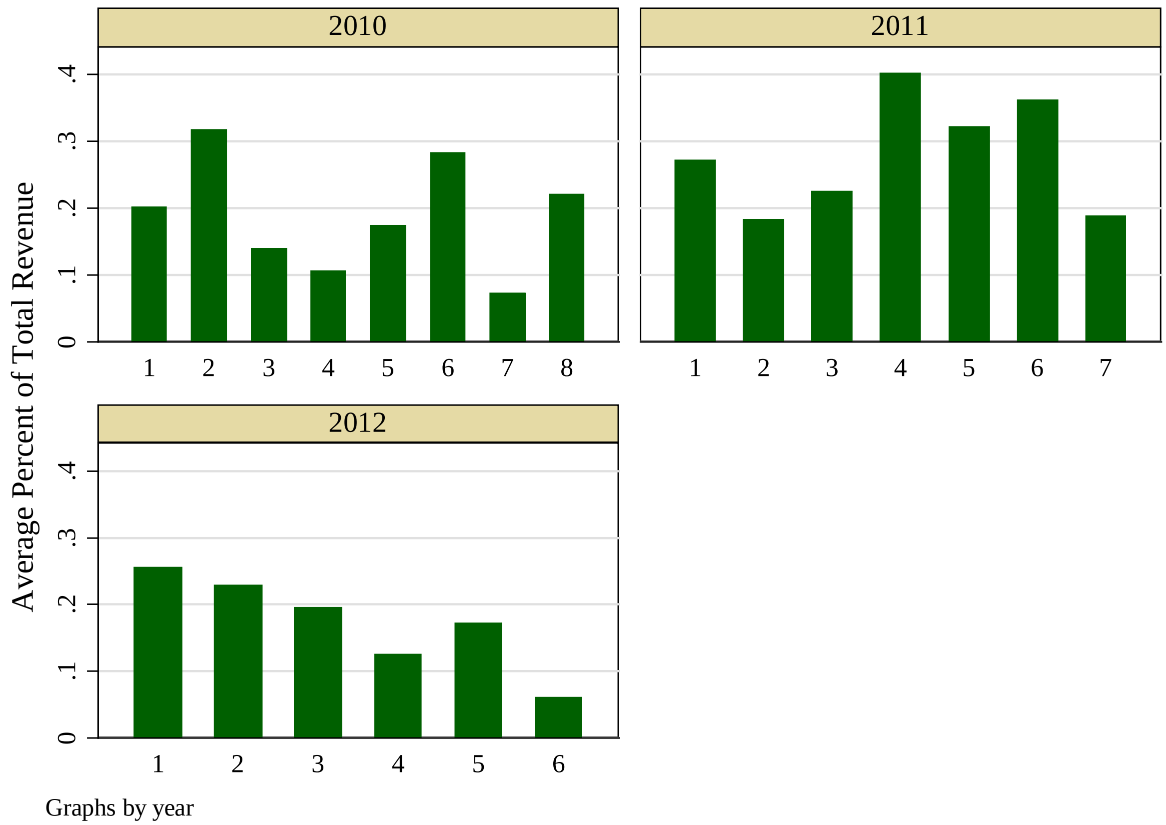


Table 83 – Recreational fishing revenue currently associated with the Southern Reference area. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual Revenue is the mean annual revenue, Individuals represents the average number of permit holders fishing in the area, and Anglers represents the Average number of anglers per year. All other statistics are estimates at the trip level. Dashes indicate information censored due to data confidentiality requirements.

Years	Annual Revenue	Individuals	Anglers	Mean Revenue	Median Revenue	SD Revenue
2006 - 2014	507,076	26	2,735	1,970	1,118	2,525
2010 - 2014	366,637	22	1,969	1,530	1,118	1,826
2012 - 2014	372,735	16	2,003	1,475	1,118	1,726

Option B excludes recreational groundfish fishing from the northern DHRA reference area. Figure 49 shows the total number of charter and party boat trips in the northern reference area, grouped by whether or not at least a single groundfish was caught on the trip. The vast majority of trips reported to fall within the northern reference area catch groundfish.

Figure 50 presents the total revenue estimated to have been generated from trips within the northern reference area, delineated by a ranked grouping of 5 permit blocks. It indicates that the 5 permits with the highest revenue estimated to fall within the northern reference area account for 63%, 62%, and 51% of the total revenue estimates in 2012, 2011, and 2010 respectively. This is a very similar pattern to the estimates for the southern reference area, although the total revenues in 2012 are roughly $125,000 higher in the northern area.

Figure 51 graphs the average percentage of each ranked group's total revenue, including commercial revenue, that the recreational revenue within the northern reference area represents. The importance of the northern reference area seems to be increasing for individuals fishing in this area, as defined by the percentage of total revenue generated. This seeming trend is in contrast to the southern reference area in which the percentages were relatively constant across 2010 – 2012.

Table 84 details the longer-term trends in trips within the northern reference area. Although the number of permit holders is lower than the number fishing within the southern reference area, the other statistics are consistently higher for the northern, when compared to the southern, reference area.

When compared to Alternative 1/No Action or Option C, Option B is expected to generate a highly negative impact for the charter and party boats fishing within these waters. Although the VTR data are unlikely to classify trips inside versus outside these small reference areas with any precision, they should accurately represent general trends of intensity. Thus, although some of the trips reporting latitude/longitude within the northern reference area likely expended effort in the southern reference area and vice versa, the relative magnitude should indicate which of the areas is more heavily fished. In all indicators, save the number of permit holders, the northern reference area looks to be more intensively fished when compared to the southern reference area. The magnitude of the negative impact of Option B on recreational fishermen is thus expected to be larger than Option A.

Other fisheries are not impacted by the DHRA Alternative 3 Option B, when compared to no action. However, given that habitat Alternatives 2 – 7 in the western Gulf of Maine could change area management in that sub-region, the designation of the DHRA could have a broad range of economic impacts depending on the final habitat alternative chosen. As noted above, sense of these impacts can be gleaned from the economic impacts discussion of western Gulf of Maine habitat Alternative 6.

In the long-term, benefits are expected to accrue to all groundfish fisheries through more informed, and ostensibly better, management decisions. Option B is thus expected to generate a net positive benefit when compared to no action, with additional concentrated costs accruing to a small number of recreational fishermen in the short term, and diffuse positive benefits in the form of improved groundfish management in the long term. The net benefits are expected to be smaller than Option A and C, given the higher revenue estimates within the northern reference area and the expected difficulty of identifying the impact of fish removal on such a small scale (see this volume for expected habitat impacts and Volume 5 for expected impacts on groundfish). Although discounting plays a role in whether the net benefits are ultimately positive or negative, the sort-term slightly negative impacts, and long-term slightly positive impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

The social impacts of Alternative 3 Option B in comparison to Alternative 1/No Action are expected to be positive. However there may be negative impacts related to the recreational fishery which is heavily reliant on this area. This will particularly impact communities on the South Shore of Massachusetts Bay and Cape Cod (Table 86).

However, substantial uncertainty exists regarding both the benefits and costs of these Options, as they ultimately depend on the quality and quantity of scientific research being generated from the DHRA and the ability of fishermen to change their fishing practices/location.

Option C would not restrict recreational groundfishing and is thus expected to have similar impacts to Alternative 1/No Action in terms of the party and charter recreational groundfishing industry. Table 85 summarizes recreational revenue for the entire Stellwagen DHRA area, including both reference areas and the portion of the DHRA outside the reference areas. Given the expected difficulties in identifying the effect of removals on such a small area (see this volume for expected habitat impacts and Volume 5 for expected impacts on groundfish), the magnitude of benefits derived from Option C is expected to be larger than Options A and B.

Figure 49 – The total number of recreational trips (party and charter) reported within the northern reference area, grouped by whether at least one groundfish was caught on the trip

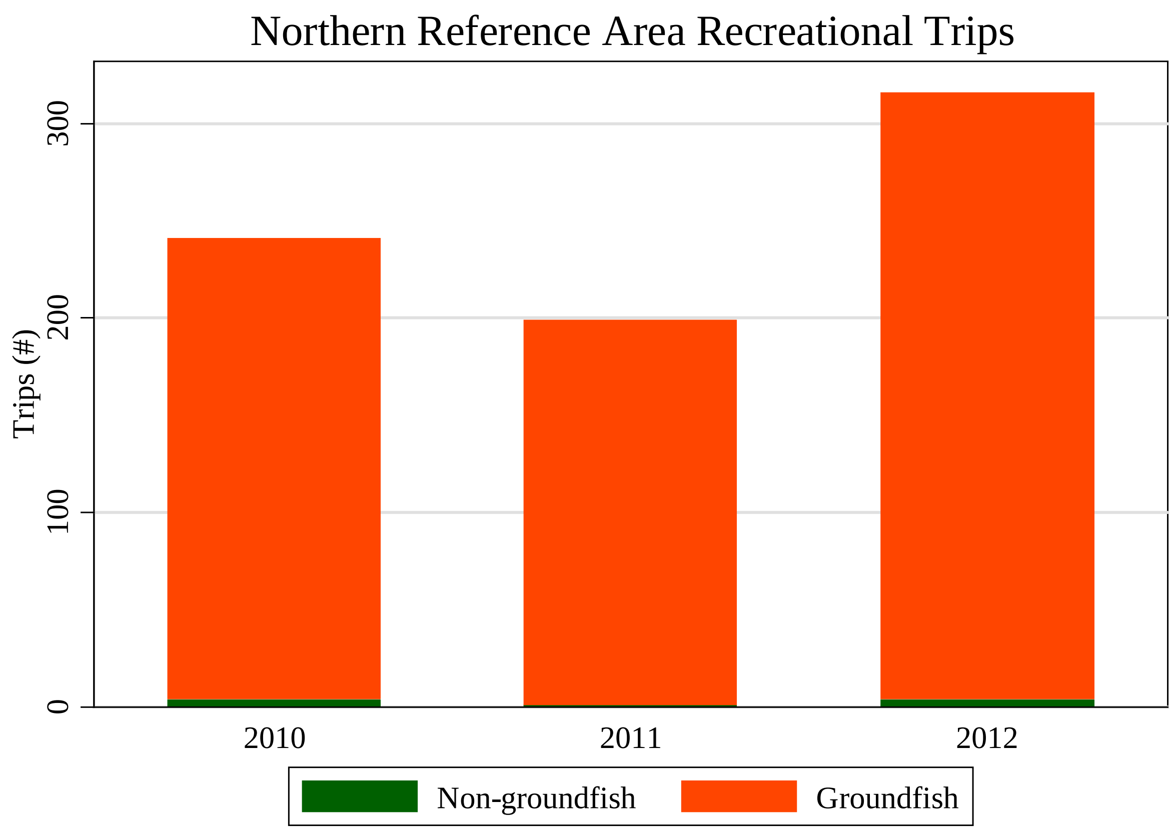


Figure 50 – Recreational revenue estimated to have been generated by trips reported within the northern reference area, with groups representing blocks of 5 permits, ranked by the revenue estimated to fall within the reference area. Note: Groups do not necessarily consist of the same individuals across years

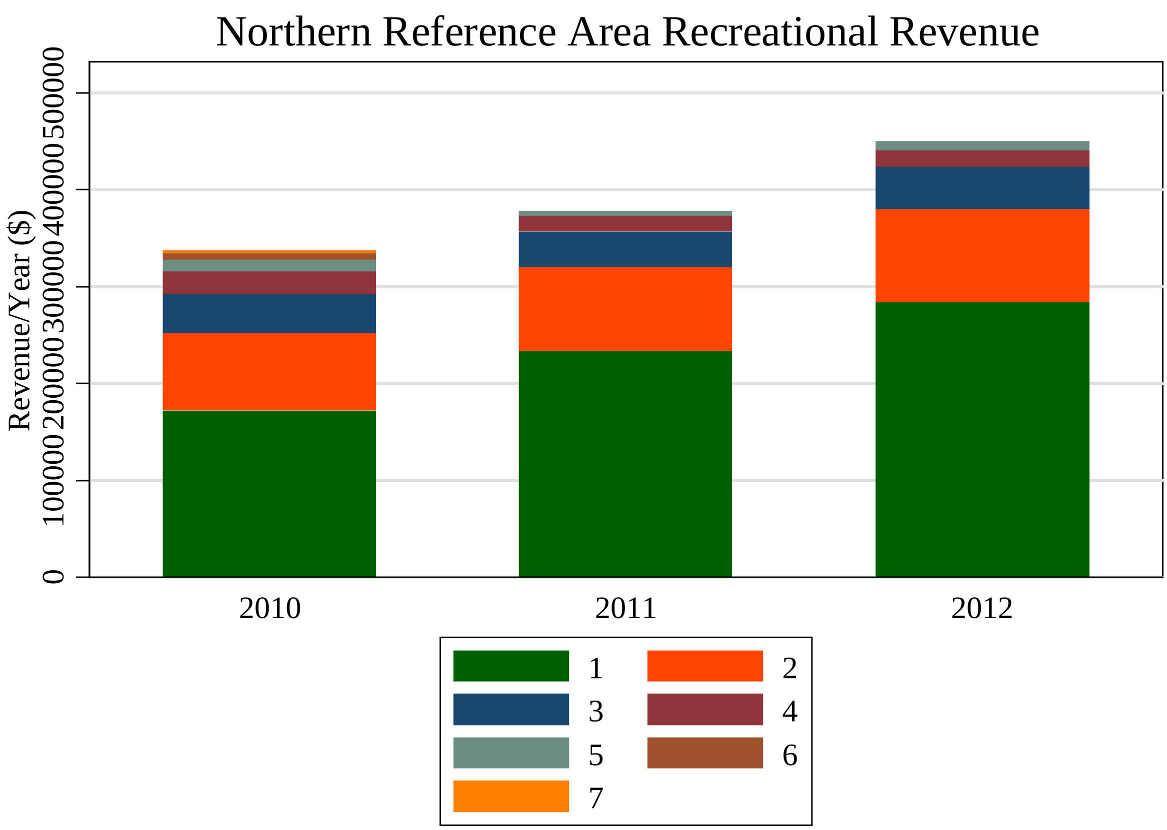


Figure 51 – Percent, averaged across permits, of each ranked group's total revenue (including commercial revenue) estimated to have been generated by recreational trips within the northern reference area

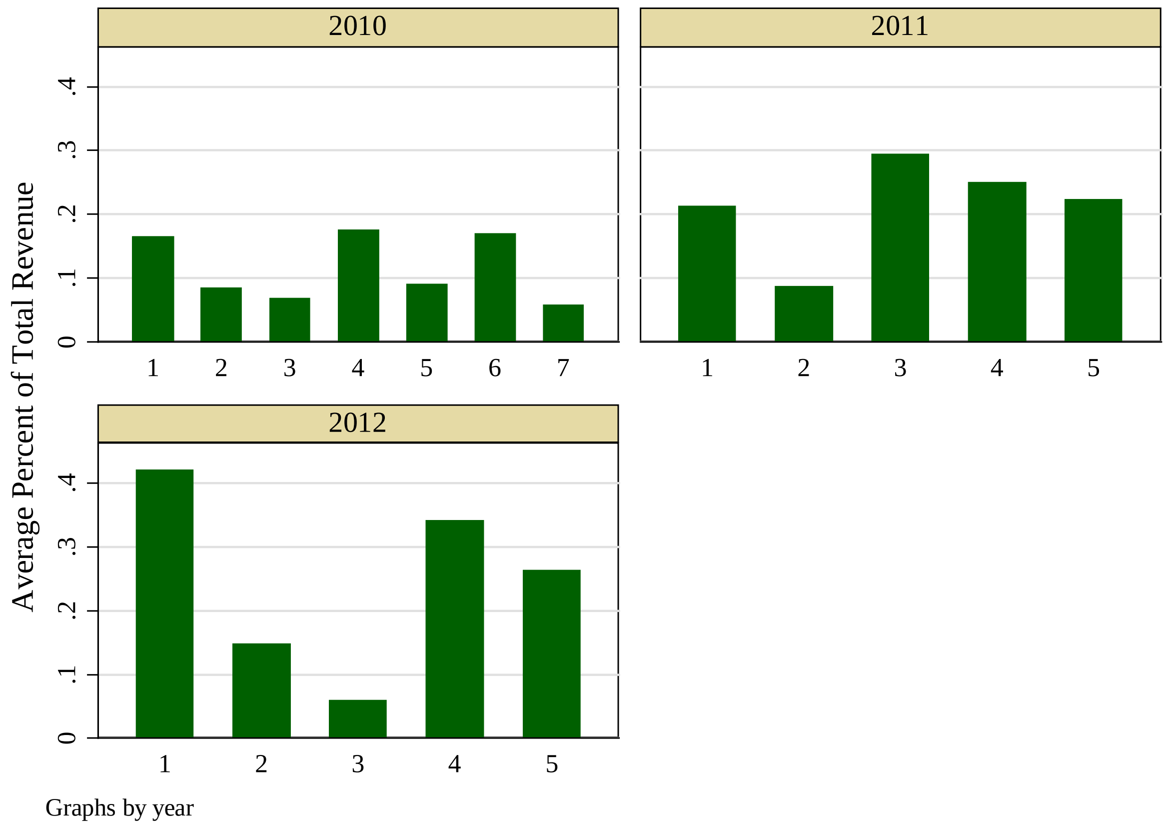


Table 84 – Recreational fishing revenue currently associated with the Northern Reference area. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual Revenue is the mean annual revenue, Individuals represents the average number of permit holders fishing in the area, and Anglers represents the Average number of anglers per year. All other statistics are estimates at the trip level.

Years	Annual Revenue	Individuals	Anglers	Mean Revenue	Median Revenue	SD Revenue
2006 - 2014	507,076	26	2,735	1,970	1,118	2,525
2010 - 2014	366,637	22	1,969	1,530	1,118	1,826
2012 - 2014	372,735	16	2,003	1,475	1,118	1,726

Table 85 – Recreational fishing revenue currently associated with the entire Stellwagen DHRA. Revenue generated from MRIP data, using average annual revenue per angler by state. Annual Revenue is the mean annual revenue, Individuals represents the average number of permit holders fishing in the area, and Anglers represents the Average number of anglers per year. All other statistics are estimates at the trip level.

Years	Annual Revenue	Indiv.	Anglers	Mean Revenue	Median Revenue	SD Revenue
2006 - 2014	2,101,074	72.86	12,070.71	2,466.05	1,117.74	2702.337

Years	Annual Revenue	Indiv.	Anglers	Mean Revenue	Median Revenue	SD Revenue
2010 - 2014	1,785,023	70.6	10,352	2,252.11	1,117.74	2429.294
2012 - 2014	1,767,647	71.67	10,052.33	2,213.25	1,117.74	2443.019

Table 86 – Total number of permits by port of landing or city of registration associated with at least three permits conducting recreational fishing trips associated with the Northern and Southern Reference Areas.

Stellwagen		Option A (Southern)		Option B (Northern)	
State	Community	Port	City	Port	City
MA		30	29	27	26
	Gloucester	7	3	6	3
	Marshfield	16	6	13	6
	Newburyport				
	Plymouth		3		3
	Scituate			3	

Table 87 – Sum of 2012 party/charter recreational fishing revenue associated with the Northern and Southern Reference Areas. Ports with less than 3 vessels each were included in the state totals only.

Alternative		Option A (Southern)	Option B (Northern)
State	Port	Value	Value
MA	Total	**312,408.30**	**449,890.40**
	GLOUCESTER	37,444.29	107,116.80
	MARSHFIELD	177,161.80	250,001.20
	SCITUATE		7,824.18

4.4.4 Alternative 4 (preferred)

Alternative 4 would designate a Dedicated Habitat Research Area on Georges Bank. Alternative 4 has a neutral impact on commercial fisheries when compared to the Alternative 1/No Action, as it is fully encompassed by the southern portion of the Closed Area I habitat/groundfish closure, an area currently closed to both gear capable of catching groundfish and mobile bottom-tending gears, and outside of the hook and line SAP exemption area. However, the full economic impact of this alternative ultimately depends on the final alternatives selected for habitat and spawning. Fishing effort distribution maps in Volume 1 of this EIS indicate that the majority of observed effort surrounding Closed Area I does not abut the boundaries of the Georges Bank DHRA. This suggests that the negative impact of Alternative 4 on fisheries employing mobile bottom-tending gear is expected to be relatively small, regardless of the final alternative chosen. There is some scallop dredge effort reported along the boundary of the Georges Bank DHRA. However, the scallop PDT’s assessment indicates that the DHRA does not host a substantial concentration of scallop biomass (~0.1% of scallop LT yield), and thus this impact is again expected to be relatively small, and the adjacent fishing effort is within the access area just to the north of the DHRA. Although some recreational effort has been reported within a 10 nautical mile buffer of Closed Area I (see Table 64 in the habitat alternatives section), the relative number of trips in the vicinity of Closed Area I suggest only neutral to slightly negative impacts of this alternative on recreational fishing. Generally, the distance from shore precludes most recreational fishing from the area encompassed by Alternative 4.

Long-term impacts are expected to be slightly positive, when compared to Alternative 1/No Action, given the expected improvement in management stemming from improved scientific knowledge of species under Federal management. The positive benefits are expected to be larger than Alternative 2, given the historical exclusion of mobile bottom-tending gear from Closed Area I, but smaller than Alternative 3 given the substantial knowledge of the western Gulf of Maine closure already amassed (see Section 3.4.3). However, substantial uncertainty exists regarding both the benefits and costs of these Options, and the trade-off ultimately depends on the quality and quantity of scientific research being generated from the DHRA. Although discounting plays a role in whether the net benefits are ultimately positive or negative, the sort-term slightly negative impacts, and long-term slightly positive impacts make clear that the net benefits are likely to be relatively marginal/negligible regardless of their ultimate sign.

The social impacts of Alternative 4 in comparison to Alternative 1/No Action are expected to be positive. Because the Georges Bank DHRA is in a currently closed area the social impacts are expected to be minor. There may be a small positive impact on the *Attitudes, Beliefs, and Values* regarding management flexibility because no new areas will be closed to fishing activities for this research to occur.

4.4.5 Alternative 5 (preferred)

This alternative would implement a sunset provision whereby any DHRA designations implemented by the amendment could be removed administratively after a three year period if specific conditions are not met. There is a neutral impact when compared to Alternative 1/No Action, as Alternative 5 is superfluous unless at least one of Alternatives 2 – 4 is also selected. However, this sunset provision helps decrease the uncertainty regarding the benefit/cost trade-off of Alternatives 2-4, as the cost of these other alternatives will cease if and when the positive benefits expected from increased scientific knowledge fail to materialize. Thus, Alternative 5 is expected to have slightly positive impacts when coupled with at least one of the Alternatives 2-4.

The social impacts of Alternative 5 in comparison to the no action alternative are expected to be positive. The creation of a sunset provision will ensure that if DHRAs are not providing a research benefit they will be open to fishing activities. This will have a positive impact on the *Attitudes, Beliefs, and Values* regarding management flexibility.

5 Protected resources

The spatial management alternatives proposed in this amendment have the potential to change fishing behavior and patterns of gear use in the affected waters, which may influence the magnitude of protected resources impacts in the affected region (see Volume 1, section 4.8.3 for description of gear types and their risk to protected resources). The management measures currently in place for the Northeast multispecies, monkfish, and skate fisheries (i.e., the fisheries that utilize gillnets and bottom trawls) and the scallop fishery (i.e., fishery that uses scallop dredge and scallop trawls) all limit the overall amount of fishing effort, mainly through annual catch limits on target stocks. As a result, the changes proposed in this amendment are generally not expected to result in an increase in fishing effort overall, just shifts in the location of that effort.

Because a number of the alternatives would potentially open areas to fishing that have been closed for a significant period of time, there are limited data to provide insight as to how fishing effort may potentially shift and, if there is a shift, what kind of impact that may have on protected species. As a result, it is not possible to forecast precisely what entanglement or interaction risks would exist if the closures are relieved or modified; however, we can assess the range of possible impacts to protected species that could result from shifts in effort and the risks associated with these possible impacts.

When looking at protected species interaction risks, we are concerned about the total amount of gear in the water, soak or tow time, and co-occurrence with protected species. Generally speaking, if shifts in effort result in more gear being present for a longer period of time and in areas of high protected species co-occurrence, this is likely to result in increased interaction risks. However, relative to current operating conditions in and around the existing closed areas, we do not expect the outcome of opening or reducing the size of any of the existing closed areas, or introducing new HMAs, to result in significant changes in overall fishing effort or behavior (e.g., gear type, gear quantity, area fished) in the affected area. Regardless of the area opened or modified, the number of vessels and amount of gear in the water are not expected to be substantially different from current conditions. What will differ is that these vessels will now be able to fish and set gear in different areas. These changes do not necessarily equate to increased protected species interactions. Additionally, depending on yearly allocations of target stocks, and the conditions of those stocks in newly opened areas, fishing behavior (e.g., duration of time gear set in the water) may potentially change for the better for protected species, either because fishing becomes more efficient such that gear is in the water less, or because activity shifts away from areas with relatively higher interaction rates.

Taking into consideration the above, effects on protected species could, in theory, range from positive to negative. Using information on species distribution and abundance, available bycatch/entanglement data, as well as information on gear types that pose the greatest risk to a particular species, the following are some possible effort shift scenarios and the interaction risks that could present themselves:

- If the waters around the closed area have had few observed cases of bycatch/entanglement of a particular protected species, there is no information to suggest that bycatch/entanglement rates within the closed area would be higher than areas immediately adjacent to the closure, should it be opened. <u>As a result, if effort is simply redistributed from outside the area to within, we would not expect impacts to that species to increase, i.e. impacts would be neutral.</u>

- The waters around the closed area have had few observed cases of bycatch/entanglement of a particular protected species, such that low bycatch/entanglement rates are predicted within the closed area. The closed area is opened, resulting in an effort shift from an area where bycatch/entanglement of that species is high to an area where interactions have been low. <u>This could generate positive impacts.</u>
- The waters around the closed area have had many observed cases of bycatch/entanglement of a particular protected species, such that high bycatch/entanglement rates are predicted within the closed area. The closed area is opened, resulting in an effort shift from an area where bycatch/entanglement of that species is low to the closed area, where a higher rates of interactions are predicted. <u>This could generate negative impacts.</u>
- Under status quo conditions, gear is set in high concentrations along the border of the closed areas. This creates an elevated risk of entanglement as species cannot move through the area without the risk of an interaction; this is seen in observer data where interactions with particular protected species are observed concentrated around the border of the closed area. However, opening the closed area results in a shift in effort into the opened area resulting in the dispersion of gear that once was concentrated along the closed area border. With gear being more dispersed, a barrier to movement has been eliminated and therefore, interactions with protected species are likely to decrease in the vicinity of the reopened area. <u>This could generate positive impacts.</u>
- Quota allocations in affected area. The closed area has enabled growth of a target stock. The closed area is now opened and effort shifts to this area to take advantage of the target stock. With greater target stock availability, quota can be attained more quickly and therefore, in a manner that equates to gear being present in the water for less time. With a decrease in overall soak time, potential interactions with protected species would likely decrease as well. <u>This could generate positive impacts.</u>

Without knowing exactly how fishing behavior will change, and without information on bycatch within the closed area, we cannot definitively state that interactions will increase as a result of opening or modifying any of the closed areas. As a result, for each sub-region, the sections below assess the impacts of each alternative on protected species, taking into consideration the above scenarios and focusing primarily on the impacts of shifting and/or concentrating gears into areas where they were previously prohibited. There may be localized increases in effort as a result of some of these alternatives and the impacts from those changes will be discussed as well.

5.1 Habitat management alternatives

The proposed habitat management alternatives, except for the no action alternatives, would remove or modify year-round groundfish and habitat closures and introduce new habitat management areas or HMAs. In general restrictions in the new and modified HMAs would prohibit mobile bottom-tending gears. There are some specific exemptions proposed in certain areas, and other (generally non-preferred) alternatives would enact gear modification requirements for trawls, but allow their use. Dredges would be allowed under the gear modification proposals. The following analyses are presented by sub-region and then by the type of protected resource.

5.1.1 Eastern Gulf of Maine

There are three habitat management alternatives for the Eastern Gulf of Maine sub-region: (1) no action/no HMAs, (2) Machias and Eastern Maine Large areas with Options 1-5, and (3) Machias, Eastern Maine Small, and Toothaker Ridge areas with Options 1-4. The preferred alternative is a variation of Alternative 3, with the Small Eastern Maine HMA only as a closure to mobile bottom-tending gears (Option 1). Regardless of which alternative and associated option(s) are chosen, fishing effort and behavior (e.g., amount and type of gear, area fished,) in this sub-region is not expected to change substantially from current operating conditions (i.e., Alternative 1/No Action).

Specifically, under Alternative 2, the Machias HMA and the Large Eastern Maine HMA are proposed. Fisheries overlapping the Machias and Large Eastern Maine HMAs are primarily prosecuted with trap gear, followed by clam dredge (Machias HMA) and purse seines (Large and Small Eastern Maine HMAs) and to a lesser extent, shrimp bottom trawl or scallop dredge gear. Mobile bottom tending gear (i.e., clam dredge and shrimp bottom trawl) comprises a very small component of the fisheries prosecuted in these areas, so prohibiting their uses in these areas is not expected to result in significant shifts of this gear type outside of the proposed HMAs. Therefore, this alternative would not result in significant shifts in effort or increases in effort in surrounding areas. Similarly, trap gear generates most of the revenue from either HMA. Since it would not be affected by the management options (1-5), the amount and distribution of this gear type is not expected to change substantially, if at all, from current operating conditions in these areas. As a result, we would not expect substantial changes in effort or distribution of effort with this gear type.

Similar conclusions can be drawn for Alternative 3. A subset of this alternative, Small Eastern Maine HMA only, is preferred. Fisheries overlapping the Machias, Small Eastern Maine, and Toothaker Ridge HMAs are primarily prosecuted with trap (Machias and Small Eastern Maine HMAs) or gillnet (Toothaker Ridge HMA) gear, followed by, depending on HMA, clam dredge (Machias HMA), purse seines (Small Eastern Maine HMA), or trap gear (Toothaker Ridge HMA) and to a lesser extent across all HMAs, shrimp bottom trawl, mid-water, trawl, or scallop dredge gear. Options 1-4 may be applied to these areas under Alternative 3. Mobile bottom tending gear (i.e., clam dredge and shrimp bottom trawl) comprises a very small component of the fisheries prosecuted in these areas, so prohibiting or possible permitting some form of mobile bottom tending gear in these areas is not expected to result in significant shifts of this gear type outside of the proposed HMAs. Therefore, this alternative would not result in substantial shift in effort or increases in effort in surrounding areas. Similarly, with the primary gear types used in any of the proposed HMAs consisting of fixed fishing gear (trap or gillnet gear), and none of the potential options affecting fixed fishing gear presence in the HMAs, the amount and distribution of this gear type is not expected to change substantially, if at all, from current operating conditions in these areas. Further, as described above, current fishing practices in the Eastern GOM are not based strongly on mobile bottom tending gear. As a result, we would not expect fixed fishing gear distributions to change as a result of large shifts in mobile bottom-tending gear use.

Therefore, overall, the alternatives in the Eastern Gulf of Maine are likely to result in neutral impacts to protected resources relative to the baseline conditions because few, if any, shifts in fishing behavior are expected.

5.1.1.1 *Impacts to marine mammals*

ESA and non-ESA listed species of marine mammals are known to occur in waters of the eastern Gulf of Maine. Of the gear types used in the eastern Gulf of Maine, marine mammals are known to interact with gillnet, bottom trawl, mid-water trawl, purse seine, or trap gear (see Volume 1, section 4.8.3.1). Of these gear types, gillnet and bottom trawl pose the greatest risk of serious injury and mortality to small cetaceans and pinnipeds, while gillnet and trap gear pose the greatest risk of serious injury and mortality to large whales. Interactions with the other gear types used in the area (clam or scallop dredges) are non-existent and therefore, do not pose an interaction risk to any marine mammals.

As marine mammals co-occur with fisheries operating in the eastern Gulf of Maine, marine mammal interactions with gear are possible. The primary concern for marine mammal species is how the proposed alternatives in the eastern Gulf of Maine would change the distribution and quantity of gillnet, trap, mid-water trawl, purse seine, and/or bottom trawl gears in the region. Specifically, if any of the alternatives resulted in: (1) gear being more widely distributed and/or concentrated in the area relative to current conditions; or (2) a shift in effort into waters where there is a high incidence of observe marine mammal interactions with gear (e.g., gillnet gear: western Gulf of Maine; bottom trawl gear: Georges Bank); and/or (3) a shift in effort into areas with an already high co-occurrence of gear and marine mammals (e.g., western Gulf of Maine and trap gear), causing a gear concentration effect, then interaction risks for marine mammals would likely increase, resulting in negative impacts to marine mammals. However, as described above, fishing behavior and effort, including distribution of gear and quantity of gear, is not expected to change substantially under any alternative proposed for the eastern Gulf of Maine. Fishing behavior and effort are expected to be similar to status quo conditions and as a result, none of the proposed alternatives are expected to introduce any new interaction risks to these species that would result in animals experiencing levels of serious injury or mortality above and beyond current conditions and thus, above and beyond levels previously consider by NMFS in its assessment of fishery interaction risks and impacts to marine mammals (Waring et al. 2014, Waring et al. 2015, NMFS 2002; NMFS 2012a; NMFS 2013; NMFS 2014a).

Specifically, as provided in Waring et al. (2014, 2015), aside from several large whale species (e.g., North Atlantic right, humpback, and fin), harbor porpoise, and several stocks of bottlenose dolphin, there has been no indication that takes of marine mammals in commercial fisheries have gone above and beyond levels which would result in the inability of each species population to sustain itself. Aside from several large species of large whales, harbor porpoise and several stocks of bottlenose dolphin, the Potential Biological Removal threshold has not been exceeded for any of the non-ESA listed marine mammal species identified in sections 4.8.3.2, 4.8.3.3, or 4.8.3.4 of Volume 1 (Waring et al. 2014, 2015). Although several species of large whales, harbor porpoise and several stocks of bottlenose dolphin have experienced levels of take that have resulted in the exceedance of each species' potential biological removal threshold, take reduction plans have been implemented to reduce bycatch in the fisheries affecting these species (i.e., Atlantic Large Whale Take Reduction Plan, Harbor Porpoise Take Reduction Plan, and the Bottlenose Dolphin Take Reduction Plan see Volume 1, section 4.8.3.1 for details). These plans are still in place and are continuing to assist in decreasing bycatch levels for these species. Although the information presented in Waring et al. (2014, 2015) is a collective representation of commercial fishery interactions with marine mammals, and does not address the effects of any FMP specifically, the information does demonstrate that fishery operations over last five or more years have not resulted in a collective level of take that threatens the continued existence of marine mammal populations (aside from those species noted above). Based on this information, to date, there is no indication that fishing operations in the eastern Gulf of Maine have resulted in levels of take above and beyond those already considered by Waring et al. (2014) and Waring et al. (2015). As a result, we do not expect status quo conditions, and maintenance of this condition, to result in levels of take that will affect the continued existence of marine mammals. None of the proposed alternatives for the eastern Gulf of Maine are expected to result in substantial changes in fishing behavior or effort from status quo conditions. Therefore, these alternatives are not expected introduce any new risks to these species that have not previously been considered.

In conjunction with the above, additional analysis on the impacts of the operation of fisheries in the northeast region have also been conducted by NMFS, pursuant to section 7 of the ESA, for ESA-listed species of marine mammals. In biological opinions issued for specific FMPs in 2002, 2012(a), 2013, and 2014, NMFS concluded that the operation of these FMPs in the region, including those identified in the amendment, may affect, but will not jeopardize the continued existence of any ESA listed species of marine mammals. Since issuance of these opinions, there has been no indication that these fisheries have changed in any significant manner such that levels of take have gone above and beyond those considered by NMFS in its assessment of fisheries affects to listed species (if they had, NMFS would have reinitiated the opinions). As a result, we do not expect impacts to ESA-listed species of marine mammals under status quo conditions to be different from those already considered by NMFS (NMFS 2002; NMFS 2012a; NMFS 2013; NMFS 2014a) and as all the proposed alternatives for the eastern Gulf of Maine are expected to maintain conditions similar to status quo, impacts to ESA-listed marine mammals are expected to remain consistent with those already considered by NMFS. Fishing behavior under any of the proposed alternatives is not expected to introduce any new risks or additional takes to ESA listed species that have not already been considered by NMFS to date in trap/pot, gillnet, purse seine, clam or scallop dredge, mid-water trawl, and shrimp bottom trawl gears. As a result, none of the proposed alternatives are expected to result in interactions with ESA listed species of marine mammals that are above and beyond levels previously considered by NFMS. Based on this, the proposed alternatives for the eastern Gulf of Maine, and the resultant fishing behavior under any of these conditions, are not, as concluded in the opinions issued by NMFS, expected to result in levels of take that would jeopardize the continued existence of ESA listed species of marine mammals.

Based on the above information, and the fact that all fisheries in the eastern Gulf of Maine must comply with existing Atlantic Large Whale Take Reduction Plan and Harbor Porpoise Take Reduction Plan regulations, it is expected that impacts to marine mammals from any of the proposed alternatives for the eastern GOM would be slightly negative to neutral. As there is no information to demonstrate that one alternative might result in more positive or more negative impacts to marine mammals, any alternative, relative to another, would result in neutral impacts to marine mammals.

5.1.1.2 *Impacts to sea turtles*

Hard-shelled sea turtle species, i.e. Kemp's ridley, green, and loggerhead, are rare to non-existent in both the eastern and central Gulf of Maine sub-regions (Blumenthal et al. 2006; Braun and Epperly 1996; Braun-McNeill and Epperly 2002; Braun-McNeill et al. 2008; Epperly et al. 1995a,b,c; Griffin et al. 2013; Hawkes et al. 2006; Hawkes et al. 2011; Mansfield et al. 2009; McClellan and Read 2007; Mitchell et al. 2003; TEWG 2009; Morreale and Standora 2005; Mitchell et al. 2003; Morreale and Standora 2005; NMFS and USFWS 2008; NMFS and USFWS 1991, 1998b; NMFS et al. 2011; Shoop and Kenney 1992; TEWG 2009; http://seamap.env.duke.edu/). Kemp's ridely and green sea turtles are not known to occur in this sub-region and in fact, have not been documented in these waters (see references above; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; http://www.nefsc.noaa.gov/fsb/take_reports/asm.html). Loggerhead sea turtles, although rare, have been found as far north as southern Canada and therefore, the waters of the central Gulf of Maine likely approximate the northern limits for this species (see references above). Due to hard-shelled sea turtles rarity in this area, there is an infrequent overlap between sea turtles and any fishery operating in the eastern and central Gulf of Maine. This is supported by no observed fishery interactions or or reported entanglements in these waters over a period of 12 or more years (NMFS NEFSC FSB 2015; STDN 2014). Therefore, the proposed alternatives in the central Gulf of Maine sub-region are likely to result in negligible impacts to any hard shelled sea turtle species.

Although hard-shelled sea turtles are rare to non-existent in the central Gulf of Maine, leatherback sea turtles are known to occur in more northern waters and in fact, have been observed in the eastern and central Gulf of Maine, albeit in low numbers relative to their presence in other sub-regions, such as the western Gulf of Maine (e.g., Cape Cod Bay) and Southern New England (Nantucket Sound and Buzzards Bay; NMFS and USFWS 1992; James et al. 2005; James et al. 2006; Dodge et al. 2014; Dodge et al. 2015; Eckert et al. 2006; Murphy et al. 2006; NMFS and USFWS 1992, 1998a; STDN 2014). As a result, the remainder of this section will discuss potential impacts of the proposed alternatives in the eastern and central Gulf of Maine sub-regions on leatherback sea turtles.

Trap, gillnet, purse seine, clam or scallop dredge, mid-water trawl, and shrimp bottom trawl gear are used to prosecute fisheries in the eastern Gulf of Maine. Leatherback sea turtles have never been observed or documented to interact with shrimp bottom trawl, clam dredge, or purse seine gear (NMFS NEFSC FSB 2015; see Volume 1, section 4.8.3.2). Albeit possible, interaction risks with mid-water trawls and gillnet gear are expected to be low based on the few numbers of interactions observed with this gear type over the last 25 years. For example, between 1989-2014, five sea turtles observed in mid-water trawl fishery; five sea turtles observed in gillnets; NMFS NEFSC FSB 2015; see Volume 1, section 4.8.3.2. Leatherback sea turtles are known; however, to be vulnerable to interactions with trap gear. As noted in Volume 1, section 4.8.3.2, NMFS Northeast Region Sea Turtle Disentanglement Network's (STDN) database, a component of the Sea Turtle Stranding and Salvage Network, provides the most complete dataset on sea entanglements. Based on information provided in this database, between 2002 and 2013, a total of 263 sea turtle entanglements in vertical line gear were reported to the STDN and NMFS GARFO. A number of these reported incidences were documented in waters of the Eastern Gulf of Maine, although, much fewer than those reported in waters of the Weastern Gulf of Maine and Southern New England.

The greatest risk for leatherback sea turtles in the eastern Gulf of Maine is that the alternatives proposed for this area would change the distribution and quantity of trap gear in the area. Specifically, if any of the alternatives resulted in: (1) Gear likely to interact with leatherback sea turtles (trap gear, gillnet, or midwater trawl) being more widely distributed and/or concentrated in the eastern Gulf of Maine relative to current conditions; (2) a shift in effort into waters where there is a high incidence of observed or documented leatherback interactions with those gears (e.g., Western Gulf of Maine and Southern New England); and/or (3) a shift in effort of those gears into waters with an already high co-occurrence of gear and leatherbacks (e.g., western Gulf of Maine and southern New England), then interaction risks for leatherbacks would likely increase, resulting in negative impacts to this species. However, fishing effort, including distribution of gear and quantity of gear, is not expected to change substantially under any alternative proposed for the eastern Gulf of Maine. As a result, none of the proposed alternatives are expected to introduce any new interaction risks to these species that would result in animals experiencing levels of serious injury or mortality above and beyond current conditions.

Further, none of the proposed alternatives are expected to change fishing operations to an extent not previously consider by NMFS in its assessment of fishery interaction risks and impacts to this and other protected species (NMFS 2002, NMFS 2012a, NMFS 2013; NMFS 2014a). Specifically, two recent biological opinions, NMFS (2013) and NMFS (2014a), which take into consideration the same spatial context as this amendment and its specific sub-regions, as well as the operation of fisheries prosecuting the gear types of concern for leatherbacks in the affected area (specifically trap gear), determined that these fisheries and gear types may affect, but will not jeopardize the species. Note that each opinion authorizes take of listed species, including leatherback sea turtles. These recent opinions take into consideration operation of fisheries both in past and current context, and the alternatives proposed do not change or modify any of the operation of fisheries in the eastern Gulf of Maine or gear use in this or surrounding areas that were not previously considered in these opinions. The alternatives proposed for the eastern Gulf of Maine do not appear to introduce new risks or take to leatherback or any sea turtle species that have not already been considered and authorized by NMFS to date (NMFS 2013, NMFS 2014a). As a result, the proposed alternatives for the eastern Gulf of Maine are not, as concluded in the 2013 and 2014 opinions, expected to result in levels of take that would jeopardize the continued existence of leatherback sea turtles or any other ESA-listed species. For these reasons, it is expected that impacts to sea turtles from any of the proposed alternatives for the eastern GOM would be slightly negative to neutral. As there is no information to demonstrate that one alternative might result in more positive or more negative impacts to sea turtles, any alternative, relative to another, would result in neutral impacts to sea turtles.

5.1.1.3 *Impacts to Atlantic sturgeon and Atlantic salmon*

As summarized in Volume 1, sections 4.8.2.5 and 4.8.2.6, Atlantic sturgeon and Atlantic salmon are found throughout the Gulf of Maine, and therefore, these species are likely to co-occur with fisheries operating in the eastern Gulf of Maine. Of the gear types potentially used in the area (see section 4.2.1), gillnet and bottom trawl gear pose the greatest interaction risk to these species (see Volume 1, sections 4.8.3.3 and 4.8.3.4). Interactions with the other gear types potentially used in the eastern Gulf of Maine (trap, purse seine, clam or scallop dredge, mid-water trawl) are rare to non-existent (see Volume 1 sections 4.8.3.3 and 4.8.3.4) and therefore, do not pose a serious interaction risk to Atlantic sturgeon and Atlantic salmon. As described in section 4.2.1, bottom trawl gear is rarely used in the eastern Gulf of Maine, and although gillnet gear is used predominantly in the Toothaker Ridge HMA, relative to the entire Gulf of Maine, gillnet gear is used minimally to prosecute fisheries in this sub-region. Based on this informationinteraction risks with Atlantic sturgeon and Atlantic salmon are expected to be low in this region. Trap gear, a gear type not known to pose a risk to these species, is the predominant gear type used to prosecute fisheries in the eastern Gulf of Maine. This is further substantiated by records of observed Atlantic sturgeon and Atlantic salmon interactions with fishing gear. Since 1989, in the northeast region, there has been no observed Atlantic salmon or Atlantic sturgeon interactions with trap gear, and within the area defined as the eastern Gulf of Maine, only one observed Atlantic salmon interaction with gillnet gear.

The greatest risk for these species in the eastern Gulf of Maine is that the alternatives under consideration for this area would change the distribution and quantity of gillnet and bottom trawl gear in the eastern Gulf of Maine. Specifically, if any of the alternatives resulted in: (1) Gillnet or bottom trawl gear being more widely distributed and/or concentrated in the eastern Gulf of Maine relative to current conditions; or (2) a shift in gillnet or bottom trawl effort into waters where there is a high incidence of observed Atlantic sturgeon or Atlantic salmon interactions with gillnet or bottom trawl gear (e.g. western Gulf of Maine), then interaction risks for Atlantic sturgeon or Atlantic salmon would likely increase, resulting in negative impacts to these species. However, as described in section 4.2.1, fishing behavior and effort, including distribution of gear, type of gear, and quantity of gear, is not expected to change substantially under any alternative considered within the eastern Gulf of Maine. Fishing behavior and effort are expected to remain equal to status quo conditions and as a result, none of the alternatives are expected to change the presence, quantity, or degree of gillnet or bottom trawl gear use in this sub-region.

Thus, none of the eastern Gulf of Maine alternatives are expected to introduce any new interaction risks to these species that would result in animals experiencing levels of serious injury or mortality above and beyond current conditions. Further, none of the alternatives are expected to change fishing operations to extent not previously consider by NMFS in its assessment of fishery interaction risks and impacts to these and other protected species (NMFS 2012a,b , NMFS 2013). Specifically, NMFS (2012a) and NMFS (2013) biological opinions, which take into consideration the same spatial context of this amendment and its specific sub-regions, as well as the operation of fisheries prosecuting the gear types of concern for Atlantic sturgeon and Atlantic salmon in the affected area, determined that these fisheries and gear types may affect, but will not jeopardize the species. Note that each opinion authorized take of listed species, including Atlantic salmon and/or Atlantic sturgeon. These recent opinions take into consideration operation of fisheries both in past and current context, and the alternatives under consideration do not change or modify any of the operation of fisheries in the eastern Gulf of Maine or gear use in this or surrounding areas that were not previously considered in these opinions. The alternatives under consideration for the eastern Gulf of Maine do not appear to introduce new risks or take to Atlantic sturgeon and Atlantic salmon that have not already been considered and authorized by NMFS to date (NMFS 2012a, NMFS 2013). As a result, the alternatives for the Eastern Gulf of Maine are not, as concluded in the 2012(a) and 2013 opinions, expected to result in levels of take that would jeopardize the continued existence of Atlantic sturgeon, Atlantic salmon or any other ESA listed species for that matter. Therefore, it is expected that impacts to Atlantic sturgeon or Atlantic salmon from any of the proposed alternatives for the eastern GOM would be slightly negative to neutral. As there is no information to demonstrate that one alternative might result in more positive or more negative impacts to Atlantic sturgeon or Atlantic salmon, any alternative, relative to another, would result in neutral impacts to Atlantic sturgeon or Atlantic salmon.

5.1.2 Central Gulf of Maine

There are four habitat management alternatives for the Central Gulf of Maine sub-region: (1) no action Cashes Ledge and Jeffreys Bank Habitat Closure Areas and no action Cashes Ledge Groundfish Closed Area, (2) no HMAs, (3) modified Cashes Ledge, Ammen Rock, modified Jeffreys Bank, Fippennies Ledge, and Platts Bank and (4) Modified Cashes Ledge, Ammen Rock, and Modified Jeffreys Bank. For alternatives 3 and 4, each area except Ammen Rock, which would be closed to all fishing except lobster trapping, could have any one of the four gear restriction options. The Council’s preferred alternative combines elements of Alternative 1 and Alternative 3, specifically including the Cashes Ledge Closure Area, modified Jeffreys Bank and Cashes Ledge HMAs, and new HMAs on Ammen Rock and Fippennies Ledge.

5.1.2.1 *Impacts to marine mammals*

ESA and non-ESA listed species of marine mammals are known to occur in waters of the central Gulf of Maine. Of the gear types potentially used in the sub-region, gillnet, purse seine, and bottom trawl gear pose the greatest interaction risk to small cetaceans and pinnipeds, while trap and gillnet gear pose the greatest interaction risk to large whales (Waring et al. 2014; Waring et al.2015; Johnson et al. 2005; NMFS 2014a,c; see Volume 1, section 4.8.3.1). Interactions with the other gear types used in the area, i.e. scallop dredge and shrimp bottom trawl, are non-existent and therefore, do not pose a serious interaction risk to any species of marine mammal (Johnson et al. 2005; NMFS 2014a,c; Kenney and Hartley 2001; Hartley et al. 2003; Whittingham et al. 2005a,b; Waring et al. 2014; Waring et al. 2015; see Northeast Fisheries Observer Program:Incidental Take Reports[7]; see Volume 1, section 4.8.3.1). These latter gear types will not be considered further in the analysis as any potential impacts with these gear types, regardless of alternative, is expected to be negligible.

Based on over ten years of observer data, the central Gulf of Maine sub-region has a low incidence of small cetacean and pinniped interactions with sink gillnet, bottom trawl, and purse seine gear (Waring et al. 2014; Waring et al. 2015; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; http://www.nefsc.noaa.gov/fsb/take_reports/asm.html). In regards to large whales, both trap and gillnet gear are used in the central Gulf of Maine, and therefore, interaction risks to these species are present (NMFS 2014a; Waring et al. 2014; Waring et al. 2015; see

[7] Northeast Fisheries Observer Program:Incidental Take Reports can be found at the following website: http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; http://www.nefsc.noaa.gov/fsb/take_reports/asm.html

http://www.greateratlantic.fisheries.noaa.gov/Protected/whaletrp/). However, delineating particular sub-regions of the Northwest Atlantic as having high or low incidences of large whale entanglements is not possible at this time. Although large whale entanglements are reported, and databases exist on these entanglements, the first sighting of a large whale entanglement does not necessarily equate to the origin of the entanglement as the animal often travels some distance before the discovery of the incident.

5.1.2.1.1 Alternative 1/No Action

Under Alternative 1, the Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas will remain closed and fishery operations in the central Gulf of Maine will remain similar to status quo operating conditions.

As Alternative 1 will maintain current fishing restrictions, interaction risks to marine mammals in this sub-region are not expected to change substantially from what has been observed to date. Specifically, fishing behavior and effort are expected to remain relatively equal to status quo conditions. Therefore, Alternative 1 is not expected to introduce any new interaction risks to marine mammal species that would result in elevated levels of interactions above and beyond that which have been observed and considered by NMFS to date (Waring et al. 2014; Waring et al. 2015; NMFS 2002; NMFS 2012a; NMFS 2013; NMFS 2014a; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; www.nefsc.noaa.gov/fsb/take_reports/asm.html). Specifically, Alternative 1 is not expected to change fishing operations to extent not previously consider by NMFS in its assessment of fishery interaction risks and impacts to marine mammals (Waring et al. 2014, Waring et al. 2015, NMFS 2002; NMFS 2012a; NMFS 2013; NMFS 2014a). As provided in Waring et al. (2014, 2015), aside from North Atlantic right, humpback, and fin whales, harbor porpoise, and several stocks of bottlenose dolphin, there has been no indication that takes of marine mammals in commercial fisheries have exceeded potential biological removal thresholds, and therefore, gone above and beyond levels which would result in the inability of each species' population to sustain itself (Waring et al. 2014, 2015). Although, as noted above, several species of large whales, harbor porpoise and several stocks of bottlenose dolphin have experienced levels of take that have resulted in the exceedance of each species potential biological removal threshold, take reduction plans have been implemented to reduce bycatch in the fisheries affecting these species (i.e., Atlantic Large Whale Take Reduction Plan, Harbor Porpoise Take Reduction Plan, and the Bottlenose Dolphin Take Reduction Plan; see details in Volume 1). These plans are still in place and are continuing to assist in decreasing bycatch levels for these species. Although the information presented in Waring et al. (2014, 2015) is a collective representation of commercial fishery interactions with marine mammals, and does not address the effects of any fishery management plan specifically, the information does demonstrate that fishery operations over last five or more years have not resulted in a collective level of take that threatens the continued existence of marine mammal populations (aside from those species noted above). Based on this information, there is no indication that fishing operations in the central Gulf of Maine to date have resulted in levels of take above and beyond those already considered by NMFS (Waring et al. 2014, Waring et al. 2015; NMFS 2002; NMFS 2012a; NMFS 2013, NMFS 2014a). As a result, status quo conditions, and maintenance of these conditions, are not expected to result in levels of take that will affect the continued existence of marine mammals. For these reasons, Alternative 1/No Action is not expected to introduce any new risks to these species that have not previously been considered.

In conjunction with the above, additional analysis on the impacts of the operation of fisheries in the Northeast region have also been conducted by NMFS, pursuant to section 7 of the ESA, for ESA-listed species of marine mammals. In biological opinions issued for specific FMPs in 2002, 2012(a), 2013, and 2014a, NMFS concluded that the operation of these FMPs in the region, including those identified in the amendment, may affect, but will not jeopardize the continued existence of, any ESA-listed species of marine mammals. Since issuance of these opinions, there has been no indication that these fisheries have changed in any significant manner such that the level of marine mammal interactions has gone above and beyond those considered by NMFS in its assessments of fisheries effects on listed species (if they had, NMFS would have again reinitiated the opinions). As Alternative 1 will essentially maintain status quo conditions, impacts to ESA-listed species of marine mammals under Alternative 1 are not expected to be different from those already considered by NMFS (NMFS 2002; NMFS 2012a; NMFS 2013; NMFS 2014a). Therefore, Alternative 1 is not expected to result in interactions levels that would jeopardize the continued existence of ESA listed species of marine mammals.

Based on the above information, and the fact that all fisheries in the central Gulf of Maine must comply with existing Atlantic Large Whale Take Reduction Plan and Harbor Porpoise Take Reduction Plan regulations, impacts to marine mammals (both listed and non-listed) are expected to range from slightly negative to neutral. Relative to Alternatives 2, 3, or 4, Alternative 1 will result in neutral to slightly more negative impacts to marine mammals as it does not afford any potential positive impacts to marine mammals that are provided under Alternatives 2, 3, or 4 (see sections for Alternative 2 and Alternative 3-4 for details). The preferred alternative which combines elements of Alternatives 1 and 3 is expected to have similar impacts to Alternative 1/No Action, which maintains the year-round groundfish closure and associated fixed gear restrictions.

5.1.2.1.2 Alternative 2

Alternatives 2 will remove the existing Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas, which has the potential to change the distribution and/or quantity of fishing effort with some gear types within the central Gulf of Maine sub-region. Specifically, in terms of gear at greatest risk of interacting with marine mammals, opening the closed areas has the potential to change gillnet and bottom trawl gear distribution and/or quantity in this sub-region. Changes in trap gear or purse seines are not expected (see below for details). Several potential scenarios are possible: 1) Existing vessels shift into the now open areas, resulting in a more widespread distribution of vessels. This could result in a change in gear (gillnet and/or bottom trawl) distribution, but not quantity. (2) A shift in gillnet and/or bottom trawl effort from surrounding sub-regions could occur, resulting in more vessels and gear in the central Gulf of Maine sub-region.

If we consider scenario one, impacts to marine mammals are not expected to be any greater than those experienced under status quo conditions, and in fact, may provide some slightly positive impacts to marine mammals. The same number of vessels currently fishing in the central Gulf of Maine sub-region (specifically the waters in and around the closed areas) are expected to remain under this scenario and therefore, the same number of gillnets or bottom trawls are expected to be set or towed in the sub-region as under status quo conditions; the only change will be the distribution of the gear fished, not the quantity. Specifically, opening the Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas is likely to result in existing vessels shifting effort, and thus gear, into the waters in and around these once-closed areas. As provided above, over the last ten years, marine mammal interactions with gillnet and bottom trawl gear are infrequent in the central Gulf of Maine and thus, there is no information to suggest that bycatch rates within the Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas are higher than areas immediately adjacent to the closures. As such, if effort is simply redistributed from outside the areas to within, we would not expect impacts to marine mammals to increase. Also, as only the distribution of gear is expected to change, the co-occurrence between gear and marine mammals will remain similar to that which has been observed to date in this sub-region (Waring et al. 2014; Waring et al. 2015; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; http://www.nefsc.noaa.gov/fsb/take_reports/asm.html), and therefore, new or additional gear interaction risks to marine mammals are not expected.

Further, under scenario 1, depending on the overall status of fish stocks and resultant fishery allocations, re-opening closed areas may not provide sufficient incentive for existing vessels to change their behavior relative to status quo conditions. If some stocks are more abundant in the closures, and vessels have sufficient quota to target those stocks, activity in the closures could increase. If catch per unit effort is higher inside the closure areas than outside, this could result in less fishing time overall for certain target species. As interactions with protected species, including marine mammals, are strongly associated with the amount of gear fished and duration of fishing time, increasing efficiency is likely to result in a decrease in the interaction risks to marine mammals, if overall quotas are held constant. This could generate slightly positive impacts to marine mammals. Conversely, if a stock is not more abundant within the closures, or if stock status is poor, there would not be an incentive to direct additional effort into reopened areas. Under these conditions, impacts to marine mammals are not expected to differ substantially from status quo conditions (i.e., slightly negative to neutral). Overall, under scenario 1, impacts to marine mammals could range from slightly negative to slightly positive.

Under the second scenario, vessels from the eastern Gulf of Maine, western Gulf of Maine, Great South Channel/Southern New England, or Georges Bank sub-regions could shift effort into the central Gulf of Maine to take advantage of newly accessible fishing grounds, resulting in a net increase in effort within the central Gulf of Maine. Increased effort in the central Gulf of Maine could increase interaction risks to marine mammals within the sub-region. However, an important consideration in terms of overall impacts to marine mammals is where effort is shifting to and from. If vessels from the western Gulf of Maine, Georges Bank, or Great South Channel/Southern New England shift effort into the central Gulf of Maine, effort is shifting from an area of high observed/recorded bycatch (western Gulf of Maine and Southern New England) to an area with low observed marine mammal bycatch (central Gulf of Maine, including areas within and around existing closed areas). Under this consideration, overall impacts to marine mammals could be slightly positive as the resultant change in fishing behavior shifts gear out of a an area with a high interaction risk. Although this shift in fishing behavior from a high bycatch area to a low bycatch area wouldn't eliminate take of marine mammals in the high or even the low risk area, some reduction in overall bycatch is possible as effort, and therefore, co-occurrence of gear and marine mammals, has been reduced in the high risk area. Another important consideration in terms of overall impacts to marine mammals is status of fish stocks, and therefore, fishery allocations. In particular, if particular target stocks are overfished, fishery allocations for these stocks will likely constrain fishing effort. As a result, any incentive for vessels operating in other sub-regions to redirect effort into the central Gulf of Maine may be lacking and in fact, may deter any shift in effort. If there is no incentive to shift effort into the central Gulf of Maine, interaction risks and impacts to marine mammals are likely to be no greater than those provided in scenario 1 above (i.e., slightly negative to slightly positive impacts).

Trap gear and purse seines, other gear types in the central Gulf of Maine that have the potential to interact with marine mammals, have never been restricted in the Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas. Thus, fishing behavior, including distribution of gear, has been established in these waters regardless of these closures. Therefore, removing the closed areas is not expected to change the quantity or distribution of these gear types relative to status quo conditions. As a result, regardless of whether the closed areas remain in existence or not, new or increased interaction risks with trap gear or purse seines are not likely to be experienced by marine mammals in the central Gulf of Maine sub-region. Overall impacts to marine mammals, therefore, are not expected to be any greater than those experienced under status quo conditions (i.e., slightly negative to neutral).

In summary, the impacts of Alternative 2 to marine mammals will be highly dependent on how fishing behavior in the central Gulf of Maine and surrounding sub-regions reacts to opening of existing closures. As these shifts are difficult to predict, it is not possible to definitively state what impacts to marine mammals will be. It is also important to note that the currently designated closed areas were not created to protect marine mammals, so removing these areas does not equate to the removal of marine mammal protected areas designated per the Marine Mammal Protection Act. Measures to reduce marine mammal gear interactions, and thus, reduce incidences of serious injury and mortality to these species, are in existence via the regulations and management areas established under the Marine Mammal Protection Act's HPTRP and ALWTRP. Although the management areas and regulations of the HPTRP and ALWTRP overlap with many designated habitat or groundfish closed areas in the Northwest Atlantic, they were not predicated on the fishery management closures and stand on their own. Further, although the HPTRP and ALWTRP are specific to particular marine mammal species, their purpose and associated regulations have indirect benefits to co-occuring marine mammal species. As a result, regardless of the whether the Closed Areas remain in existence, existing Marine Mammal Protection Act areas and their associated restrictions will remain in the central Gulf of Maine. Based on this and the best available information, we expect that impacts will range from slightly negative to slightly positive. Relative to Alternative 1, Alternative 2 is expected to provide neutral to slightly positive impacts to marine mammals; however, relative to Alternatives 3 or 4, impacts of Alternative 2 on marine mammals are expected to be neutral.

5.1.2.1.3 Alternatives 3-4

Under Alternatives 3-4, existing closed areas in the central Gulf of Maine will be removed or modified, and various new HMAs are proposed. Options under these alternatives may prohibit mobile bottom-tending gear, or require modifications to mobile bottom tending gear operating in the HMAs. All other fixed or non-bottom tending gear could be used in the proposed HMAs with no restrictions (apart from the Ammen Rock HMA, which would be closed to all types of fishing gear except for lobster traps). Potential effort shifts, including changes in gear distribution and quantity, are expected to be similar to that described for Alternative 2, with the exception that bottom trawl gear would be prohibited within the HMAs. Potential shifts in effort are not expected to be any greater than those identified under Alternative 2. As a result, impacts to marine mammals, regardless of alternative (3 or 4), are expected to be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3 or 4 are expected to result in neutral to slightly positive impacts to marine mammals; however, relative to Alternative 2, Alternatives 3 or 4, are expected to have neutral impacts on marine mammals. Relative to each other, Alternatives 3 or 4, would result in neutral impacts to marine mammals as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to marine mammals.

5.1.2.2 ***Impacts to sea turtles***

The distribution of sea turtles in the central and eastern Gulf of Maine is described in section 5.1.1.2 above. Leatherbacks are the only species likely to occur in any numbers in the sub-region, and will be discussed further below.

The primary gear types used to prosecute fisheries in the central Gulf of Maine include bottom trawl, sink gillnet, and purse seines; trap gear, shrimp bottom trawl, and scallop dredge gear are used to a lesser extent. Leatherback sea turtles have never been observed or documented to interact with shrimp bottom trawl, purse seine, or scallop dredge gear (NMFS NEFSC FSB 2015). Albeit possible, interaction risks with bottom trawl gear are expected to be low based on the small numbers of interactions observed with this gear type over the last 25 years. In particular, between 1989 and 2014, six leatherback sea turtles were observed in bottom trawl gear (NMFS NEFSC FSB 2015), and none of these interactions were observed in the central Gulf of Maine. Leatherback sea turtles are known, however, to be vulnerable to interactions with vertical lines associated with fixed fishing gear, such as trap gear and gillnet gear. NMFS Northeast Region Sea Turtle Disentanglement Network's (STDN) database, a component of the Sea Turtle Stranding and Salvage Network, provides the most complete dataset on sea entanglements. Based on information provided in this database, between 2002 and 2013, a total of 225 confirmed leatherback sea turtle entanglements in vertical line gear were reported to the STDN and NMFS GARFO; 126 cases were associated with trap gear and 99 cases were vertical line entanglements attributed to unknown gear types (STDN 2014). Most of these reported incidences were documented in waters of the Western Gulf of Maine and Southern New England (172 cases total), and to a lesser extent near shore waters of Eastern Gulf of Maine (23 cases) and the Mid-Atlantic (30 cases); no incidences were reported in the central Gulf of Maine (STDN 2014).

5.1.2.2.1 Alternative 1/No Action

Under Alternative 1, the Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas will remain closed and fishery operations in the central Gulf of Maine will remain similar to status quo operating conditions.

As Alternative 1 will maintain status quo gear restrictions, and there is no information to date to suggest any variation in the distribution or occurrence of leatherback sea turtle species in the central Gulf of Maine, interaction risks to leatherback sea turtles in this sub-region are not expected to change substantially from what has been observed to date in this region. Specifically, fishing behavior and effort are expected to remain similar to status quo conditions and as a result, Alternative 1 is not expected to change the presence, quantity, or degree of bottom trawl or other gear types used in this sub-region. Therefore, Alternatives 1 is not expected to introduce any new interaction risks to sea turtle species that would result in animals experiencing levels of serious injury or mortality above and beyond current conditions. Further, none of the proposed alternatives are expected to change fishing operations to extent not previously considered by NMFS in its assessments of fishery interaction risks and impacts to these and other protected species (NMFS 2012a,b, NMFS 2013). Specifically, NMFS (2013), NMFS (2012a) and NMFS (2014a) biological opinions, which take into consideration the same spatial context of the Amendment, as well as the operation of fisheries prosecuting the gear types of concern for leatherback sea turtles (e.g.., pot, gillnet, bottom trawl), determined that these fisheries and gear types may affect, but will not jeopardize the continued existence of any sea turtle species, including leatherback sea turtles. Each opinion authorized take of leatherback, as well as other listed species of sea turtles. As these recent opinions take into consideration operation of fisheries both in past and current context, and Alternative 1 does not modify fishing restrictions in the central Gulf of Maine, Alternatives 1 does not introduce new interaction risks to any sea turtle species that have not already been considered by NMFS to date (NMFS 2013, NMFS 2012a, NMFS 2014a). As a result, Alternatives 1 for the central Gulf of Maine is not expected to result in levels of take that would jeopardize the continued existence of any listed sea turtle species. For these reasons, impacts to leatherback sea turtles from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2, 3, or 4, Alternative 1 will result in neutral to slightly more negative impacts to sea turtles as it does not afford any potential positive impacts to sea turtles that are provided under Alternatives 2, 3, or 4 (see sections for Alternative 2 and Alternative 3-4 for details).

5.1.2.2.2 Alternative 2

Alternative 2 will remove the existing year-round groundfish and habitat closed areas in the central Gulf of Maine. Removing these closures has the potential to change the distribution and/or quantity of some gear types in the central Gulf of Maine. Specifically, in terms of gear at risk of interacting with leatherback sea turtles, opening the closed areas has the potential to change gillnet and/or bottom trawl gear distribution and/or quantity in this sub-region; however, changes in trap gear are not expected (see below for details). Two scenarios are possible: 1) existing vessels shift into the now open areas, resulting in a more widespread distribution of vessels. This could result in a change in gear (bottom trawl and/or gillnet) distribution, but not quantity in the sub-region; and/or (2) bottom trawl and/or gillnet effort from surrounding sub-regions may move into the central Gulf of Maine, resulting in more gear in the central Gulf of Maine.

Under the first scenario, impacts to sea turtles are not expected to be any greater than those experienced under status quo conditions. The same number of gillnets or trawls are expected to be set or towed in the sub-region as under status quo conditions; the only change would be the distribution of the gear fished, not the quantity. Specifically, opening the Cashes Ledge Closure

Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas are likely to result in existing vessels shifting effort, and thus gear, into prior closures. Over the last 25 years, observed leatherback sea turtle interactions with bottom trawl or gillner gear are rare, and have never been observed in the central Gulf of Maine. Similarly, leatherback entanglements have never been reported in the central Gulf of Maine. Further, there is no information to suggest that bycatch rates within the central Gulf of Maine closed areas would be higher than areas immediately adjacent to the closures. As such, if effort is simply redistributed from outside the areas to within, there is no reason to expect impacts to leatherback sea turtles to increase. Also, as the distribution and occurrence of leatherback sea turtles are not expected to change substantially in the central Gulf of Maine, and only the distribution of gear is expected to change under Alternative 2, the co-occurrence between gear and sea turtles is expected to remain similar to what has been observed to date in this sub-region (NMFS NEFSC FSB 2015; STDN 2014; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; http://www.nefsc.noaa.gov/fsb/take_reports/asm.html). As a result, new or additional gear interaction risks to leatherback sea turtles are not expected. Based on this information and considerations, impacts to leatherback sea turtles under scenario 1 are expected to be slightly negative to neutral.

Under the second scenario, vessels from Georges Bank, Great South Channel/Southern New England, eastern Gulf of Maine, or the western Gulf of Maine could shift effort into the central Gulf of Maine to take advantage of newly accessible fishing grounds, resulting in an increase in the number of bottom trawl or gillnets towed or set in this sub-region. Specifically, the shift in effort from surrounding sub-regions is likely to be directed into the waters in and around the existing closed areas. Although interactions with leatherback sea turtles occurring in the central Gulf of Maine have the potential to increase any potential increase in interactions is not expected to be significant relative to current conditions, owing to (1) the infrequent overlap of fishing effort and leatherback sea turtle distribution that has been observed in this sub-region over the last 25 years, and (2) the likelihood that the distribution and occurrence of leatherback sea turtles will remain similar to current conditions. As a result, although it could increase relative to Alternative 1, the level of co-occurrence between gear and leatherback sea turtles is expected to remain low for this sub-region relative to areas where leatherback sea turtles are more common (i.e., western Gulf of Maine, Southern New England). Therefore, interaction rates are not expected to go above and beyond levels that have been previously observed in this sub-region and thus, impacts to leatherback sea turtles are expected to be slightly negative to neutral.

However, another consideration under this scenario is whether opening the closed areas provides incentives for vessels to shift effort away from sub-regions where leatherback sea turtles are more commonly observed or reported as bycatch (i.e., western Gulf of Maine, Southern New England; STDN 2014; NMFS NEFSC FSB 2015). Overall impacts to leatherback sea turtles could be slightly positive if gear is shifted from a high interaction risk area (e.g., western Gulf of Maine, Southern New England) to an area with low interaction risks (e.g., central Gulf of Maine). Although this shift in fishing behavior will not eliminate the potential take of leatherback sea turtles in the high or even the low risk area, some reduction in overall bycatch is possible. However, fishing effort shifts from surrounding sub-regions into the central Gulf of Maine are only likely to occur if target stock status supports them. If stock conditions are poor, fishery allocations for these stocks will likely constrain fishing effort. As a result, any incentive for vessels operating in other sub-regions to redirect effort into the central Gulf of Maine may be lacking and in fact, may deter any shift in effort. Should this occur, interaction risks and impacts to leatherback sea turtles are likely to be no greater than those provided in scenario 1 above (i.e., slightly negative to neutral).

Pot gear has not been restricted within the existing central Gulf of Maine closed areas, so fishing behavior, including distribution of gear, has been well established regardless of area closures. Removing closed areas, therefore, is not expected to change the quantity or distribution of trap gear in this sub-region relative to status quo conditions. As a result, regardless of whether the closed areas remain in existence or not, new or increased interaction risks with trap gear are not likely to be experienced by leatherback sea turtles in the central Gulf of Maine. Overall impacts to leatherback sea turtles, therefore, are not expected to be any greater than those experienced under status quo conditions (i.e., slightly negative to neutral).

Based on the information and associated analysis provided above, we expect that the impacts of Alternative 2 to leatherback sea turtles will be highly dependent on how fishing behavior in the central Gulf of Maine and surrounding sub-regions reacts to opening existing closed areas. As such shifts are difficult to predict, it is not possible to definitively state what impacts to leatherback sea turtles will be; however, impacts will likely range from slightly negative to slightly positive. Relative to Alternative 1, Alternative 2 is expected to provide neutral to slightly positive impacts to sea turtles; however, relative to Alternatives 3 or 4, impacts of Alternative 2 on sea turtles are expected to be neutral.

5.1.2.2.3 Alternatives 3-4

Under Alternatives 3-4, existing closed areas in the central Gulf of Maine will be removed or modified, and various new HMAs are proposed. Options under these alternatives may prohibit mobile bottom-tending gear, or require modifications to mobile bottom tending gear operating in the HMAs. All other fixed or non-bottom tending gear could be used in the proposed HMAs with no restrictions (apart from the Ammen Rock HMA, which would be closed to all types of fishing gear except for lobster traps). Potential effort shifts, including changes in gear distribution and quantity, are expected to be similar to that described for Alternative 2, with the exception that bottom trawl gear would be prohibited within the HMAs. Potential shifts in effort are not expected to be any greater than those identified under Alternative 2. As a result, impacts to leatherback sea turtles, regardless of alternative (3 or 4), are expected to be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3 or 4 are expected to result in neutral to slightly positive impacts to sea turtles; however, relative to Alternative 2, Alternatives 3 or 4, are expected to have neutral impacts on sea turtles. Relative to each other, Alternatives 3 or 4, would result in neutral impacts to sea turtles as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to sea turtles.

5.1.2.3 *Impacts to Atlantic sturgeon*

As summarized in Volume 1, section 4.8.2.5, Atlantic sturgeon are found throughout the Gulf of Maine (ASSRT 2007). Based on fishery independent and dependent data, as well as data collected from marine tracking and tagging studies, Atlantic sturgeon appear to primarily occur inshore of the 50 meter 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). Based on this information, Atlantic sturgeon are not expected to be common in the central Gulf of Maine; this is supported by the lack of observed Atlantic sturgeon fishery interactions in this sub-region over the last 25 years (NMFS NEFSC FSB 2015).

Based on observed gear interactions, of the gear types potentially used in the central Gulf of Maine, gillnet and bottom trawl gear pose the greatest interaction risk to Atlantic sturgeon (NMFS NEFSC FSB 2015; NMFS 2013; see Volume 1, section 4.8.3.3). Interactions with other gear types used in the area (pot, shrimp bottom trawl, purse seine, or scallop dredge) are rare to non-existent for this species (NMFS NEFSC FSB 2015; NMFS 2013; NMFS 2012a) and therefore, do not pose a serious interaction risk to Atlantic sturgeon. Therefore, these latter gear types will not be discussed further as neutral impacts are associated with the usage of these gears, regardless of alternative.

5.1.2.3.1 Alternative 1/No Action

Under Alternative 1, the Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas will remain closed and fishery operations in the central Gulf of Maine will remain similar to status quo operating conditions.

As Alternative 1 essentially maintains status quo conditions, interaction risks to Atlantic sturgeon in this sub-region are not expected to change substantially from what has been observed and assessed to date in this region (i.e., remain rare; see section 4.2.4.2.3; NMFS 2012a,b, NMFS 2013, NMFS 2014a). Specifically, fishing behavior and effort are expected to remain relatively equal to status quo conditions and as a result, Alternative 1 is not expected to change the presence, quantity, or degree of gillnet, bottom trawl or other gear types used in this sub-region. Therefore, Alternatives 1 is not expected to introduce any new interaction risks to Atlantic sturgeon that would result in animals experiencing levels of serious injury or mortality above and beyond current conditions. Further, Alternative 1 is not expected to change fishing operations to extent not previously consider by NMFS in its assessment of fishery interaction risks and impacts to these and other protected species (NMFS 2012a,b, NMFS 2013, NMFS 2014a). Specifically, NMFS (2013), NMFS (2012a) and NMFS (2014a) biological opinions, which take into consideration the same spatial context of the Amendment, as well as the operation of fisheries prosecuting the gear types of concern for Atlantic sturgeon (i.e., gillnet and bottom trawl), determined that these fisheries and gear types may affect, but will not jeopardize the continued existence of Atlantic sturgeon; each opinion authorized take of listed species, including Atlantic sturgeon. As these recent opinions take into consideration operation of fisheries both in past and current context, and Alternative 1 does not substantially modify any of the operations of fisheries in the central Gulf of Maine or gear use in this or surrounding sub-regions that were not previously considered in these opinions, we have determined that Alternatives 1 does not introduce new interaction risks to Atlantic sturgeon that have not already been considered by NMFS to date (NMFS 2013, NMFS 2014a). As a result, Alternatives 1, as concluded in NMFS' opinions, is not expected to result in levels of take that would jeopardize the continued existence of Atlantic sturgeon. For these reasons, and based on the fact that there is likely an infrequent overlap in fishing gear and Atlantic sturgeon distribution in the central Gulf of Maine, impacts to Atlantic sturgeon from Alternatives 1 are expected to be slightly negative to neutral. Relative to Alternatives 2, 3, or 4, Alternative 1 will result in neutral to slightly more negative impacts to Atlantic sturgeon as it does not afford any potential positive impacts to Atlantic sturgeon that are provided under Alternatives 2, 3, or 4 (see see sections for Alternative 2 and Alternative 3-4 for details).

5.1.2.3.2 Alternative 2

Alternative 2 will remove the existing year-round groundfish and habitat closed areas in the central Gulf of Maine. Removing these closures has the potential to change the distribution and/or quantity of some gear types in the central Gulf of Maine sub-region. Specifically, in terms of gear at greatest risk of interacting with Atlantic sturgeon, opening areas has the potential to change gillnet and/or bottom trawl gear distribution and/or quantity. Two scenarios are possible: 1) existing vessels shift into the now open areas, resulting in a more widespread distribution of vessels. This could result in a change in gear (bottom trawl and/or gillnet) distribution, but not quantity in the sub-region; and/or (2) bottom trawl and/or gillnet effort from surrounding sub-regions may move into the central Gulf of Maine, resulting in more gear in the central Gulf of Maine.

Under the first scenario, impacts to Atlantic sturgeon are not expected to be any greater than those experienced under status quo conditions. The same number of gillnets or trawls are expected to be set or towed in the sub-region as under status quo conditions; the only change would be the distribution of the gear fished, not the quantity. Specifically, opening the Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas are likely to result in existing vessels shifting effort, and thus gear, into prior closures. Over the last 25 years, observed Atlantic sturgeon interactions with fishing gear, including gillnet and bottom trawl gear, are non-existent in the central Gulf of Maine and thus, there is no information to suggest that bycatch rates within the closures would be higher than in areas immediately adjacent to the closures. As such, if effort is simply redistributed from outside the areas to within, we would not expect impacts to Atlantic sturgeon to increase. Further, as described previously, Atlantic sturgeon generally occur inshore of the 50 meter depth contour. In addition, significant changes in Atlantic sturgeon occurrence and distribution in the central Gulf of Maine are not expected. Thus, under this scenario, the co-occurrence of gear and Atlantic sturgeon is expected to remain infrequent and therefore, new or additional gear interaction risks to Atlantic sturgeon are not expected. Therefore, impacts to Atlantic sturgeon could range from slightly negative to neutral.

Under the second scenario, vessels from Georges Bank, Great South Channel/Southern New England, eastern Gulf of Maine, or the western Gulf of Maine could shift effort into the central Gulf of Maine to take advantage of newly accessible fishing grounds, resulting in an increase in the number of bottom trawl or gillnets towed or set in this sub-region. Specifically, the shift in effort from surrounding sub-regions is likely to be directed into the waters in and around the existing closed areas. Although interactions with Atlantic sturgeon could potentially increase in the central Gulf of Maine, substantial changes are unlikely, due to (1) the infrequent overlap between fishing effort and Atlantic sturgeon distribution observed in this sub-region over the last 25 years; and (2) the likelihood that the distribution and occurrence of Atlantic sturgeon will remain similar to current conditions. As a result, the level of co-occurrence between gear and Atlantic sturgeon is expected to remain low for this sub-region relative to areas where sturgeon are more common (i.e., inshore of the 50 meter depth contour; western Gulf of Maine, Southern New England). Therefore, under this scenario, interaction rates are not expected to go above and beyond levels that have been previously observed in this sub-region and thus, impacts to Atlantic sturgeon are expected to be slightly negative to neutral.

However, another consideration under this scenario is whether opening the closed areas provides incentives for vessels to shift effort away from sub-regions where Atlantic sturgeon are more commonly observed or reported as bycatch (NMFS NEFSC FSB 2015; Stein et al. 2004 a,b; Erickson et al. 2011; Dunton et al. 2010). If this occurred, overall impacts to Atlantic sturgeon could be slightly positive if gear shifts out of a high interaction risk area (e.g., western Gulf of Maine) to an area with low interaction risks (e.g., central Gulf of Maine). Although this shift in fishing behavior will not eliminate the potential take of Atlantic sturgeon in the high or even the low risk area, some reduction in overall bycatch is possible as effort, and therefore, co-occurrence of gear and Atlantic sturgeon, has been reduced in the high risk, inshore areas. However, fishing effort shifts from surrounding sub-regions into the central Gulf of Maine are only likely to occur if target stock status supports them. If stock conditions are poor, fishery allocations for these stocks will likely constrain fishing effort. As a result, any incentive for vessels operating in other sub-regions to redirect effort into the central Gulf of Maine may be lacking and in fact, may deter any shift in effort. Should this occur, interaction risks and impacts to Atlantic sturgeon are likely to be no greater than those provided under scenario 1 above (i.e., slightly negative to neutral).

Based on the information and associated analysis provided above, the impacts of Alternative 2 on Atlantic sturgeon will be highly dependent on how fishing behavior in the central Gulf of Maine and surrounding sub-regions reacts to reopening existing closures. As such shifts are difficult to predict, it is not possible to definitively state what impacts to Atlantic sturgeon will be; however, impacts will likely range from slightly negative to slightly positive. Relative to Alternative 1, Alternative 2 provides neutral to slightly positive impacts to Atlantic sturgeon; however, relative to Alternatives 3 or 4, impacts of Alternative 2 on Atlantic sturgeon are expected to be neutral.

5.1.2.3.3 Alternatives 3-4

Under Alternatives 3-4, existing closed areas in the central Gulf of Maine will be removed or modified, and various new HMAs are proposed. Options under these alternatives may prohibit mobile bottom-tending gear, or require modifications to mobile bottom tending gear operating in the HMAs. All other fixed or non-bottom tending gear could be used in the proposed HMAs with no restrictions (apart from the Ammen Rock HMA, which would be closed to all types of fishing gear except for lobster traps). Potential effort shifts, including changes in gear distribution and quantity, are expected to be similar to that described for Alternative 2, with the exception that bottom trawl gear would be prohibited within the HMAs. Potential shifts in effort are not expected to be any greater than those identified under Alternative 2. As a result, impacts to Atlantic sturgeon, regardless of alternative (3 or 4),are expected to be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3 or 4 are expected to result in neutral to slightly positive impacts to Atlantic sturgeon; however, relative to Alternative 2, Alternatives 3 or 4, are expected to have neutral impacts on Atlantic sturgeon. Relative to each other, Alternatives 3 or 4, would result in neutral impacts to Atlantic sturgeon as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to Atlantic sturgeon.

5.1.2.4 *Impacts to Atlantic salmon*

As summarized in Volume 1, section 4.8.2.6, Atlantic salmon are found throughout the Gulf of Maine (Kocik et al. 2014; NMFS and USFWS 2005; Fay et al. 2006). Although Atlantic salmon are known to make marine migrations across the Gulf of Maine to Canadian waters, to date, NEFOP and ASM have only documented a total of 15 individual salmon incidentally caught on over 60,000 observed commercial fishing trips from 1989 through August 2013 (NMFS 2013; Kocik et al. 2014); and only two of these observed interactions have occurred in the central Gulf of Maine. As a result, there appears to be very low co-occurrence between Atlantic salmon and fisheries operating in the central Gulf of Maine.

Based on observed gear interactions, of the gear types used in the central Gulf of Maine, gillnet and bottom trawl gear pose the greatest interaction riskto Atlantic salmon (NMFS NEFSC FSB 2015; NMFS 2013; Kocik et al. 2014; see Volume 1, section 4.8.3.4). Interactions with other gear types used in the area (pot, shrimp bottom trawl, purse seine, or scallop dredge) are rare to non-existent for this species (NMFS NEFSC FSB 2015; NMFS 2013; Kocik et al. 2014) and therefore, do not pose a serious interaction risk to Atlantic salmon. Therefore, these gear types will not be discussed further as neutral impacts are associated with the usage of these gears, regardless of alternative.

5.1.2.4.1 Alternative 1/No Action

Under Alternative 1, the Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas will remain closed and fishery operations in the central Gulf of Maine will remain similar to status quo operating conditions.

Under this alternative, interaction risks to Atlantic salmon are not expected to change substantially from what has been observed and assessed to date in this region (i.e., remain rare; see above section, and all NMFS BOs). Specifically, fishing behavior and effort are expected to remain similar to status quo conditions and as a result, Alternative 1 is not expected to change the amount of gillnet, bottom trawl or other gear types usage in this sub-region. Therefore, Alternative 1 is not expected to introduce any new interaction risks to Atlantic salmon that would result in animals experiencing levels of serious injury or mortality above and beyond current conditions. Further, Alternative 1 is not expected to change fishing operations to extent not previously consider by NMFS in its assessment of fishery interaction risks and impacts to salmon and other protected species (NMFS 2012a,b, NMFS 2013, NMFS 2014a). Specifically, three biological opinions, NMFS 2013, NMFS 2012a, and NMFS 2014a, which take into consideration the same spatial context of this amendment, as well as the operation of fisheries prosecuting the gear types of concern for Atlantic salmon (i.e., gillnet and bottom trawl), determined that these fisheries and gear types may affect, but will not jeopardize the continued existence of Atlantic salmon. Each opinion authorized take of listed species, including Atlantic salmon. As these recent opinions consider past and current fisheries operations, and Alternative 1 does not substantially change or modify the fisheries in the central Gulf of Maine, Alternatives 1 does not introduce new risks to Atlantic salmon that have not already been considered by NMFS (NMFS 2013, NMFS 2014a). As a result, Alternative 1 is not expected to result in levels of take that would jeopardize the continued existence of Atlantic salmon. For these reasons, the impacts to Atlantic salmon from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2, 3, or 4, Alternative 1 will result in neutral impacts to Atlantic salmon (see sections for Alternative 2 and Alternative 3-4 for details).

5.1.2.4.2 Alternative 2

Alternative 2 will remove the existing year-round groundfish and habitat closed areas in the central Gulf of Maine. Removing these closures has the potential to change the distribution and/or quantity of some gear types in the central Gulf of Maine sub-region. Specifically, in terms of gear at greatest risk of interacting with Atlantic salmon, opening the closed areas has the potential to change gillnet and/or bottom trawl gear distribution and/or quantity in this sub-region. Two scenarios are possible: 1) existing vessels shift into the now open areas, resulting in a more widespread distribution of vessels. This could result in a change in gear (bottom trawl and/or gillnet) distribution, but not quantity in the sub-region; and/or (2) bottom trawl and/or gillnet effort from surrounding sub-regions may move into the central Gulf of Maine, resulting in more gear in the central Gulf of Maine.

Under the first scenario, impacts to Atlantic salmon are not expected to be any greater than those experienced under status quo conditions. The same number of gillnets or trawls are expected to be set or towed in the sub-region as under status quo conditions; the only change would be the distribution of the gear fished, not the quantity. Specifically, opening the Cashes Ledge Closure Area and the Cashes Ledge and Jeffreys Bank Habitat Closure Areas are likely to result in existing vessels shifting effort, and thus gear, into prior closures. Over the last 25 years, observed Atlantic salmon interactions with fishing gear, including gillnet and bottom trawl gear, are non-existent in the central Gulf of Maine and thus, there is no information to suggest that bycatch rates within the closures would be higher than in areas immediately adjacent to the closures. As such, if effort is simply redistributed from outside the areas to within, we would not expect impacts to Atlantic salmon to increase. In addition, significant changes in Atlantic salmon occurrence and distribution in the central Gulf of Maine are not expected. Thus, under this scenario, the co-occurrence of gear and Atlantic salmon is expected to remain infrequent and therefore, new or additional gear interaction risks to Atlantic salmon are not expected. Therefore, impacts to Atlantic salmon could range from slightly negative to neutral.

Under the second scenario, vessels from Georges Bank, Great South Channel/Southern New England, eastern Gulf of Maine, or the western Gulf of Maine could shift effort into the central Gulf of Maine to take advantage of newly accessible fishing grounds, resulting in an increase in the number of bottom trawl or gillnets towed or set in this sub-region. Specifically, the shift in effort from surrounding sub-regions is likely to be directed into the waters in and around the existing closed areas. Although interactions with Atlantic salmon could potentially increase in the central Gulf of Maine, substantial changes are unlikely, due to (1) the infrequent overlap between fishing effort and Atlantic salmon distribution observed in this sub-region over the last 25 years; and (2) the likelihood that the distribution and occurrence of Atlantic salmon will remain similar to current conditions. As a result, the level of co-occurrence between gear and Atlantic salmon is expected to remain low. Therefore, under this scenario, interaction rates are not expected to go above and beyond levels that have been previously observed in this sub-region and thus, impacts to Atlantic salmon are expected to be slightly negative to neutral.

Based on the information and associated analysis provided above, we expect that the impacts of Alternative 2 on Atlantic salmon will be highly dependent on how fishing behavior in the central Gulf of Maine and surrounding sub-regions reacts to opening existing closed areas in this sub-region. As such shifts are difficult to predict, it is not possible to definitively state what impacts to Atlantic salmon will be; however, impacts will likely range from slightly negative to neutral. Relative to Alternatives 1, 3, or 4, Alternative 2 is expected to provide neutral impacts to Atlantic salmon.

5.1.2.4.3 Alternatives 3-4

Under Alternatives 3-4, existing closed areas in the central Gulf of Maine will be removed or modified, and various new HMAs are proposed. Options under these alternatives may prohibit mobile bottom-tending gear, or require modifications to mobile bottom tending gear operating in the HMAs. All other fixed or non-bottom tending gear could be used in the proposed HMAs with no restrictions (apart from the Ammen Rock HMA, which would be closed to all types of fishing gear except for lobster traps). Potential effort shifts, including changes in gear distribution and quantity, are expected to be similar to that described for Alternative 2, with the exception that bottom trawl gear would be prohibited within the HMAs. Potential shifts in effort are not expected to be any greater than those identified under Alternative 2. As a result, impacts to Atlantic salmon, regardless of Alternative (3 or 4),are expected to be similar to those described for Alternative 2 (i.e., slightly negative to neutral). Relative to Alternatives 1 or 2, Alternatives 3 or 4 are expected to result in neutral impacts to Atlantic salmon. Relative to each other, Alternatives 3 or 4, would also result in neutral impacts to Atlantic salmon as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to Atlantic salmon.

5.1.3 Western Gulf of Maine

There are eight habitat management alternatives for the Central Gulf of Maine sub-region: (1) no action Western Gulf of Maine Habitat Closure Area and Western Gulf of Maine Closure Area, (2) no HMAs, (3) Large Stellwagen HMA and Large Bigelow Bight HMA, (4) Small Stellwagen HMA, Jeffreys Ledge HMA and Large Bigelow Bight HMA, (5) Small Stellwagen HMA, Jeffreys Ledge HMA and Small Bigelow Bight HMA, (6) Large Stellwagen HMA, (7A/7B) which would implement roller gear restrictions as a habitat management measure in the existing area (A) or a modified area (B), and could be combined with one of the other alternatives, and (8) which would exempt shrimp trawls from the northwestern corner of the WGOM Habitat Closure Area, if Alternative 1/No Action was selected. For Alternatives 3-6, each management area could be implemented with one of four gear restrictions measures (Option 1, 2, 3, or 4). The preferred approach combines a modified version of Alternative 1, with the Western Gulf of Maine Closure Area boundary shifted west by five degrees, with the existing roller gear restricted area as a habitat measure (Alt. 7A), and the shrimp gear access area in the northwestern corner of the WGOM (Alt. 8). Because Alternatives 7A/7B are expected to have a very minor influence on the distribution of fishing effort in the western Gulf of Maine, impacts of these alternatives are expected to be neutral for all protected resources.

5.1.3.1 *Impacts to marine mammals*

ESA and non-ESA listed species of marine mammals (i.e., seals and cetaceans) are known to occur in waters of the Western Gulf of Maine. Of the gear types potentially used in the Western Gulf of Maine (see section 4.2.3.3), marine mammals are known to interact with gillnet, bottom trawl, mid-water trawl, purse seine, and trap gear (see Volume 1, section 4.8.3.1). Of these gear types, gillnet and bottom trawl pose the greatest risk of serious injury and mortality to small cetaceans and pinnipeds, while gillnet and trap gear pose the greatest risk of serious injury and mortality to large whales (see Volume 1, section 4.8.3.1). Interactions with the other gear types used in the area (shrimp bottom trawl clam or scallop dredge) are non-existent (see Volume 1, section 4.8.3.1) and therefore, do not pose a serious interaction risk to any specie of marine mammal; these gear types will not considered further in the analysis as any potential impacts with these gear types, regardless of Alternative, is expected to be negligible.

Based on over 10 years of observer data, the Western Gulf of Maine sub-region has a high incidence of small cetacean and pinniped interactions in gillnet gear, followed by bottom trawl gear
(see: http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html;www.nefsc.noaa.gov/fsb/take_reports/asm.html). Specifically, along the western boundary of the Habitat and Groundfish Closure Areas, numerous interactions with small cetaceans and pinnipeds, particularly harbor porpoise and harbor seals have been observed (Waring et al. 2014, Waring et al. 2015; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html;www.nefsc.noaa.gov/fsb/take_reports/asm.html); this is due to the concentration of fixed fishing gear, specifically gillnet gear, along the western boundary of the Closed Areas. Bottom trawl interactions have also frequently been observed in the Western Gulf of Maine over the last ten years as well. These interactions have primarily been observed along the eastern or western boundary of the Western Gulf of Maine Closure Area, with interactions primarily involving harbor porpoise, harbor seals, gray seals, harp seals, white sided dolphins, and pilot whales (Waring et al. 2014, Waring et al. 2015; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; www.nefsc.noaa.gov/fsb/take_reports/asm.html).

In regards to large whales, there is a co-occurrence of trap and gillnet gear in the western Gulf of Maine and therefore, interaction risks to these species (NMFS 2014a,c; Waring et al. 2014; Waring et al. 2015; see http://www.greateratlantic.fisheries.noaa.gov/Protected/whaletrp/); however, the ability to quantify this risk in the western Gulf of Maine , or any other region in the Northwest Atlantic, is not possible. Although large whale entanglements are reported, and databases exist on these entanglements, the first sighting of a large whale entanglement does not necessarily equate to the origin of the entanglement as the animal often travels some distance before the discovery of the incident. As a result, delineating particular sub-regions of the Northwest Atlantic as having high or low incidences of large whale entanglements is not possible at this time.

5.1.3.1.1 Alternative 1/No Action and Alternative 8

Under the No Action, the Western Gulf of Maine Habitat Closure Area and the Western Gulf of Maine [Groundfish] Closure Area would remain. Alternative 8 is an add-on to the No Action alternative that creates an exemption area for shrimp trawls. Although the exemption area in

Alternative 8 does represent a change from current management, under either alternative, overall fishing behavior and effort in the Northwest Atlantic is not expected to change substantially from current operating conditions; that is fishing practices, including the distribution and quantity of these gear (e.g., gillnet, pot, bottom trawl, mid-water trawl, purse seines), are not expected to differ substantially from status quo conditions under either alternative.

As Alternative 1 or 8 will essentially maintain status quo conditions, interaction risks to marine mammals in this sub-region are not expected to change substantially from what has been observed to date in this region to date. As a result, neither alternative is expected to change the presence, quantity, or degree of gillnet, pot, bottom trawl or other gear types used in this sub-region. Therefore, Alternatives 1 and 8 are not expected to introduce any new interaction risks to marine mammal species that would result in elevated levels of interactions above and beyond that which has been observed and considered by NMFS to date (Waring et al. 2014; Waring et al. 2015; NMFS 2002; NMFS 2012a; NMFS 2013; NMFS 2014a; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; www.nefsc.noaa.gov/fsb/take_reports/asm.html). Specifically, these alternatives are not expected to change fishing operations to extent not previously consider by NMFS in its assessment of fishery interaction risks and impacts to these and other protected species (Waring et al. 2014, Waring et al. 2015, NMFS 2002; NMFS 2012a; NMFS 2013; NMFS 2014a). As provided in Waring et al. (2014, 2015), aside from several large whale species (e.g., North Atlantic right, humpback, and fin), harbor porpoise, and several stocks of bottlenose dolphin, there has been no indication that takes of marine mammals in commercial fisheries has exceeded potential biological removal thresholds, and therefore, gone above and beyond levels which would result in the inability of each species population to sustain itself (Waring et al. 2014, 2015).

Although, as noted above, several species of large whales, harbor porpoise and several stocks of bottlenose dolphin have experienced levels of take that have resulted in the exceedance of each species potential biological removal threshold, take reduction plans have been implemented to reduce bycatch in the fisheries affecting these species (i.e., Atlantic Large Whale Take Reduction Plan, Harbor Porpoise Take Reduction Plan, and the Bottlenose Dolphin Take Reduction Plan see Volume 1, section 4.8.3.1 for details). These plans are still in place and are continuing to assist in decreasing bycatch levels for these species,co-occurring with the fishery closed areas in the western Gulf of Maine. Although the information presented in Waring et al. (2014, 2015) is a collective representation of commercial fishery interactions with marine mammals, and does not address the effects of any FMP specifically, the information does demonstrate that fishery operations over past five or more years have not resulted in a collective level of take that threatens the continued existence of marine mammal populations (aside from those species noted above). Based on this information, there is no indication that fishing operations in the western Gulf of Maine to date have resulted in levels of take above and beyond those already considered by NMFS (Waring et al. (2014) and Waring et al. (2015); NMFS 2002; NMFS 2012a; NMFS 2013; NMFS 2014a). As a result, we do not expect status quo conditions, and maintenance of this condition, to result in levels of take that will affect the continued existence of marine mammals. As Alternatives 1 or 8 are not expected to result in significant changes in fishing behavior from status quo conditions, neither alternative is expected to introduce any new risks to these species that have not previously been considered.

In conjunction with the above, additional analysis on the impacts of the operation of fisheries in the northeast region have also been conducted by NMFS, pursuant to section 7 of the ESA, for ESA-listed species of marine mammals. In biological opinions issued for specific FMPs in 2002, 2012(a), 2013, and 2014a, NMFS concluded that the operation of these FMPs in the region, including those identified in the amendment, may affect, but will not jeopardize the continued existence of any ESA listed species of marine mammals. Since issuance of these opinions, there has been no indication that these fisheries have changed in any significant manner such that the level of marine mammal interactions has gone above and beyond those considered by NMFS in its assessment of fisheries affects to listed species (if they had, NMFS would have re-reinitiated the opinions). As Alternative 1 or 8 will essentially maintain status quo conditions, neither alternative is expected to result in interactions with marine mammals that are above and beyond levels previously considered by NMFS. As a result, we do not expect, impacts to ESA-listed species of marine mammals under status quo conditions to be different from those already considered by NMFS (NMFS 2002; NMFS 2012a; NMFS 2013; NMFS 2014a) and therefore, we do not, as concluded by NMFS, expect either Alternative to result in interactions levels that would jeopardize the continued existence of ESA listed species of marine mammals.

The Council's preferred alternative modifies the boundary of the Western Gulf of Maine Closure Area, shifting it five minutes (approximately five nautical miles) west to match the habitat closure boundary. While there is substantial bottom trawl effort along the existing western boundary, gillnet activity is only concentrated along the eastern boundary, which would not change under the preferred approach. The boundary change will likely result in a shift of bottom trawl effort into the reopened area, and there may be a concentration of effort along the new boundary, such that the risk of mammal/trawl interaction along the western edge of the updated closure will remain similar to the current risk.

Based on the above information, and the fact that all fisheries in the western Gulf of Maine must comply with existing Atlantic Large Whale Take Reduction Plan and Harbor Porpoise Take Reduction Plan regulations, we expect impacts to marine mammals (both listed and non-listed) from Alternatives 1 and 8 to be slightly negative to neutral, even under the preferred boundary change to the Western Gulf of Maine Closure Area. Relative to Alternatives 2-6, Alternative 1 will have slightly negative impacts to marine mammals as it does not afford any potential positive impacts to marine mammals that are provided under Alternatives 2-6 (for further rationale see Alternative 2 and Alternatives 3-6 sections).

5.1.3.1.2 Alternative 2

Alternative 2 will remove the existing Western Gulf of Maine Habitat and Groundfish Closure areas in their entirety. These closed areas have been in place for almost 20 years. As a result, there is no history of marine mammal bycatch within these areas over this timeframe because fishing effort has been limited to a small sub-set of gear types. This lack of information makes it impossible to quantitatively forecast what interaction/entanglement risks will exist if the closures are opened. This section is therefore a qualitative evaluation, using the best available information, of the potential outcomes of removing the closed areas on fishing behavior and its effects on marine mammals.

Removing these closures has the potential to change the distribution and quantity of some gear types in the western Gulf of Maine. Specifically, opening the closed areas has the potential to change gillnet and bottom trawl gear distribution and quantity in this sub-region; however, changes in trap, mid-water trawl, or purse seine gear are not expected (see below for details). The latter changes may result in one of two potential scenarios: 1) Existing gillnet or bottom trawl gear shifts into the now open areas, resulting in a change in gear distribution, but not quantity in the sub-region; or (2) a shift in gillnet or trawl effort from surrounding waters into the Western Gulf of Maine , resulting in more gear in the Western Gulf of Maine.

Under the first scenario, impacts to marine mammal are not expected to be any greater than those experienced under status quo conditions (see above), and in fact, may result in some slightly positive impacts to these species if gear is less spatially concentrated. The same number of vessels currently fishing in the Western Gulf of Maine are expected to remain under this scenario and therefore, the same number of gillnets or trawls are expected to be set or towed in the sub-region as under status quo conditions; the only change will be the distribution of the gear fished, not the quantity. As described above, currently gillnet and bottom trawl gear are concentrated along the eastern and/or western boundary of the Habitat and Groundfish Closure Areas; this creates an elevated risk of entanglement as species cannot move through the area without the risk of an interaction, as is demonstrated by the numerous observed interactions with particular marine mammal species along the eastern or western border of the Closed Areas (Waring et al. 2014, Waring et al. 2015; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; www.nefsc.noaa.gov/fsb/take_reports/asm.html). However, under this scenario, opening the closed area will result in a shift in effort into the opened area resulting in the dispersion of gear that once was concentrated along the closed area border. With gear being more dispersed, a barrier to movement without incidence of entanglement has been eliminated and therefore, interactions with marine mammals are likely to decrease in that area, affording positive impacts to the species.

Under the second scenario, vessels from Georges Bank or Southern New England could shift effort into the western Gulf of Maine, resulting in an increase in the number of fishing events in the western Gulf of Maine relative to status quo conditions. As interaction risks to marine mammals are strongly associated with the amount of gear in the water and its soak/tow time, under this scenario, interaction risks may increase. Further, in waters where there has been high observed bycatch of a particular protected species, any shift in effort into these waters introduces additional risks to that species and therefore, increases the potential for interactions. As the western Gulf of Maine is an area of high observed marine mammal bycatch (see above), any shift in effort into the western Gulf of Maine has the potential to increase interactions with these species. However, an important consideration in this sub-region is, depending on the health of the fish stocks in the western Gulf of Maine and thus, quota allocations, incentive for vessels operating outside of the western Gulf of Maine to redirect effort into the western Gulf of Maine may be lacking. In fact, based on current trends for some groundfish stocks in the western Gulf of Maine, effort for many vessels has been constrained by quota allocations for those stocks in poor condition; continuation of these poor stock conditions in the western Gulf of Maine in the near future is likely to deter the latter shift in fishing behavior. As a result, although it is unlikely that scenario 2 will be experienced in this sub-region in the near term, effort shifts into the western Gulf of Maine could occur if stock conditions in this sub-region improve. Thus, assuming a worst case scenario, impacts to marine mammals are expected to be negative under scenario 2.

Pot, mid-water trawl, and purse seine gears, the other predominant gear type in the western Gulf of Maine, has never been restricted in any of the Closed areas, so fishing behavior, including distribution of gear, has been well established in the western Gulf of Maine regardless of these Closed Areas. Removing the Closed areas, therefore, is not expected to change the quantity or distribution of trap, mid-water trawl, or purse seine gears in this sub-region relative to status quo conditions. As a result, regardless of whether the closed areas remain in existence or not, new or increased interaction risks are not likely to be experienced by marine mammals in the western Gulf of Maine, and therefore, overall impacts to marine mammals are not expected to be any greater than those experienced under status quo conditions (i.e., slightly negative to neutral; see section above describing impacts of Alternatives 1 and 8).

Based on the information and associated analysis provided above, we expect that the impacts of Alternative 2 to marine mammals will be highly dependent on how fishing behavior in the western Gulf of Maine and surrounding waters reacts to opening of these Closed Areas. As this information can only be obtained and assessed once such an alternative is implemented, we cannot definitively state what impacts to marine mammals will be. It is also important to note that the currently designated Closed Areas were not created to protect marine mammals, so removing these areas does not equate to the removal of marine mammal protected areas designated per the MMPA. Measures to reduce marine mammal gear interactions, and thus, reduce incidences of serious injury and mortality to these species have been established through the HPTRP and ALWTRP. Although the management areas and regulations of the HPTRP and ALWTRP overlap with many designated Habitat or Groundfish closed areas in the Northwest Atlantic, the HPTRP an ALWTRP measures stand on their own. Further, although the HPTRP and ALWTRP are specific to particular marine mammal species, their purpose and associated regulations have indirect benefits to other marine mammal species that co-occur with those marine mammal species identified in their plans, because all mammal species have the potential for gear interactions. As a result, even if the current fishery closure areas are not maintained, existing MMPA protected areas, pursuant to the HPTRP and ALWTRP, will remain effective in the western Gulf of Maine. Considering both effort redistribution scenarios and the continuance of the MMPA area in the TRPs, impacts of Alternative 2 in the western Gulf of Maine may range from slightly negative to slightly positive. Relative to Alternative 1, Alternative 2 is expected to have negative to slightly positive impacts on marine mammals. Relative to Alternatives 3-6, Alternative 2 is expected to have neutral impacts to marine mammals.

5.1.3.1.3 Alternatives 3-6

Under Alternatives 3-6, existing Habitat and Groundfish Closure Areas will be removed, and various new HMAs are proposed in the western Gulf of Maine. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; all other fixed or non-bottom tending gear could be placed or used in any of the proposed HMAs with no restrictions. The resulting outcome of any of these alternatives/options on fishing behavior (e.g., effort shifts, gear distribution and quantity) is expected to be similar to that described for Alternative 2, with a small exception that the presence and/or distribution of trawl gear may be reduced or limited based on which alternative and option is chosen. Regardless, potential shifts in effort and the resultant distribution and quantity of gear in the western Gulf of Maine is not expected to be any greater than that described under Alternative 2, which in essence, represents the worst case scenario (i.e., no limits or restrictions on the gear type used in the sub-region) of fishing behavior in the absence of any closed areas or HMAs. As a result, impacts to marine mammals from any of the alternatives/options are expected be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3-6 are expected to result in negative to slightly positive impacts to marine mammals; however, relative to Alternative 2, Alternatives 3-6, are expected to have neutral impacts on marine mammals. Relative to each other, Alternatives 3, 4, 5, or 6, would result in neutral impacts to marine mammals as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to marine mammals.

5.1.3.2 *Impacts to sea turtles*

Seasonally, hardshelled and leatherback sea turtles are known to occur in the western Gulf of Maine (see Volume 1, section 4.8.2.4). However, the occurrence and distribution of sea turtles in this sub-region varies by species. Hard shelled sea turtles are much less common in the western Gulf of Maine than in waters of Southern New England and the Mid-Atlantic, while leatherback sea turtles are commonly found in the western Gulf of Maine, particularly in Cape Cod Bay. This variation in distribution and occurrence may in part be due to difference in thermal tolerances between leatherback and hard shelled sea turtles. Leatherback sea turtles have a greater thermal tolerance enabling a much broader distribution in the Gulf of Maine. Hard-shelled sea turtles, however, are more temperature sensitive, resulting in a much more constrained distribution, with the western Gulf of Maine and portions of Georges Bank approximating the northern limit for most hard-shelled sea turtle species (loggerheads are an exception, and feed as far north as southern Canada).

Although the western Gulf of Maine contains gear types known to pose a risk to sea turtles (i.e., gillnet, pot, scallop dredge, and bottom trawl gear; see Volume 1 section 4.8.3.2 for details), the variation in sea turtle occurrence in the Western Gulf of Maine has highly influenced the level of co-occurrence between gear and sea turtles in these waters, and therefore, incidences of sea turtle interactions in this sub-region to date. Specifically, interaction rates in this sub-region are rare for hard-shelled sea turtles. Based on observer records over the last 25 years, there has only been one observed gear interaction with a hard-shelled sea turtle (loggerhead sea turtle and gillnet gear) in the western Gulf of Maine (NMFS NEFSC FSB 2015). As hard-shelled sea turtles are less common in the western Gulf of Maine, this trend in interactions is likely reflective of the low level of co-occurrence between hard-shelled sea turtles and gear in this sub-region. Leatherback sea turtles interactions with fishing gear (i.e., trap gear), however, are commonly reported in this sub-region (primarily in Cape Cod Bay); this is likely due to the common occurrence of this species in this sub-region and therefore, a higher level of co-occurrence between leatherback sea turtles and gear in the western Gulf of Maine.

Over the last 25 years, sea turtle interactions with other gear types used in the western Gulf of Maine, such as shrimp bottom trawl, mid-water trawl, purse seine, and longline, are rare to non-existent (NMFS NEFSC FSB 2015). As a result, these gear types were not considered further in the analysis as any potential impacts with these gear types, regardless of management alternative, is expected to be negligible.

5.1.3.2.1 Alternative 1/No Action and Alternative 8

Under the No Action, the Western Gulf of Maine Habitat Closure Area and the Western Gulf of Maine [Groundfish] Closure Area would remain. Alternative 8 is an add-on to the No Action alternative that creates an exemption area for shrimp trawls. Although the exemption area in Alternative 8 does represent a change from current management, under either alternative, overall fishing behavior and effort in the western Gulf of Maine is not expected to change substantially from current operating conditions; that is, fishing practices, including the distribution and quantity of these gear (e.g., gillnet, pot, bottom trawl), are not expected to differ substantially from status quo conditions under either alternative.

As either alternative will essentially maintain status quo conditions, and there is no information to date to suggest any recent variation in the distribution or occurrence of specific sea turtle species in the Western Gulf of Maine, interaction risks to sea turtles in this sub-region are not expected to change substantially from what has been observed to date in this region to date (i.e., interactions are expected to remain rare). Specifically, fishing behavior and effort are expected to remain relatively equal to status quo conditions and as a result, neither alternative is expected to change the presence, quantity, or degree of gillnet, pot, bottom trawl or other gear types used in this sub-region. Therefore, Alternatives 1 and 8 are not expected to introduce any new interaction risks to sea turtle species that would result in animals experiencing levels of serious injury or mortality above and beyond current conditions.

Further, neither alternative is expected to change fishing operations to extent not previously consider by NMFS in its assessment of fishery interaction risks and impacts to these and other protected species (NMFS 2012a,b, NMFS 2013). Specifically, NMFS (2013), NMFS (2012a) and NMFS (2014a) biological opinions, which take into consideration the same spatial context of the Amendment and its specific sub-regions, as well as the operation of fisheries prosecuting the gear types of concern for sea turtles in the affected area (i.e., pot, gillnet, bottom trawl, scallop dredge), determined that these fisheries and gear types may affect, but will not jeopardize the continued existence of any sea turtle species; each opinion authorized take of loggerhead, Kemp’s ridley, green, and leatherback sea turtles, as well as other listed species. As these recent opinions take into consideration operation of fisheries both in past and current contexts, and the alternatives under consideration do not substantially change or modify any of the operations of fisheries in the western Gulf of Maine or gear use in this or surrounding areas that were not previously considered in these opinions, Alternatives 1 and 8 do not introduce new risks or take to any sea turtle species that have not already been considered and authorized by NMFS to date (NMFS 2013, NMFS 2012a, NMFS 2014a). As a result, Alternatives 1 or 8 for the Western Gulf of Maine are not expected to result in levels of take that would jeopardize the continued existence of any listed sea turtle species. For these reasons, and given that patterns of sea turtle occurrence and distribution in the western Gulf of Maine are not expected to change in the near term, impacts to sea turtles from Alternatives 1 or 8 are expected to be slightly negative to neutral. Relative to Alternatives 2-6, Alternative 1 will have slightly negative impacts to sea turtles as it does not afford any potential positive impacts to sea turtles that are provided under Alternatives 2-6 (for further rationale see Alternative 2 and Alternatives 3-6 sections).

The Council's preferred alternative modifies the boundary of the Western Gulf of Maine Closure Area, shifting it five minutes (approximately five nautical miles) west to match the habitat closure boundary. While there is substantial bottom trawl effort along the existing western boundary, gillnet activity is only concentrated along the eastern boundary, which would not change under the preferred approach. The boundary change will likely result in a shift of bottom trawl effort into the reopened area, and there may be a concentration of effort along the new boundary, such that the risk of turtle/trawl interaction along the western edge of the updated closure will remain similar to the current risk.

5.1.3.2.2 Alternative 2

Alternative 2 will remove the existing Western Gulf of Maine Habitat and Groundfish Closure areas in their entirety. These closed areas have been in place for almost 20 years. As a result, there is no history of turtle bycatch within these areas over this timeframe because fishing effort has been limited to a small sub-set of gear types. This lack of information makes it impossible to quantitatively forecast what interaction/entanglement risks will exist if the closures are opened. This section is therefore a qualitative evaluation, using the best available information, of the potential outcomes of removing the closed areas on fishing behavior and its effects on sea turtles.

Removing these closures has the potential to change the distribution and quantity of some gear types in the western Gulf of Maine. Specifically, in terms of gear at greatest risk of interacting with sea turtles, opening the closed areas has the potential to change gillnet, scallop dredge, and bottom trawl gear distribution and quantity in this sub-region; however, changes in trap gear are not expected (see below for details). The latter changes may result in one of two potential scenarios: 1) Existing gillnet, scallop dredge, or trawl gear shifts into the now open areas, resulting in a change in gear distribution, but not quantity in the sub-region; or (2) a shift in gillnet, scallop dredge, or trawl effort from surrounding waters into the Western Gulf of Maine , resulting in more gear in the Western Gulf of Maine.

Under the first scenario, impacts to sea turtles are not expected to change from status quo conditions (see above section). The same number of vessels currently fishing in the western Gulf of Maine are expected to remain under this scenario and therefore, the same number of gillnets, scallop dredges, or trawls are expected to be set or towed in the sub-region as under status quo conditions; the only change will be the distribution of the gear fished, not the quantity. As only the distribution of gear is expected to change, and changes in sea turtle occurrence and distribution in the western Gulf of Maine are not expected change, co-occurrence between gear and sea turtles will remain low. As a result, interactions with sea turtles are expected to reamin rare under this sceanio and therefore, result in slightly negative to neutral impacts to sea turtles.

Under the second scenario, vessels from Georges Bank or Southern New England could shift effort into the western Gulf of Maine, resulting in an increase in trawl, scallop dredge, and/or gillnet fishing events in the western Gulf of Maine. Although interactions with sea turtles could increase, this increase is not expected to be significant relative to what has been observed in this sub-region over the last 25 years (see Alternative 1 and 8 discussion above; NMFS NEFSC FSB 2015). Specifically, although gear quantity could increase, the occurrence and distribution of sea turtles in this sub-region will not change. As a result, although minimally higher than status quo, the level of co-occurrence between gear and sea turtles will still remain low for this sub-region relative to areas where sea turtles are more common (i.e., Southern New England and Mid-Atlantic). Therefore, even if effort in the western Gulf of Maine increases, impacts to sea turtles are expected to be slightly negative. However, another consideration under this scenario is if effort shifts from an area of high observed sea turtle bycatch (Southern New England and Mid-Atlantic), impacts to sea turtles could be slightly positive as the resultant change in fishing behavior shifts gear out of a high risk area. Although this shift in fishing behavior from high a bycatch area to a low bycatch area would nott eliminate take of sea turtles in the high risk area, some reduction in bycatch is possible as effort, and therefore, co-occurrence of gear and sea turtles, has been reduced in this area.

Trap gear, the other predominant gear type in the western Gulf of Maine, has never been restricted in any of the closed areas, so fishing behavior, including distribution of gear, has been well established within them. Removing the fishery closed areas, therefore, is not expected to change the quantity or distribution of trap gear in this sub-region relative to status quo conditions. As a result, regardless of whether the closed areas remain in existence or not, new or increased interaction risks with trap gear are not likely to be experienced by sea turtles in the western Gulf of Maine. Overall impacts to sea turtles, therefore, are not expected to be any greater than those experienced under status quo conditions (i.e., slightly negative to neutral; see see Alternative 1 and 8 discussion above.

In summary, the impacts of Alternative 2 to sea turtles will be highly dependent on how fishing behavior in the western Gulf of Maine and surrounding waters reacts to the opening of area closures. As this information can only be obtained and assessed once such an alternative is implemented, we cannot definitively state what impacts to turtles will be, but impacts will most likely range from slightly negative to slightly positive.. Relative to Alternative 1, Alternative 2 is expected to have neutral to slightly positive impacts to sea turtles. Relative to Alternatives 3-6, Alternative 2 is expected to have neutral impacts on sea turtles.

5.1.3.2.3 Alternatives 3-6

Under Alternatives 3-6, existing Habitat and Groundfish Closure Areas will be removed, and various new HMAs are proposed in the western Gulf of Maine. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; all other fixed or non-bottom tending gear could be placed or used in any of the proposed HMAs with no restrictions. The resulting outcome of any of these Alternatives/options on fishing behavior (e.g., effort shifts, gear distribution and quantity) is expected to be similar to that described for Alternative 2, with a small exception that the presence and/or distribution of trawl gear may be reduced or limited based on which alternative and option is chosen. Regardless, potential shifts in effort and the resultant distribution and quantity of gear in the western Gulf of Maine is not expected to be any greater than that described under Alternative 2. As a result, we expect impacts to sea turtles from any of the Alternatives/options to be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3-6 are expected to have neutral to slightly positive impacts to sea turtles, while relative to Alternative 2, Alternatives 3-6 are expected to have nuetral impacts to sea turtles. Relative to each other, Alternatives 3, 4, 5, or

6, would result in neutral impacts to sea turtles as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to sea turtles.

5.1.3.3 *Impacts to Atlantic sturgeon and Atlantic salmon*

As summarized in Volume 1, sections 4.8.2.5 and 4.8.2.6, Atlantic sturgeon and Atlantic salmon are found throughout the Gulf of Maine, and therefore, these species may co-occur with fisheries operating in the western Gulf of Maine. Of the gear types potentially used in the western Gulf of Maine, gillnet and bottom trawl gear pose the greatest risk of serious injury and mortality to these species (see Volume 1, section 4.8.3.3). In fact, Atlantic sturgeon and Atlantic salmon interactions with gillnet and/or bottom trawl gear have been observed in this sub-region, with most observed interactions involving Atlantic sturgeon and gillnets and only several involving salmon and gillnets (NMFS NEFSC FSB 2015; NMFS 2013; Kocik et al. 2014). As noted in section 5.1.2.3, Atlantic sturgeon are primarily found in coastal waters in depths of 50 meters or less.

Interactions with other gear types used in the area (pot, shrimp bottom trawl, purse seine, clam or scallop dredge, mid-water trawl) are rare to non-existent for these species (see Volume 1 sections 4.8.3.3 and 4.8.3.4) and therefore, do not pose a serious interaction risk to Atlantic sturgeon or Atlantic salmon. Therefore, these latter gears type will not be considered further as impacts of pot, shrimp bottom trawl, purse seine, clam or scallop dredge, or mid-water trawl to Atlantic sturgeon or Atlantic salmon are expected to be negligible, regardless of alternative.

5.1.3.3.1 Alternative 1/No Action and Alternative 8

Under the No Action, the Western Gulf of Maine Habitat Closure Area and the Western Gulf of Maine [Groundfish] Closure Area would remain. Alternative 8 is an add-on to the No Action alternative that creates an exemption area for shrimp trawls. Although the exemption area in Alternative 8 does represent a change from current management, under either alternative, overall fishing behavior and effort in the western Gulf of Maine is not expected to change substantially from current operating conditions; that is, fishing practices, including the distribution and quantity of these gear (e.g., gillnet, trap, bottom trawl), are not expected to differ substantially from status quo conditions under either alternative.

As either alternative will essentially maintain status quo conditions, interaction risks to Atlantic sturgeon or Atlantic salmon in this sub-region are not expected to change substantially from what has been observed and assessed to date in this region (i.e., remain rare). Specifically, fishing behavior and effort are expected to remain relatively equal to status quo conditions and as a result, neither alternative is not expected to change the presence, quantity, or degree of gillnet, bottom trawl or other gear types used in this sub-region. Therefore, Alternatives 1 and 8 are not expected to introduce any new interaction risks to Atlantic sturgeon or Atlantic salmon that would result in animals experiencing levels of serious injury or mortality above and beyond current conditions.

Further, neither of the alternatives is expected to change fishing operations to an extent not previously consider by NMFS in its assessment of fishery interaction risks and impacts to these and other protected species (NMFS 2012a,b, NMFS 2013, NMFS 2014a). Specifically, NMFS (2013), NMFS (2012a) and NMFS (2014a) biological opinions. These opinions take into consideration the same spatial context of this amendment and its specific sub-regions, as well as the operation of fisheries prosecuting the gear types of concern for Atlantic sturgeon and Atlantic salmon in the affected area (i.e., gillnet and bottom trawl), and determined that these fisheries and gear types may affect, but will not jeopardize the continued existence of either fish species. Each opinion authorized take of listed species, including Atlantic sturgeon and Atlantic salmon. As these recent opinions take into consideration operation of fisheries both in past and current context, and the alternatives under consideration do not substantially change or modify any of the operations of fisheries in the western Gulf of Maine or gear use in this or surrounding areas that were not previously considered in these opinions, Alternatives 1 and 8 do not introduce new risks or take to Atlantic sturgeon or Atlantic salmon that have not already been considered and authorized by NMFS to date (NMFS 2013, NMFS 2014a). As a result, Alternatives 1 or 8 for the western Gulf of Maine are not, as concluded in NMFS' opinions, expected to result in levels of take that would jeopardize the continued existence of Atlantic sturgeon or Atlantic salmon. For these reasons, the impacts to Atlantic sturgeon and Atlantic salmon from Alternatives 1 or 8 for the western Gulf of Maine are expected to be slightly negative to neutral. Relative to Alternatives 2-6, Alternative 1 will have slightly negative impacts to Atlantic sturgeon or Atlantic salmon as it does not afford any potential positive impacts to Atlantic sturgeon or Atlantic salmon that are provided under Alternatives 2-6 (for further rationale see Alternative 2 and Alternatives 3-6 sections).

The Council's preferred alternative modifies the boundary of the Western Gulf of Maine Closure Area, shifting it five minutes (approximately five nautical miles) west to match the habitat closure boundary. While there is substantial bottom trawl effort along the existing western boundary, gillnet activity is only concentrated along the eastern boundary, which would not change under the preferred approach. The boundary change will likely result in a shift of bottom trawl effort into the reopened area, and there may be a concentration of effort along the new boundary, such that the risk of sturgeon or salmon trawl interaction along the western edge of the updated closure will remain similar to the current risk.

5.1.3.3.2 Alternative 2

Alternative 2 will remove the existing Western Gulf of Maine Habitat and Groundfish Closure areas in their entirety. These closed areas have been in place for almost 20 years. As a result, there is no history of sturgeon or salmon bycatch within these areas over this timeframe because fishing effort has been limited to a small sub-set of gear types. This lack of information makes it impossible to quantitatively forecast what interaction/entanglement risks will exist if the closures are opened. This section is therefore a qualitative evaluation, using the best available information, of the potential outcomes of removing the closed areas on fishing behavior and its effects on these listed fish species.

Removing these closures has the potential to change the distribution and quantity of some gear types in the western Gulf of Maine. Specifically, in terms of gear at greatest risk of interacting with Atlantic sturgeon or Atlantic salmon, opening the closed areas has the potential to change gillnet and bottom trawl gear distribution and quantity in this sub-region. These changes may result in one of two potential scenarios: 1) Existing gillnet or bottom trawl gear shifts into the now open areas, resulting in a change in gear distribution, but not quantity in the sub-region; or

(2) a shift in gillnet or trawl effort from surrounding waters into the western Gulf of Maine, resulting in more gear in the western Gulf of Maine.

Under the first scenario, impacts to Atlantic sturgeon or Atlantic salmon are not expected to be any greater than those experienced under status quo conditions, and may result in some slightly positive impacts to these species. The same number of vessels currently fishing in the western Gulf of Maine are expected to remain under this scenario and therefore, the same number of gillnets or trawls are expected to be set or towed in the sub-region as under status quo conditions; the only change will be the spatial distribution of the gear fished, not the quantity. As described above, gillnet and bottom trawl gear are concentrated along the eastern and/or western boundary of the Habitat and Groundfish Closure Areas. Currently, this creates an elevated risk of entanglement as species cannot move through the area without the risk of an interaction. However, under this scenario, opening the closed area results in a shift in effort into the opened area resulting in the dispersion of gear that once was concentrated along the closed area border. With gear being more dispersed, a barrier to movement without incidence of entanglement has been eliminated and therefore, interactions with Atlantic sturgeon or Atlantic salmon have the potential to decrease in this sub-region, affording positive impacts to the species.

Under the second scenario, vessels from Georges Bank or Southern New England could shift effort into the western Gulf of Maine, resulting in an increase in the number of trawl and/or gillnets towed or set in the western Gulf of Maine relative to status quo conditions. As interaction risks to Atlantic sturgeon or Atlantic salmon are strongly associated with the amount of gear in the water and its soak/tow time, under this scenario, interaction risks to these species may increase. Further, in waters where there has been high observed bycatch of a particular protected species, any shift in effort into these waters introduces additional risks to that species and therefore, increases the potential for interactions. As the western Gulf of Maine is an area where many Atlantic sturgeon have been observed bycaught in gillnet and bottom trawl gear (NMFS NEFSC FSB 2015), any shift in effort into the Western Gulf of Maine has the potential to increase interactions with this species. Although the western Gulf of Maine has not been an area with high observed bycatch of Atlantic salmon, any increase in gear has the potential to increase interactions with this species as the co-occurrence of gear and the species will have increased under this scenario relative to status quo conditions. However, an important consideration in this sub-region is, depending on the health of the fish stocks in the western Gulf of Maine and thus, quota allocations, incentive for vessels operating outside of the western Gulf of Maine to redirect effort into the western Gulf of Maine may be lacking. Based on current trends for some groundfish stocks in the western Gulf of Maine, effort for many vessels has been constrained by quota allocations for those stocks in poor condition; continuation of these poor stock conditions in the western Gulf of Maine in the near future is likely to deter the latter shift in fishing behavior. As a result, although it is unlikely that scenario 2 will be experienced in this sub-region, we cannot discount the possibility of scenario 2 coming to fruition should conditions in this sub-region change. As a result, assuming a worst case scenario, impacts to Atlantic sturgeon or Atlantic salmon could be negative under a scenario where effort in the western Gulf of Maine increases.

Based on the information and associated analysis provided above, we expect that the impacts of Alternative 2 to Atlantic sturgeon or Atlantic salmon will be highly dependent on how fishing behavior in the Western Gulf of Maine and surrounding waters reacts to opening of these closed areas. Such changes are difficult to predict. The impacts of Alternative 2 may range from negative to slightly positive. Relative to Alternative 1, Alternative 2 is expected to have slightly negative to slightly positive impacts on Atlantic sturgeon or Atlantic salmon. Relative to Alternatives 3-6, Alternative 2 is expected to have neutral impacts to Atlantic sturgeon or Atlantic salmon.

5.1.3.3.3 Alternatives 3-6

Under Alternatives 3-6, existing Habitat and Groundfish Closure Areas will be removed, and various new HMAs are proposed in the western Gulf of Maine, some overlapping with existing closures. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; all other fixed or non-bottom tending gear could be placed or used in any of the proposed HMAs with no restrictions. The resulting outcome of any of these alternatives/options on fishing behavior (e.g., effort shifts, gear distribution and quantity) is expected to be similar to that described for Alternative 2, with a small exception that the presence and/or distribution of trawl gear may be reduced or limited based on which alternative and option is chosen. Regardless, potential shifts in effort and the resultant distribution and quantity of gear in the western Gulf of Maine is not expected to be any greater than that described under Alternative 2. As a result, we expect impacts to Atlantic sturgeon or Atlantic salmon from any of the Alternatives/options to be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3-6 are expected to result in negative to slightly positive impacts to Atlantic sturgeon or Atlantic salmon; however, relative to Alternative 2, Alternatives 3-6, are expected to have neutral impacts on Atlantic sturgeon or Atlantic salmon. Relative to each other, Alternatives 3, 4, 5, or 6, would result in neutral impacts to Atlantic sturgeon or Atlantic salmon as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to Atlantic sturgeon or Atlantic salmon.

5.1.4 Georges Bank

The habitat management alternatives for the Georges Bank sub-region include various combinations of 19 areas (Table 23). Alternative 10, which is preferred, also includes a seasonal closure for scallop dredges in Closed Area II north of 41° 30’ N. For Alternatives 3-10, the fishing restriction options available for each area area listed below. Some areas could be managed as closures to some or all mobile bottom-tending gears (Options 1 and 2) and some are proposed as gear modification areas only (Options 3 and 4).

Table 88 – Habitat management alternatives for the Georges Bank sub-region. MBTG denotes a closure to mobile bottom-tending gears, with a possible exemption for hydraulic dredges.

Alternative	Areas	Possible fishing restrictions
1 (No Action)	Closed Area II Habitat Closure Area, Closed Area I N Habitat Closure Area, Closed Area I S Habitat Closure Area, Closed Area II, Closed Area I	Current measures
2	None	n/a
3	Northern Edge HMA	Options 1-4
4	Northern Edge HMA and Georges Shoal Gear Modified Area	NE: Options 1-4, GS: Options 3-4

5	Georges Shoal 1 MBTG HMA and Northern Georges Gear Modified Area	GS: Options 1-2, NG: Options 3-4
6A	EFH Expanded 1 HMA	Options 1-4
6B	EFH Expanded 2 HMA	Options 1-4
7	Georges Shoal 2 MBTG HMA and EFH South MBTG HMA	Options 1-2
8	Northern Georges MBTG HMA	Options 1-2
9	Mortality Closure, Eastern and Western MBTG HMA	Eastern and Western Areas - Options 1-2; mortality closure managed like CAII.
10	Northern Edge MBTG HMA, Northern Edge Reduced Impact HMA, Georges Shoal 2 MBTG HMA	Northern Edge MBTG HMA and Georges Shoal 2 MBTG HMA - Options 1-2. Reduced Impact HMA closed to hydraulic dredges, most trawling; scallop dredging rotationally.

5.1.4.1 *Impacts to marine mammals*

ESA and non-ESA listed species of marine mammals are known to occur on Georges Bank (Waring et al. 2014; Waring et al. 2015). Of the gear types used in the Georges Bank sub-region, bottom trawls pose the greatest interaction risk to small cetaceans and pinnipeds, while traps pose the greatest risk to large whales (Waring et al. 2014; Waring et al. 2015; Johnson et al. 2005; NMFS 2014a,c; Kenney and Hartley 2001; Hartley et al. 2003; Whittingham et al. 2005a,b; see Volume 1, section 4.8.3.1). Interactions with clam or scallop dredges, the other predominant gears fished in this sub-region, are rare to non-existent (Waring et al. 2014; Waring et al. 2015; see Volume 1, section 4.8.3.1) and therefore, do not pose a serious interaction risk to any species of marine mammal. Therefore, these latter gear types will not be discussed further as neutral impacts to marine mammals are associated with the usage of these gears, regardless of alternative.

Based on over ten years of observer data, the Georges Bank sub-region has a high incidence of small cetacean and pinniped interactions in bottom trawl gear (Waring et al. 2014; Waring et al. 2015; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; http://www.nefsc.noaa.gov/fsb/take_reports/asm.html). Specifically, there is a corridor of observed marine mammal-bottom trawl interactions extending from the northeast corner of Closed Area I east toward the northern tip of Closed Area II. These takes are largely pilot whales, white-sided dolphins, and gray seals, with fewer recorded takes of common dolphins (Waring et al. 2014; Waring et al. 2015). There is another corridor of bottom trawl takes extending from the southeastern end of Closed Area I east to the southwestern corner of Closed Area II, and along the southern edge of Closed Area II. Takes recorded here are mainly common dolphins, pilot whales, and gray seals (Waring et al. 2014; Waring et al. 2015).

Trap gear and large whales co-occur in the Georges Bank sub-region, and therefore, there are interaction risks (NMFS 2014a,c; Waring et al. 2014; Waring et al. 2015; http://www.greateratlantic.fisheries.noaa.gov/Protected/whaletrp/). However, delineating particular sub-regions of the Northwest Atlantic as having higher or lower incidences of large whale entanglements is not possible at this time. Although large whale entanglements are reported and cataloged, the first sighting of a large whale entanglement does not necessarily equate to the origin of the entanglement, as the animal often travels some distance before the discovery of the incident.

5.1.4.1.1 Alternative 1/No Action

As Alternative 1 will maintain existing management areas and fishing restrictions, new or additional interaction risks to marine mammals are not expected. As a result, interactions with marine mammals are not expected to go above and beyond that which has been observed and considered by NMFS in its assessment of fishery interaction risks to this species (Waring et al. 2014; Waring et al. 2015; NMFS 2002; NMFS 2012a; NMFS 2013, NMFS 2014a) and therefore, impacts to marine mammals from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2-10, Alternative 1 will have slightly negative impacts to marine mammals as it does not afford any potential positive impacts to marine mammals that are provided under Alternatives 2-10 (for further rationale see Alternative 2 and Alternatives 3-10 sections).

5.1.4.1.2 Alternative 2

Alternative 2 will remove the existing Closed Area I and Closed Area II groundfish and habitat closures, which has the potential to change patterns of fishing effort. Specifically, in terms of gear at greatest risk of interacting with marine mammals, opening the closed areas has the potential to change patterns of bottom trawl effort. Two scenarios are possible: (1) existing vessels shift into the now open areas, resulting in a more widespread distribution of effort, but not a change in the quantity of effort in the sub-region; and/or (2) bottom trawl effort from surrounding sub-regions may move onto Georges Bank, resulting in more gear fished on Georges Bank.

Under the first scenario, impacts to marine mammals are not expected to be any greater than those experienced under existing management areas and fishing restrictions, and in fact, may result in some slightly positive impacts to these species if the same or similar magnitude of bottom trawl activity is more evenly dispersed over the bank. Specifically, opening Closed Area I and Closed Area II may cause existing vessels to shift effort, and thus gear, into waters in and around these closed areas. As decribed above, bottom trawl gear use and interactions are concentrated along the northern and southern margins of the bank between these two closures. These concentrated corridors of bottom trawl gear create an elevated risk of entanglement to all protected species as animals cannot move through the area without the risk of an interaction, as is demonstrated by the numerous observed interactions with particular marine mammal species within and along these corridors (Waring et al. 2014, Waring et al. 2015; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; www.nefsc.noaa.gov/fsb/take_reports/asm.html). Opening the closures could lead to a dispersion of gear that is currently more spatially concentrated, which could reduce barriers to movement and therefore entanglement risk, affording slightly positive impacts to the species. A caveat to this is that depending on the overall health of fish stocks and resultant fishery allocations, opening a closed areas may not provide incentive for existing vessels to change fishing behavior in the sub-region. Thus, it is possible that impacts would be closer to those associated with Alternative 1/No Action (i.e. slightly negative to neutral) if patterns of effort remain stable.

Under the second scenario, impacts to marine mammals could be negative if effort moves from regions with fewer interactions onto Georges Bank. Vessels from the Gulf of Maine (any sub-region), Great South Channel/Southern New England, or even the Mid-Atlantic could shift effort onto Georges Bank to take advantage of newly accessible fishing grounds, resulting in an increase in bottom trawl effort on Georges Bank. As interaction risks to marine mammals are strongly associated with the amount of gear in the water and its soak or tow time, under this scenario, interaction risks could potentially increase. As Georges Bank is an area of high observed marine mammal bycatch, any shift in effort onto Georges Bank has the potential to increase interactions. As above, if stock conditions do not create sufficient incentive for effort shifts into reopened areas, impacts would be closer to those associated with Alternative 1/No Action (i.e. slightly negative to neutral).

Substantial changes in patterns of trap gear effort are not expected as traps are presently allowed to operate in the closures, although trap fishermen could adjust their fishing activity due to the presence of mobile bottom-tending gears. Therefore, interaction risks associated with trap gear are expected to remain similar to existing risks, i.e. Alternative 2 should have similar impacts on marine mammals compared to Alternative 1/No Action, i.e. slightly negative to neutral.

Overall, the potential impacts of Alternative 2 on marine mammals will be highly dependent on how fishing behavior on Georges Bank changes in response to opening Closed Areas I and II. These changers are difficult to estimate and therefore it is challenging to assess the magnitude and direction of impacts. However, it is important to note that the currently designated closed areas were not created to protect marine mammals, so removing these areas does not equate to the removal of marine mammal protected areas designated per the Marine Mammal Protection Act. Measures to reduce marine mammal gear interactions, and thus, reduce incidences of serious injury and mortality to these species have been established under the Marine Mammal Protection Act's HPTRP and ALWTRP. Although the management areas and regulations of the HPTRP and ALWTRP overlap with many designated habitat and groundfish closure areas, they were not predicated on these closures and stand on their own. Further, although the HPTRP and ALWTRP are specific to particular marine mammal species, their purpose and associated regulations have indirect benefits to other marine mammal species that co-occur with those marine mammal species identified in their plans. As a result, regardless of the whether the existing groundfish and habitat remain in existence, HPTRP and ALWTRP areas will remain on Georges Bank. In addition, voluntary measures to reduce the incidental capture of marine mammals in trawl gear are provided by the Atlantic Trawl Gear Take Reduction Strategy (see http://www.greateratlantic.fisheries.noaa.gov/Protected/mmp/atgtrp/). Considering complementary HPTRP and ALWTRP measures, the analysis above, and the best available information, the impacts of Alternative 2 on marine mammals may range from slightly negative to slightly positive. Relative to Alternative 1, Alternative 2 is expected to have neutral to slightly positive impacts to marine mammals. Relative to Alternatives 3-10, Alternative 2 is expected to have neutral impacts on marine mammals.

5.1.4.1.3 Alternatives 3-10

Under Alternatives 3-10, the Closed Area I and Closed Area II habitat and groundfish closures will be removed, and various new HMAs are proposed on Georges Bank. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; fixed or pelagic gear could be used in any of the proposed HMAs with no restrictions. Shifts in trawl gear effort are likely to be similar to Alternative 2 for many alternatives. Alternatives 3, 4, 6A, and 6B will maintain smaller closures on the northeastern corner of the bank but in general more areas will be open to bottom trawl activity. Alternative 5 maintains a small closure towards the center of the bank and would designate a larger trawl gear modification area, and will likely have very similar impacts to Alternative 2. Alternatives 7, 9, and 10 (Alternative 10 is preferred) designate new closures on the shoals west of Closed Area II, and maintain some closures overlapping the habitat closure in the northern part of Closed Area II. These alternative should also distribute trawl effort more broadly across Georges Bank, thereby reducing barriers to movement. Alternative 8 would remove the existing closures, but designate a large new management area on the northeastern portion of the bank. This alternative should remove some barriers to movement along the southern edge of the bank, but trawl activity could remain concentrated west of the new area. For all alternatives, potential shifts in effort are not expected to be any greater than changes that described under Alternative 2. As a result, impacts to marine mammals from any of Alternatives 3-10 should be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3-10 are expected to have neutral to slightly positive impacts to marine mammals, while Relative to Alternative 2, Alternatives 3-10 are expected to have nuetral impacts to marine mammals. Relative to each other, Alternatives 3, 4, 5, 6, 7, 8, 9, or 10 would result in neutral impacts to marine mammals as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to marine mammals.

5.1.4.2 ***Impacts to sea turtles***

Seasonally, hard-shelled and leatherback sea turtles are known to occur on Georges Bank (Blumenthal et al. 2006; Braun and Epperly 1996; Braun-McNeill and Epperly 2002; Braun-McNeill et al. 2008; Epperly et al. 1995a,b,c; Griffin et al. 2013; Hawkes et al. 2006; Hawkes et al. 2011; Mansfield et al. 2009; McClellan and Read 2007; Mitchell et al. 2003; TEWG 2009; Morreale and Standora 2005; Mitchell et al. 2003; Morreale and Standora 2005; NMFS and USFWS 2008; NMFS and USFWS 1991, 1998b; NMFS et al. 2011;Shoop and Kenney 1992; TEWG 2009; http://seamap.env.duke.edu/). However, the occurrence and distribution of sea turtles in this sub-region does vary by species. Leatherback sea turtles are common (Dodge et al. 2014; Dodge et al. 2015; James et al. 2005; James et al. 2006; http://seamap.env.duke.edu/), while encounter rates of hard-shelled sea turtles are lower on Georges Bank relative to Mid-Atlantic shelf waters (primarily between 37° N and 40° N) (Murray and Orphanidies 2013; http://seamap.env.duke.edu/).

The predominant gear types used in the Georges Bank sub-region include hydraulic clam dredges, scallop dredges, bottom trawl, and trap gear. Of these gear types, scallop dredge, trap, and bottom trawl gear pose the greatest interaction risk to hard-shelled sea turtles, while trap, and bottom trawl gear pose the greatest interaction risk to leatherback sea turtles (see Volume 1, section 4.8.3.2). A small number (8) of hard-shelled sea turtle interactions in this sub-region have been observed or reported with scallop dredge and bottom trawl gear since 1989, however no interactions with leatherback sea turtles have been reported or observed during this period (NMFS NEFSC FSB 2015; STDN 2014). Interactions in Mid-Atlantic shelf waters are more numerous. To date, sea turtle interactions with hydraulic clam dredge gear have never been observed (NMFS NEFSC FSB 2015; see Volume 1, section 4.8.3.2). As a result, this latter gear type will not be considered further as impacts of clam dredges are expected to be negligible, regardless of alternative.

5.1.4.2.1 Alternative 1/No Action

As Alternative 1/No Action will maintain existing management areas and fishing restrictions, new or additional interaction risks to sea turtles are not expected. As a result, interactions with sea turtles are not expected to go above and beyond that which has been observed and considered by NMFS in its assessment of fishery interaction risks to this species (NMFS 2002; NMFS 2012a; NMFS 2013, NMFS 2014a) and therefore, impacts to sea turtles from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2-10, Alternative 1 will have slightly negative impacts to sea turtles as it does not afford any potential positive impacts to sea turtles that are provided under Alternatives 2-10 (for further rationale see Alternative 2 and Alternatives 3-10 sections).

5.1.4.2.2 Alternative 2

Alternative 2 will remove the existing Closed Area I and Closed Area II groundfish and habitat closures, which has the potential to change patterns of fishing effort. Specifically, in terms of gear at greatest risk of interacting with sea turtles, opening the closed areas has the potential to change scallop dredge and bottom trawl gear distributions. Two scenarios are possible: (1) existing vessels shift into the now open areas, resulting in a more widespread distribution of effort, but not a change in the quantity of effort in the sub-region; and/or (2) bottom trawl and/or scallop dredge effort from surrounding sub-regions may move onto Georges Bank, resulting in more gear fished on Georges Bank.

Under the first scenario, if effort is redistributed but does not increase on Georges Bank, impacts to sea turtles are not expected to be any greater than those experienced under existing management areas and fishing restrictions. As described above, over the last 25 years, observed hard shelled sea turtle interactions with scallop dredge or bottom trawl gear were rare, and reported leatherback entanglements/interactions with gear were non-existent, on Georges Bank (NMFS NEFSC FSB 2015; STDN 2014). As a result, there is no information to suggest that bycatch rates within Closed Area I or Closed Area II are higher than areas immediately adjacent to the closure. As such, if effort is simply redistributed from outside the areas to within, we would not expect impacts to sea turtles to increase. Also, as the distribution and occurrence of sea turtles are not expected to change substantially on Georges Bank, the co-occurrence between gear and sea turtles is expected to remain similar to that which has been observed to date in this sub-region, assuming the overall amount of fishing activity remains relatively constant (NMFS NEFSC FSB 2015; STDN 2014). As a result, new or additional gear interaction risks to sea turtles are not expected. A caveat to this is that depending on the overall health of fish stocks and resultant fishery allocations, opening a closed areas may not provide incentive for existing vessels to change fishing behavior in the sub-region. Thus, it is possible that impacts would be closer to those associated with Alternative 1/No Action (i.e. slightly negative to neutral) if patterns of effort remain stable.

Under the second scenario, impacts to sea turtles could range from slightly negative to slightly positive. Vessels from the Gulf of Maine, Great South Channel/Southern New England, or even the Mid-Atlantic could shift effort onto Georges Bank to take advantage of newly accessible fishing grounds, resulting in an increase in the number of bottom trawls or scallop dredges towed in this sub-region. This could increase interaction risks relative to Alternative 1/No Action.

However, due to the history of low interaction rates, and the fact that the distribution and occurrence of sea turtles are not expected to change substantially in this sub-region, the magnitude of any increase in risk is likely small. The level of co-occurrence between gear and sea turtles is expected to remain low for this sub-region relative to other areas, specifically in the Mid-Atlantic for hard-shelled sea turtles and in the western Gulf of Maine and Southern New England for leatherbacks.

Because the rate of encounters varies by turtle type and sub-region, it matters where effort might be shifting from. The mid-Atlantic, followed by Southern New England, has the highest incidence of observed hard-shelled sea turtle interactions with fishing gear. Therefore, any incentive for Mid-Atlantic/Southern New England vessels to shift effort outside of either sub-region onto Georges Bank equates to fishing effort shifting gear out of a high interaction risk area to an area with a low interaction risk to hard -shelled sea turtles. Similarly, relative to Georges Bank, the Western Gulf of Maine and Southern New England have higher incidences of leatherback interactions with fishing gear; such that any incentive for vessels to shift effort from these sub-regions onto Georges Bank will result in removal of some fishing effort from a high interaction risk area. As a result, should opening Closed Area I and Closed Area II provide incentive to Western Gulf of Maine, Mid-Atlantic and/or Southern New England vessels to shift effort onto Georges Bank, overall impacts to sea turtles could be slightly positive as the resultant change in fishing behavior shifts gear out of areas with a high interaction risk. Although such shifts in fishing behavior from a high bycatch area to a low bycatch area would not eliminate take of sea turtles, some reduction in overall bycatch is possible. Again, the magnitude of these shifts is dependant on stock status.

Substantial changes in patterns of trap gear effort are not expected as traps are presently allowed to operate in the closures, although trap fishermen could adjust their fishing activity due to the presence of mobile bottom-tending gears. Therefore, interaction risks associated with trap gear are expected to remain similar to existing risks, i.e. Alternative 2 should have similar impacts on sea turtles compared to Alternative 1/No Action, i.e. slightly negative to neutral.

Overall, the potential impacts of Alternative 2 on sea turtles will be highly dependent on how fishing behavior on Georges Bank changes in response to opening Closed Areas I and II. These changers are difficult to estimate and therefore it is challenging to assess the magnitude and direction of impacts. Overall, impacts will likely range from slightly negative to slightly positive. Relative to Alternative 1, Alternative 2 is expected to have neutral to slightly positive impacts to sea turtles. Relative to Alternatives 3-10, Alternative 2 is expected to have neutral impacts on sea turtles.

5.1.4.2.3 Alternatives 3-10

Under Alternatives 3-10, the Closed Area I and Closed Area II habitat and groundfish closures will be removed, and various new HMAs are proposed on Georges Bank. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; fixed or pelagic gear could be used in any of the proposed HMAs with no restrictions. Shifts in trawl gear effort are likely to be similar to Alternative 2 for many alternatives (see section 5.1.4.1.3 in the marine mammals discussion for details). Shifts are somewhat easier to predict for scallop dredges because the target stock is sessile and its distribution is well known. All of the alternatives will likely result in slight increases in effort within Closed Area I, if the scallop access area there is expanded and access is granted more frequently and/or if more trips are allocated. Scallop fishing activity would likely increase along the northern edge of the bank under some alternatives, namely Alternatives 5, 7, 9, and 10, while it would likely decrease under Alternatives 3, 4, 6A, 6B, and 8. It is difficult to assess whether effort would shift from elsewhere on Georges Bank, for example from open areas into modified or newly created access areas, or if effort would move to Georges Bank from the mid-Atlantic. This will be driven by spatial patterns in scallop recruitment and growth in addition to changes in area management.

For all alternatives and considering both trawls and dredges, potential shifts in effort and the resultant distribution and quantity of gear on Georges Bank is not expected to be any greater than changes that described under Alternative 2. As a result, impacts to sea turtles from any of Alternatives 3-10 should be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3-10 are expected to have neutral to slightly positive impacts to sea turtles, while Relative to Alternative 2, Alternatives 3-10 are expected to have nuetral impacts to sea turtles. Relative to each other, Alternatives 3, 4, 5, 6, 7, 8, 9, or 10 would result in neutral impacts to sea turtles as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to sea turtles.

5.1.4.3 ***Impacts to Atlantic sturgeon***

As summarized in Volume 1, section 4.8.2.5, Atlantic sturgeon can be found on Georges Bank (ASSRT 2007). Based on fishery independent and dependent data, as well as data collected from marine tracking and tagging studies, Atlantic sturgeon appear to primarily occur inshore of the 50 meter 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). Given their generally shallow, inshore distribution, overlaps between fishing effort and Atlantic sturgeon on Georges Bank are likely infrequent. This is further supported by the lack of observed Atlantic sturgeon interactions in this sub-region over the last 25 years (NMFS NEFSC FSB 2015).

Based on observed gear interactions in other areas, of the gear types potentially used on Georges Bank, bottom trawl gear pose the greatest interaction riskto Atlantic sturgeon (NMFS NEFSC FSB 2015; NMFS 2013; see Volume 1, section 4.8.3.3). Interactions with other gear types used in the area (pot, scallop dredge) are rare to non-existent for this species (NMFS NEFSC FSB 2015; NMFS 2013; see Volume 1, section 4.8.3.3) and therefore, are not expected to pose a serious interaction risk to Atlantic sturgeon. Therefore, these latter gear types will not be considered further as impacts of pot or scallop dredges are expected to be negligible, regardless of alternative.

5.1.4.3.1 Alternative 1/No Action

As Alternative 1/No Action will maintain existing management areas and fishing restrictions, new or additional interaction risks to Atlantic sturgeon are not expected. As a result, interactions with Atlantic sturgeon are not expected to go above levels observed and considered by NMFS in its assessment of fishery interaction risks to this species (NMFS 2012a; NMFS 2013, NMFS

2014a) and therefore, impacts to Atlantic sturgeon from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2-10, Alternative 1 will have slightly negative impacts to Atlantic sturgeon as it does not afford any potential positive impacts to Atlantic sturgeon that are provided under Alternatives 2-10 (for further rationale see Alternative 2 and Alternatives 3-10 sections).

5.1.4.3.2 Alternative 2

Alternative 2 will remove the existing Closed Area I and Closed Area II groundfish and habitat closures, which has the potential to change patterns of fishing effort. Specifically, in terms of gear at greatest risk of interacting with Atlantic sturgeon, opening the closed areas has the potential to change patterns of bottom trawl effort. Two scenarios are possible: (1) existing vessels shift into the now open areas, resulting in a more widespread distribution of effort, but not a change in the quantity of effort in the sub-region; and/or (2) bottom trawl effort from surrounding sub-regions may move onto Georges Bank, resulting in more gear fished on Georges Bank.

Under the first scenario, if effort is redistributed but does not increase on Georges Bank, impacts to sea turtles are not expected to be any greater than those experienced under existing management areas and fishing restrictions. As described above, over the last 25 years, observed Atlantic sturgeon interactions with bottom trawl gear are non-existent on Georges Bank and thus, there is no information to suggest that bycatch rates within Closed Area I or Closed Area II are higher than areas immediately adjacent to those closures. As such, if effort is simply redistributed from outside the areas to within, there is no reason to expect increased interactions. Further, as described above, Atlantic sturgeon generally occur inshore of the 50 meter depth contour. Combining these two factors, the co-occurrence between gear and Atlantic sturgeon is expected to remain infrequent. Therefore, if trawl effort on Georges Bank does not increase, but is merely redistributed, impacts to Atlantic sturgeon could range from slightly negative to neutral.

Under the second scenario, vessels from the Great South Channel/Southern New England, Gulf of Maine, or the Mid-Atlantic could shift effort onto Georges Bank to take advantage of newly accessible fishing grounds, resulting in an increase in the number of bottom trawls towed in this sub-region. Even if trawl effort on Georges Bank increases, interactions with Atlantic sturgeon would likely remain rare, given the lack on interaction history and their generally inshore distribution, such that impacts would remain slightly negative to neutral. If opening the closed areas on Georges Bank causes effort to shift effort away from inshore waters, and therefore away from areas where Atlantic sturgeon primarily occur and are bycaught, impacts could be slightly postive (NMFS NEFSC FSB 2015; Stein et al. 2004 a,b; Erickson et al. 2011; Dunton et al. 2010). The likelihood of effort shifts will be influenced by the status of target stocks.

Based on the information and associated analysis provided above, the impacts of Alternative 2 to Atlantic sturgeon will be dependent on how fishing behavior in Georges Bank and surrounding sub-regions reacts to opening the Georges Bank closed areas. However, given the historic lack of sturgeon interactions on Georges Bank, any negative or positive impacts will be slight in magnitude. Combining both scenarios described above, impacts to Atlantic sturgeon from Alternative 2 will likely range from slightly negative to slightly positive. Relative to Alternative

1, Alternative 2 is expected to have neutral to slightly positive impacts to Atlantic sturgeon. Relative to Alternatives 3-10, Alternative 2 is expected to have neutral impacts on Atlantic sturgeon.

5.1.4.3.3 Alternatives 3-10

Under Alternatives 3-10, the Closed Area I and Closed Area II habitat and groundfish closures will be removed, and various new HMAs are proposed on Georges Bank. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; fixed or pelagic gear could be used in any of the proposed HMAs with no restrictions. Shifts in trawl gear effort are described in section 5.1.4.1.3. For all alternatives, potential shifts in effort on Georges Bank are not expected to be any greater than changes that described under Alternative 2. As a result, impacts to Atlantic sturgeon from any of Alternatives 3-10 should be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3-10 are expected to have neutral to slightly positive impacts to Atlantic sturgeon, while Relative to Alternative 2, Alternatives 3-10 are expected to have nuetral impacts to Atlantic sturgeon. Relative to each other, Alternatives 3, 4, 5, 6, 7, 8, 9, or 10 would result in neutral impacts to Atlantic sturgeon as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to Atlantic sturgeon.

5.1.4.4 ***Impacts to Atlantic salmon***

As summarized in Volume 1, section 4.8.2.6, Atlantic salmon could potentially occur on Georges Bank, and they are known to make marine migrations across the Gulf of Maine to Canadian waters (Kocik et al. 2014; NMFS and USFWS 2005; Fay et al. 2006). However, to date, NEFOP and ASM have only documented a total of 15 individual salmon incidentally caught on over 60,000 observed commercial fishing trips from 1989 through August 2013 (NMFS 2013; Kocik et al. 2014), and only two of these interactions occurred in the Georges Bank sub-region. As a result, there appears to be very low co-occurrence between Atlantic salmon and fisheries operating in Georges Bank. As a result, the impacts of any of the alternatives proposed for the Georges Bank sub-region are expected to be slight.

Of the gear types potentially used in Georges Bank, bottom trawl gear poses the greatest interaction riskto Atlantic salmon (NMFS NEFSC FSB 2015; NMFS 2013; Kocik et al. 2014; see Volume 1, section 4.8.3.4). Interactions with other gear types used in the area (traps, scallop dredges) are rare to non-existent for this species (NMFS NEFSC FSB 2015; NMFS 2013; Kocik et al. 2014; see Volume 1, section 4.8.3.4) and therefore, do not pose a serious interaction risk to Atlantic salmon. Therefore, these latter gear types will not be considered further as impacts of traps or scallop dredges are expected to be negligible, regardless of alternative.

5.1.4.4.1 Alternative 1/No Action

As Alternative 1 will maintain existing management areas and fishing restrictions, so new or additional interaction risks to Atlantic salmon are not expected. As a result, interactions with Atlantic salmon are not expected to go above and beyond that which has been observed and considered by NMFS in its assessment of fishery interaction risks to this species (NMFS 2012a; NMFS 2013, NMFS 2014a) and therefore, impacts to Atlantic salmon from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2-10, Alternative 1 will have slightly negative impacts to Atlantic salmon as it does not afford any potential positive impacts to Atlantic salmon that are provided under Alternatives 2-10 (for further rationale see Alternative 2 and Alternatives 3-10 sections).

5.1.4.4.2 Alternative 2

Alternative 2 will remove the existing Closed Area I and Closed Area II groundfish and habitat closures, which has the potential to change patterns of fishing effort. Specifically, in terms of gear at greatest risk of interacting with Atlantic salmon, opening the closed areas has the potential to change patterns of bottom trawl effort. Two scenarios are possible: (1) existing vessels shift into the now open areas, resulting in a more widespread distribution of effort, but not a change in the quantity of effort in the sub-region; and/or (2) bottom trawl effort from surrounding sub-regions may move onto Georges Bank, resulting in more gear fished on Georges Bank.

Under the first scenario, impacts to Atlantic salmon are not expected to change significantly from status quo conditions, because interactions between fishing activities and Atlantic salmon on Georges Bank are already extremely rare. Under the second scenario, if fishing effort redistributes from areas with higher rates of interaction with Atlantic salmon (i.e. the coastal Gulf of Maine), there could be slight positive impacts on the stock. However, fishery interactions in the Gulf of Maine are also extremely rare, such that any increases in negative impacts from effort redistribution are likely to be slight. Overall, removing area closures on Georges Bank will likely have slightly negative to slightly positive impacts on Atlantic salmon. Relative to Alternative 1, Alternative 2 is expected to have neutral to slightly positive impacts to Atlantic salmon. Relative to Alternatives 3-10, Alternative 2 is expected to have neutral impacts on Atlantic salmon.

5.1.4.4.3 Alternatives 3-10

Under Alternatives 3-10, the Closed Area I and Closed Area II habitat and groundfish closures will be removed, and various new HMAs are proposed on Georges Bank. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; fixed or pelagic gear could be used in any of the proposed HMAs with no restrictions. Shifts in trawl gear effort are described in section 5.1.4.1.3. For all alternatives, potential shifts in effort on Georges Bank are not expected to be any greater than changes that described under Alternative 2. As a result, impacts to Atlantic salmon from any of Alternatives 3-10 should be similar to those described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3-10 are expected to have neutral to slightly positive impacts to Atlantic salmon, while relative to Alternative 2, Alternatives 3-10 are expected to have nuetral impacts to Atlantic salmon. Relative to each other, Alternatives 3, 4, 5, 6, 7, 8, 9, or 10 would result in neutral impacts to Atlantic salmon as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to Atlantic salmon.

5.1.5 Great South Channel/Southern New England

There are six habitat management alternatives for the Georges Bank sub-region: (1) no action Nantucket Lightship Habitat Closure Area and Groundfish Closed Area, (2) no HMAs, (3) Great South Channel East HMA and Cox Ledge HMA, (4) Great South Channel HMA and Cox Ledge HMA, and (5) Nantucket Shoals HMA and Cox Ledge HMA, and (6) Nantucket Shoals West MBTG HMA as a mobile bottom-tending gear closure and Great South Channel Gear Modification Area. Any areas in Alternatives 3, 4, or 5 could have any of the options applied to them. The Council's preferred alternative is to designate the Cox Ledge HMA as a closure to hydraulic dredges, and an area where trawls would not be allowed to use groundcables. In addition, the Council recommends designation of the Great South Channel HMA, with a complete restriction on mobile bottom-tending gears in the northeastern corner, and temporary, one year exemption for hydraulic clam dredges in the rest of the area.

5.1.5.1 *Impacts to marine mammals*

ESA and non-ESA listed species of marine mammals are known to occur in waters of the Great South Channel/Southern New England sub-region (Waring et al. 2014; Waring et al. 2015). Of the gear types potentially used in this sub-region, gillnets and bottom trawls pose the greatest risk of serious injury and mortality to small cetaceans and pinnipeds, while gillnets and traps pose the greatest serious injury and mortality risk to large whales (Waring et al. 2014; Waring et al. 2015; Johnson et al. 2005; NMFS 2014a,c; Kenney and Hartley 2001; Hartley et al. 2003; Whittingham et al. 2005a,b; See Volume 1, section 4.8.3.1). Marine mammals are not known to be vulnerable to interactions with hydraulic clam dredges and scallop dredges (Waring et al. 2014; Waring et al. 2015, Volume 1, section 4.8.3.1). Therefore, these latter gears type will not be considered further as impacts of clam or scallop dredges to marine mammals are expected to be negligible, regardless of alternative.

In regards to small cetaceans and pinnipeds, based on over 10 years of observer data, a high number of interactions with gillnet gear have been observed in the Great South Channel/Southern New England sub-region, specifically in the nearshore waters of the Great South Channel and along the western and southwestern boundary of the Nantucket Lightship Closed Area (Waring et al. 2014; Waring et al. 2015; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html;www.nefsc.noaa.gov/fsb/take_reports/asm.html). Observed gillnet interactions in these location have primarily been with harbor porpoises, gray seals, and harbor seals (Waring et al. 2014; Waring et al. 2015). Based on the very few observed interactions between bottom trawls and small cetaceans or pinnipeds over the last 10 years, such interactions are likely to be rare in this sub-region (Waring et al. 2014, Waring et al. 2015; http://www.nefsc.noaa.gov/fsb/take_reports/nefop.html; www.nefsc.noaa.gov/fsb/take_reports/asm.html).

Traps and gillnets co-occur with large whales in the Great South Channel/Southern New England subregion, and therefore, interaction risks are present (NMFS 2014a,c; Waring et al. 2014; Waring et al. 2015; see http://www.greateratlantic.fisheries.noaa.gov/Protected/whaletrp/). However, delineating particular sub-regions of the Northwest Atlantic as having high or low incidences of large whale entanglements is not possible at this time. Although large whale entanglements are reported, and databases exist on these entanglements, the first sighting of a large whale entanglement does not necessarily equate to the origin of the entanglement as the animal often travels some distance before the discovery of the incident.

5.1.5.1.1 Alternative 1/No Action

Alternative 1 would retain the existing Nantucket Lightship Closed Area and Habitat Closure Area. As Alternative 1 will maintain existing management areas and fishing restrictions, new or additional interaction risks to marine mammals are not expected. As a result, interactions with marine mammals are not expected to go above and beyond levels that have been previously observed and considered by NMFS in its assessment of fishery interaction risks to marine mammals (Waring et al. 2014; Waring et al. 2015; NMFS 2002; NMFS 2012a; NMFS 2013, NMFS 2014a). Therefore, impacts to marine mammals from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2-6, Alternative 1 will have slightly negative impacts to marine mammals as it does not afford any potential positive impacts to marine mammals that are provided under Alternatives 2-6 (for further rationale see Alternative 2 and Alternatives 3-6 sections).

5.1.5.1.2 Alternative 2

Alternative 2 would remove the existing Nantucket Lightship Closed Area and Habitat Closure Area. Removing these areas may change patterns of fishing activity in the Great South Channel sub-region. Specifically, in terms of gear at greatest risk of interacting with marine mammals, changes in the distribution of gillnet and bottom trawl gear are expected. Two scenarios are possible: (1) Existing bottom trawl or gillnet vessels shift their effort into the reopened areas, but there is no net increase in effort within the sub-region, or (2) gillnet or bottom trawl vessels shift effort from surrounding sub-regions into the reopened areas, resulting in a net increase in effort in the Great South Channel/Southern New England sub-region and a corresponding decrease elsewhere. Changes in trap gear distributions are not expected as traps are already permitted within the closed areas. Therefore, no changes in trap-related impacts to marine mammals are expected as a result of Alternative 2.

Under the first scenario, impacts to marine mammal are not expected to be any greater than those experienced under status quo conditions, and in fact, there may be slightly positive impacts. Specifically, opening the Nantucket Lightship Closed Area closed area is likely to result in existing vessels shifting effort, and thus gear, into waters in and around the Nantucket Lightship Closed Area. As described above, gillnet gear is currently concentrated in the nearshore waters of the Great South Channel and along the western and southwestern boundary of the Nantucket Lightship Closed Area, which creates an elevated risk of entanglement for all protected species as it is difficult for animals to move through the area without encountering gear. Opening the Nantucket Lightship Closed Area will likely shift some effort into the opened area, dispersing gear that once was concentrated along the closed area border. This will remove barriers to movement and therefore interactions with marine mammals are likely to decrease. Under the second scenario, impacts to marine mammals could be slightly negative if effort shifts from regions of lower marine mammal interactions into this sub-region where encounters are more frequent. Depending on the overall health of fish stocks and resultant fishery allocations, opening a closed areas may not provide incentive for existing vessels to change fishing behavior in the sub-region. Thus, it is possible that impacts would be closer to those associated with Alternative 1/No Action (i.e. slightly negative to neutral) if patterns of effort remain stable.

Overall, the impacts of Alternative 2 to marine mammals will be highly dependent on how fishing behavior in the Great South Channel/Southern New England sub-region and surrounding sub-regions reacts to opening of the Nantucket Lightship Closed Area and Nantucket Lightship Habitat Closed Area. However, it is important to note that the currently designated closed areas were not created to protect marine mammals, so removing these areas does not equate to the removal of marine mammal protected areas designated per the Marine Mammal Protection Act. Measures to reduce marine mammal gear interactions, and thus, reduce incidences of serious injury and mortality to these species have been established under the Marine Mammal Protection Act's HPTRP and ALWTRP. Although the management areas and regulations of the HPTRP and ALWTRP overlap with many designated habitat and groundfish closure areas, they were not predicated on these closures and stand on their own. Further, although the HPTRP and ALWTRP are specific to particular marine mammal species, their purpose and associated regulations have indirect benefits to other marine mammal species that co-occur with those marine mammal species identified in their plans. As a result, regardless of the whether the existing groundfish and habitat remain in existence, HPTRP and ALWTRP areas will remain on Georges Bank. In addition, voluntary measures to reduce the incidental capture of marine mammals in trawl gear are provided by the Atlantic Trawl Gear Take Reduction Strategy (http://www.greateratlantic.fisheries.noaa.gov/Protected/mmp/atgtrp/). Considering complementary HPTRP and ALWTRP measures, the analysis above, and the best available information, the impacts of Alternative 2 on marine mammals may range from slightly negative to slightly positive. Relative to Alternative 1, Alternative 2 is expected to have neutral to slightly positive impacts to marine mammals. Relative to Alternatives 3-6, Alternative 2 is expected to have neutral impacts on marine mammals.

5.1.5.1.3 Alternatives 3-6

Under Alternatives 3-6, the Nantucket Lightship Closed Area and Habitat Closure will be removed, and various new HMAs are proposed. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; all other fixed or pelagic gear could be placed or used in any of the proposed HMAs with no restrictions. Potential shifts in effort are not expected to be any greater than that described under Alternative 2. Therefore, impacts to marine mammals from any of the alternatives should be similar to those described for Alternative 2, slightly negative to slightly positive. Relative to Alternative 1, Alternatives 3-6 are expected to have neutral to slightly positive impacts to marine mammals, while relative to Alternative 2, Alternatives 3-6 are expected to have neutral impacts to marine mammals. Relative to each other, Alternatives 3, 4, 5, or 6 would result in neutral impacts to marine mammals as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to marine mammals.

5.1.5.2 *Impacts to sea turtles*

Seasonally, hard-shelled and leatherback sea turtles are known to occur in the Great South Channel/Southern New England sub-region (Blumenthal et al. 2006; Braun and Epperly 1996; Braun-McNeill and Epperly 2002; Braun-McNeill et al. 2008; Epperly et al. 1995a,b; Dodge et al. 2014; Dodge et al. 2015; Griffin et al. 2013; Hawkes et al. 2006; Hawkes et al. 2011; James et al. 2005; James et al. 2006; Mansfield et al. 2009; McClellan and Read 2007; Mitchell et al.

2003; TEWG 2009; Morreale and Standora 2005; Mitchell et al. 2003; Morreale and Standora 2005; Murphy et al. 2006; NMFS and USFWS 1991,1992, 1998a,b;2008; Shoop and Kenney 1992; TEWG 2009; http://seamap.env.duke.edu/). However, the occurrence and distribution of sea turtles in this sub-region does vary by species. Relative to Mid-Atlantic shelf waters (primarily between 37° N and 40° N), encounter rates of hard shelled sea turtles are lower in the Great South Channel/Southern New England sub-region (Murray and Orphanidies 2013; http://seamap.env.duke.edu/). Leatherback sea turtles are commonly found in this sub-region. Based on tagging, entanglement, and observation data, they occur primiarily in and around nearshore waters of the Great South Channel, southern Massachusetts (i.e., Buzzards Bay, Nantucket and Vineyard Sound, nearshore waters off the southern Massachusetts mainland), and in waters west of these areas (Dodge et al. 2014; Dodge et al. 2015; STDN 2014; http://seamap.env.duke.edu/).

The predominant gear types used in the Great South Channel/Southern New England sub-region include hydraulic clam dredges, scallop dredges, gillnets, and to a lesser extent bottom trawl and trap gear. Of these gear types, scallop dredge, gillnet, trap, and bottom trawl gear pose an interaction risk to hard-shelled sea turtles, while gillnet, trap, and bottom trawl gear pose an interaction risk to leatherback sea turtles (NMFS NEFSC FSB 2015; Murray and Orphanides 2013; Murray 2011, 2013, 2015a,b; Warden 2011; NMFS 2013; NMFS 2012a; see Volume 1, section 4.8.3.2). Hard shelled sea turtle interactions with gillnet, bottom trawl, and scallop dredge gear primarily occur south of approximately 42° N and west of 71° W (NMFS NEFSC FSB 2015; Murray and Orphanides 2013; Murray 2011, 2013, 2015a,b; Warden 2011; NMFS 2013; NMFS 2012a). Reported leatherback entanglements in fixed fishing gear are commonly reported in Southern New England, although observed interactions with other fishing gear types (e.g., bottom trawl) are rare in this sub-region (i.e., only one interaction over 25 years NMFS NEFSC FSB 2015; STDN 2014). Additionally, no interactions have been observed/reported in or around the boundary of the Nantucket Lightship Closed Area (NMFS NEFSC FSB 2015; STDN 2014). To date, sea turtle interactions with hydraulic clam dredge gear have never been observed (NMFS NEFSC FSB 2015). As a result, this latter gear type will not be discussed further as any potential impacts, regardless of alternative, are expected to be negligible.

5.1.5.2.1 Alternative 1/No Action

As Alternative 1 will maintain existing management areas and fishing restrictions, new or additional interaction risks to sea turtles are not expected. As a result, interactions with sea turtles are not expected to go above and beyond those previously observed and considered by NMFS in its assessment of fishery interaction risks to sea turtles (NMFS 2002; NMFS 2012a; NMFS 2013, NMFS 2014a) and therefore, impacts to sea turtles from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2-6, Alternative 1 will have slightly negative impacts to sea turtles as it does not afford any potential positive impacts to sea turtles that are provided under Alternatives 2-6 (for further rationale see Alternative 2 and Alternatives 3-6 sections).

5.1.5.2.2 Alternative 2

Alternative 2 would remove the existing Nantucket Lightship Closed Area and Habitat Closure Area. Removing these areas may change patterns of fishing activity in the Great South Channel sub-region. Specifically, in terms of gear at greatest risk of interacting with sea turtles, opening the closed areas has the potential to change patterns of gillnet, scallop dredge, and bottom trawl effort in this sub-region. Two scenarios are possible: (1) Existing bottom trawl, scallop dredge, or gillnet vessels shift their effort into the reopened areas, but there is no net increase in effort within the sub-region, or (2) gillnet, scallop dredge, or bottom trawl vessels shift effort from surrounding sub-regions into the reopened areas, resulting in a net increase in effort in the Great South Channel/Southern New England sub-region and a corresponding decrease elsewhere. Changes in trap gear distributions are not expected as traps are already permitted within the closed areas. Therefore, no changes in trap-related impacts to sea turtles are expected as a result of Alternative 2.

Under the first scenario, impacts to sea turtles are not expected to be any greater than those experienced under status quo conditions. For all sea turtle species, no interactions with fishing gear have been observed in and around the Nantucket Lightship Closed Area. As a result, there is no information to suggest that bycatch rates within the closed area are higher than areas immediately adjacent to the closure. As such, if effort is simply redistributed from outside the area to within, there is no reason to expect impacts to sea turtles to increase. Further, gillnet gear is concentrated along the western and southwestern boundary of the Nantucket Lightship Closed Area. Currently, this creates an elevated risk of entanglement to all protected species including turtles. If gear is dispersed, a barrier to movement without incidence of entanglement has been eliminated and therefore, interaction risks to sea turtles have the potential to decrease, affording slightly positive impacts to the species.

Under the second scenario, vessels from the Gulf of Maine, Georges Bank, or even the Mid-Atlantic could shift effort into the Great South Channel/Southern New England sub-region to take advantage of newly accessible fishing grounds, resulting in an increase in the number of bottom trawls, scallop dredges, and/or gillnets towed or set in this sub-region. Although interactions with sea turtles occurring in the Great South Channel/Southern New England sub-region have the potential to increase, any potential increase in interactions is not expected to be significant relative to current conditions. This is due to: (1) the low overlap of fishing ffort and sea turtle distribution that has been observed in this sub-region, relative to the Mid-Atlantic, over the last 25 years; (2) the lack of observed sea turtles interactions with fishing gear in and around Nantucket Lightship Closed Area specifically; and (3) the fact that the distribution and occurrence of sea turtles are not expected to change substantially in the area identified as the Great South Channel/Southern New England sub-region in the near term. Therefore, interaction rates are not expected to go above and beyond levels that have been previously observed in this sub-region and thus, impacts to are expected to be slightly negative to neutral. If effort shifts from the Mid-Atlantic in particular, this could have slight positive impacts for hard-shelled sea turtles. Relative to Southern New England, Georges Bank, and Gulf of Maine sub-regions, the Mid-Atlantic has the highest incidence of observed hard-shelled sea turtle interactions with fishing gear (NMFS NEFSC FSB 2015). Any incentive for Mid-Atlantic vessels to shift effort outside of this sub-region equates to fishing effort shifting gear our of an area with high interaction risks to an area with low interaction risks. Although any shifts in fishing location from a higher bycatch area to a lower bycatch area would not eliminate takes of sea turtles, some reduction in overall bycatch is possible. Similar slightly positive effects to leatherback sea turtles may be experienced if opening the Nantucket Lightship Closed Area results in effort shifting from nearshore/coastal waters of Southern New England where reported entanglement of leatherback sea turtles are high (i.e., Buzzards Bay, Nantucket and Vineyard Sound, nearshore waters off the Southern Massachusetts mainland), to the Nantucket Lightship Closed Area, where no interactions have been observed to date with this species. Of course, shifts in effort will depend on target stock allocations in this sub-region compared to others, among other factors that drive the distribution of fishing effort.

In summary, the impacts of Alternative 2 to sea turtles will be highly dependent on how fishing behavior in the Great South Channel/Southern New England sub-region and surrounding sub-regions reacts to opening existing closed areas. While such changes are difficult to forecast, the range of impacts is likely slightly negative to slightly positive. Relative to Alternative 1, Alternative 2 is expected to have neutral to slightly positive impacts to sea turtles. Relative to Alternatives 3-6, Alternative 2 is expected to have neutral impacts on sea turtles.

5.1.5.2.3 Alternatives 3-6

Under Alternatives 3-6, the existing Nantucket Lightship Closed Area and Habitat Closure Area will be removed, and various new HMAs will be implemented. New HMAs are proposed on Cox Ledge for all alternatives, and in various overlapping locations generally located north and east of the existing closures, i.e. on Nantucket Shoals and in the hard bottom habitats west of the Great South Channel. Areas would either restrict all mobile bottom-tending gears or just a subset of those gears. The preferred alternative (Alternative 4) will exempt clam dredges from much of the proposed Great South Channel HMA for a one-year period, but otherwise the proposed area would be closed to mobile bottom-tending gears. For the Cox Ledge HMA, the preferred alternative would prohibit clam dredges and allow trawls but only if they fish without ground cables.

As noted above, the mobile bottom-tending gears in this sub-region that pose the greatest interaction risk to sea turtles are scallop dredges and bottom trawls. As a result, each of these alternatives, through their resultant impact on scallop dredge or bottom trawl effort, has the potential to affect sea turtles in the sub-region. In terms of scallop dredging effort, major changes in effort from status quo conditions are not expected, because much of the scallop biomass in the Nantucket Lightship Closed Area is already fished via an access fishery. However, there are currently small scallops in the habitat closure portion of the Nantucket Lightship, so some effort will shift into that area over the medium term as these scallops begin to recruit to the fishery, under any of Alternatives 3-6. These shifts may be transient as scallop recruitment within this part of the existing Nantucket Lightship Closed Area is more typically low, relative to other locaitons. Alternative 3 is the only alternative in this sub-region that overlaps a substantial amount of scallop biomass in areas west of the Great South Channel. This is an important fishing area for both day (limited access general category) and trip (limited access) vessels. Therefore, Alternative 3, which is not preferred, could shift some scallop effort out of this sub-region and onto Georges Bank or into the Mid-Atlantic. Shifting scallop effort to the Mid-Atlantic could have slight negative impacts on sea turtles.

Bottom trawl gear is prohibited in the existing management areas, and would be prohibited or restricted in any of the new HMAs. Some shifts in the distribution of bottom trawl gear are likely under any of the proposed alternatives, including the preferred alternative, Alternative 4. Stock conditions (for example in the Southern New England winter flounder stock) may have a larger effect on the distribution of groundfish effort than any changes in area management. Substantial changes in the magnitude of trawl effort are not expected.

Gillnet vessels would be allowed in the reopened Nantucket Lightship Closed Area under any of these alternatives. It is difficult to forcast how effort with this gear type might shift, but it is likely that the gear would be less densely concentrated once the area reopens. Substantial changes in the magnitude of gillnet effort are not expected.

Overall, the co-occurrence of scallop dredge, bottom trawl, or gillnet gear and sea turtles in this sub-region is not expected to change markedly relative to current conditions, and low rates of co-occurrence are expected to continue. As a result, interactions risks with these gear types in the Great South Channel/Southern New England sub-region are not expected to increase or change significantly from what has been observed in this sub-region to date (Murray and Orphanides 2013; NMFS NEFSC FSB 2015). In general, shifts in effort are not expected to be any greater than those described under Alternative 2. As a result, impacts to sea turtles from any of Alternatives 3-6 should be within the range described for Alternative 2 (i.e., slightly negative to slightly positive). Relative to Alternative 1, Alternatives 3-6 are expected to have neutral to slightly positive impacts to sea turtles, while relative to Alternative 2, Alternatives 3-6 are expected to have nuetral impacts to sea turtles. Relative to each other, Alternatives 3, 4, 5, or 6 would result in neutral impacts to sea turtles as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to sea turtles.

5.1.5.3 *Impacts to Atlantic sturgeon*

As summarized in Volume 1, section 4.8.2.5, Atlantic sturgeon occur in the Great South Channel/Southern New England sub-region (ASSRT 2007). As decribed above, Atlantic sturgeon appear to primarily occur inshore of the 50 meter depth contour, but are not restricted to these depths and 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). Atlantic sturgeon are likely to be more common in the nearshore/coastal waters of the sub-region (inshore of the 50 meter depth contour), including within some of the proposed new HMAs, and less common in waters exceeding the 50 meter depth contour (e.g., waters in and around the Nantucket Lightship Closed Area). This is consistent with observed Atlantic sturgeon fishery interactions in this sub-region over the last 25 years (NMFS NEFSC FSB 2015).

Based on observed gear interactions, of the gear types potentially used in the Great South Channel/Southern New England sub-region, gillnet and bottom trawl gear pose the greatest interaction risk, and thus, incidence of serious injury and mortality to Atlantic sturgeon (NMFS NEFSC FSB 2015; NMFS 2013; see Volume 1, section 4.8.3.3). Interactions with other gear types used in the area (traps, clam dredges, scallop dredges) are rare to non-existent for this species (NMFS NEFSC FSB 2015; NMFS 2013; NMFS 2012a; see Volume 1, section 4.8.3.3) and therefore, do not pose a serious interaction risk to Atlantic sturgeon. These latter gear types will not be discussed further in the following impact analysis as any potential impacts with these gear types, regardless of alternative, are expected to be neutral.

5.1.5.3.1 Alternative 1/No Action

As Alternative 1 will maintain existing management areas and fishing restrictions, new or additional interaction risks to Atlantic sturgeon are not expected. As a result, interactions with Atlantic sturgeon are not expected to go above and beyond that which has been observed and considered by NMFS in its assessment of fishery interaction risks to this species (NMFS 2012a; NMFS 2013, NMFS 2014a) and therefore, impacts to Atlantic sturgeon from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2-6, Alternative 1 will have slightly negative impacts to Atlantic sturgeon as it does not afford any potential positive impacts to Atlantic sturgeon that are provided under Alternatives 2-6 (for further rationale see Alternative 2 and Alternatives 3-6 sections).

5.1.5.3.2 Alternative 2

Alternative 2 would remove the existing Nantucket Lightship Closed Area and Habitat Closure Area. Removing these areas may change patterns of fishing activity in the Great South Channel sub-region. Specifically, in terms of gear at greatest risk of interacting with Atlantic sturgeon, opening the closed areas has the potential to change gillnet and/or bottom trawl gear distribution and/or quantity in this sub-region. Potential changes in gillnet and bottom trawl activity are described under the Alternative 2 discussion for marine mammals (section 5.1.5.1.2). Potential impacts to sturgeon will be influenced by the degree to which the overall magnitude of effort remains constant, versus effort moving from this sub-region into other sub-regions, or from other sub-regions into this one. In addition, because sturgeon are primarily distributed nearer to shore in shallower waters, shifts in effort from inshore to offshore could reduce impacts on the species.

If the overall amount of gillnet and bottom trawl effort remains similar to current levels, impacts to Atlantic sturgeon are not expected to be any greater than those experienced under status quo conditions. Specifically, opening the Nantucket Lightship Closed Area closed area is likely to result in existing vessels shifting effort, and thus gear, into waters in and around the Nantucket Lightship Closed Area. Given the more offshore location of the existing closures, it is possible that removing these areas will shift the distribution of effort offshore, and away from areas with a higher potential for an interaction. Given an historic lack of sturgeon interactions in gillnet and bottom trawl gear in and near the Nantucket Lightship Closed Area, reopening the closure is not expected to result in impacts to Atlantic sturgeon that go above and beyond status quo conditions, and impacts could be positive relative to No Action.

Even if effort shifts into the sub-region from other locations, impacts to Atlantic sturgeon are not likely to increase, because any shift in effort from surrounding sub-regions that results from Alternative 2 is likely to be directed into waters in and around the Nantucket Lightship Closed Area and therefore, away from nearshore/coastal waters within the 50 meter depth contour where Atlantic sturgeon primarily occur and where interaction risks are therefore higher. Therefore, under an increased effort scenario, impacts to Atlantic sturgeon could also range from slightly negative to slightly positive.

Overall, impacts of Alternative 2 to Atlantic sturgeon will be highly dependent on how fishing behavior in the Great South Channel/Southern New England sub-region and surrounding sub-regions react to opening of the Closed Areas in this sub-region. While such shifts are difficult to predict, impacts should range from slightly negative to slightly positive. Relative to Alternative 1, Alternative 2 is expected to have neutral to slightly positive impacts to Atlantic sturgeon. Relative to Alternatives 3-6, Alternative 2 is expected to have neutral impacts on Atlantic sturgeon.

5.1.5.3.3 Alternatives 3-6

Under Alternatives 3-6, the Nantucket Lightship Closed Area and Habitat Closure will be removed, and various new HMAs are proposed. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; all other fixed or pelagic gear could be placed or used in any of the proposed HMAs with no restrictions. Given that the new management areas are closer to shore and in shallower waters than the existing closures, Alternatives 3-6 are likely to shift effort from inshore areas to offshore areas. However, the magnitude of this shift is probably limited, as there is limited bottom trawl and scallop dredge activity within the Great South Channel HMA (Alternative 4, which is preferred), Nantucket Shoals HMA (Alternative 5), and the Nantucket Shoals West HMA (Alternative 6). Effort shifts would be greater under Alternative 3 (Great South Channel East HMA), which overlaps more scallop dredge and bottom trawl effort along the eastern boundary. While clam dredges are used extensively in all four of the areas mentioned above, this gear does not pose an interaction risk for sturgeon. Overall, potential shifts in effort are not expected to differ substantially from Alternative 2, which would reopen existing areas without designating new ones. Therefore, impacts to Atlantic sturgeon from any of the alternatives should be similar to those described for Alternative 2, slightly negative to slightly positive. Relative to Alternative 1, Alternatives 3-6 are expected to have neutral to slightly positive impacts to Atlantic sturgeon, while relative to Alternative 2, Alternatives 3-6 are expected to have neutral impacts to Atlantic sturgeon. Relative to each other, Alternatives 3, 4, 5, or 6 would result in neutral impacts to Atlantic sturgeon as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to Atlantic sturgeon.

5.1.5.4 *Impacts to Atlantic salmon*

As summarized in Volume 1, section 4.8.2.6, Atlantic salmon are primarily found throughout the Gulf of Maine, but they may occur in the Great South Channel/Southern New England subregion, although such occurrences are likely rare (Kocik et al. 2014; NMFS and USFWS 2005; Fay et al. 2006). To date, NEFOP and ASM have only documented a total of 15 individual salmon incidentally caught on over 60,000 observed commercial fishing trips from 1989 through August 2013 (NMFS 2013; Kocik et al. 2014), with seven of these observed interactions in the Great South Channel/Southern New England sub-region. In short, the co-occurrence between Atlantic salmon and fisheries operating in the Southern New England sub-region is likely very infrequent.

Of the gear types potentially used in the Southern New England sub region, gillnet and bottom trawl gear pose the greatest interaction risk, and thus, incidence of serious injury and mortality, to Atlantic salmon (NMFS NEFSC FSB 2015; NMFS 2013; Kocik et al. 2014; see Volume 1, section 4.8.3.4). Interactions with other gear types used in the area (traps, clam dredges, scallop dredges) are non-existent for this species (NMFS NEFSC FSB 2015; NMFS 2013; Kocik et al. 2014; see Volume 1, section 4.8.3.4) and therefore, will not be considered further as impacts of traps, clam dredges, or scallop dredges to Atlantic salmon are expected to be negligible, regardless of alternative.

5.1.5.4.1 Alternative 1/No Action

As Alternative 1 will maintain existing management areas and fishing restrictions, new or additional interaction risks to Atlantic salmon are not expected. As a result, interactions with Atlantic salmon are not expected to go above and beyond that which has been observed and considered by NMFS in its assessment of fishery interaction risks to this species (NMFS 2002; NMFS 2012a; NMFS 2013, NMFS 2014). Therefore, impacts to Atlantic salmon from Alternative 1 are expected to be slightly negative to neutral. Relative to Alternatives 2-6, Alternative 1 is expected to result in neutral impacts to Atlantic salmon.

5.1.5.4.2 Alternative 2

Alternative 2 would remove the existing Nantucket Lightship Closed Area and Habitat Closure Area. Removing these areas may change patterns of fishing activity in the Great South Channel sub-region. Specifically, in terms of gear at greatest risk of interacting with Atlantic salmon, opening the closed areas has the potential to change gillnet and/or bottom trawl gear distribution and/or quantity in this sub-region. Potential changes in gillnet and bottom trawl activity are described under the Alternative 2 discussion for marine mammals (section 5.1.5.1.2). Potential impacts to salmon will be influenced by the degree to which the overall magnitude of effort remains constant, versus effort moving from this sub-region into other sub-regions, or from other sub-regions into this one.

If the overall amount of gillnet and bottom trawl effort remains similar to current levels, impacts to Atlantic salmon are not expected to be any greater than those experienced under status quo conditions. Specifically, opening the Nantucket Lightship Closed Area closed area is likely to result in existing vessels shifting effort, and thus gear, into waters in and around the Nantucket Lightship Closed Area. Given an historic lack of salmon interactions in gillnet and bottom trawl gear in and near the Nantucket Lightship Closed Area, reopening the closure is not expected to result in impacts to Atlantic salmon that go above and beyond status quo conditions. Even if effort shifts into the sub-region from other locations, impacts to Atlantic salmon are not likely to change from those under Alternative 1/No Action, because Atlantic salmon interactions within fishing gear in the Great South Channel/Southern New England sub-region have been very low over the last 25 years.

Overall, the impacts of Alternative 2 to Atlantic salmon will depend somewhat on how fishing behavior in the Great South Channel/Southern New England sub-region and surrounding sub-regions reacts to opening of the closed areas in this sub-region. But perhaps more importantly, interactions between Atlantic salmon and regional fisheries have been very low in the past, such that changes in spatial management are unlikely to materially affect the impact that fishing activies in this sub-region have on salmon. Therefore, impacts are expected to remain similar to Alternative 1 and therefore, may range from slightly negative to neutral. Relative to Alternatives 1 or 3-6, Alternative 2 is expected to result in neutral impacts to Atlantic salmon.

5.1.5.4.3 Alternatives 3-6

Under Alternatives 3-6, the Nantucket Lightship Closed Area and Habitat Closure will be removed, and various new HMAs are proposed. Options under these alternatives may place restrictions on the use of mobile bottom tending gear or require modifications to mobile bottom tending gear operating in the HMAs; all other fixed or pelagic gear could be placed or used in any of the proposed HMAs with no restrictions. Potential shifts in effort and the resultant distribution and quantity of gear in the Great South Channel/Southern New England sub-region is not expected to be any greater than that described under Alternative 2, under which there would be no year-round groundfish closed areas or HMAs. As a result, we expect impacts to Atlantic salmon from any of the Alternatives/options to be similar to those described for Alternative 2 (i.e., slightly negative to neutral). Relative to Alternatives 1 or 2, Alternatives 3-6 are expected to have neutral impacts to Atlantic salmon. Relative to each other, Alternatives 3, 4, 5, or 6 would also result in neutral impacts to Atlantic salmon as there is no information to demonstrate that one alternative might result in more positive or more negative impacts to Atlantic salmon.

5.2 Spawning protection alternatives

5.2.1 Gulf of Maine

Generally, the spawning alternatives prohibit the use of gear capable of catching groundfish, including trawls, gillnets, dredges, and, in some cases, hook and line.

5.2.1.1 *Alternative 1 (A and B)*

Alternative 1A (Regulatory No Action) includes year-round closure of the Cashes Ledge and Western Gulf of Maine closed areas, the Gulf of Maine Cod Protection Areas (implemented through groundfish FW53), the Gulf of Maine Cod Spawning Protection Area (commonly referred to as the “Whaleback” area) and the year-round Western Gulf of Maine and Cashes Ledge Closure Areas. Alternative 1B (Baseline No Action) includes year-round closure of the Cashes Ledge and Western Gulf of Maine closed areas, the sector and common pool rolling closures, and the Gulf of Maine Cod Spawning Protection Area (the “Whaleback” area).

Either Alternative has the potential to result in low negative to low positive impacts to protected species. As both alternatives essentially are describing the No Action, they both in essence are providing a depiction of status quo conditions, or least conditions in the fishery that have existed over the last several years. As provided in other sections of this document, NFMS has assessed fishery impacts to protected species over this timeframe (e.g., most recent marine mammal stock assessment report covers the period from 2008-2012 (Waring et al. 2015); NMFS Biological Opinion on the Multispecies and six other FMPS was issued in 2013 (NMFS 2013) and have determined that although interactions are occurring, they have not reached levels such that the continued existence of a species or population is jeopardized. As neither alternative is expected to change fishing operations in a manner above and beyond that which has been considered in terms of fishery impacts to protected species, impacts to protected species are also not expected to exceed a level that hasn’t been previously considered; however, this is not to say interactions won’t happen. Interactions are possible, they just are not expected to go above and beyond what has been observed and considered over the last several years during which the fishing operations considered in Alternative 1 A or 1B were in place. Based on this, impacts to protected species from either Alternative have to the potential to be low negative. However, as provided in groundfish FW 53, both Alternatives have the potential to result in low positive impacts to protected species. Cumulatively, the closures, whether year round or seasonally, in place in the GOM may result in reduced interaction by shifting gear out of areas with high incidences of interactions or by changing the quantity of gear present based on the overlap and time in which seasonal closures overalp with year round closures; additional details that support this rationale can be found in groundfish FW 53.

Based on the above, Alternatives 1A or 1B have the potential to result in low positive to low negative impacts to protected species. Alternative 1A, relative to 1B, has less of positive impact on protected species due to the reduction in seasonal rolling closures in the GOM and therefore, a "smaller" area in which areas could be closed and therefore, potentially reduce protected species interactions. Alternatives 1A or 1B, relative to Alternative 2, are expected to result in neutral to potentially more of positive impacts to protected species. Cumulatively, when the rolling closures are considered with the year round closures of the WGOM and Cashes Ledge closed areas, during periods of time in which rolling closures around the WGOM or Cashes Ledge closed areas are in place, a "larger" closed area is created (i.e., WGOM closed area + surrounding rolling closure blocks that overlap with or are near the WGOM closed area) which, in essence could provide more protection from gear interactions than it would absent the WGOM and Cashes Ledge Closed Areas. Relative to Alternative 3 and 4, Alternative 1A and 1B are expected to have neutral impacts on protected species (see below for details).

5.2.1.2 ***Alternative 2***

Alternative 2 will maintain the existing rolling closures that currently apply to sector enrolled vessels during April, May, and June for groundfish spawning protection purposes. These closed areas would apply from April to June to all vessels capable of catching groundfish, whether the vessel is in the common pool or enrolled in a sector, with possible exemptions as identified in the options below. This alternative would also designate the Massachusetts Bay Cod Spawning Protection Area and would be closed from November 1 through January 31 with the same restrictions as the GOM Cod Spawning Protection (Whaleback) Area. Under this alternative, the March-June common pool rolling closures would also be eliminated. In addition, the Western Gulf of Maine and the Cashes Ledge Closure Areas would also be eliminated unless maintained for habitat protection purposes. The Gulf of Maine Cod Spawning Protection (Whaleback) Area would be maintained as is, as well.

Impacts to protected species from Alternative 2 (and any of its options) are likely to range from low positive to low negative.[8] The rationale to support this conclusion is similar to that provided for Alternative 2 for each protected species, under section's WGOM and CGOM. Relative to Alternatives 1A,1B,3 or 4, Alternative 2 is likely to have neutral to more of a negative impact on protected species as cumulatively, the removal of the WGOM and Cashes Ledge year closed

[8] There are two sub-options under Alternative 2. As there is no information to demonstrate that one sub-option might result in more positive or more negative impacts to protected species, either option, relative to another, would result in neutral impacts to protected species.

areas, would remove the potential benefits of having a "larger" closed area that would result during periods of time in which the surrounding rolling closures are in place (i.e., WGOM closed area + surrounding rolling closure blocks that overlap with or are near the WGOM closed area). (see Alternative 1A or 1B above for details).

5.2.1.3 *Alternative 3*

Alternative 3 would designate the Massachusetts Bay Spawning Protection Area as described under Alternative 2A/2B. The Council's intent was that this designation could be combined with Alternative 1/No Action. The area would be closed to all fishing vessels from November 1 to January 31, with some exemptions. As this Alternative in essence is combined with Alternative 1/No Action, impacts to protected species are expected to similar to those provided above for this Alternative (i.e., low positive to low negative). Relative to Alternatives 1A, 1B, and 4, Alternative 3 is expected to have neutral impacts on protected species. Relative to Alternative 2, Alternative 3 is expected to result in neutral to more of a positive impact on protected species.

5.2.1.4 *Alternative 4*

Alternative 4 would close thirty-minute block 125 from April 15-April 30, with some exemptions. Alternative 4 is intended to be applied in conjunction with Alternative 1A (regulatory no action) and Alternative 3 (MA Bay Spawning Closure). Based in on this information, impacts to protected species are expected to be similar to thos provided in Alternative 1A and Alternative 3 (i.e., low positive to low negative). Relative to Alternatives 1A and 3, Alternative 4 is expected to have neutral impacts on protected species. Relative to Alternative 1B, Alternative 4 is likely to have more of a positive impact on protected species (see Alternative 1A/1B discussion above for rationale). Relative to Alternative 2, Alternative 4 is expected to result in neutral to more of a positive impact on protected species.

5.2.2 Georges Bank and Southern New England

5.2.2.1 *Alternative 1(No Action)*

Alternative 1 would retain the existing year round closed areas on Georges Bank and in southern New England, specifically Closed Area I, Closed Area II, the Nantucket Lightship Closed Area, and the Georges Bank Seasonal Closure Area. Impacts to protected species from Alternative 1 are likely to range from low negative to neutral. The rationale to support this conclusion is similar to that provided for Alternative 1 for each protected species, under sections 5.1.4 and 5.1.5. Relative to Alternatives 2 and 3, Alternative 1 is expected to have slightly negative impacts to protected species as it does not afford any potential positive impacts to species that are provided under Alternatives 2 and 3 (see below for details).

5.2.2.2 *Alternative 2*

Alternative 2 would retain as spawning closures Closed Area I and Closed Area II during the months of February, March, and the first half of April. The Nantucket Lightship Closed Area and the Georges Bank Seasonal Closure Area would be eliminated. The options consider closures to just commercial gears (Option A) or commercial and recreational or commercial and recreational gears (Option B).

Impacts to protected species from Alternative 2 (and either sub-option) are likely to range from low negative to low positive.[9] The rationale to support this conclusion is similar to that provided for Alternatives 2 (which consider removal of existing year round habitat and/or groundfish closed areas) and 3 (creating new HMAs) for each protected species, under section's 5.1.4 and 5.1.5. Relative to Alternatives 1, Alternative 2 is expected to have slightly more positive impacts to protected species. Relative to Alternative 3, Alternative 2 is expected to have neutral impacts on protected species.

5.2.2.3 *Alternative 3*

Alternative 3 would retain as spawning closures the northern part of Closed Area I and Closed Area II during the months of February, March, and the first half of April. The Nantucket Lightship Closed Area and the Georges Bank Seasonal Closure Area would be eliminated. The options consider closures to just commercial gears (Option A) or commercial and recreational gears (Option B).

Impacts to protected species from Alternative 3 (and either sub-option) are likely to range from low negative to low postive.[10] The rationale to support this conclusion is similar to that provided for Alternatives 2 (which consider removal of existing year round habitat and/or groundfish closed areas) and 3 (creating new HMAs) for each protected species, under section's 5.1.4 and 5.1.5. Relative to Alternatives 1, Alternative 3 is expected to have slightly more positive impacts to protected species. Relative to Alternative 2, Alternative 3 is expected to have neutral impacts on protected species.

5.3 Dedicated habitat research area alternatives

There are five alternatives considered in this section. Alternative 1/No Action would not implement any dedicated habitat research areas. Alternatives 2, 3, and 4 would implement DHRAs in Eastern Maine, Stellwagen Bank, and western Georges Bank, respectively. The DHRAs overlap areas and measures evaluated in the habitat management areas section of the amendment. Given that none of the alternatives will contribute any greater positive or negative impacts to protected species than those already considered within the context of the HMAs, impacts of any alternative in this section to protected species are expected to be within in the range of those provided in sections 5.1 and 5.2 above. Because Alternatives 2, 3, and 4 can be selected in any combination, comparisons between Alternatives 2, 3, and 4 are not meaningful outside of the cumulative effects context. Each alternative is, however, compared to not designating that DRHA, i.e. selecting Alternative 1/No Action. This section describes the changes in fishing privileges that would be associated with various HMA, spawning area, and DHRA combinations, and then assesses the impacts to protected resources of such changes, based on the conclusions provided in sections 5.1 and 5.2. Note that the more 'direct' impacts of

[9] There are two sub-options under Alternative 2. As there is no information to demonstrate that one sub-option might result in more positive or more negative impacts to protected species, either option, relative to another, would result in neutral impacts to protected species.

[10] There are two sub-options under Alternative 2. As there is no information to demonstrate that one sub-option might result in more positive or more negative impacts to protected species, either option, relative to another, would result in neutral impacts to protected species.

DHRAs related to development of projects that improve fisheries management are not expected to accrue to protected resources, as these species are not the target of the research agenda. Thus, all impacts discussed below are in relation to shifts in fishing effort that could have bycatch related impacts on protected species.

5.3.1 Alternative 1 (No Action)

If a DHRA is not selected in a particular sub-region, no changes to current fishing practices are expected beyond what would be expected from modifying the habitat and spawning management areas in that location. As a result, the impacts on protected resources would depend on the underlying habitat and spawning measures selected.

In the eastern Gulf of Maine, there are currently no habitat or groundfish management areas. Selecting No Action for DHRAs as well would continue with this status quo management approach, which is expected to result in slightly negative to neutral impacts on various types of protected resources as described in section 5.1.1. If an action alternative is selected for this location (EGOM Habitat Alternative 2 or 3) and fishing privileges are altered in the area overlapping the Eastern Maine DHRA (i.e. the Small Eastern Maine HMA), impacts are still expected to be slightly negative to neutral. The preferred habitat management alternative adopts the Small Eastern Maine HMA as a mobile bottom-tending gear closure. Selecting No Action for the DHRA in this sub-region, as is preferred, will not affect the impacts associated with the underlying habitat management alternative.

In the western Gulf of Maine, the area identified as the Stellwagen DHRA is currently managed as a closure to both mobile bottom-tending gears and gears capable of catching groundish, as is proposed for the DHRA. Thus, if No Action is continued in this sub-region, as is preferred, there is no additional impact on the distribution of fishing effort regardless of whether or not the DHRA is adopted. If any of Habitat Management Alternatives 2-6 were adopted (these are not preferred), selecting no action for the Stellwagen DHRA would have the effect of defaulting to the measures associated with the underlying habitat management areas. Combining No Action on the Stellwagen DHRA with Habitat Alternative 2, 3, 4, 5, or 6 and Spawning Alternative 2 would eliminate gillnet and longline restrictions currently in effect. As described in section 5.1.3, the effects of changing these fixed gear restrictions are uncertain, but in the worst case if substantial effort shifts into the western Gulf of Maine, effects on protected resources could be slightly negative. If effort shifts are more limited, impacts would be neutral relative to current conditions.

On Georges Bank, the area identified as the Georges Bank DHRA is currently managed as a closure to mobile bottom-tending gears, which would be continued if the DHRA was selected. Thus, if Habitat Alternative 1/No Action was selected in this sub-region, the selection of no action with respect to the Georges Bank DHRA would have no additional impact on the distribution of fishing effort. The impacts on protected resources of selecting no action for habitat and groundfish management in this sub-region are expected to be slightly negative to neutral as described in section 5.1.4. Under any combination of action alternatives for habitat or spawning (Habitat Alternative 10 and Spawning Alternatives 3A and 3C are preferred), the area of the Georges Bank DHRA would be open to fishing year-round. If the DHRA is not designated, the area of the DHRA would reopen to fishing, and impacts would be similar to Habitat Alternative 2 (slightly negative to slightly positive).

5.3.2 Alternative 2

Alternative 2, which is not preferred, would adopt the Eastern Maine DHRA as a mobile bottom-tending gear closure. This action would generate the same impacts as Alternatives 2 and 3 in the eastern Gulf of Maine sub-region, i.e. slightly negative to neutral across all protected resources.

5.3.3 Alternatives 3A, 3B, and 3C (3C Preferred)

Alternative 3, which is preferred (3C does not have a recreational closure reference area) would adopt the Stellwagen Bank DHRA. The DHRA regulations would maintain the existing restrictions on mobile and fixed gear within the southern portion of the existing Western Gulf of Maine Closure Area. This alternative would therefore generate the same impacts as western Gulf of Maine Alternative 1, i.e. slightly negative to neutral across all protected resources.

5.3.4 Alternative 4 (Preferred)

Alternative 4, which is preferred, would adopt the Georges Bank DHRA as a mobile bottom-tending gear closure, which would continue Georges Bank Alternative 1/No Action restrictions in one of five existing management areas. Georges Bank Habitat Alternative 1 is expected to have slightly negative to neutral impacts across all protected resources. The effects of DHRA Alternative 4 are likely to be slight, given that it only affects a subset of the No Action management areas on Georges Bank.

5.3.5 Alternative 5 (Preferred)

Alternative 5, which is preferred, would implement a sunset provision that lifts a DHRA designation if relevant research activity has not been conducted or planned. DHRAs would have a minimum duration of three years, after which the sunset could be triggered. Because this would eliminate the gear restrictions associated with the DHRA, impacts would likely be similar to DHRA No Action, i.e. slightly negative to slightly positive. However, because at minimum the designations would be lifted three years after implementation of the amendment, it is difficult to predict effects this far into the future.

6 Impacts of the framework adjustment and monitoring alternatives on all VECs

The following sections discuss the impacts of the two framework adjustment and monitoring alternatives on all valued ecosystem components. The impacts from Alternative 1 and 2 would not directly affect valued ecosystem components (fishery resources, protected species). This is because the process for making adjustments to the habitat management alternatives are administrative functions. The impacts from actionable changes to the habitat protection measures would be the same, regardless of the process utilized (i.e. framework or amendment). The changes themselves (i.e. modifications HMAs, spawning alternatives, DHRAs) would directly impact VECs, and these effects would be analyzed during the development of a frawework (or amendment) to modify habitat protection measures.

6.1 Alternative 1 (No Action)

Alternative 1/No Action would use existing ad hoc framework adjustment procedures scattered across five FMPs, each having a different set of specification on measures that may be adjusted. While the Council could initiate at any time one or more framework adjustment actions to evaluate the performance of habitat management and spawning protection areas, there would be no certainty about when such an action would be initiated. Also it would be unclear what information would be needed, how it would be evaluated, or how it would affect future management decisions.

Because it is not an ideal process for a coordinated review of management area performance, this alternative has indirect, moderately negative impacts on all managed species, including the large-mesh groundfish species for which some of the habitat management and all of the spawning management alternatives were designed. Alternative 1/No Action would also have moderately negative impacts on the physical and biological environment, including EFH and HAPCs, as coordinated review and improved data collection under Alternative 2 would best allow for the evaluation of tradeoffs between habitat protection, fish conservation, and economic and social issues. The resulting impacts are indirect, since the framework and monitoring alternatives are administrative in nature and intended to contribute to the overall efficiency of fisheries management.

Given that Alternative 1/No Action leads to uncertainty and management inefficiency, the indirect economic impact of this alternative is expected to be moderately negative. Social impacts associated with framework adjustments and monitoring are expected to be minor. The social impacts associated with Alternative 1 are expected to be negative as there would be no systematic process developed to review the effectiveness of spatial management measures. This may have moderately negative impacts on the *Attitudes and Beliefs* about management.

Alternative 1/No Action is expected to have neutral impacts on protected resources, when compared to the baseline environmental condition, as fishery management measures are generally not designed with protected resource conservation in mind, although impacts of fishery management actions on protected resources are analyzed as part of the NEPA process, and positive benefits for protected resources may occur incidental to fishery management benefits.

Protected resources management actions are developed via different management structures than fishery management actions.

6.2 Alternative 2 – Planned, strategic framework adjustment and monitoring (Preferred)

This alternative would establish a habitat management and spawning protection review and adjustment procedure that would have the following three elements:

- Specify additional spatial management measures as frameworkable in various Council FMPs,
- Develop a regular, strategic process to review the effectiveness of spatial management measures, and
- Define a series of research priorities related to the review and development of spatial management measures.

This new process would have several advantages over the existing ad hoc framework adjustment mechanism (Alternative 1/No Action). First, it would set up an expectation that after an appropriate period of time, the performance of habitat and spawning areas would be re-evaluated and adjustments would be made. It would also establish a consistent set of measures that could be adjusted by framework action in each FMP, making the process clearer. Third, and possibly most important, it would establish an understandable and more comprehensive performance monitoring program that researchers can use to address management priorities and more successfully seek funding for their related research.

Although a comprehensive spatial management performance review would take longer, during the first few years after implementation of this amendment the Council may learn new information to make mid-term adjustments as needed, while waiting for long enough to collect sufficient performance data to make more comprehensive changes and adjustments. This could include a better understanding of the linkage between habitat quality and stock or ecosystem productivity, enabling better general management of our fisheries.

As with Alternative 1/No Action, this alternative are likely to indirectly affect VECs analyzed in the EIS. Therefore, compared to Alternative 1/No Action, the impact from this alternative is likely to be moderately, indirectly positive on habitat and fishery productivity in the short term as preliminary information is gathered and analyzed, allowing for some mid-term ad hoc adjustments and better informed fisheries management decisions in general. In the long term, this alternative is likely to have highly positive, indirect impacts on both habitat and fishery productivity as better and more efficient conservations measures are identified and become effective. Because the many of the measures are directly focused on changes to the large-mesh groundfish fishery, the impacts to the other managed species, their EFH, and the human communities involved in those fisheries are likely to be slightly positive for those stocks whose life histories and preferred habitats are similar to large-mesh groundfish, and neutral for those species whose life histories and preferred habitats are unaffected by the habitat management alternatives implemented through this amendment.

The economic impacts of Alternative 2 are expected to be moderately, indirectly positive when compared to Alternative 1/No Action, both in the short and long run, due to increased management efficiency and positive benefits to groundfish stocks. The social impacts of Alternative 2 in comparison to Alternative 1/No Action are expected to be positive. There may be positive impacts on the *Attitudes and Beliefs* about management if there is a systematic process developed to review the effectiveness of spatial management measures.

As above, impacts on protected resources are expected to be neutral when compared to the baseline environmental condition.

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